ICESat-2 Project Controlled Document
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ICE, CLOUD, and Land Elevation Satellite (ICESat-2) Project

Spacecraft Requirements Document (SRD) ICESat-2-SYS-REQ-0002

Revision A

Effective Date: 03/30/2011

Expiration Date: 03/30/2016

National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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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 Configuration Controlled Request (CCR), 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."

Questions or comments concerning this document should be addressed to:

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CHANGE RECORD PAGE

Document Version	Document Release Date	CCR Number	CCR Approval Date	Pages Affected	Description
Rev -	02/23/2011	0058	02/23/2011	All	Initial release of document.
Rev A	03/30/2011	0088	03/30/2011	Page 9	Error made in the semi-major value of the MRD. Change impact SCSPEC33 to correct the value.

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
SCSPEC6	Ground Storage Phase	I, A, T	If prolonged ground storage is required, the spacecraft shall be placed in a state that does not require physical access by personnel for at least 7 days excluding anomalous events.	In the event of a launch vehicle delay or instrument delay the storage of the spacecraft is necessary.	Object Identifier:MRD38 Object Identifier:MRD169			
SCSPEC7	Ground Storage Phase	I, A, T	The spacecraft shall command, collect, and monitor telemetry from aliveness and limited functional tests of critical systems during the ground storage phase once every 30 days.	In the event of a launch vehicle delay or instrument delay the storage of the spacecraft is necessary. After storage the spacecraft must still meet all mission requirements. Aliveness tests and functional tests may be performed once every 30-days to ensure no deterioration of the spacecraft is occurring.	Object Identifier:MRD38 Object Identifier:MRD71 Object Identifier:MRD169			
SCSPEC8	Design Life	I, A, T	The spacecraft shall meet all mission requirements, including design lifetime after the completion of a Ground Storage Phase lasting up to 2 years.	Storage of the spacecraft will not degrade performance. Pre-Launch Phase	Object Identifier:MRD38 Object Identifier:MRD82			
SCSPEC9	SC Atlas Interface	I, T	The Spacecraft shall accommodate the instrument volume as defined in SC ATLAS IDD 104.	The ATLAS instrument system volume will fit within the limits shown in the ATLAS SPACECRAFT to INSTRUMENT MECHANICAL ICD Drawing 2153300. The defined not-to-exceed ATLAS system envelope will include the basic ATLAS structure, instrument-unique mounts, instrument-unique mounting hardware, mounting feet, thermal blankets (including billowing during launch and ascent), connectors (ATLAS-side only), intra-instrument harness (with connectors), and any other items that constitute any part of the deliverable instrument as well as any additional volume required for the IMSC.		Object Identifier:IDD104		
SCSPEC10	SC Alignment Cubes	I	The Spacecraft shall have optical cubes installed for measuring instrument to spacecraft relative	The observatory will have optical cubes on the instrument and		Object Identifier:IDD14		

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			alignment as described in SC-ATLAS IDD 14.	spacecraft for measuring relative alignment.				
SCSPEC11	Observatory Volume	I, T	The Observatory shall fit within the limits shown in LSIDD2.					Object Identifier:LSIDD2
SCSPEC12	SC Instrument Alignment	I, T	The Spacecraft alignment cubes shall be as described in SC ATLAS IDD 15.	Optical cubes on the spacecraft and instrument used for measuring alignment between the two will each be visible from two orthogonal axes when the instrument is integrated to the spacecraft. Optical cubes on the observatory will be covered with a flight quality (and flight capable) cover. Optical cube covers will allow cubes to be visible during Integration and Test Optical cube covers will be installed prior to integration onto the launch vehicle.		Object Identifier:IDD15		
SCSPEC488	SC Instrument Alignment		The Spacecraft alignment cubes shall be as described in SC ATLAS IDD 16.	Requirement split into two for clarity. This requirement captures content for IDD 16		Object Identifier:IDD16		
SCSPEC13	Launch Service Interface	I, A, M	The Spacecraft shall be designed for a launch in accordance with the Launch Services Interface Description Document (LSIDD), ICESat-2-SYS-IFACE-0326.	Launch requirements are documented in the LS LDD				
SCSPEC14	Launch Service Interface	I	The Spacecraft shall be compatible with the payload processing facility at the launch site.	Government will contract with a Payload Processing Facility.				Object Identifier:LSIDD89
SCSPEC15	Launch Site Safety	I, T	The Spacecraft and its Ground Support Equipment used at the launch site shall comply with the US Air Forces Space Command Manual 91-710 Range Safety User Requirements, dated July 1, 2004 and the Range Safety Memorandum entitled "Joint 45 SW/SE and 30 SW/SE Interim Policy Regarding EWR 127-1 Requirements for System Safety for Flight and Aerospace Ground Equipment Lithium-Ion Batteries".	Launch service environments, launch vehicle physical interface requirements and performance will all be defined in the LSIDD.				Object Identifier:LSIDD90
SCSPEC16	Contamination	I, A	The Spacecraft shall meet all contamination constraints when exposed to the cleanliness levied on the Government Furnished launch service as	The permitted launch service cleanliness levels will be defined in the LSIDD. The Spacecraft	Object Identifier:MRD38			Object Identifier:LSIDD49

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
			defined in the LSIDD 19-55 for ninety days.	should plan for this contamination and ensure adequate margins and processes are developed to meet mission performance requirements.	Object Identifier:MRD174			Object Identifier:LSIDD50 Object Identifier:LSIDD51 Object Identifier:LSIDD52 Object Identifier:LSIDD53 Object Identifier:LSIDD54 Object Identifier:LSIDD55
SCSPEC18	Aliveness Test	T	The Spacecraft shall perform aliveness tests of the spacecraft and integrated instrument while mated to the launch vehicle.	To identify any possible ground handling problems and provide confidence in a successful mate to the LV, the spacecraft needs to perform some aliveness tests. Examples of this include health check, function test or BIT of instrument and SC subsystems. Additionally, copper path tests will be performed whenever a de-mate/mate cycle takes place after the last functional test (to verify that every wire is properly reconnected.				
SCSPEC19	Launch and Early Orbit Phase	I, T	The Spacecraft shall transmit real-time spacecraft housekeeping telemetry starting prior to spacecraft separation from the launch vehicle.	To provide as much information as is reasonable about the spacecraft state of health during launch and to track / lock onto the spacecraft from the supporting ground stations. The s/c is required to be powered during the launch phase.	Object Identifier:MRD156			
SCSPEC20	Launch and Early Orbit Phase	I, T	The Spacecraft shall not free radiate RF energy inside the LV fairing.	To prevent any interference with LV electronics during launch.				
SCSPEC21	Instrument Mass	I, T	The Spacecraft shall provide for the payload mass as described in SC ATLAS IDD 2 and SC ATLAS	The mass of the ATLAS instrument is defined in the AIDD		Object Identifier:IDD2		

