Ice, Cloud, and Land Elevation Satellite

(ICESat-2) Project

Advanced Topographic Laser Altimeter System (ATLAS)

Component Environmental Requirements Document

ICESat-2-ATSYS-REQ-0517

Revision (A)

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National Aeronautics and Space Administration

CM FOREWORD

This document is an Ice, Cloud, and Land Elevation (ICESat-2) Project signature-controlled document. Changes to this document require prior approval of the applicable Product Design Lead (PDL) or designee. Proposed changes shall be submitted in the ICESat-2 Management Information System (MIS) via a Signature Controlled Request (SCoRe), along with supportive material justifying the proposed change.

In this document, a requirement is identified by “shall,” a good practice by “should,” permission by “may” or “can,” expectation by “will,” and descriptive material by “is.”

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CHANGE RECORD PAGE

Document Version	Document Release Date	SCoRe Number	SCoRe Approval Date	Pages Affected	Description
Rev -	09/24/10	0027	09/24/10	All	Initial release of baseline.
Rev A	11/16/10	0114	11/16/10	All	Updated for iSRR

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25	Section 3.8.2	**ERD23**: Venting analyses of all ATLAS components susceptible to pressure loading shall show positive margins of	Mission	PDR

Item No.	Location	Summary	Ind./ Org.	Due Date
		safety for ultimate and yield failures using the loads equal to twice those induced by the maximum pressure differential during launch (TBD) and the appropriate factor of safety specified below:		
26	Section 5.2.2.1	**ERD40**: All ATLAS components that contain power leads shall not malfunction or suffer degradation of performance when subjected to the following radiated test signals: 1. 20 V/m (TBR) 14 kHz to 30 GHz (TBR)	Missi on	PDR
27	Section 5.2.2.1	2. 30 V/m (TBR) 2287.5 ±5 MHz (spacecraft transmitter)	Missi on	PDR
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31	Section 5.2.2.1	6. 20 V/m (TBR) Frequency TBD C-band tracking radars.	Missi on	PDR
33	Section 6.3.1	**ERD41**: The maximum DC dipole moment produced by any ATLAS component shall not exceed 3.0 (TBD) Ampere per meter^2 (Am^2), dipole moment.	Missi on	PDR
34	Section 6.3.2	**ERD42**: All ATLAS components shall be exposed to a magnetic field environment of 650 microteslas or 6.24 Gauss without damage or degradation of performance. Rationale: The magnetic field specification ensures that ATLAS components are designed to operate in the magnetic environment generated by other ICESat-2 systems. Trace: IDD TBD	Missi on	PDR

1 GENERAL INFORMATION

1.1 PURPOSE AND SCOPE

This document provides specifications for the operating environment and requirements for the environmental verification program of components of the Ice, Cloud, and Land Elevation Satellite-2 (ICESAT-2) Advanced Topographic Laser Altimeter System (ATLAS) instrument. This document describes methods for implementing those requirements. It contains a baseline for demonstrating by test and analysis the satisfactory performance of hardware in the expected mission environments, and that minimum workmanship standards have been met. It elaborates on those requirements, gives test levels, provides guidance in the choice of test options, and describes acceptable test and analytical methods for implementing the requirements.

This document was adopted from the ICESAT-2 Environmental Description Document (EDD).

1.2 APPLICABILITY AND LIMITATION

These requirements apply to ATLAS component flight hardware and associated flight software that is to be launched on an Expendable Launch Vehicle (ELV).

1.3 DEFINITIONS

The following are definitions of flight hardware used in this document. These definitions are taken directly from GSFC-STD-7000, General Environmental Verification Standard (GEVS) for GSFC Flight Programs and Projects.

Component: A functional subdivision of a subsystem and generally a self-contained combination of items performing a function necessary for the subsystem's operation. Examples are electronic box, transmitter, gyro package, actuator, motor, battery. For the purposes of this document, "component" and "unit" are used interchangeably.

Instrument: A spacecraft subsystem consisting of sensors and associated hardware for making measurements or observations in space. For the purposes of this document, an instrument is considered a subsystem (of the spacecraft).

1.4 THE ATLAS COMPONENT VERIFICATION APPROACH

The ATLAS components will be verified under conditions that simulate the launch operations, flight operations and flight environment as realistically as possible.

Units powered on for launch, will be powered on and their performance monitored during test. However, it is recognized that there may be unavoidable exceptions, or conditions which make it preferable to perform the verification activities at other levels of assembly.

The total verification process also includes the development of models representing the hardware, tests to verify the adequacy of the models, analyses, alignments, calibrations, functional/performance tests to verify proper operation, and finally end-to-end tests and simulations to show that the total system will perform as specified.

1.5 RESPONSIBILITY FOR ADMINISTRATION

The responsibility and authority for decisions in waiving or deviating from the requirements of this document are subject to review and approval by the ATLAS Instrument Manager (IM).

1.6 CONFIGURATION CONTROL AND DISTRIBUTION

This document is controlled and maintained by the GSFC ICESAT-2 Project Office.

2 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents provide information Applicable (i.e., binding/required) to the ATLAS instrument. These documents are applicable in the sections referenced in the text of this document. Since these documents are subject to periodic revisions, the user should refer to the latest available version. In the event of a conflict between this document and the documents referenced herein, this document takes precedence. Contractors will use the current version in effect at the time of procurement.

1. GSFC-STD-1000-E, Goddard Space Flight Center Rules for the Design, Development, Verification, and Operation of Flight Systems
2. GSFC-STD-7000, General Environmental Verification Standard (GEVS) for GSFC Flight Programs and Projects
3. ICESat-2-ATPM-PLAN-0126, ATLAS Peer Review Plan
4. ICESat-2-ATSYS-PLAN-0297, ATLAS Contamination Control Plan
5. ICESat-2-ATSYS-REQ-0479, ATLAS Resource Allocations
6. ICESat2-SYS-PLAN-0210, ICESAT-2 Environmental Description Document (EDD)
7. ICESat-2-THM-IFACE-0214, ATLAS Thermal ICD
8. MIL-STD-461C Part 3, as amended by Notice 1
9. MIL-STD-462, as amended by Notice 1
10. NASA-STD-5001A, Structural Design and Test Factors of Safety for Space Flight Hardware

3 ATLAS COMPONENT REQUIREMENTS VERIFICATION MATRIX

ERD998: Each ATLAS component shall meet all applicable requirements contained within this document, the ATLAS Component Environmental Requirements Document (ICESat-2-ATSYS-REQ-0517).

Rationale: The ATLAS components need to demonstrate the ability to meet performance requirements for all mission environments to ensure a successful mission.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Components

Applicability: All ATLAS components

ERD999: Each ATLAS component shall provide a completed ATLAS Environmental Requirements Verification Matrix showing proof of compliance with each of the applicable requirements in is document, the ATLAS Component Environmental Requirements Document (ICESat-2-ATSYS-REQ-0517).

Rationale: The verification matrix easily demonstrates that each ATLAS component has met all applicable environmental requirements to ensure a successful mission.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Components

Applicability: All ATLAS components

4 MECHANICAL ENVIRONMENT AND VERIFICATION

All testing is to protoflight levels unless otherwise specified.

4.1 MASS PROPERTIES

4.1.1 Mass Properties Verification

ERD1: The weight of each ATLAS flight component shall be measured to within ± 0.2%.

Rationale: The ATLAS component weight measurement shows compliance with specified component requirements and provides accurate data for the observatory mass properties control program.

Trace:

1. EDD155 Section 4.1.4.3 Mass Properties Measurement
2. EDD249 Section 4.4.1.1 Mass Properties Measurement

ERD2: The center of gravity (CG) of each ATLAS flight component, referenced to the ATLAS to spacecraft mounting plane, shall be verified to within ± 0.15 centimeters (cm). The CG may be analytically derived.

Rationale: The ATLAS component CG measurement shows compliance with specified component requirements and provides accurate data for the observatory mass properties control program.

Trace:

1. EDD155 Section 4.1.4.3 Mass Properties Measurement
2. EDD322 Section 4.4.4.3 Mass Properties Measurement
3. EDD249 Section 4.4.1.1 Mass Properties Measurement
4. EDD334 Section 4.4.1.1 Mass Properties Measurement

ERD3: The moments of inertia (MOI) of each ATLAS flight component, referenced to the ATLAS to spacecraft mounting plane, shall be verified to within ± 1.5%. The MOI may be analytically derived.

Rationale: The ATLAS moments of inertia measurements shows compliance with specified ATLAS component requirements and provides accurate data for the observatory mass properties control program.

Trace:

5. EDD155 Section 4.1.4.3 Mass Properties Measurement
1. EDD249 Section 4.4.1.1 Mass Properties Measurement

4.2 FUNDAMENTAL FREQUENCY

4.2.1 Fundamental Frequency Specification

ERD4: The fundamental frequencies of the ATLAS components shall be greater than or equal to 100 Hertz (Hz).

Rationale: ATLAS component fundamental frequencies should avoid launch vehicle induced excitation frequencies.

Trace:

1. EDD93 Section 3.2.2 Fundamental Frequencies.

ERD5: Deleted.

ERD104: The fundamental frequency of the ATLAS structure, including mass simulators, shall be greater than or equal to 50 Hz.

Rationale: The ATLAS structure fundamental frequency should avoid launch vehicle induced excitation frequencies.

Trace:

1. EDD93 Section 3.2.2 Fundamental Frequencies.

4.2.2 Fundamental Frequency Testing

ERD6: Each ATLAS component shall undergo a low-level sine survey, also called a sine sweep to verify the modal frequencies of the component.

ATLAS components having mass less than 2 kg may supply analytically-derived frequencies.

Rationale: A low-level sine sweep determines the modal signature of the flight item which verifies compliance with fundamental frequency requirements.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Components
2. EDD93 Section 3.2.2 Fundamental Frequencies
3. EDD158 Section 4.1.4.6 Sine Survey
4. EDD248 Section 4.4.1 Required Tests

5. EDD254 Section 4.4.1.3 Sine Survey

Guideline test parameters are shown below.

1) Frequency: 5 – 2000 Hz
2) Acceleration: 0.25 g
3) Sweep Rate: 2 octaves/minute

ERD106: The assembled ATLAS structure, including mass simulators, shall undergo a low-level sine survey, also called a sine sweep to verify the modal frequencies.

Rationale: A low-level sine sweep determines the modal signature of the flight item which verifies compliance with fundamental frequency requirements.

Trace:

6. EDD89 Section 3.2 Instrument Suite and Components
7. EDD93 Section 3.2.2 Fundamental Frequencies
8. EDD158 Section 4.1.4.6 Sine Survey
9. EDD248 Section 4.4.1 Required Tests
10. EDD254 Section 4.4.1.3 Sine Survey

Guideline test parameters are shown below.

4) Frequency: 5 – 2000 Hz
5) Acceleration: 0.25 g
6) Sweep Rate: 2 octaves/minute

4.3 QUASI-STATIC LOADS

4.3.1 Quasi-Static Loads Analysis

ERD7: Structural analysis of ATLAS components shall show positive margins of safety (MS) for ultimate and yield failures verified by a detailed stress analysis that assesses all primary and secondary structure, joints, and fasteners for the limit loads defined in Figure 4-1 and the appropriate factor of safety specified below:

1. Metallic, Beryllium, Composite - Table 4.3-1
2. Glass - Table 4.3-2
3. Glass bonds – Table 4.3-3

Rationale: Quasi-static acceleration represents the combination of steady-state accelerations and the low frequency mechanically transmitted dynamic accelerations that occur during launch. The purpose of the structural analyses is to show compliance with the mechanical/structural design and test requirements.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component

2. EDD91 Section 3.2.1.1 Limit Loads
3. EDD92 Section 3.2.1.2 Factors of Safety
4. EDD146 Section 4.1.2.1 Mechanical Analyses

The margin of safety is defined as follows:

MS = {Allowable Stress (or Load) ÷ (Applied Limit Stress (or Load) x FS)} – 1

The limit loads used in the static analysis are defined in the mass-acceleration curve (MAC) shown in Figure 4-1. MAC loads are single axis loads that can occur in any direction relative to the ATLAS component.

The breakpoints for the MAC are given in Table 4.3-4. The design loads shown in the MAC will be updated based on the results of coupled loads analysis.

Table 4.3-1 - Flight Hardware Design/Analysis Factors of Safety Applied to Limit Loads for Non-glass and Non-pressurized ATLAS Components

Type	Static	Sine	Random/ Acoustic[1]
Metallic Yield	1.25	1.25	1.6
Metallic Ultimate	1.4	1.4	1.8
Stability Ultimate	1.4	1.4	1.8
Beryllium Yield	1.4	1.4	1.8
Beryllium Ultimate	1.6	1.6	2.0
Composite Ultimate	1.5	1.5	1.9
Bonded Inserts/Joints Ultimate	1.5	1.5	1.9

1. Factors shown should be applied to statistically derived peak response based on RMS level. As a minimum, the peak response will be calculated as a 3-sigma value.