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	Accommodation		IDD 58.	and includes mounting flexures, intra-instrument harnessing, and any attached external harnessing extending to the spacecraft, but not including the mass of IMSC or harnessing extending between the IMSC and the spacecraft connector.		Object Identifier:IDD58		
SCSPEC22	Instrument Accommodation	I, A, M, T	The Spacecraft shall accommodate the payload moments of inertia as described in the SC ATLAS IDD 5.191	The moments of inertia of the ATLAS instrument system, including IMSC, will lie within the limits shown in Table 1.		Object Identifier:IDD5		
SCSPEC23	Spacecraft Mass	I, T	The Spacecraft mass including propellant and all necessary hardware required to interface with instrument and the launch vehicle, not including the Dual Payload Adaptor (DPA) and any margin shall not exceed 871 kg.	871kg is the Not to Exceed for the spacecraft wet mass, contractor must manage contingency/margin to this mass	Object Identifier:MRD67	Object Identifier:IDD2 Object Identifier:IDD57		
SCSPEC24	Launch and Early Orbit Phase	A, M, T	The Spacecraft shall have control authority using non-thruster components to stabilize the Observatory given launch vehicle attitude, velocity and induced tip-off rates, as defined in LSIDD78, LSIDD79, LSIDD80, LSIDD83.	Ensure compatibility with the launch vehicle tip off rates and compliance with gold rule language. An additional driving design consideration is the sun exclusion requirement.	Object Identifier:MRD43 Object Identifier:MRD51 Object Identifier:MRD53 Object Identifier:MRD157			Object Identifier:LSIDD78 Object Identifier:LSIDD79 Object Identifier:LSIDD80 Object Identifier:LSIDD83
SCSPEC25	Launch and Early Orbit Phase	A, T	The Spacecraft shall have a launch readiness capability once every 24 hours.	Spacecraft and Spacecraft staffing will meet a once daily launch attempt (once every 24 hours). Note: This does not include 1) Several launch delays in a row requiring crew stand-down, 2) Delays that are LV driven and/or 3) Delays that have been long enough to require battery reconditioning.	Object Identifier:MRD71			
SCSPEC26	Launch and Early Orbit Phase	A, T	The Spacecraft battery shall remain above 30% state of charge for a nominal launch, separation and initial sun acquisition.	Maintain sufficient battery power to be able to get to sun acquisition.	Object Identifier:MRD38			
SCSPEC27	Launch and	A, T	The Spacecraft shall autonomously deploy the	Want to have the solar arrays				

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	Early Orbit Phase		solar arrays and orient to the sun after separation from the launch vehicle.	deployed autonomously after launch so that a ground command is not needed.				
SCSPEC28	Launch and Early Orbit Phase	I, A	The Spacecraft hardware shall be vented to ensure depressurization consistent with the pressure profile, as documented in the LSIDD.	To prevent damage due to pressure differentials.				
SCSPEC29	Spacecraft Commissioning Phase	I, A	The Spacecraft shall complete commissioning within 30 days of launch.	The 60-day requirement for observatory commissioning is to constrain the amount of time necessary before commencing operations. It is anticipated that the S/C will finish within the first 30 days.	Object Identifier:MRD11 Object Identifier:MRD12 Object Identifier:MRD39 Object Identifier:MRD71			
SCSPEC30	Spacecraft Decommissioning Phase	I, A, M	The Spacecraft with the integrated instrument shall be compliant with NASA Procedural Requirements for Limiting Orbital Debris, NPR 8715.6.	Thus minimizing potential for future orbital debris, minimize non-operational lifetime on orbit, minimize earth impact debris footprint, and have a system capable of performing any required maneuvers at end of spacecraft design life.	Object Identifier:MRD11 Object Identifier:MRD12 Object Identifier:MRD54 Object Identifier:MRD71			
SCSPEC31	Spacecraft Decommissioning Phase	A, M	The Spacecraft shall perform a controlled re-entry at the completion of the mission design life	In compliance with NPR 8715.6 the spacecraft will perform a controlled re-entry. This is in lieu of a natural decay and uncontrolled entry.	Object Identifier:MRD54 Object Identifier:MRD71			
SCSPEC32	Spacecraft Decommissioning Phase	I, A	The Spacecraft shall meet the overall probability of success for controlled re-entry given the instrument debris casualty area allocation as defined in SC ATLAS IDD 129, as defined in the following figure	Joy to provide table.		Object Identifier:IDD129		

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			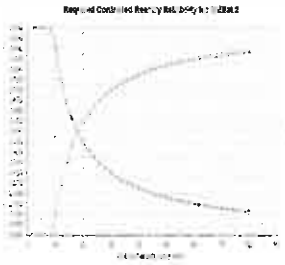					
SCSPEC33	Science Orbit	I, A, M, T	The Spacecraft shall achieve the mission science orbit after separation from the launch vehicle as defined in the ICESAT-2 mission science orbit be as follows: Element Mean Value Semi-Major Axis 6859441.69m Eccentricity 0.0013 Inclination 94° Right Ascension of the Ascending Node not controlled Argument of Perigee 90 degree	Orbit definition for ICESat-2 mission.	Object Identifier:MRD39			
SCSPEC34	Calibration Orbit	A, M, T	The Spacecraft shall control the ground track at the equator to an accuracy of ±800m (East or West) relative to a reference satellite ground track (RGT).	Beam needs to point to the reference ground track. This is done by a combination of off-pointing & orbit control. 800m allows for small, low-error off-point (~0.076deg). RGT's are modeled with an ideal orbit, taking into consideration gravity, but no drag.	Object Identifier:MRD18 Object Identifier:MRD19 Object Identifier:MRD33			
SCSPEC35	Pointing Control Error - Roll	A, M, T	The Spacecraft shall control the orientation of the outgoing laser beam to +/- 31.5 (1 sigma) micro-radians around the roll axis.	This is the spacecraft pointing control accuracy required to meet mission performance requirements.	Object Identifier:MRD15 Object			