Table 4.3-2 – Minimum Design and Test Factors for Glass

Source: NASA-STD-5001A Section 5.1.4

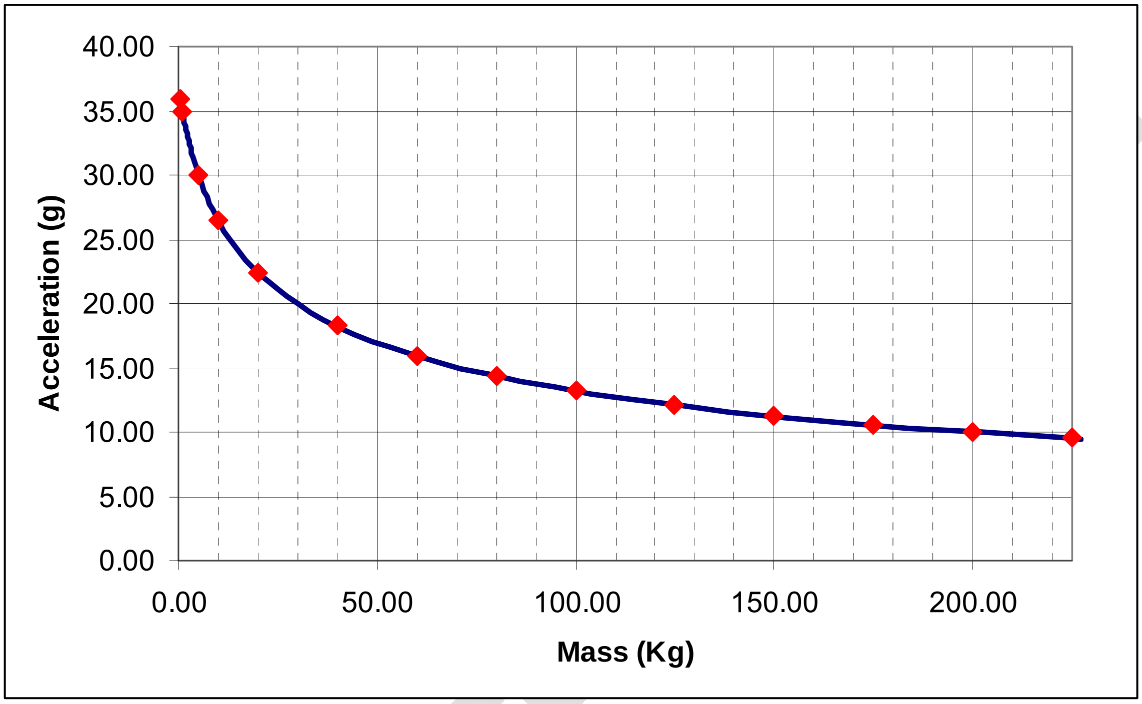
Verification Approach	Loading Condition	Ultimate Design Factor	Qualification Test Factor	Acceptance or Proof Test Factor
Protoflight	Nonpressurized	3.0	NA	1.2
	Pressurized	3.0	NA	2.0
Analysis Only	Nonpressurized	5.0	NA	NA

Table 4.3-3 – Minimum Design and Test Factors for Glass Bonds

Source: NASA-STD-5001A Section 5.1.5

Ultimate Design Factor	Qualification Test Factor	Acceptance or Proof Test Factor
2.0	1.4	1.2

Figure 4-1 – ATLAS Component Mass Acceleration Curve (MAC) [1, 2]



1) Linear interpolation may be used between break-points to determine limit load

Table 4.3-4 – ATLAS Component Design Loads (Break Points)

ATLAS Component Mass (Kg)	Limit Load (G, Any Direction)
0.5	35.9
1	35.0
5	30.1
10	26.5
20	22.4
40	18.2
60	15.9
80	14.3
100	13.2
125	12.1
150	11.2

175	10.6
200	10.0
225	9.5

IRD107: Structural analysis of the ATLAS instrument structure shall show positive margins of safety (MS) for ultimate and yield failures verified by a detailed stress analysis that assesses all primary and secondary structure, joints, and fasteners subjected to limit loads equal to 10 g's applied to each axis separately,**Error! Reference source not found.** and the appropriate factor of safety specified in Table 4.3-1.

Rationale: Quasi-static acceleration represents the combination of steady-state accelerations and the low frequency mechanically transmitted dynamic accelerations that occur during launch. The purpose of the structural analyses is to show compliance with the mechanical/structural design and test requirements.

Trace:

1. EDD91 Section 3.2.1.1 Limit Loads
2. EDD92 Section 3.2.1.2 Factors of Safety
3. EDD146 Section 4.1.2.1 Mechanical Analyses

The margin of safety is defined as follows:

MS = {Allowable Stress (or Load) ÷ (Applied Limit Stress (or Load) x FS)} – 1

The limit loads will be updated based on the results of coupled loads analysis.

4.3.2 Quasi-Static Loads Testing - Sine Burst

ERD8: ATLAS components shall undergo sine burst protoflight testing performed in each of three orthogonal axes to limit loads defined in Figure 4-1 times a test factor specified below:

a) Metal and composite test factor = 1.25
b) Beryllium test factor = 1.4.

Test frequency will be less than one-third of the resonant frequency of the ATLAS component to avoid dynamic amplification during test.

The number of cycles at maximum level will be at least 5.

Metallic structures, excluding Beryllium, may be qualified by analysis only with approval of the ATLAS IM. These analyses will show positive margin using factors of safety of 2.0 on yield and 2.6 on ultimate.

All structural elements fabricated from composite materials must be proof tested even if previously strength qualified on valid prototype or protoflight hardware.

Rationale: Sine burst testing verifies the structural strength of ATLAS components.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD153 Section 4.1.4.4 Test Factors and Durations

3. EDD323 Section 4.1.4.4 Sine Burst Test
4. EDD326 Section 4.1.4.4 Sine Burst Test
5. EDD248 Section 4.4.1.2 Sine Burst Test
6. EDD250 Section 4.4.1.2 Sine Burst Test
7. EDD251 Section 4.4.1.2 Sine Burst Test
8. EDD252 Section 4.4.1.2 Sine Burst Test

ERD9: Deleted

ERD10: Deleted

IRD108: The ATLAS instrument structure shall undergo sine burst protoflight testing performed in each of three orthogonal axes to limit loads equal to 10 g's times a test factor specified below:

a) Metal and composite test factor = 1.25.
b) Beryllium test factor = 1.4.

Metallic structures, excluding Beryllium, may be qualified by analysis only with approval of the ATLAS IM. These analyses will show positive margin using factors of safety of 2.0 on yield and 2.6 on ultimate.

All structural elements fabricated from composite materials must be proof tested even if previously strength qualified on valid prototype or protoflight hardware.

Rationale: Sine burst testing verifies the structural strength of ATLAS.

Trace:

1. EDD156 Section 4.1.4.4 Sine Burst Test
2. EDD92 3.2.1.2 Factors of Safety

4.4 SINE VIBRATION

4.4.1 Sine Vibration Analysis

ERD11: Each ATLAS component, including the instrument structure, shall show positive margins of safety for ultimate and yield failures in a structural analysis using the loads specified in Table 4.4-1and the appropriate factor of safety specified below:

1. Metallic, Beryllium, Composite – Table 4.3-1
2. Glass – Table 4.3-2
3. Glass bonds – Table 4.3-3

Rationale: Sine vibration loads simulate launch vehicle loading conditions. The purpose of the structural analyses is to show compliance with the mechanical/structural design and test requirements.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD92 Section 3.2.1.2 Factors of Safety
3. EDD94 Section 3.2.3 Sine Vibration
4. EDD146 Section 4.1.2.1 Mechanical Analyses

The margin of safety is defined as follows:

MS = {Allowable Stress (or Load) ÷ (Applied Limit Stress (or Load) x FS)} – 1

These levels will be updated using a combination of coupled loads results and base-drive analysis.

4.4.2 Sine Vibration Testing

ERD12: ATLAS components, including the instrument structure, shall undergo sine vibration testing to the protoflight levels specified in Table 4.4-1in each of three mutually perpendicular axes without damage or degradation of performance.

Rationale: Sine vibration testing is intended to verify workmanship quality and to simulate launch vehicle loading conditions.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD153 Section 4.1.4.4 Test Factors and Durations
3. EDD166 Section 4.1.4.7 Sine Vibration Test
4. EDD330 Section 4.1.4.7 Sine Vibration Test
5. EDD167 Section 4.1.4.7 Sine Vibration Test
6. EDD248 Section 4.4.1 Required Tests
7. EDD256 Section 4.4.1.4 Sine Vibration Verification Test
8. EDD257 Section 4.4.1.4 Sine Vibration Verification Test

For the sine vibration tests, the unit under test will be attached to the vibration table using the same configuration, attachment points, preloads, and attachment hardware that will be used during launch and flight.

During the test, the test input level shall be reduced (notched) at critical frequencies, if required, to limit the vibration loads and/or acceleration responses to the protoflight levels specified in Table 4.4-1.

Notching will require the approval of the ATLAS IM.

These levels will be updated using a combination of coupled loads results and base-drive analysis.

Table 4.4-1 - Sinusoidal Vibration Levels for ATLAS Components

Test	Axis	Frequency (Hz)	Level (peak)	Sweep Rate (octaves/min)
Acceptance	Thrust	5 – 20 20 – 50	0.5 inches D.A. 10.0 g	4

	Lateral	5 – 20 20 – 50	0.5 inches D.A. 10.0 g	4
Proto-flight	Thrust	5 – 20 20 – 50	0.63 inches D.A. 12.5 g	4
	Lateral	5 – 20 20 – 50	0.63 inches D.A. 12.5 g	4
Qualification	Thrust	5 – 20 20 – 50	0.63 inches D.A. 12.5 g	2
	Lateral	5 – 20 20 – 50	0.63 inches D.A. 12.5 g	2

Note: These vibration levels apply in the stowed configuration

4.5 RANDOM VIBRATION

4.5.1 Random Vibration Analysis

ERD13: Each ATLAS component shall show positive margins of safety for ultimate and yield failures in a structural analysis using the protoflight loads specified in Table 4.5-1, and the appropriate factor of safety specified below:

1. Metallic, Beryllium, Composite - Table 4.3-1
2. Glass - Table 4.3-2
3. Glass bonds - Table 4.3-3

Rationale: The random vibration environment results from the coupling of structure-borne random vibration with the acoustic noise inside the payload fairing. The purpose of the structural analyses is to show compliance with the mechanical/structural design and test requirements.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD92 Section 3.2.1.2 Factors of Safety
3. EDD95 Section 3.2.4 Random Vibration
4. EDD146 Section 4.1.2.1 Mechanical Analyses

The margin of safety is defined as follows:

MS = {Allowable Stress (or Load) ÷ (Applied Limit Stress (or Load) x FS)} – 1

Random vibration loads will be statistically derived peak responses based on RMS level from the specification in Table 4.5-1. As a minimum, the peak responses will be calculated as 3-sigma value.

Table 4.5-1 - Random Vibration Levels for ATLAS Components (GEVS Table 2.4-3)

Random Levels for Components Weighing Less Than 22.7 kg (50 lbs.)			
Frequency (Hz)	**Acceptance ASD (G^2/Hz)**	**Proto-flight ASD (G^2/Hz)**	**Qualification ASD (G^2/Hz)**
20	0.013	0.026	0.026
20-50	+6 dB/Octave	+6 dB/Octave	+6 dB/Octave
50-800	0.08	0.16	0.16
800-2000	-6 dB/Octave	-6 dB/Octave	-6 dB/Octave
2000	0.013	0.026	0.026
Overall (G_{rms})	10.0	14.1	14.1
Duration (minutes)	1	1	2

Random Levels for Components Weighing Greater Than 22.7 kg (50 lbs.)

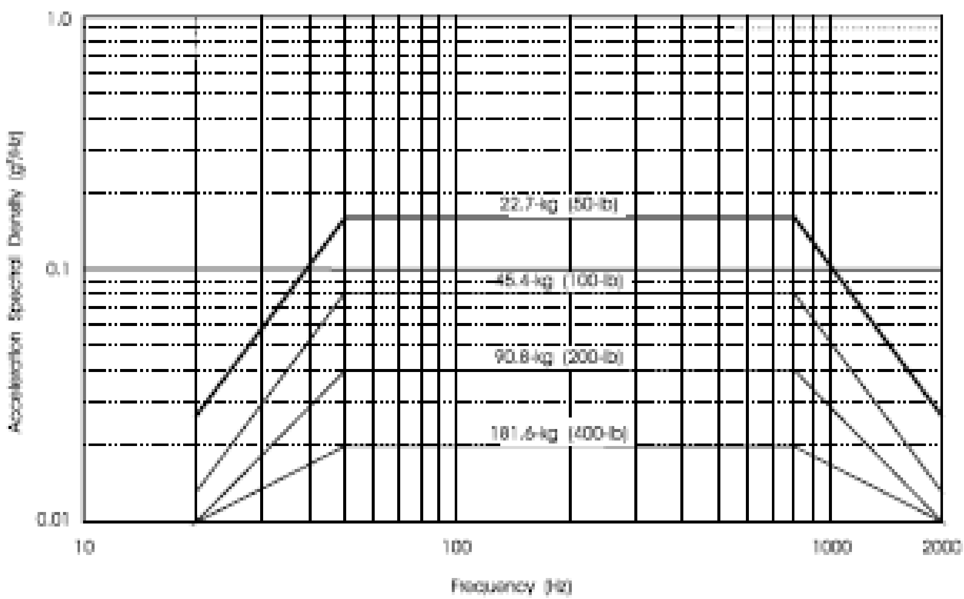
The acceleration spectral density level may be reduced for components weighing more than 22.7-kg (50 lb) according to:

	Weight in kg	Weight in lb	
dB reduction	= 10 log(W/22.7)	10 log(W/50)	
$ASD_{(50\text{-}800\ Hz)}$	= 0.16•(22.7/W)	0.16•(50/W)	for protoflight
$ASD_{(50\text{-}800\ Hz)}$	= 0.08•(22.7/W)	0.08•(50/W)	for acceptance

Where W = component weight.