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
					Identifier:MRD33 Object Identifier:MRD159			
SCSPEC487	Pointing Control - Yaw		The Spacecraft shall maintain pointing control to +/- 1000.0 (1 sigma) micro-radians about the yaw axis, including jitter.	This is the spacecraft pointing control accuracy required to meet mission performance requirements. This includes any s/c induced jitter.	Object Identifier:MRD15 Object Identifier:MRD33 Object Identifier:MRD159			
SCSPEC38	Decommissioning Phase	A, T	The Spacecraft shall achieve a Perigee Altitude of 50-km or less at the end of the Decommissioning Phase	To minimize the dispersions associated with the entry footprint it is necessary to achieve an entry angle of attack large enough to ensure capture and prevent any atmospheric skipping of the observatory.	Object Identifier:MRD54 Object Identifier:MRD71			
SCSPEC40	Launch Vehicle Interface	I, T	The spacecraft shall be powered by ground support equipment when on the LV as defined in LSIDD 5, 6, 7, 8, 9, 10, 11, and 12.	LSIDD section TBD	Object Identifier:MRD157			Object Identifier:LSIDD5 Object Identifier:LSIDD6 Object Identifier:LSIDD7 Object Identifier:LSIDD8 Object Identifier:LSIDD9 Object Identifier:LSIDD10 Object Identifier:LSIDD11 Object Identifier:LSIDD12
SCSPEC41	Launch Vehicle Interface	I, T	The spacecraft shall provide telemetry through and receive commands by ground support equipment when on the LV, as defined in LSIDD18, 19, and 20.	Commands to the spacecraft originate from the Spacecraft vendor's GSE. Power and command signals are isolated.	Object Identifier:MRD157		Object Identifier:GSIDD1 Object Identifier:GSIDD2 Object	Object Identifier:LSIDD18 Object Identifier:LSIDD19 Object

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Identifier:GSIDD3	Identifier:LSIDD20
SCSPEC42	Science Support	A, M, T	The Spacecraft shall point up to +/- 5 degrees off the reference ground track for science and calibration measurements.	Details of the off-nadir pointing requirements are in the GN&C section. The spacecraft will need to be able to point off nadir and do conical scans to support calibration and off-nadir functions.	Object Identifier:MRD19 Object Identifier:MRD20 Object Identifier:MRD23 Object Identifier:MRD119			
SCSPEC43	Science Support	A, T	The Spacecraft shall perform calibration scans that target a discrete number of points lying on a ground track that would be created by completely revolving a fixed instrument off-pointing angle about the nadir vector once.	Calibration scans are used by science to correct/calibrate the models used to generate the RGT. These off-pointing targets approximate a conical scan of approximately 5° or a series (almost continuous) calibration off-pointing during one orbit. Sci works with GS to select targets. Multiple calibration scans are used together in different scan types (see subsequent requirements).	Object Identifier:MRD19 Object Identifier:MRD20 Object Identifier:MRD23 Object Identifier:MRD119			
SCSPEC486	Science Support		The Spacecraft shall perform a calibration scan within 10 minutes. (as per SCSPEC43)	To ensure multiple scans over ocean can be obtained.	Object Identifier:MRD24 Object Identifier:MRD26 Object Identifier:MRD119			
SCSPEC44	Science Support	A, T	The Spacecraft shall perform Round-The-World Scans consisting of calibration scans performed back-to-back for an entire orbit.	Details of the off-nadir pointing requirements are in the GN&C section. However, approximately once every 8 days continual conical scans are need for calibration (excluding over Antarctica).	Object Identifier:MRD25 Object Identifier:MRD26 Object Identifier:MRD27 Object Identifier:MRD28			

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
					Object Identifier:MRD119			
SCSPEC45	Spacecraft Modes	A, T	The Spacecraft shall be capable of being commanded by the ground into any mode.	Operational flexibility but also should not be possible to command the Spacecraft into the launch or storage modes.	Object Identifier:MRD118 Object Identifier:MRD156		Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD14 Object Identifier:GSIDD15 Object Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD28 Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
SCSPEC46	Spacecraft Modes	A, T	Spacecraft shall autonomously transition to the safe hold mode(s) upon detection of faults that threaten the health and/or safety of the spacecraft.	Spacecraft should autonomously transition into a safer, less complex and less power demanding modes to recover from unexpected conditions.	Object Identifier:MRD164 Object Identifier:MRD169			
SCSPEC47	Spacecraft Modes	A, T	The Spacecraft shall transition out of the safe hold mode(s) only via ground command.	Ground intervention required when faults are encountered and corrected.	Object Identifier:MRD118			
SCSPEC48	Mission Lifetime	I, A, T	The Spacecraft shall meet all requirements for the 3-year on-orbit mission life.	Supports the Level 1 mission duration requirement.	Object Identifier MRD35			
SCSPEC49	Mission Lifetime	A, T	The spacecraft shall have propellant for minimum 7 years (2 sigma Schatten predictions) on-orbit.	Provides flexibility for extended operations, if other components are lasting beyond design life.	Object Identifier:MRD36			
SCSPEC51	Mission Lifetime	I, A, T	The spacecraft shall be fully redundant, with the exceptions of the following allowable single point failure components, as noted in the following table. 	Class C - high value mission	Object Identifier:MRD35 Object Identifier:MRD173 Object Identifier:MRD175			
SCSPEC52	Redundancy Requirements	I, A, T	The Spacecraft shall upon ground command, switch from the active unit to the backup unit for redundant systems.	Be able to switch back and forth between prime and backup units through ground commands.	Object Identifier:MRD118		Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12	