The slopes shall be maintained at + and - 6dB/oct for components weighing up to 59-kg (130-lb). Above that weight, the slopes shall be adjusted to maintain an ASD level of 0.01 g^2/Hz at 20 and 2000 Hz.

For components weighing over 182-kg (400-lb), the test specification will be maintained at the level for 182-kg (400 pounds).



ERD113: The ATLAS structure shall show positive margins of safety for ultimate and yield failures in a structural analysis using the protoflight loads specified in Table 4.5-2, and the appropriate factor of safety specified below:

4. Metallic, Beryllium, Composite - Table 4.3-1
5. Glass - Table 4.3-2
6. Glass bonds - Table 4.3-3

Rationale: The random vibration environment results from the coupling of structure-borne random vibration with the acoustic noise inside the payload fairing. The purpose of the structural analyses is to show compliance with the mechanical/structural design and test requirements.

Trace:

5. EDD89 Section 3.2 Instrument Suite and Component

6. EDD92 Section 3.2.1.2 Factors of Safety
7. EDD95 Section 3.2.4 Random Vibration
8. EDD146 Section 4.1.2.1 Mechanical Analyses

The margin of safety is defined as follows:

MS = {Allowable Stress (or Load) ÷ (Applied Limit Stress (or Load) x FS)} – 1

Random vibration loads will be statistically derived peak responses based on RMS level from the specification in Table 4.5-1. As a minimum, the peak responses will be calculated as 3-sigma value.

Table 4.5-2 ATLAS Instrument Structure Random Vibration Levels

Levels Derived from GEVS Table 2.4-3

Frequency (Hz)	Acceptance ASD (G^2/Hz)	Proto-flight ASD (G^2/Hz)
20	**0.005**	**0.01**
20-50	**+2.28 dB/Octave**	**+2.28 dB/Octave**
50-800	**0.01**	**0.02**
800-2000	**-2.28 dB/Octave**	**-2.28 dB/Octave**
2000	**0.005**	**0.01**
Overall (G_{rms})	**3.99**	**5.65**
Duration (minutes)	**1**	**1**

4.5.2 Random Vibration Testing

ERD14: Each ATLAS component shall undergo random vibration testing to the protoflight levels specified in Table 4.5-1, applied in each of three orthogonal axes, without damage or degradation of performance.

Rationale: The random vibration test demonstrates workmanship quality and simulates launch vehicle environmental levels due to vibro-acoustics.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD95 Section 3.2.4 Random Vibration
3. EDD153 Section 4.1.4.4 Test Factors and Durations
4. EDD160 Section 4.1.4.8 Random Vibration Test
5. EDD161 Section 4.1.4.8 Random Vibration Test
6. EDD162 Section 4.1.4.8 Random Vibration Test
7. EDD163 Section 4.1.4.8 Random Vibration Test

8. EDD164 Section 4.1.4.8 Random Vibration Test
9. EDD248 Section 4.4.1 Required Tests
10. EDD259 Section 4.4.1.5 Random Vibration Test
11. EDD260 Section 4.4.1.5 Random Vibration Test

The unit under test will be attached to the vibration table using the same configuration, attachment points, preloads, and attachment hardware that will be used during launch and flight.

During the test, cross-axis responses of the fixture will be monitored to preclude unrealistic levels.

The test input level may be reduced (notched) at the fundamental modes of the test article such that the interface loads do not exceed 1.25 times design limit levels.

Additional input notching at critical frequencies of the test article may be allowed based on force-limiting techniques or based on response limiting if flight or test responses at higher levels of assembly are known.

Guidelines for developing appropriate force-limiting criteria can be found in NASA-HDBK-7004.

Notching will be limited to –12 dB of the original input and to a bandwidth of less than 100 Hz.

Notching will require ATLAS IM approval.

IRD114: The ATLAS instrument structure shall undergo random vibration testing to the protoflight levels specified in Table 4.5-2, applied in each of three orthogonal axes, without damage or degradation of performance.

Rationale: The random vibration test demonstrates workmanship quality and simulates launch vehicle environmental levels due to vibro-acoustics.

Trace:

1. EDD95 Section 3.2.4 Random Vibration
2. EDD160 Section 4.1.4.8 Random Vibration Test
3. EDD161 Section 4.1.4.8 Random Vibration Test
4. EDD162 Section 4.1.4.8 Random Vibration Test
5. EDD163 Section 4.1.4.8 Random Vibration Test
6. EDD164 Section 4.1.4.8 Random Vibration Test
7. EDD165 Section 4.1.4.8 Random Vibration Test
8. EDD248 Section 4.5.1 Required Tests

The unit under test will be attached to the vibration table using the same configuration, attachment points, preloads, and attachment hardware that will be used during launch and flight.

During the test, cross-axis responses of the fixture will be monitored to preclude unrealistic levels.

The test input level may be reduced (notched) at the fundamental modes of the test article such that the interface loads do not exceed 1.25 times design limit levels.

Additional input notching at critical frequencies of the test article may be allowed based on force-limiting techniques or based on response limiting if flight or test responses at higher levels of assembly are known.

Guidelines for developing appropriate force-limiting criteria can be found in NASA-HDBK-7004.

Notching will be limited to –12 dB of the original input and to a bandwidth of less than 100 Hz.

Notching will require ATLAS IM approval.

Note: ATLAS instrument random vibration test levels derived from GEVS Table 2.4-3 as shown in **Error! Reference source not found.**

4.6 ACOUSTICS

4.6.1 Acoustic Loads Analysis

ERD15: All ATLAS components, including the instrument structure, shall perform an acoustic loads analysis showing positive margins of safety for ultimate and yield failures using the loads specified in Table 4.6-1 and the appropriate factor of safety specified below:

7. Metallic, Beryllium, Composite – Table 4.3-1
8. Glass – Table 4.3-2
9. Glass bonds - Table 4.3-3

Rationale: Acoustic noise occurs during launch, at lift-off and in the transonic region. Structural analysis of ATLAS flight components may wring out design problems before flight hardware testing.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD92 Section 3.2.1.2 Factors of Safety
3. EDD98 Section 3.2.6 Acoustics
4. EDD146 Section 4.1.2.1 Mechanical Analyses

The margin of safety is defined as follows:

MS = {Allowable Stress (or Load) ÷ (Applied Limit Stress (or Load) x FS)} – 1

Acoustic loads will be statistically derived peak responses based on RMS level from the specifications in Table 4.6-1. As a minimum, the peak responses will be calculated as 3-sigma value.

ERD16: Deleted.

4.6.2 Acoustic Testing

ERD17: All ATLAS components, including the instrument structure, meeting either of the two criteria below with strength protoflight loads that do not cover acoustic loading, shall undergo acoustic testing to the loads in Table 4.6-1 without damage or degradation of performance.

1. Shown by analysis to be sensitive to the acoustics environment
2. Having an area to mass ratio of greater than 50 in^2/ lb. (0.072 m^2 / kg),

Rationale: Ensures the component will withstand the acoustic environment of the launch phase.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD98 Section 3.2.6 Acoustics
3. EDD153 Section 4.1.4.4 Test Factors and Durations
4. EDD170 Section 4.1.4.9 Acoustic Test
5. EDD248 Section 4.4.1 Required Tests
6. EDD261 Section 4.4.1.6 Acoustic Test
7. EDD262 Section 4.4.1.6 Acoustic Test

Table 4.6-1 - Observatory Acoustic Levels (Composite with Taurus-II)

1/3 Octave Band Center Frequency (Hz)	Max. Predicted Environment (dB)	Proto-flight Test Level (dB)	Qualification Test Level (dB)
	126	129	129
	127	130	130
32	126	129	129
40	129	132	132
50	132	135	135
63	134	137	137
80	135	138	138
100	135.5	138.5	138.5
125	136	139	139
160	135	138	138
200	133	136	136
250	132	135	135
315	132	135	135
400	131	134	134
500	130	133	133
630	128.5	131.5	131.5
800	127	130	130
1000	124	127	127
1250	122	125	125
1600	120.5	123.5	123.5
2000	121	124	124
2500	118	121	121

1/3 Octave Band Center Frequency (Hz)	Max. Predicted Environment (dB)	Proto-flight Test Level (dB)	Qualification Test Level (dB)
3150	117.5	120.5	120.5
4000	115.5	118.5	118.5
5000	114.5	117.5	117.5
6300	113.5	116.5	116.5
8000	114	117	117
10000	114.5	117.5	117.5
OASPL	141.2	144.2	144.2
Duration	60 sec	60 sec	120 sec

4.7 SHOCK

4.7.1 Shock Analysis

ERD18: All ATLAS components, including the instrument structure, shall perform a shock loads analysis showing positive margins of safety for ultimate and yield failures using the loads specified in Table 4.7-1 and the appropriate factor of safety specified below:

1. Metallic, Beryllium, Composite – Table 4.3-1
2. Glass – Table 4.3-2
3. Glass bonds - Table 4.3-3

Rationale: Certain ATLAS components may be sensitive to shock loads, such as such as observatory separation, boom deployment, etc. Evaluating shock sensitivity of ATLAS flight components may wring out design problems before flight hardware testing

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
5. EDD92 Section 3.2.1.2 Factors of Safety
2. EDD96 Section 3.2.5 Shock
3. EDD146 Section 4.1.2.1 Mechanical Analyses
4. EDD263 Section 4.4.1.7 Shock

4.7.2 Shock Testing

ERD19: Any ATLAS component, including instrument structure, shown by shock analysis to be susceptible to the shock environment shall undergo shock testing to one of the levels specified below, without suffering damage or degradation of performance.

1. Shock testing performed by firing the actual device, consisting of two actuations, for internally induced shocks.
2. Simulated shock testing performed to 1.4 times the levels specified in Table 4.7-1, for externally induced shocks, performing 2 tests per axis for protoflight testing.

Rationale: Shock testing is designed to verify that flight hardware will survive expected shock events such as observatory separation, boom deployment, etc.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD96 Section 3.2.5 Shock
3. EDD97 Section 3.2.5 Shock
4. EDD153 Section 4.1.4.4 Test Factors and Durations
5. EDD176 Section 4.1.4.11 Shock
6. EDD263 Section 4.4.1.7 Shock
7. EDD264 Section 4.4.1.7 Shock

Table 4.7-1 – ATLAS Component Shock Response Spectrum

Component	**Shock Level Protoflight/Qualification (g)**
Laser Assembly	TBD
Laser Select Mechanism (LSM)	TBD
Transmitter Fiber Optics	TBD
Laser Pickoff Assembly	TBD
Reflective Beam Expander Assembly	TBD
Diffractive Optical Element (DOE) Assembly	TBD
Fold Mirrors	TBD
Receiver Fiber Optics	TBD
Start Pulse Detector Assembly	TBD
Telescope Assembly	TBD
Aft Optics Assembly	TBD
Optical Filter Assembly (OFA)	TBD
Detector Array Assembly (DAA)	TBD
Telescope Alignment Monitoring System (TAMS) Assembly	TBD
Laser Reference System (LRS)Assembly	TBD
Lateral Transfer Retro-reflector (LTR) Assembly	TBD
Beam Steering Mechanism (BSM)	TBD
Thermal Control Subsystem (TCS)	TBD
ATLAS Structure	TBD
Main Electronics Box (MEB)	TBD
Power Distribution Unit (PDU)	TBD
High Voltage Power Converter (HVPC)	TBD
Harness	TBD

4.8 PRESSURE

4.8.1 Ambient Pressure

ERD20: All ATLAS components, including instrument structure, shall be designed to meet all performance requirements while operating at pressure levels of 1.33 x 10^{-3} N/m^2 (1 x 10^{-5} Torr) or less.

Rationale: The instrument will operate in a vacuum environment.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD99 Section 3.2.8.1 Ambient Pressure
3. EDD248 Section 4.4.1 Required Tests

ERD21: All ATLAS components, including instrument structure, shall survive exposure to a maximum depressurization rate of 0.9 psi/s experienced during launch and ascent, without any damage or degradation of performance.

Rationale: The instrument will operate after being exposed to de-pressurization during launch and ascent.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD308 Section 3.2.8.1 Ambient Pressure

4.8.2 Pressure Profile Verification Analyses

ERD23: Venting analyses of all ATLAS components, including instrument structure, susceptible to pressure loading shall show positive margins of safety for ultimate and yield failures using the loads equal to twice those induced by the maximum pressure differential during launch (TBD) and the appropriate factor of safety specified below:

1. Metallic, Beryllium, Composite – Table 4.3-1
2. Glass - Table 4.3-2
3. Glass bonds - Table 4.3-3

The maximum pressure differential will be updated once a launch vehicle is chosen.

Rationale: This analysis verifies that ATLAS components (such as thermal blankets and contamination enclosures) susceptible to pressure loadings will survive exposure to the launch pressure profile.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD151 Section 4.1.2.4 Pressure Profile Verification Analysis

4.9 THERMAL LOADS ANALYSIS

ERD24: Each ATLAS component, including instrument structure, shall show positive margins of safety for ultimate and yield failures in a structural analysis using the maximum on-orbit temperature gradients specified in ICESat-2-THM-IFACE-0214, ATLAS Thermal ICD, and the appropriate factor of safety specified below:

1. Metallic, Beryllium, Composite – Table 4.3-1
2. Glass - Table 4.3-2
3. Glass bonds - Table 4.3-3

Rationale: This analysis verifies structures will survive on orbit stresses due to temperature loading and coefficient of thermal expansion mismatches.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD146 Section 4.1.2.1 Mechanical Analyses

5 THERMAL REQUIREMENTS

All testing is to protoflight levels unless otherwise specified.

5.1 THERMAL ANALYSIS

ERD25: Each ATLAS component, including instrument structure, shall show in a thermal analysis that parts and materials maintain the minimum temperature margin required as shown in Table 5.1-1 for the temperatures specified in ICESat-2-THM-IFACE-0214, ATLAS Thermal ICD, and do not exceed allocated heater powers specified in the ATLAS resource allocations document (ICESat-2-ATSYS-REQ-0479).

Rationale: The thermal analyses will show that parts and materials do not exceed temperature limits during the operational and test environment.

Trace:

1. EDD148 Section 4.1.2.3 Thermal Analyses
2. EDD320 Section 4.1.2.3 Thermal Analyses
3. EDD321 Section 4.1.2.3 Thermal Analyses

Table 5.1-1 – ATLAS Thermal Design Margins

Source: Gold Rule 4.25 (GSFC-STD-1000-E, Goddard Space Flight Center Rules for the Design, Development, Verification, and Operation of Flight Systems)

4.25	Thermal Design Margins					Mechanical	
Rule: R	Thermal design shall provide adequate margin between stacked worst-case flight predictions and component allowable flight temperature limits per GEVS 2.6 and 545-PG-8700.2.1A. Note: This applies to normal operations and planned contingency modes. This does not apply to cryogenic systems.						
Rationale:	Positive temperature margins are required to account for uncertainties in power dissipations, environments, and thermal system parameters.						
Phase:	**<A**	**A**	**B**	**C**	**D**	**E**	**F**
Activities:	1. Thermal design concept produces minimum 5C margins, except for heater controlled elements which have a maximum 70% heater duty cycle, and two-phase flow systems which have a minimum 30% heat transport margin. For Pre-A, larger margins advisable.	1. Thermal design concept produces minimum 5C margins, except for heater controlled elements which have a maximum 70% heater duty cycle, and two-phase flow systems which have a minimum 30% heat transport margin. For Phase A, larger margins advisable.	1. Thermal design concept produces minimum 5C margins, except for heater controlled elements which have a maximum 70% heater duty cycle, and two-phase flow systems which have a minimum 30% heat transport margin.	1. Thermal design concept produces minimum 5C margins, except for heater controlled elements which have a maximum 70% heater duty cycle, and two-phase flow systems which have a minimum 30% heat transport margin.	1. System thermal balance test produces test-correlated model. Test and worst-case flight thermal analysis with test-correlated model demonstrate minimum 5C margins, except for heater controlled elements which demonstrate a maximum 70% heater duty cycle, and two-phase flow systems which demonstrate a minimum 30% heat transport margin.	1. Thermal analysis with flight-correlated model shows minimum 5C margins for mission trade studies, except for heater controlled elements which have a maximum 70% heater duty cycle, and two-phase flow systems which have a minimum 30% heat transport margin.	1. Thermal analysis with flight-correlated model shows minimum 5C margins for mission disposal options, except for heater controlled elements which have a maximum 70% heater duty cycle, and two-phase flow systems which have a minimum 30% heat transport margin.
Verification:	1. Verify at MCR.	1. Verify worst-case thermal analysis of concept through peer review and at SRR and MDR.	1. Verify worst-case thermal analysis of design through peer review and at PDR.	1. Verify worst-case thermal analysis of detailed design through peer review and at CDR.	1. Verify through peer review and at PER and PSR.	1. Verify thermal analysis of flight system using flight-correlated thermal model through peer review.	1. Verify thermal analysis of flight system using flight-correlated thermal model through peer review.
Revision Status: Rev. E		**Owner:** Thermal Engineering Branch (545)				**Reference:** GEVS 2.63 545-PG-8700.2.1A	

5.2 THERMAL VACUUM PROTOFLIGHT TESTING

ERD26: Deleted

ERD27: All ATLAS components, including instrument structure, shall meet all performance requirements during and after exposure to the thermal vacuum protoflight test environment specified below (see GEVS Section 2.6.2 for more details).

Note: The laser subsystem will test to a modified GEVS specification.

Rationale: The thermal vacuum protoflight test verifies ATLAS components for the mission thermal environments.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD153 Section 4.1.4.4 Test Factors and Durations
3. EDD179 Section 4.1.4.13 Thermal Vacuum Test
4. EDD180 Section 4.1.4.13 Thermal Vacuum Test
5. EDD181 Section 4.1.4.13.1 Thermal Vacuum Test Parameters
6. EDD182 Section 4.1.4.13.2 Component Level Thermal Vacuum Test Profile
7. EDD248 Section 4.4.1 Required Tests
8. EDD271 Section 4.4.1.12 Thermal Vacuum Test

The thermal vacuum protoflight test environment includes the following:

1. 4 cycles of thermal vacuum testing.
   a. 1 cycle between survival limits.
      i. Soak for 4 hours at each extreme.
      ii. ATLAS component is off at temperatures past the operating limits.
      iii. ATLAS component performs turn on after exposure to each of the survival limits at its cold survival limit or a start temperature agreed upon by both the component and instrument. Test turn-on temperatures should be at either the survival/safehold or qualification/protoflight temperature conditions, whichever is more extreme.
      iv. After turn on, ATLAS component undergoes functional testing and meets all performance requirements.
   b. 3 cycles between operating limits
      i. Soak for 4 hours at each extreme.
      ii. Functional tests will be performed at each hot and cold soak plateau. A comprehensive performance test (CPT) will be performed at least once during hot plateau(s) and once during cold plateau(s).
      iii. ATLAS component is operating during transitions between the operating limits. Functional tests will be performed during the transitions.
   c. Over the range of possible survival flight voltages

The thermal vacuum protoflight test specification includes the following:

1. Temperature Limits - Temperature limits are specified in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Thermal vacuum temperature limit envelopes are shown in Figure 5-1.
2. Maximum rate of temperature change - Maximum rates of temperature change will not exceed the limits defined in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). The limits are based on hardware characteristics or orbital predictions.
3. Test Temperature Soak Criteria - Temperature soaks will begin when the "control" temperature is within ± 2°C of the proposed test temperature.
4. Test Margins - For actively controlled systems such as those using heaters, thermo electric coolers (TECs), loop heat pipes (LHPs), or other devices with selectable/variable set points, a test temperature margin of no less than 5°C will be imposed on the respective set point band that is under control. For all passively-controlled systems, a test temperature margin of no less than 10C will be imposed.
5. Avoiding Contamination -Elements of a test item can be sensitive to contamination arising from test operations or from the test item itself. In all cases, every effort should be made to keep the test article warmer than its surroundings during testing.
6. Durations – The thermal soaks will be of sufficient duration to allow time for functional tests for all modes of operation, and will be no less than 4 hours.
7. Pressure – The chamber pressure will be less than 1.33×10^{-3} Pa. (1×10^{-5} Torr).
8. Test Environment - For ATLAS components that have been shown by analysis to be insensitive to vacuum effects relative to temperature levels and temperature gradients, the requirements may be satisfied by temperature cycling at normal room pressure in an air or gaseous-nitrogen environment. However, the recommended approach is to test in the expected environment (vacuum). If testing at ambient pressure is implemented, GSFC project approval is required based on the results of a rigorous thermal analysis.
9. Profile – Figure 5-2 shows a typical thermal vacuum testing profile for ATLAS components.
10. Comprehensive Performance Test (CPT) - Used to verify full compliance of each flight unit to all of its performance requirements, within the limitations of the environment and facilities. This test is also defined in Section 6.0 Performance Tests.
11. Functional Test (FT) - Also known as a Limited Performance Test (LPT). The FT is a subset of the Performance Test and is designed to verify functionality of the flight unit under nominal input/output conditions. The FT will be used to verify unit operation when it is not practical to use the CPT. Typically, it is used to during and after certain environmental tests to demonstrate that the functional capability of the ATLAS component has not been degraded due to environmental exposure, handling, and transportation. It is also commonly used during some of the hot and cold plateaus during thermal vacuum testing. This test is also defined in Section 6.0 Performance Tests.

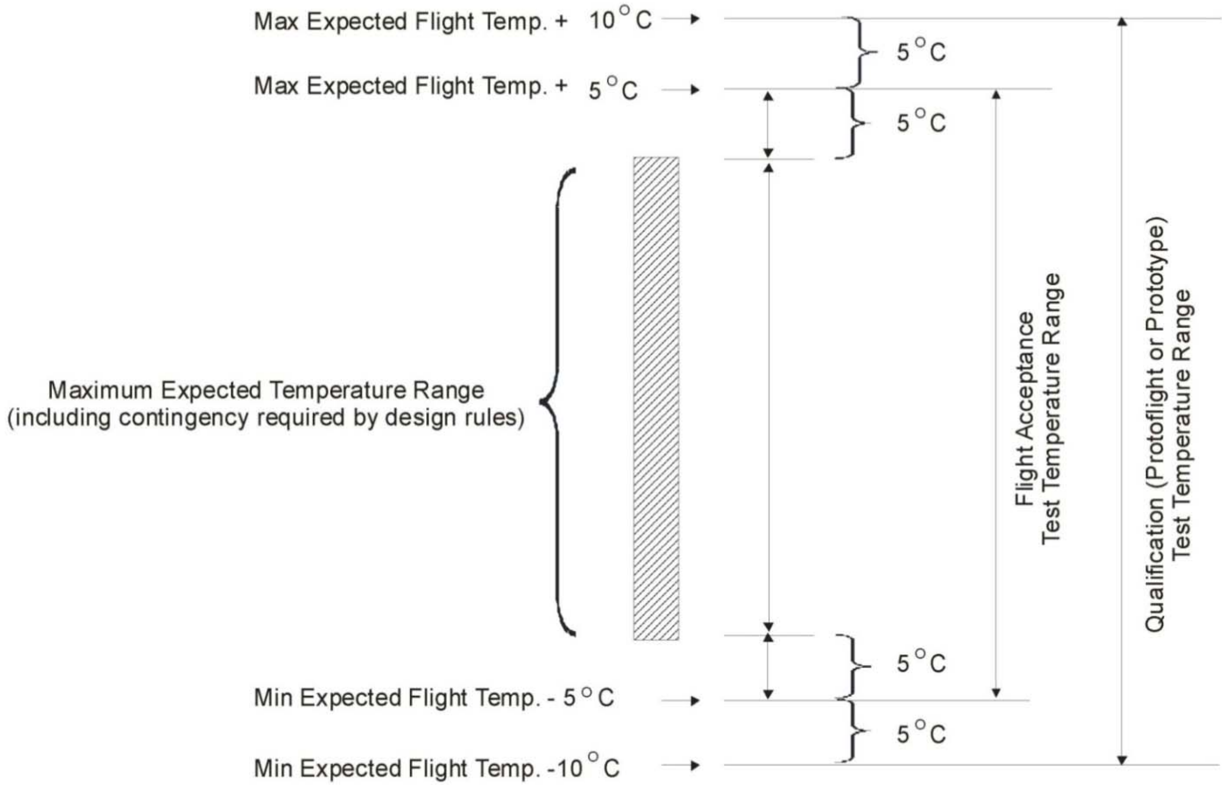


Figure 5-1 – Qualification/Protoflight and Acceptance Levels Thermal Vacuum Temperatures

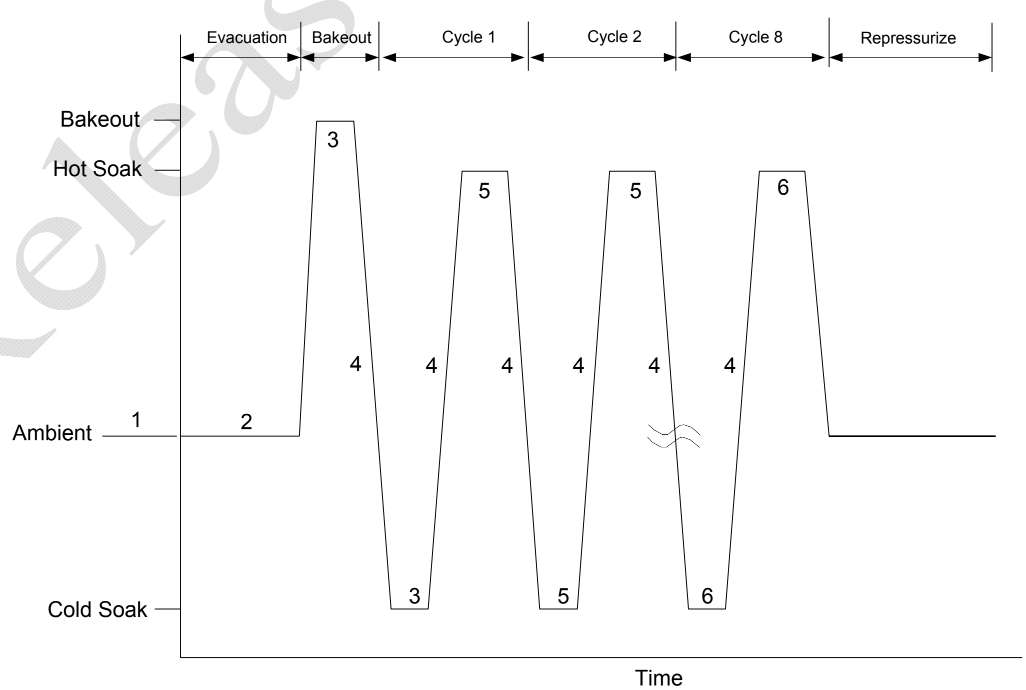


Figure 5-2 – Typical ATLAS Component Thermal Vacuum Cycle Profile (Note: ATLAS Components required cycles is 4)

5.3 THERMAL CYCLING TEST

ERD28: ATLAS components, including instrument structure, requiring life-cycle thermal testing shall undergo additional thermal cycling concurrent with performance testing at ambient pressure on qualification units.