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							Object Identifier:GSIDD13 Object Identifier:GSIDD14 Object Identifier:GSIDD15 Object Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD28 Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	
SCSPEC53	Redundancy Requirements	I, A, T	A single fault occurring on the A or B side of the command, power, and telemetry path shall not propagate to the redundant system	To protect from any credible event, which may cause the loss of a functional path, and to reduce the likelihood of the loss of the alternate or redundant path.				
SCSPEC54	Redundancy Requirements	I, A, T	The Spacecraft shall provide status telemetry for redundant systems when powered.	Telemetry needs to come from redundant units as well as prime units.	Object Identifier:MRD169		Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object	

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							Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC55	Redundancy Requirements	I, T	The Spacecraft shall provide in housekeeping telemetry which unit in a redundant system is operating.	Ground needs to know which side of the redundant string is operating.	Object Identifier:MRD169		Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object	

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							Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC56	Redundancy Requirements	I, A, M, T	The Spacecraft shall remain power positive and thermally safe in safe hold mode without ground commanding.	In the event there is a failure in the communications or operations systems the Spacecraft can safe itself including powering off non-essential equipment as necessary.	Object Identifier:MRD164 Object Identifier:MRD169 Object			

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
					Identifier:MRD172			
SCSPEC57	Autonomy	A, T	The Spacecraft shall operate in operational mode and meet performance requirements for at least 72 hours without ground commands.	In support of lights-out operations, the spacecraft should have sufficient command storage to implement science, record and playback operations as planned during that 72-hour period. It is assumed that GS will autonomously acquire data and confirm data transmissions from the spacecraft. This will also include being able to keep within pointing requirements using on-board navigation capabilities.	Object Identifier:MRD89			
SCSPEC58	Autonomy	T	The Spacecraft shall autonomously continue in operational mode pointing to the Reference Ground Track upon completion of 72 hour ATS Load.	In case ground commanding is lost, complete the current stored commands and then go to a safe operating configuration until commands are received. Verify if this is the correct path or return to ICESAT path				
SCSPEC59	Autonomy	T	The Spacecraft shall autonomously switch to the backup component of redundant systems based on established failure criteria.	To ensure survivability safe hold mode(s) the spacecraft should be able to switch to a back-up element of a redundant system. There is no requirement for autonomous switching to support any other functions.	Object Identifier:MRD174			
SCSPEC60	Autonomy	I, T	The Spacecraft shall not autonomously switch to a known failed redundant component.	To prevent switching from a healthy unit to a failed unit.				
SCSPEC61	Autonomy	I, T	The Spacecraft autonomy system shall utilize a set of autonomy rules in flight software	Want to be able to change autonomy rules from the ground.				
SCSPEC62	Autonomy	T	The Spacecraft shall modify autonomy rules and limits in flight based on ground commands.	Autonomy rules & Fault Detection & Correction rules may need to be modified because of component aging, or unforseen circumstances. It is understood that autonomy or FDC functions that are inherently performed by hardware or by firmware may not be capable of being changed in flight.	Object Identifier:MRD76		Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13	

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							Object Identifier:GSIDD14 Object Identifier:GSIDD15 Object Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD28 Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	
SCSPEC63	Autonomy	I, T	The Spacecraft shall initiate a stored command sequence in response to pre-defined Spacecraft and Instrument monitored conditions.	To provide a nominal response based on changing states within the spacecraft.				
SCSPEC64	Autonomy	T	The Spacecraft shall over-ride autonomous functions in response to ground command.	The ground may need to over-ride or suspend an autonomous response so it can be reprogrammed or just simply stopped. Allowable exceptions include HW or firmware that cannot be modified post-launch.			Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13	

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SCSPEC65	Autonomy	I, T	The Spacecraft shall report autonomous reconfigurations in housekeeping telemetry.	Whenever the state of a hardware configuration is changed this needs to be tracked and reported in T/M			Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22	

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SCSPEC66	Autonomy		The Spacecraft shall monitor pre-defined components, instrument, and subsystems.	Monitoring the power, temperature and operations of sub-systems provides the information necessary to take autonomous actions.				
SCSPEC67	Autonomy	I, T	The Spacecraft shall report detection of out of limit conditions for monitored systems in Spacecraft housekeeping telemetry.	Fault detection and limit violation data should be available for ground analysis.	Object Identifier:MRD169		Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20	

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC68	Autonomy	T	The Spacecraft subsystems that perform self-diagnostics shall report the results in Spacecraft housekeeping telemetry.	If a heritage system is capable of performing self-diagnostics then use that capability.	Object Identifier:MRD169		Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20	

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Released: March 30, 2011

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SCSPEC69	Autonomy	I, T	The Spacecraft subsystems that support self-diagnostics shall accept ground commands to run diagnostics and report the results in Spacecraft housekeeping telemetry.	Flexibility is necessary to support debugging conditions that may not be known until after launch.			Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20	

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Released: March 30, 2011

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SCSPEC70	Autonomy	T	The Spacecraft shall send a warning message to the instrument upon detection of an off nominal spacecraft condition.	Mode change from nominal to off-nominal or detected power, attitude, etc., problems so the instruments can elect to perform a self-protection as necessary.				
	Autonomy	T	The Spacecraft shall send a warning message to the instrument whenever the sun is predicted to be within 35 degrees of the instrument telescope field	Supports protection of the instrument.				