Rationale: Additional thermal cycling at ambient pressure on qualification units increases the total number of cycles experienced by the ATLAS component.

Trace:

1. EDD153 Section 4.1.4.4 Test Factors and Durations
2. EDD184 Section 4.1.4.14 Thermal Cycling Test

Some ATLAS components may require life-cycle thermal testing to qualify the design. Since it is not practical to perform very large number cycles in vacuum, additional thermal cycling at ambient pressure may be used on qualification units to increase the total number of cycles. Prior to ambient-pressure thermal cycling, the units are still required to undergo thermal vacuum cycling as called out in Section 4.3. Performance tests will be performed periodically during these cycles to detect problems early.

5.4 THERMAL BAKE-OUT

ERD29: ATLAS components, including instrument structure, shall undergo thermal bake-out tests per the ATLAS Contamination Control Plan (ICESat-2-ATSYS-PLAN-0297).

Rationale: Thermal bake-out tests reduce out gassing of contaminants to acceptable levels.

Trace:

1. EDD177 Section 4.1.4.12 Thermal Bake-Out
2. EDD178 Section 4.1.4.12 Thermal Bake-Out
3. EDD269 Section 4.4.1.10 Thermal Bake-Out

All flight hardware will undergo thermal bake-out tests to reduce out gassing of contaminants to acceptable levels. Thermal bake-out may be performed during thermal vacuum testing. The bake-out will be performed in a thermal vacuum chamber with a cleanliness class in compliance with the ATLAS Contamination Control Plan. The outgassing rates for each ATLAS component are defined in the ATLAS Contamination Control Plan. For each bake-out, Quartz Crystal Microbalances (QCM) will be used to determine the out gassing rates.

5.5 HUMIDITY

ERD30: ATLAS components, including instrument structure, shall be designed to withstand relative humidity levels from 35% to 70% without any damage or degradation of performance.

NOTE: A lower humidity level may be required to not condense dew when the ground cooling system is operating if the laser operational temperature is below the dew point. A dry nitrogen purge may be required for this operation.

Rationale: Humidity levels are also important to reduce or eliminate the possibility of an ESD event which could damage flight hardware.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD102 Section 3.2.9 Humidity

6 ELECTROMAGNETIC ENVIRONMENT AND REQUIREMENTS

All testing is to protoflight levels unless otherwise specified.

Tests are prescribed at the ATLAS component level of assembly.

The ATLAS components will be electromagnetically compatible with each other and with the external environments encountered during their operation. ATLAS components will meet the electromagnetic emission and requirements from GSFC-STD-7000, General Environmental Verification Standard (GEVS) for GSFC Flight Programs and Projects. Most of the EMI/EMC tests are based on the requirements of MIL-STD-461C Part 3 and MIL-STD-462, as amended by Notice 1.

Spurious signals that lie above specified testing limits will be eliminated. Spurious signals that are below specified limits will be analyzed to determine if a subsequent change in frequency or amplitude is possible; if it is possible, the spurious signals should be eliminated to protect payload and instruments from the possibility of interference. Retest will be performed to verify that intended solutions are effective.

6.1 EMISSION REQUIREMENTS

6.1.1 Conducted Emission Limits

6.1.1.1 Narrowband Conducted Emissions

ERD31: ATLAS components with power and power return leads shall undergo narrowband conducted emissions tests limited to the levels specified in Figure 6-1, in accordance with MIL-STD-461C, Part 3, Section 2.0 and 3.0, and MIL-STD-462, test numbers CE01 and CE03.

Rationale: Conducted emission limits and requirements on power leads verify that ATLAS components are electromagnetically compatible with other systems and do not generate conducted signals that could hinder the operation of other systems.

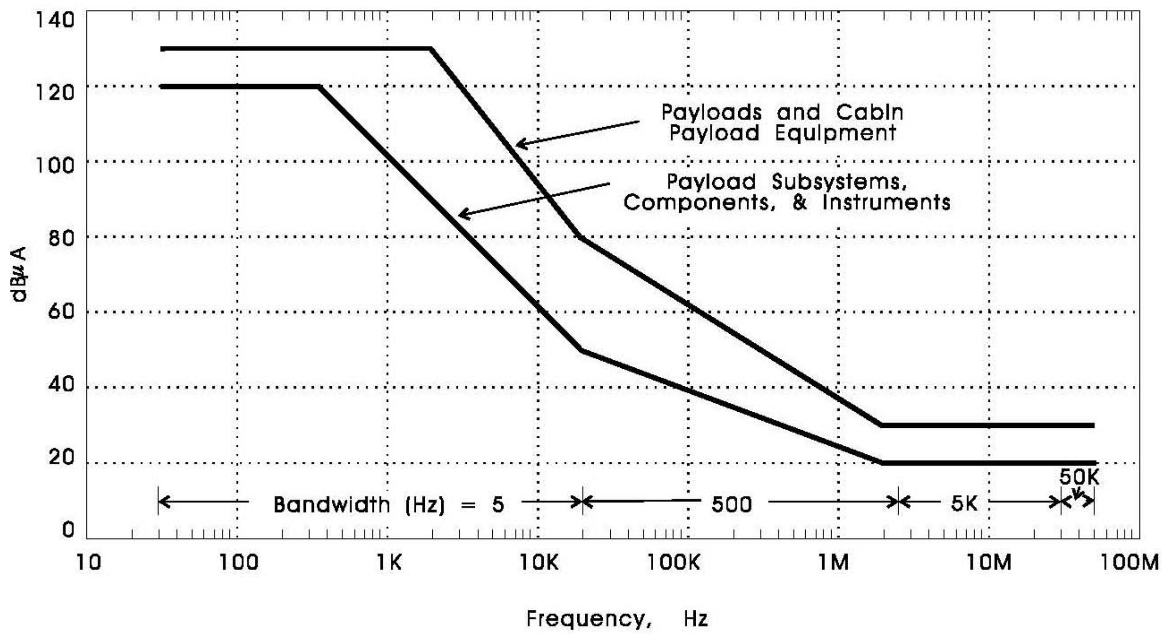
Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD106 3.2.10.12 CE01/CE03 Differential Mode Emission
3. EDD107 3.2.10.12 CE01/CE03 Differential Mode Emission
4. EDD265 4.4.1.8 CE01/CE03 Electromagnetic Compatibility Test

The requirements do not apply to secondary power leads to subunits within the level of assembly under test unless they are specifically included in a hardware specification.

Test limits for CE01 are in a frequency range from 30 Hz to 20 kHz. Test limits for CE03 are in a frequency range from 20 kHz to 50 MHz.

Figure 6-1 – Narrowband Conducted (CE01 & CE03) Emission Limits on Payload Power Lines



6.1.1.2 Common Mode Noise (CMN) Conducted Emissions

ERD32: Each ATLAS non-passive component which receives or generates spacecraft primary power shall undergo a Conducted Emissions (CE) frequency domain current test to the limits of Figure 6-2.

Rationale: The purpose of the test is to limit CMN emissions that flow through the spacecraft structure and flight harness which result in the generation of undesirable electrical currents, and electro-magnetic fields at the integrated system level.

Trace:

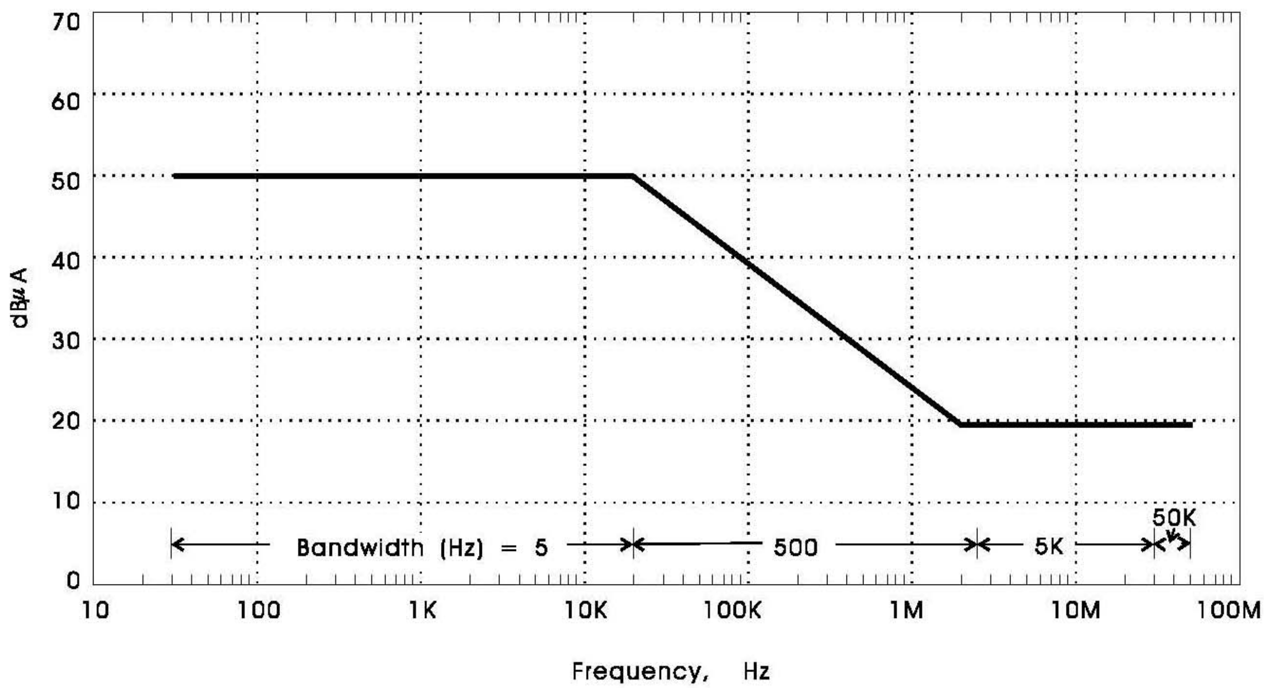
1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD108 3.2.10.12 CE01/CE03 Common Mode Emission
3. EDD109 3.2.10.12 CE01/CE03 Common Mode Emission
4. EDD265 4.4.1.8 CE01/CE03 Electromagnetic Compatibility Test

A Conducted Emissions (CE) test is performed to control Common Mode Noise (CMN). This frequency domain current test is performed on all non-passive ATLAS components which receive or generate spacecraft primary power.

Specific CMN requirements will be determined carefully from spacecraft hardware designs or mission scenario. Spacecraft which have analog or low level signal interfaces, low level detectors, and instruments that measure electromagnetic fields may be particularly sensitive to CMN. If mission requirements do not place stricter control on CMN, the limits of Figure 6-2 are required.

The CMN test procedure is the same as narrowband CE01/03 except that the current probe is placed around both the plus and return primary wires together.