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			of view.					
SCSPEC72	Availability	I, A, M	The Spacecraft shall operate in nominal Science mode > 98% of the time, after commissioning is complete, as measured on a monthly basis.	Need to be able to be in operational mode and collecting science data at least 98% of the time.	Object Identifier:MRD95 Object Identifier:MRD114			
SCSPEC73	Availability	I, A, T	The Spacecraft shall record science data continuously in the normal operations mode.	There should not be any subsystem on the Spacecraft that needs maintenance that interferes with the mission observations. The ground may command the Spacecraft to different attitudes. Should be able to do maneuvers with the instrument powered.	Object Identifier:MRD95			
SCSPEC77	Structure and Mechanical Systems	I	The Spacecraft structure shall include a structural mounting interface for the instrument as described in SC ATLAS IDD 10.	To minimize distortion caused by mounting interface.		Object Identifier:IDD10		
SCSPEC78	Structure and Mechanical Systems	I, A, M	The Spacecraft shall provide unobstructed (clear and glint free) fields of view as described in SC ATLAS IDD 1.	The ATLAS instrument will have the optical fields of view shown in the ATLAS SPACECRAFT to INSTRUMENT MECHANICAL ICD Drawing 2153300.		Object Identifier:IDD1		
SCSPEC79	Structure and Mechanical Systems	I, T	The Spacecraft with the instrument integrated in the stowed/launch configuration shall meet the dynamic envelope for the launch vehicle fairing, as specified in the LSIDD2.	The dynamic envelope takes into account the movement of the LV fairing and the movement of the Spacecraft (assuming it meets the required stiffness) to ensure no contact with the fairing wall during launch.	Object Identifier:MRD157			Object Identifier:LSIDD2
SCSPEC81	Contamination Control System	I, A, T	The average spacecraft contamination flux of material condensable at -20 degrees C to the instrument aperture shall be less than 1e-14 g/cm2/s.	Instrument telescope & optics are contamination sensitive. This level is defined at the front plane of the telescope baffle.	Object Identifier:MRD174			
SCSPEC83	Contamination Control System	I, A, T	The average Spacecraft flux of material condensable at -20 degrees C to the instrument radiators shall be less than 1e-11 g/cm2/s.	Instrument radiator is contamination sensitive.	Object Identifier:MRD174			
SCSPEC85	Contamination Control System - Instrument integration	I	The spacecraft to instrument surface interface cleanliness, at the time of integration with the instrument, shall be Level 400 A per IEST-CC-1246 or better.		Object Identifier:MRD174			
SCSPEC86	Contamination Control System - Encapsulation	I	The spacecraft surface cleanliness at time of encapsulation shall be visibly clean, highly sensitive per SN-C-005.		Object Identifier:MRD174			

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
SCSPEC87	Contamination Control System	I	After instrument integration, the spacecraft shall be processed in ISO 14644-1 Class 7 or cleaner facilities, unless the instrument is bagged.		Object Identifier:MRD174			
SCSPEC88	Contamination Control - CVCM	I, T	Spacecraft materials with a line of sight to the instrument aperture shall meet the following criteria: Shall have CVCM < 0.1% per ASTM E595		Object Identifier:MRD174			
SCSPEC484	Contamination Control - Silicones		Spacecraft materials with a line of sight to the instrument aperture shall meet the following criteria: Shall not contain silicones unless appropriate mitigation techniques are employed to eliminate contamination migration.		Object Identifier MRD174			
SCSPEC485	Contamination Control - Particles		Spacecraft materials with a line of sight to the instrument aperture shall meet the following criteria: Shall not generate particles under normal handling conditions.		Object Identifier:MRD174			
SCSPEC89	Contamination Control System	I, A	The spacecraft bus vents shall be positioned such that they do not have a line of sight to the instrument.	Contamination deposits can degrade Instrument performance.	Object Identifier:MRD174			
SCSPEC90	Thermal System	A, T	The Spacecraft, with the instrument integrated, shall meet performance requirements in the thermal environment, per the Environmental Requirements Document, for continuous operations in all modes.	To ensure hardware performs within qualified limits for on orbit operations.				
SCSPEC91	Thermal System	A, T	The Spacecraft shall maintain subsystems, with the instrument installed, within their design survival temperature range when the Spacecraft is in Safe Hold Mode.	During Safe Hold the Spacecraft subsystems including instrument are allowed to thermally drift to minimize power consumption. The Spacecraft supplies power to all survival heaters.				
SCSPEC92	Thermal System	A, T	The spacecraft shall provide power to instrument survival heaters as defined in SC ATLAS IDD 22.	The instrument survival temperature will be maintained by survival heaters powered by the spacecraft.		Object Identifier:IDD22		
SCSPEC93	Thermal System	A, T	The Spacecraft shall maintain subsystems within their operational design temperature range in all modes, except for components that are not required to be operational during those modes; such as cold-	Keeping the Spacecraft thermally stable will have a direct affect on quality of data.				

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
			spares.					
SCSPEC94	Thermal System	I, A	The Spacecraft battery temperatures shall be designed to operate within +/-5C (TBP) from their optimum operating temperature.	To preserve and maximize battery lifetime.				
SCSPEC95	Thermal System	A, T	The spacecraft thermal control system shall operate independently of the ATLAS thermal control system during nominal operations as defined in SC ATLAS IDD 20.	The instrument will be thermally isolated from the bus.		Object Identifier:IDD20		
SCSPEC96	Thermal System	I, A	The Spacecraft shall meet the instrument mounting thermal interface as defined in SC-ATLAS IDD 21, SC ATLAS IDD 112 and SC ATLAS IDD 130.	A thermally stable instrument mounting interface will help remove the thermal distortions and alignment uncertainty associated with pointing the instruments.		Object Identifier:IDD21 Object Identifier:IDD112 Object Identifier:IDD130		
SCSPEC97	Thermal System	I	The Spacecraft shall monitor the temperatures of the instrument mounting interface at the spacecraft side of the interface.					
SCSPEC100	Thermal System	I, T	The Spacecraft shall have a thermal control system that monitors and reports, in housekeeping telemetry, the temperatures of subsystems on the Spacecraft.	Tracking and trending Spacecraft temperatures is important to the longevity of the mission.				
SCSPEC101	Thermal System - IMSC Thermal Control	A, T	The Spacecraft shall provide the thermal control of the Instrument Mounted Spacecraft Components as defined in SC ATLAS IDD 24.	Current IMSC thermal control plan places Spacecraft in charge of thermal design.		Object Identifier:IDD24		
SCSPEC483	Thermal System - IMSC Thermal Control		The Spacecraft shall provide the thermal control of the Instrument Mounted Spacecraft Components as defined in SC ATLAS IDD 110.	Current IMSC thermal control plan places Spacecraft in charge of thermal design.		Object Identifier:IDD110		
SCSPEC102	Thermal System	T	The Spacecraft programmable thermal set points shall be reprogrammable on orbit via ground command.	If programmable set points are used it provides Mission operations a better understanding of the observatory response to the space environment sometimes makes necessary changing thermal set points on the S/C			Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object	

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							Identifier:GSIDD14 Object Identifier:GSIDD15 Object Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD28 Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	
SCSPEC105	Electrical Requirements	A, T	Single-event power bus transients superimposed on the power buses at the instrument interface due to normal subsystem load switching shall be limited to +/-3.0V from the steady-state bus value.	allocation from ICESat-2 Electrical System requirements specification				
SCSPEC106	Electrical Requirements	A, T	The rate of change of any operational current transients on power buses at the instrument interface shall not exceed 30 mA/us.	reduce EMI emissions				
SCSPEC107	Electrical Requirements	A, T	When a spacecraft power service is switched off, the peak voltage transients to the instrument induced on the power service shall not exceed +40V, nor fall below -1V.	Protect component power inputs from over-stress				
SCSPEC108	Electrical Requirements	I	The ICESat-2 mission shall implement a single-point ground scheme for the primary power bus.	RF components can be grounded through the structure. Implementation of single-point ground	Object Identifier:MRD30			

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
SCSPEC109	Electrical Requirements	I	The Single-Point Ground (SPG) shall be located within the ICESat-2 spacecraft.	RF components can be grounded through the structure. Implementation of single-point ground	Object Identifier:MRD30			
SCSPEC110	Electrical Requirements	I, T	All the primary power returns shall be tied together at the SPG and connected to the SC structure (or SC chassis ground).	RF components can be grounded through the structure. Implementation of single-point ground				
SCSPEC111	Electrical Requirements	I	The ICESat-2 structure shall not be used intentionally to carry DC current or common mode current.	Implementation of single-point ground				
SCSPEC112	Electrical Requirements	I, T	The ICESat-2 structure shall be used as a common reference point for all electronics.	Implementation of single-point ground				
SCSPEC113	Electrical Requirements	I	The ICESat-2 1553 bus shall use transformer coupling as defined in Section 4.5.1.5.1 of MIL-STD-1553B.	Implementation of MIL-STD-1553 bus				
SCSPEC114	Electrical Requirements	I	The ICESat-2 1553 bus coupling transformer shall have a turn ratio of 1:1.41+/-3% (stub to bus).	Implementation of MIL-STD-1553 bus				
SCSPEC115	Electrical Requirements	I	The ICESat-2 1553 bus coupling transformer shall include fault isolation resistors in accordance with Section 4.5.1.5.1.2 of MIL-STD-1553B with R = 59 ohms (R = 0.75*Zo, with Zo = 78 ohms +/-10%).	Implementation of MIL-STD-1553 bus				
SCSPEC116	Electrical Requirements	I	The ICESat-2 1553 bus shall have a characteristic impedance of 78 ohms +/- 10% and be terminated at both ends of the bus with 78 ohms +/- 10% termination.	Implementation of MIL-STD-1553 bus				
SCSPEC117	Electrical Requirements	I, T	The ICESat-2 spacecraft shall provide a 1 Pulse per Second (pps) to ATLAS components that require SC timekeeping information.	Implementation of 1pps for instrument timekeeping		Object Identifier:IDD98		
SCSPEC118	Electrical Requirements	I	The spacecraft 1 pps shall be transmitted using redundant RS-422 differential signals.	Implementation of 1pps for instrument timekeeping				
SCSPEC119	Electrical Requirements	I	Subsystems connected using LVDS signals shall adhere to the electrical terminations as given in the Electrical Characteristics of Low Voltage Digital Signaling (LVDS) Circuits (TIA/EIA-644).	Implementation of LVDS signals				
SCSPEC120	Electrical Requirements	I	SpaceWire network shall use four twisted pair wires (100+2% ohm cable) with a separate shield around each twisted pair and an overall shield per ESA Space Wire Specification (ECSS-E-50-12).	Implementation of SpaceWire				
SCSPEC121	Electrical	I	The Spacecraft shall transmit power to the ATLAS	Overall requirement for the		Object		

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
	System		instrument across the interfaces defined in SC ATLAS IDD 31.	spacecraft to supply power to the instrument. IDD31 specifically addresses power distribution and power switching. Bus voltage is specified to be wide to envelope all spacecraft vendors. After spacecraft award the bus voltage specification will be reworded to correspond to actual spacecraft voltage limits.		Identifier:IDD31		
SCSPEC122	Electrical Requirements	I	The Spacecraft shall provide data interfaces as defined in SC ATLAS IDD 65.	ATLAS design currently incorporates 1553 command and housekeeping and Spacewire for high-rate science and LRS data		Object Identifier:IDD65		
SCSPEC123	Electrical Requirements	I	The Spacecraft shall provide redundant electrical interfaces as defined in SC ATLAS IDD 33.	Improve reliability		Object Identifier:IDD33		
SCSPEC466	Electrical Requirements		Single-event power bus transients superimposed on the power buses at the instrument interface due to normal subsystem load switching shall be limited to +/-3.0V from the steady-state bus value.	Reduce EMI emissions				
SCSPEC124	Power System	I, T	The Spacecraft shall provide the instrument power as defined in SC ATLAS IDD 35, SC ATLAS IDD 96, SC ATLAS IDD 38, ATLAS IDD 160.	Detailed power services required from the spacecraft.		Object Identifier:IDD35 Object Identifier:IDD38 Object Identifier:IDD96 Object Identifier:IDD160		
SCSPEC126	Power System	I, T	The Spacecraft shall not propagate single power faults across the instrument interface as defined in SC ATLAS IDD 43.	Faults on one side of a redundant interface should not take out the other redundant interface (otherwise the supposedly redundant interface provides no protection).		Object Identifier:IDD43		
SCSPEC127	Power System	I, T	The Spacecraft to instrument power buses shall be as defined in SC ATLAS IDD 49.			Object Identifier:IDD49		