Figure 6-2 - Common Mode (CMN) Conducted Emission Limits on Primary Power Lines

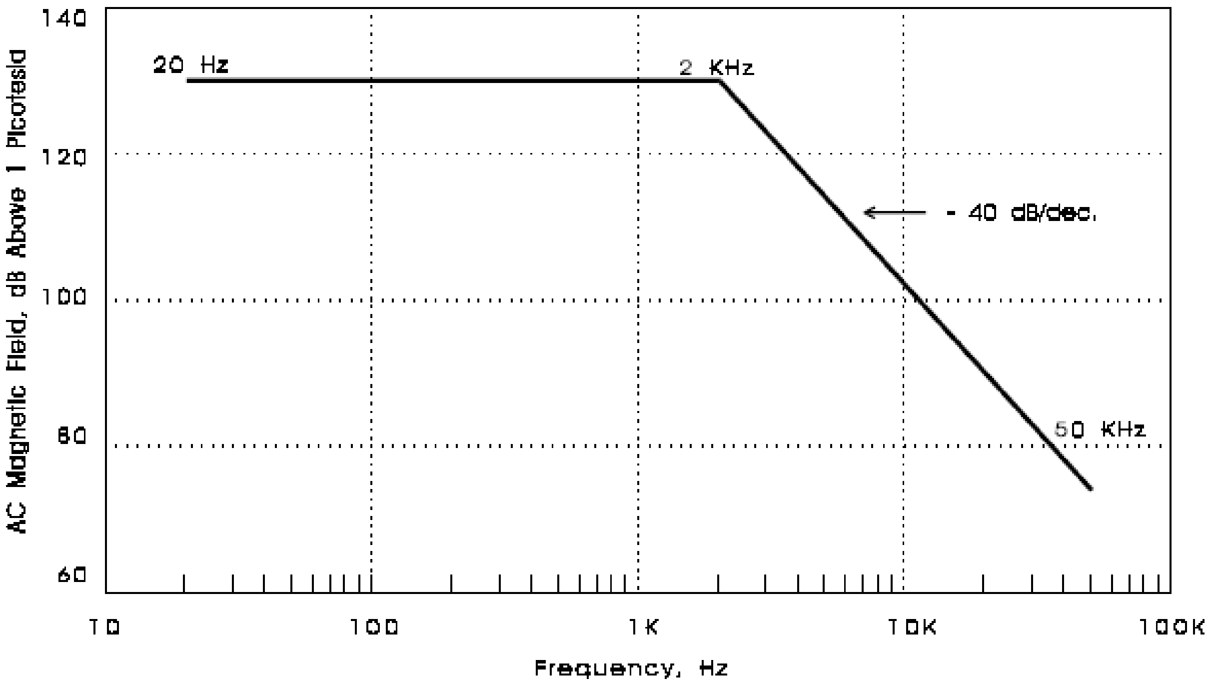


ERD33: Deleted

6.1.1.3 Radiated AC Magnetic Field (RE04)

ERD34: Radiated ac magnetic field levels produced by components at distances of 1 meter from the component shall not exceed 130 dB above 1 pico-tesla over the frequency range of 20 Hz to 2 kiloHertz (kHz), then falling 40 dB per decade to 50 kHz as shown in Figure 6-3 .

Figure 6-3: Limits of ATLAS Component Radiated AC Magnetic Field at 1 Meter from the Component



Rationale: Radiated emission limits and requirements on ac magnetic fields verify that ATLAS components are electromagnetically compatible with other systems and do not generate conducted signals that could hinder the operation of other systems.

Trace: GEVS Section 2.5.2.2

ERD35: ATLAS components with radiated alternating current magnetic fields shall undergo tests in accordance with MIL-STD-462, test number RE04.

Rationale: Radiated emission limits and requirements on ac magnetic fields verify that ATLAS components are electromagnetically compatible with other systems and do not generate conducted signals that could hinder the operation of other systems.

Trace: GEVS Section 2.5.2.2

6.1.1.4 Radiated Narrowband Electric Field (RE02)

ERD36: The unintentional radiated narrowband electric field levels produced by any ATLAS component shall not exceed the levels specified in the lower curve labeled “Payload Subsystems, Components, and Instruments” in Figure 6-4.

Rationale: Radiated emission limits and requirements on electric fields verify that ATLAS components are electromagnetically compatible with other systems and do not generate conducted signals that could hinder the operation of other systems.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD118 3.2.10.3.2 RE02 Electric Field Emissions

ERD37: ATLAS components with unintentional radiated narrowband electric fields shall undergo tests in accordance with MIL-STD 461C Part 3, Section 14.0, and MIL-STD-462, test number RE02, with the test frequency range and limits revised as defined in Figure 6-4.

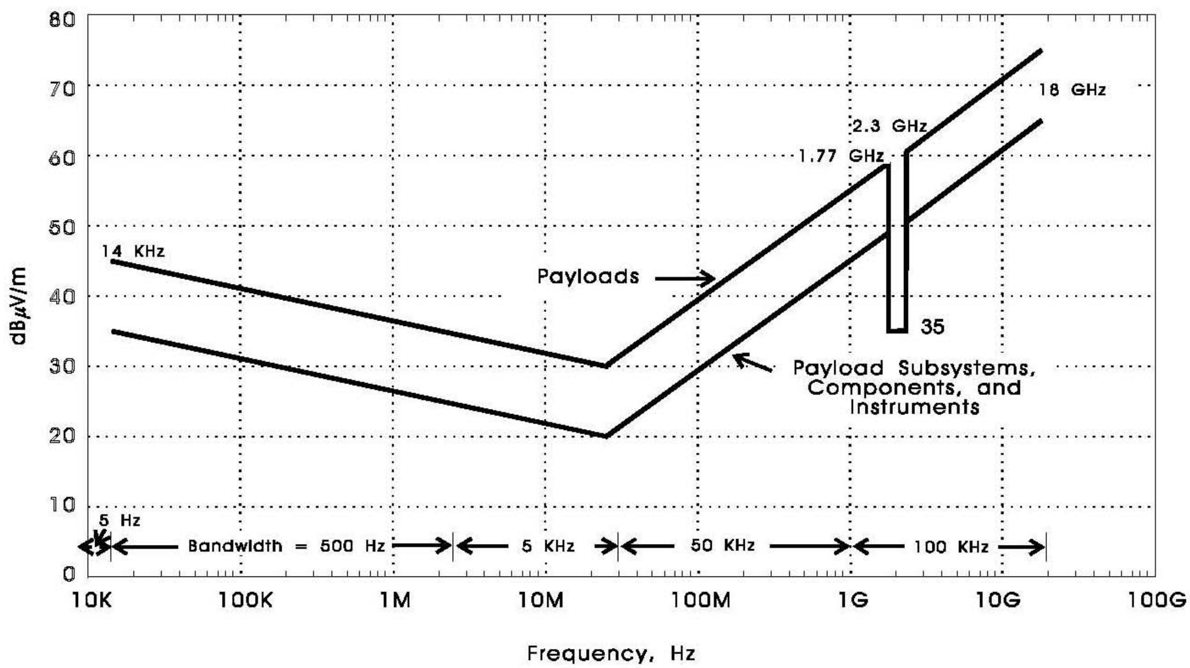
Rationale: Radiated emission limits and requirements on electric fields verify that ATLAS components are electromagnetically compatible with other systems and do not generate conducted signals that could hinder the operation of other systems.

Trace:

1. GEVS Section 2.5.2.2

Figure 6-4 - Unintentional Radiated Narrowband (RE02) Limits for Electric Field Emission Produced by Payloads and Payload Systems

Note: The lower curve is to be used for ATLAS Components



6.2 SUSCEPTIBILITY REQUIREMENTS

6.2.1 Conducted Susceptibility Requirements

6.2.1.1 Conducted Susceptibility CS01-CS02 (Power lines)

ERD38: All ATLAS components that contain the DC/DC converters or power regulation devices shall undergo a conducted susceptibility CS01 and CS02, injection of energy into power lines, test to the limits defined in MIL-STD-461C.Part 3, Section 6.0 and 7.0, and shown in Figure 6-5.

Rationale: Conducted susceptibility requirements verify that ATLAS components will operate properly if subjected to conducted or radiated emissions from other sources that could occur during launch or in orbit.

Trace:

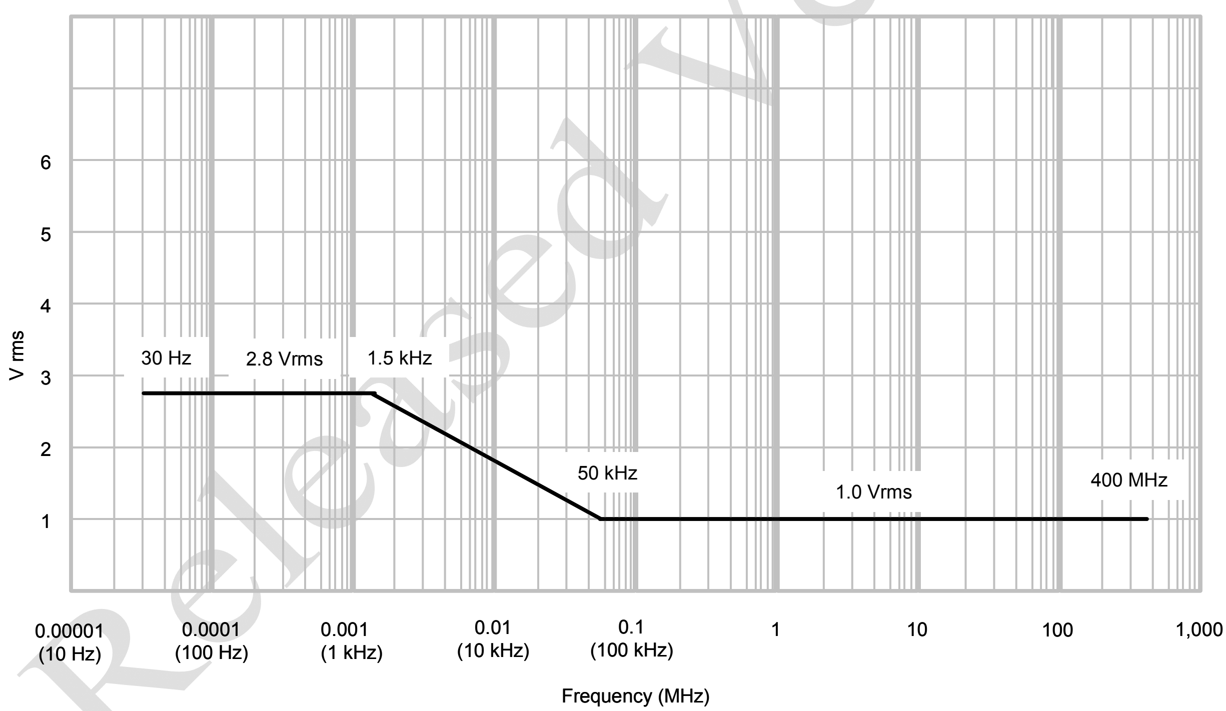
1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD113 Section 3.2.10.2.2 CS01- Low Frequency Ripple
3. EDD114 Section 3.2.10.2.3 CS02- Radio Frequency Ripple

The CS01 test limits for the ATLAS components level tests are 2.8 Vrms at the frequency range of 30 Hz to 1.5 kHz, and ramping in a straight line down to 1.0 volt at 50 kHz.

The CS02 limit for the ATLAS component level test is 1.0 Vrms at the frequency range of 50 KHz to 400 MHz

The CS01 and CS02 (injection of energy into power lines) performance are be verified at the nominal power bus voltage only.

Figure 6-5 - CS01/CS02 Limits



6.2.1.2 Conducted Susceptibility CS06 (Power line Transient)

ERD39: All ATLAS components that contain the DC/DC converters or power regulation devices shall undergo a CS06, Power line transient test conducted per MIL-STD-462 to the limits shown in Figure 6-6.

Rationale: Conducted susceptibility requirements verify that ATLAS components will operate properly if subjected to conducted or radiated emissions from other sources that could occur during launch or in orbit.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD115 Section 3.2.10.2.2 CS06- Transients

The CS06 (Power line Transient) test consists of both a positive transient test and a negative transient test, having amplitude as shown in Figure 6-6 superimposed on the power bus voltage as shown in Figure 6-6.

The CS06 positive transient pulse is limited to +56V peak absolute value and a 10 µs width at the power bus voltage steady-state bus crossing point as shown in Figure 6-6.

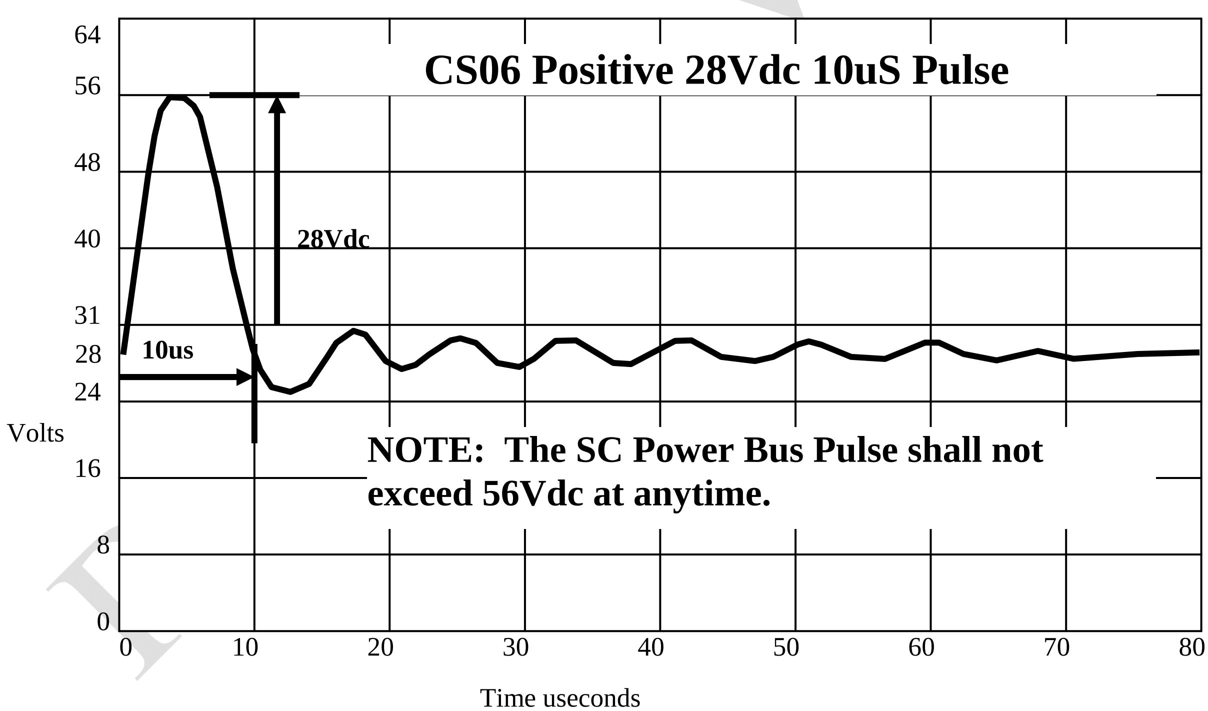
The CS06 negative transient pulse is limited to 0V value and a 10 µs width at the power bus voltage crossing point as shown in Figure 6-6.