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SCSPEC128	Power System	I	The Spacecraft harness and fusing shall be sized for peak allocated power levels as defined in SC ATLAS IDD 55.	Harness and fuses must be sized for the peak loads, not just nominal operating loads.		Object Identifier:IDD55		
SCSPEC129	Power System	I	The Spacecraft data signal lines to the instrument shall be connected as defined in SC ATLAS IDD 32.	The IEM uses one 1553 connection to the spacecraft for command and telemetry. The IEM uses one spacewire connection to the spacecraft for science data. The 1Hz time-of-day pulse will come across a discrete connection.		Object Identifier:IDD32		
SCSPEC130	Power System	I	The Spacecraft shall provide interface connections as specified in SC ATLAS IDD 61, and SC ATLAS IDD 115.	spacecraft interface power interfaces to the instrument are defined in the AIDD		Object Identifier:IDD61 Object Identifier:IDD115		
SCSPEC131	Electrical System	A, M	The Power System shall reach a full State of Charge at least once every 8 orbits. 632	Safe hold mode is a minimum power mode, in a solar array to sun attitude, the spacecraft should be able to charge battery and maintain all powered functions.				
SCSPEC132	Electrical System	I, T	The Spacecraft shall provide short circuit protection or current limitation for each switchable power circuit.	Prevents damage to harnesses & electronics during I&T and propagation of failures on orbit.				
SCSPEC133	Electrical System	I, T	The Spacecraft shall provide protection from over voltage and under voltage conditions for the Spacecraft.	Damage to electronics is probable if bus voltage is too high or too low.				
SCSPEC134	Electrical System	T	The Spacecraft circuit protection for switchable power circuits shall be resettable via ground command and not autonomously.	Want to be able to reset circuits manually and not end up in an autonomously resetting cycle.			Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD14 Object	

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							Identifier:GSIDD15 Object Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD28 Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	
SCSPEC135	Electrical System	T	The Spacecraft shall be powered from Spacecraft Test Equipment with flight or ground batteries installed.	Supports ground processing and operations on the LV.				
SCSPEC136	Electrical System	T	The Spacecraft shall be powered from Spacecraft Test Equipment with flight or ground batteries uninstalled.	Flight batteries may be removed to facilitate testing or held in storage. Need to be able to continue test program when batteries are not installed in the vehicle.				
SCSPEC137	Electrical System	I, T	The Spacecraft shall monitor and report in housekeeping telemetry switch position for each switchable power circuit at the Spacecraft distribution point.	Monitor both sides of a switched circuit to ensure that enable and disable are positively controlled.	Object Identifier:MRD169		Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object	

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SCSPEC138	Electrical System	I, T	The spacecraft shall monitor and report in housekeeping telemetry the current of each power distribution branch and each instrument power service.	Monitoring state of health	Object Identifier:MRD169		Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object	

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Released: March 30, 2011

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SCSPEC139	Electrical System	I, T	Spacecraft **shall** monitor battery voltage continuously up to launch vehicle fairing close out and via the umbilical through launch.	KSC Launch site safety requirements currently specify monitoring individual cell voltages; waivers are required for any designs which don't monitor individual cell voltages.				
SCSPEC502	Electrical System		The Spacecraft shall provide instantaneous peak power to the ATLAS instrument as defined in SC ATLAS IDD36, IDD128 and IDD161.	The interface descriptions specified provide the operational and survival heater peak-power draws for the instrument.		Object Identifier:IDD36 Object		

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Released: March 30, 2011

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						Identifier:IDD128 Object Identifier:IDD161		
SCSPEC140	Electrical System	I, T	The Spacecraft shall monitor battery voltage on-orbit.	Necessary for on-orbit battery charge control and battery management.				
SCSPEC141	Electrical System	I, T	The Spacecraft shall monitor and report in housekeeping telemetry voltage for each power branch.	Monitoring state of health	Object Identifier:MRD169		Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object	

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							Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC142	Electrical System	I, A	The Spacecraft End-of-Discharge voltage at the End of Life shall be TBD.	To maximize the operational life of the battery it should not be deep cycled. Need to make sure that the power end of life is sufficient for laser operations. SC-ATLAS IRD should state the amount of power the instrument needs for EOL.				
SCSPEC143	Electrical System	I, A, M, T	The Spacecraft flight battery depth of discharge post sun acquisition shall not exceed 30% in nominal operations and upto 40% with a single failure.	30% for operational modes but TBR for mission life requirements.				
SCSPEC503	Electrical System		Spacecraft cables that provide power from the spacecraft to the instrument shall route to interfaces mounted on the ATLAS instrument.	The ATLAS-to-Spacecraft electrical interfaces shall be mounted on the ATLAS instrument (i.e. an interface panel with bulkhead connectors, etc).		Object Identifier:IDD59		
SCSPEC504	Electrical System		Spacecraft primary and redundant interface connectors to the ATLAS instrument shall be differentiated by clearly marking all boxes and cables.	Clear marking is required to prevent mis-connecting and damage during I&T.		Object Identifier:IDD60		
SCSPEC144	FSW and Firmware	I, T	The spacecraft shall monitor instrument telemetry and respond autonomously to detected problems.	The instrument does not have an internal autonomy system. Instrument health and safety monitoring, as well as safing in response to predetermined out-of-range instrument conditions will be performed by the spacecraft.				
SCSPEC145	FSW and Firmware	I, T	The spacecraft shall monitor a number of instrument telemetry points defined in SC ATLAS IDD 119 as part of its autonomous instrument monitoring and response function.	The instrument monitoring and safing autonomy function in SCSPEC144.		Object Identifier:IDD119		
SCSPEC148	Electrical System	I, T	The Spacecraft shall have power, enable, arm, and fire functions for all circuits supplying power to a hazardous or critical function.	To provide appropriate safety and protection circuits.				
SCSPEC149	Flight software	I, T	The Spacecraft flight software contained in	This requirement provides the	Object			