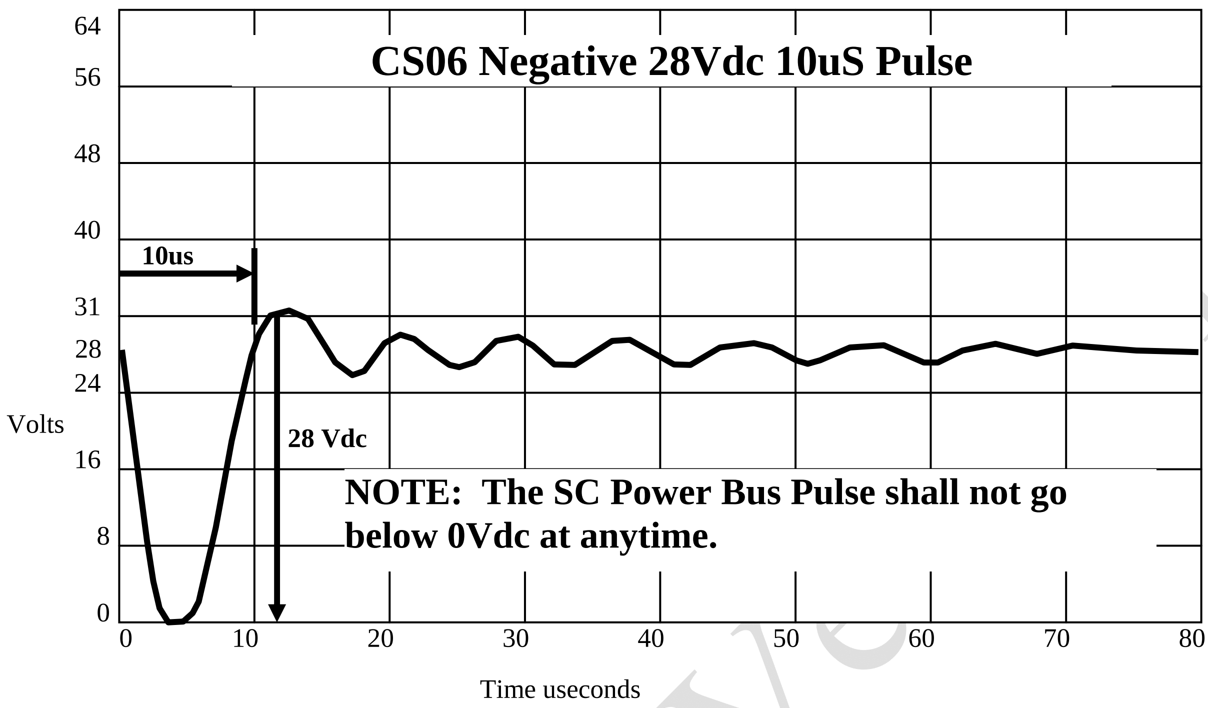
A transient signal should be applied to power lines in accordance with the procedures of MIL-STD-461C Part 3, Section 11.0, and MIL-STD-462. Because the applied transient signal should equal the power line voltage, the resulting total voltage is twice the power line level.

The transient should be applied for a duration of 5 minutes at a repetition rate of 60 pps.

The test should be applied to the input power leads of all payloads.

Figure 6-6 - CS06 Limits





6.2.2 Radiated Susceptibility Requirements

Radiated susceptibility test requirements cannot be finalized until launch vehicle is selected since the LV has a transmitter and tracking radars associated with it.

6.2.2.1 Radiated Susceptibility Test RS03 (E-field)

ERD40: All ATLAS components that contain power leads shall not malfunction or suffer degradation of performance when subjected to the following radiated test signals, in accordance with the requirements and test methods of test RS03 per MIL-STD- 462:

1. 20 V/m (TBR) 14 kHz to 30 GHz (TBR)
2. 30 V/m (TBR) 2287.5 ±5 MHz (spacecraft transmitter)
3. 30V/m (TBR) (TBD) (spacecraft X-band transmitter)
4. 20 V/m (TBR) 2250 ±5 MHz (launch vehicle S-band transmitter)
5. 20 V/m (TBR) 5765 ±5 MHz (launch vehicle C-Band transmitter)
6. 20 V/m (TBR) Frequency TBD C-band tracking radars.

These values will be updated once a launch vehicle is chosen.

Rationale: Radiated susceptibility requirements verify that ATLAS components will operate properly if subjected to radiated emissions from other sources that could occur during launch or in orbit.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD120 Section 3.2.10.4.1 Electric Field

6.3 MAGNETIC PROPERTIES

6.3.1 Magnetic Field Limits

ERD41: The maximum DC dipole moment produced by any ATLAS component shall not exceed 3.0 (TBD) Ampere per meter^2 (Am^2), dipole moment.

Rationale: Magnetic field limits ensure that ATLAS components are electromagnetically compatible with other systems and do not generate signals that interfere with spacecraft attitude control.

Trace:

1. EDD89 Section 3.2 Instrument Suite and Component
2. EDD121 Section 3.2.11 Magnetic Properties

6.3.2 Magnetic Field Environment

ERD42: All ATLAS components shall be exposed to a magnetic field environment of 650 microteslas or 6.24 Gauss without damage or degradation of performance.

Rationale: The magnetic field specification ensures that ATLAS components are designed to operate in the magnetic environment generated by other ICESat-2 systems.

Trace:

1. IDD TBD

7 PERFORMANCE TESTS

7.1.1 Comprehensive Performance Test

ERD60: All ATLAS components shall undergo a Comprehensive Performance Test (CPT) to verify full compliance of each flight unit to all of its performance requirements, in all modes and configurations and under varying input/output conditions, within the limitations of the environment and facilities.

Rationale: The CPT verifies that components meet requirements after exposure to the flight environments.

Trace:

1. EDD192 Section 4.1.4.17.1 Comprehensive Performance Test
2. EDD193 Section 4.1.4.17.1 Comprehensive Performance Test

7.1.2 Functional Test

ERD61: All ATLAS components shall undergo a Functional Test (FT), also known as a Limited Performance Test (LPT), to verify unit operation when it is not practical to use the CPT.

An Abbreviated Functional Test (AFT) may be used when it is necessary to monitor the performance of the flight unit over a very short period of time. The AFT is typically used when a unit is being subjected to vibration testing.

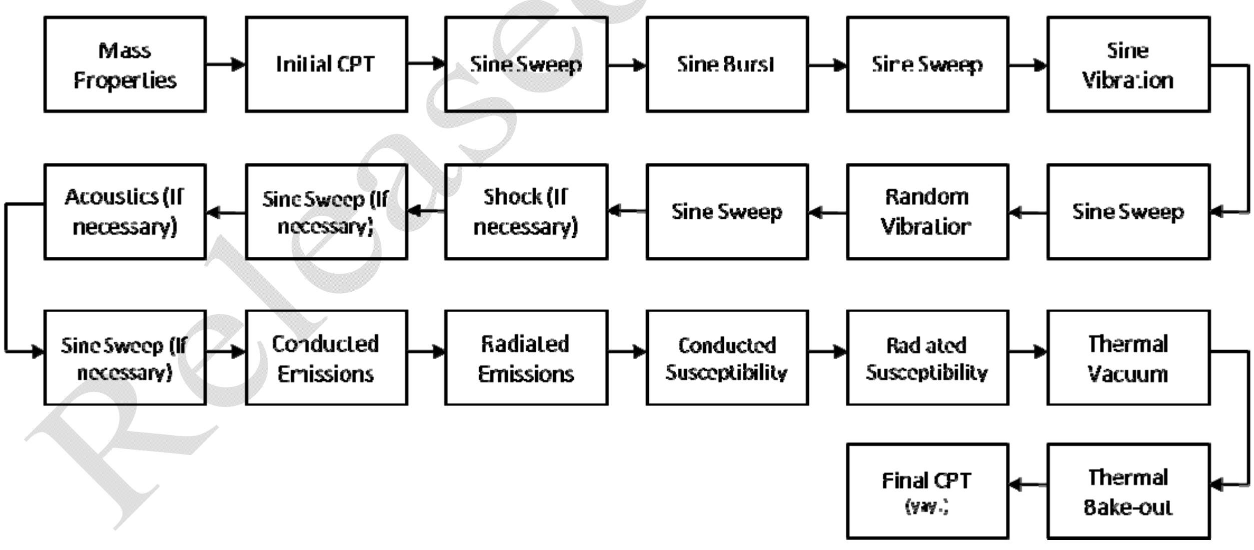
Rationale: The FT is a subset of the Performance Test and is designed to verify functionality of the flight unit under nominal input/output conditions. Typically, it is used during and after certain environmental tests to demonstrate that the functional capability of the ATLAS component has not been degraded due to environmental exposure, handling, and transportation. It is also commonly used during some of the hot and cold plateaus during thermal vacuum testing.

Trace:

1. EDD194 Section 4.1.4.17.2 Functional Test
2. EDD195 Section 4.1.4.17.2 Functional Test
3. EDD196 Section 4.1.4.17.2 Abbreviated Functional Test

8 TEST SEQUENCE

Figure 8-1: Baseline ATLAS Component Environmental Test Sequence



9 ATLAS COMPONENT VERIFICATION MATRIX

a -Analysis
i - Inspection

t - Test
t1 - Test if necessary
t2 - Tested with MEB

	Component									
Test	Laser	Fold mirrors	Fiber optics	Beam Expander	DOE	PBC	TCS	LRS	TAMS	BSM
ERD999 Verification Matrix	i	i	i	i	i	i	i	i	i	i
ERD1 Weight Verification	t	t	t	t	t	t	t	t	t	t
ERD2 CG Verification	t/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a
ERD3 MOI Verification	t/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a
ERD4 Component Fundamental Frequency	a	a	a	a	a	a	a	a	a	a
ERD104 ATLAS Structure Fundamental Frequency	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ERD6 Component Fundamental Frequency Verification (Sine Survey Test)	t	t	t	t	t	t	t	t	t	t
ERD106 ATLAS Structure Fundamental Frequency Verification (Sine Survey Test)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

ERD7 Component Quasi Static Loads Analysis	a	a	a	a	a	a	a	a	a	a

	Component									
Test	Laser	Fold mirrors	Fiber optics	Beam Expander	DOE	PBC	TCS	LRS	TAMS	BSM
ERD107 ATLAS Structure Quasi Static Loads Analysis	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ERD8 Component Sine Burst Test	t	t	t	t	t	t	t	t	t	t
ERD108 ATLAS Structure Sine Burst Test	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ERD11 Sine Vibration Analysis	a	a	a	a	a	a	a	a	a	a
ERD12 Sine Vibration Test	t	t	t	t	t	t	t	t	t	t
ERD 13 Component Random Vibration Analysis	a	a	a	a	a	a	a	a	a	a
ERD 113 ATLAS Structure Random Vibration Analysis	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

ERD 14 Component Random Vibration Test	t	t	t	t	t	t	t	t	t	t

	Component									
Test	Laser	Fold mirrors	Fiber optics	Beam Expander	DOE	PBC	TCS	LRS	TAMS	BSM
ERD 114 ATLAS Structure Random Vibration Test	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ERD15 Acoustics Analysis	a1	a1	a1	a1	a1	a1	a1	a1	a1	a1
ERD17 Acoustics Test	t1	t1	t1	t1	t1	t1	t1	t1	t1	t1
ERD18 Shock Analysis	a	a	a	a	a	a	a	a	a	a
ERD19 Shock Test	t1	t1	t1	t1	t1	t1	t1	t1	t1	t1
ERD20 Ambient Pressure	a	a	a	a	a	a	a	a	a	a
ERD21 Depressurization Rate	a	a	a	a	a	a	a	a	a	a
ERD22 Pressure Profile Verification Analysis	a	a	a	a	a	a	a	a	a	a
ERD24 Thermal Loads Analysis	a	a	a	a	a	a	a	a	a	a
ERD25 Thermal Analysis	a	a	a	a	a	a	a	a	a	a
ERD27 Thermal Vacuum Test	t	t	t	t	t	t	t	t	t	t
ERD28 Thermal Cycling Test	t1	t1	t1	t1	t1	t1	t1	t1	t1	t1
ERD 29 Thermal Bake Out	t1	t1	t1	t1	t1	t1	t1	t1	t1	t1
ERD30 Humidity Environment	a	a	a	a	a	a	a	a	a	a

	Component									
Test	Laser	Fold mirrors	Fiber optics	Beam Expander	DOE	PBC	TCS	LRS	TAMS	BSM
ERD31 Narrowband Conducted Emissions Test	t	n/a	n/a	n/a	n/a	n/a	n/a	t	n/a	t2
ERD32 Common Mode Noise (CMN) Conducted Emissions Test	t	n/a	n/a	n/a	n/a	n/a	n/a	t	n/a	t2
ERD34 Radiated AC Magnetic Field Specification	a1	n/a	n/a	n/a	n/a	n/a	n/a	a1	a1	a1
ERD35 Radiated AC Magnetic Field Test	t1	n/a	n/a	n/a	n/a	n/a	n/a	t1	t1	t1
ERD36 Radiated Narrowband Electric Field Test Specification	t	n/a	n/a	n/a	n/a	n/a	n/a	t	n/a	t2
ERD37 Radiated Narrowband Electric Field Test	t	n/a	n/a	n/a	n/a	n/a	n/a	t	n/a	t2
ERD38 Conducted Susceptibility CS01-CS02 Test	t	n/a	n/a	n/a	n/a	n/a	n/a	t	n/a	t2

ERD39 Conducted Susceptibility CS06 Test	t	n/a	n/a	n/a	n/a	n/a	n/a	t	n/a	t2

	Component									
Test	Laser	Fold mirrors	Fiber optics	Beam Expander	DOE	PBC	TCS	LRS	TAMS	BSM
ERD40 Radiated Susceptibility Test RS03	t	n/a	n/a	n/a	n/a	n/a	n/a	t	n/a	t2
ERD41 Magnetic Field Limits	t1	n/a	n/a	n/a	n/a	n/a	t1	t1	t1	t1
ERD42 Magnetic Field Environment	t1	n/a	n/a	n/a	n/a	n/a	t1	t1	t1	t1
ERD60 Comprehensive Performance Test	t	n/a	n/a	n/a	n/a	n/a	t	t	t	t
ERD61 Functional Test	t	n/a	n/a	n/a	n/a	n/a	t	t	t	t

	Component								
Test	LTR	BCE	LSA	OFA	Telescope	Aft Optics	Optical fibers	DAA	Structure
ERD999 Verification Matrix	i	i	i	i	i	i	i	i	i
ERD1 Weight Verification	t	n/a	t	t	t	t	t	t	t
ERD2 CG Verification	t/a	n/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a
ERD3 MOI Verification	t/a	n/a	t/a	t/a	t/a	t/a	t/a	t/a	t/a
ERD4 Component Fundamental Frequency	a	n/a	a	a	a	a	a	a	n/a
ERD104 ATLAS Structure Fundamental Frequency	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	a
ERD6 Component Fundamental Frequency Verification (Sine Survey Test)	t	n/a	t	t	t	t	t	t	n/a
ERD106 ATLAS Structure Fundamental Frequency Verification (Sine Survey Test)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	t
ERD7 Component Quasi Static Loads Analysis	a	n/a	a	a	a	a	a	a	n/a

	Component								
Test	LTR	BCE	LSA	OFA	Telescope	Aft Optics	Optical fibers	DAA	Structure
ERD107 ATLAS Structure Quasi Static Loads Analysis	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	a
ERD8 Component Sine Burst Test	t	n/a	t	t	t	t	t	t	t
ERD108 ATLAS Structure Sine Burst Test	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	t
ERD11 Sine Vibration Analysis	a	n/a	a	a	a	a	a	a	a
ERD12 Sine Vibration Test	t	n/a	t	t	t	t	t	t	t
ERD 13 Component Random Vibration Analysis	a	n/a	a	a	a	a	a	a	n/a
ERD 113 ATLAS Structure Random Vibration Analysis	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	a
ERD 14 Component Random Vibration Test	t	n/a	t	t	t	t	t	t	n/a

Test	Component								
	LTR	BCE	LSA	OFA	Telescope	Aft Optics	Optical fibers	DAA	Structure
ERD 114 ATLAS Structure Random Vibration Test	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	t
ERD15 Acoustics Analysis	a1	n/a	a1	a1	a1	a1	a1	a1	a1
ERD17 Acoustics Test	t1	n/a	t1	t1	t1	t1	t1	t1	t1
ERD18 Shock Analysis	a	n/a	a	a	a	a	a	a	a
ERD19 Shock Test	t1	n/a	t1	t1	t1	t1	t1	t1	t1
ERD20 Ambient Pressure	a	n/a	a	a	a	a	a	a	a
ERD21 Depressurization Rate	a	n/a	a	a	a	a	a	a	a
ERD22 Pressure Profile Verification Analysis	a	n/a	a	a	a	a	a	a	a
ERD24 Thermal Loads Analysis	a	a	a	a	a	a	a	a	a
ERD25 Thermal Analysis	a	a	a	a	a	a	a	a	a
ERD27 Thermal Vacuum Test	t	n/a	t	t	t	t	t	t	t
ERD28 Thermal Cycling Test	t1	n/a	t1	t1	t1	t1	t1	t1	t1
ERD 29 Thermal Bake Out	t1	t1	t1	t1	t1	t1	t1	t1	t1
ERD30 Humidity Environment	a	a	a	a	a	a	a	a	a

	Component								
Test	LTR	BCE	LSA	OFA	Telescope	Aft Optics	Optical fibers	DAA	Structure
ERD31 Narrowband Conducted Emissions Test	n/a	n/a	t1	n/a	n/a	n/a	n/a	t	n/a
ERD32 Common Mode Noise (CMN) Conducted Emissions Test	n/a	n/a	t1	n/a	n/a	n/a	n/a	t	n/a
ERD34 Radiated AC Magnetic Field Specification	n/a	n/a	a1	n/a	n/a	n/a	n/a	a1	n/a
ERD35 Radiated AC Magnetic Field Test	n/a	n/a	t1	n/a	n/a	n/a	n/a	t1	n/a
ERD36 Radiated Narrowband Electric Field Test Specification	n/a	n/a	t1	n/a	n/a	n/a	n/a	t	n/a
ERD37 Radiated Narrowband Electric Field Test	n/a	n/a	t1	n/a	n/a	n/a	n/a	t	n/a
ERD38 Conducted Susceptibility CS01-CS02 Test	n/a	n/a	t1	n/a	n/a	n/a	n/a	t	n/a

ERD39 Conducted Susceptibility CS06 Test	n/a	n/a	t1	n/a	n/a	n/a	n/a	t	n/a

	Component								
Test	LTR	BCE	LSA	OFA	Telescope	Aft Optics	Optical fibers	DAA	Structure
ERD40 Radiated Susceptibility Test RS03	n/a	n/a	t1	n/a	n/a	n/a	n/a	t	n/a
ERD41 Magnetic Field Limits	n/a	n/a	t1	n/a	n/a	n/a	n/a	t1	n/a
ERD42 Magnetic Field Environment	n/a	n/a	t1	n/a	n/a	n/a	n/a	t1	n/a
ERD60 Comprehensive Performance Test	n/a	n/a	t	n/a	n/a	n/a	n/a	t	n/a
ERD61 Functional Test	n/a	n/a	t	n/a	n/a	n/a	n/a	t	n/a

Test	Component		
	MEB	PDU	Electrical Harness
ERD999 Verification Matrix	i	i	i
ERD1 Weight Verification	t	t	t
ERD2 CG Verification	t/a	t/a	t/a
ERD3 MOI Verification	t/a	t/a	t/a
ERD4 Component Fundamental Frequency	a	a	a
ERD104 ATLAS Structure Fundamental Frequency	n/a	n/a	n/a
ERD6 Component Fundamental Frequency Verification (Sine Survey Test)	t	t	t
ERD106 ATLAS Structure Fundamental Frequency Verification (Sine Survey Test)	n/a	n/a	n/a
ERD7 Component Quasi Static Loads Analysis	a	a	a

	Component		
Test	MEB	PDU	Electrical Harness
ERD107 ATLAS Structure Quasi Static Loads Analysis	n/a	n/a	n/a
ERD8 Component Sine Burst Test	t	t	t
ERD108 ATLAS Structure Sine Burst Test	n/a	n/a	n/a
ERD11 Sine Vibration Analysis	a	a	a
ERD12 Sine Vibration Test	t	t	t
ERD 13 Component Random Vibration Analysis	a	a	a
ERD 113 ATLAS Structure Random Vibration Analysis	n/a	n/a	n/a
ERD 14 Component Random Vibration Test	t	t	t

Test	Component		
	MEB	PDU	Electrical Harness
ERD 114 ATLAS Structure Random Vibration Test	n/a	n/a	n/a
ERD15 Acoustics Analysis	a1	a1	a1
ERD17 Acoustics Test	t1	t1	t1
ERD18 Shock Analysis	a	a	a
ERD19 Shock Test	t1	t1	t1
ERD20 Ambient Pressure	a	a	a
ERD21 Depressurization Rate	a	a	a
ERD22 Pressure Profile Verification Analysis	a	a	a
ERD24 Thermal Loads Analysis	a	a	a
ERD25 Thermal Analysis	a	a	a
ERD27 Thermal Vacuum Test	t	t	t
ERD28 Thermal Cycling Test	t1	t1	t1
ERD 29 Thermal Bake Out	t1	t1	t1
ERD30 Humidity Environment	a	a	a

	Component		
Test	MEB	PDU	Electrical Harness
ERD31 Narrowband Conducted Emissions Test	t	t	t
ERD32 Common Mode Noise (CMN) Conducted Emissions Test	t	t	t
ERD34 Radiated AC Magnetic Field Specification	a1	a1	a1
ERD35 Radiated AC Magnetic Field Test	t1	t1	t1
ERD36 Radiated Narrowband Electric Field Test Specification	t	t	t
ERD37 Radiated Narrowband Electric Field Test	t	t	t
ERD38 Conducted Susceptibility CS01-CS02 Test	t	t	t
ERD39 Conducted Susceptibility CS06 Test	t	t	t

	Component		
Test	MEB	PDU	Electrical Harness
ERD40 Radiated Susceptibility Test RS03	t	t	t
ERD41 Magnetic Field Limits	t1	t1	t1
ERD42 Magnetic Field Environment	t1	t1	t1
ERD60 Comprehensive Performance Test	t	t	t
ERD61 Functional Test	t	t	t

10 ACRONYMS AND ABBREVIATIONS

A	Ampere
AFT	Abbreviated functional test
Am	Ampere meter
ASD	Acceleration spectral density
ATLAS	Advanced Topographic Laser Altimeter System
BSM	Beam Steering Mechanism
BTU	British thermal unit
C	Celsius
CE	Conducted emissions
CG	Center of gravity
cm	Centimeter
CMN	Common mode noise
CPT	Comprehensive performance test
CS	Conducted susceptibility
DA	Direct amplitude
DAA	Detector Array Assembly
dB	Decibel
DC	Direct current
deg	Degree
DOE	Diffractive Optical Element
E	Electric
EDD	Environmental Description Document
ELV	Expendable launch vehicle
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
ERD	Environmental Requirements Document
f	Frequency
F	Fahrenheit
FS	Factor of safety
FT	Functional test
Ft	Foot
g	Earth's gravitational force
GEVS	General Environmental Verification Specification
GHz	Gigahertz
GSFC	Goddard Space Flight Center
HDBK	Handbook
Hg	Mercury
HVPC	High Voltage Power Converter
Hz	Hertz
ICD	Interface control document
ICESat-2	Ice, Cloud, and Land Elevation Satellite 2
IM	Instrument Manager
IR	Infrared radiation

IRD	Interface Requirements Document
I&T	Integration and test
Kg	Kilogram
kHz	Kilohertz
Ku	Kurtz under
LHP	Loop heat pipe
LFT	Limited functional test
LPT	Limited performance test
LRS	Laser Reference System
LSM	Laser Select Mechanism
LTR	Lateral Transfer Retro-reflector
LV	Launch vehicle
MAC	Mass-acceleration curve
MAR	Mission Assurance Requirements
MHz	Megahertz
MIL	Military
m	Meter
MAR	Mission assurance requirements
MEB	Main Electronics Box
MECO	Main engine cutoff
mm	Millimeter
MOI	Moment of inertia
MOP	Maximum operating pressure
MS	Margin of safety
MSFC	Marshall Space Flight Center
N	Newton
NASA	National Aeronautics and Space Administration
NDE	Non destructive evaluation
OASPL	Overall sound pressure level
OFA	Optical Filter Assembly
Pa	Pascal
PDU	Power Distribution Unit
PSI	Pound per square inch
pT	pico Tesla
Q	Attenuation
QCM	Quartz crystal microbalances
RE	Radiated emissions
RH	Relative humidity
RMS	Root mean square
RS	Radiated susceptibility
s	Second
Sband	Satellite band
SEA	Statistical energy analysis
SC	Spacecraft
Sec	Second
STD	Standard
TAMS	Telescope Alignment Monitoring System
TBD	To be determined
TBR	To be resolved
TCS	Thermal Control Subsystem

TEC	Thermo electric coolers
V	Volt
W	Watt
μ (u)	Micro