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	and Firmware		reprogrammable memory shall be reprogrammable on orbit, except for the start-up code contained in Start-Up ROM (SUROM), which should be write-disabled.	capability to modify code in flight.	Identifier:MRD76			
SCSPEC150	Flight software and Firmware	I, T	Two separate images of all reprogrammable flight code shall be maintained in separate reprogrammable memory parts, and the Start-Up Code shall attempt to alternatively boot out of these 2 images upon failed boot up attempts.	Two separate images provide for the possibility that one set of code becomes corrupted. Images in separate are more reliable than two images in one device.				
SCSPEC151	Flight software and Firmware	I, T	Flight Software uploads/patches shall modify only one image of the flight code at a time, and the other image shall not be modified until that flight software patch has been verified.	In the event that there is a problem with one load image, this requirement prevents both becoming corrupted.	Object Identifier:MRD76			
SCSPEC152	Flight software and Firmware	I, T	The Spacecraft flight software shall report single bit memory errors that have been detected and corrected by the error detection and correction hardware.	Provides monitoring of memory scrub function.				
SCSPEC153	Flight software and Firmware	I, T	The Spacecraft flight software shall report multiple bit errors in memory that have been detected by the error detection and correction hardware.	Provides monitoring of multibit errors.				
SCSPEC154	Flight software and Firmware	I, T	The Spacecraft Flight software shall accept loads for any location in memory.	This requirement avoids the situation where some sections of EEPROM memory are not writable post-launch. Exceptions are SUROM & PROM	Object Identifier:MRD76			
SCSPEC155	Flight software and Firmware	I, T	The Spacecraft flight software shall, upon ground command, dump any location in program memory and hardware registers.	To support debugging efforts and provide additional telemetry points which may have been unanticipated at development time			Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD14 Object Identifier:GSIDD15 Object	

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD28 Object Identifier:GSIDD29 Object Identifier:GSIDD30	

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							Object Identifier:GSIDD31 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC156	Flight software and Firmware	I, T	The Spacecraft flight software shall, upon ground command, dump the entire memory of on-board processors.	Supports debugging efforts and provides telemetry state of the on-board flight software.			Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD14 Object Identifier:GSIDD15 Object Identifier:GSIDD16	

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Released: March 30, 2011

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							Object Identifier:GSIDD17 Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD28 Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC157	Flight software and Firmware	I, T	The Spacecraft flight software memory dump capability shall not interrupt nominal execution of the flight software.	This requirement is not to effect the ongoing Spacecraft operations or software processes. This requirement should only effect capability to get the memory dump telemetry on the ground.				
SCSPEC158	Flight software and Firmware	I, T	The Spacecraft shall implement independent hardware-based time-out monitoring and processor-reset circuits to recover from a processor hardware or software anomaly.	On-board processors should use hardware "watch dog" timers, or some hardware implemented system independent of the CPU to interrupt stuck software.				
SCSPEC159	FSW and Firmware	I, T	The Spacecraft shall time tag telemetry, with an accuracy of 100 milliseconds or less, to the GPS time.	Rationale. Defines minimum time accuracy requirement for telemetry.	Object Identifier:MRD66			
SCSPEC162	Event Logging	I, T	The Spacecraft shall preserve contents of the event log after rebooting a processor.	Aids in troubleshooting the cause of reboots.				
SCSPEC163	Initialization	I, T	The Spacecraft shall initialize flight software to a known safe state and begin operations without the need of a ground based command.	To reboot in case of a reset.				
SCSPEC164	Initialization	I, T	The Spacecraft shall reboot to a known safe state upon ground command.	This is a reboot of the flight software instruction set loaded			Object Identifier:GSIDD10	

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
				from the nonvolatile on-board memory (EEPROM, PROM, etc.) and does not require a power-on reset.			Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD14 Object Identifier:GSIDD15 Object Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD28 Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	
SCSPEC165	Initialization	I, T	The Spacecraft shall default to a known low rate telemetry configuration.	Following a restart of the flight software a standard, default configuration of the T/M is used to ensure the ground can read what is being sent down.			Object Identifier:GSIDD18 Object Identifier:GSIDD19	

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC166	Communications	I	The spacecraft shall have at least 2 S-band downlink rates per the SGIDD requirements: GSIDD20, GSIDD21, GSIDD36.	Provides for trade off between link margin & downlink capacity.			Object Identifier:GSIDD20 Object Identifier:GSIDD21	

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD36	
SCSPEC167	Initialization	I, A, T	The Spacecraft flight software shall reboot within the time frame that spacecraft attitude is maintained in a safe state as described in SCSPEC268.	The time for the computer to reboot & for the GN&C system to regain control of the spacecraft attitude must be shorter than the time for the telescope boresight to drift to the sun.				
SCSPEC168	Stored Commands	I, T	The Spacecraft shall store and execute spacecraft and instrument absolute-time command sequences.	Provide the capability for commands tied to specific times.				
SCSPEC169	Stored Commands	I, T	The Spacecraft flight software absolute-time stored command sequences shall be capable of invoking relative-time stored command sequences.	Provide the capability for absolute time commands to also include relative time commands.				
SCSPEC170	Stored Commands	I	The spacecraft shall provide a minimum of 10,000 bytes of memory for instrument stored command table.	Limit the possible size of instrument commands.				
SCSPEC171	Stored Commands	I, T	The Observatory shall store and execute spacecraft and instrument relative time command sequences.	Relative time sequenced commands are a sequence of commands that can be sent from the command storage following a pre-defined sequence. Relative time sequences are typically delta time based though they may start at an absolute time. The spacecraft will provide the only command storage on-board and must be able to execute commands at a specified time.				
SCSPEC172	Stored Commands	I, T	The Spacecraft flight software stored command sequences shall be modifiable by ground command.	By command the ground will able to reload or edit the stored command buffer			Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD14	

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD15 Object Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD28 Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	
SCSPEC173	Stored Commands	I, T	The Spacecraft flight software command sequences shall be enabled, disabled or cancelled by ground command.	Provide flexibility for the ground to use the command capability.	Object Identifier:MRD76		Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD14 Object Identifier:GSIDD15	

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD28 Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	
SCSPEC174	Stored Commands	I, A, T	The Spacecraft flight software shall have stored command capacity to store at least 72-hours of spacecraft command sequences.	The spacecraft needs to store its own commands, including those it needs to start and stop the science recorder, etc.				
SCSPEC175	Stored Commands	I, T	The Spacecraft flight software shall be capable of placing the contents of the stored command buffer(s) into the telemetry.	The stored command buffer needs to be read by the POT, stored command sequence table can be dumped to the ground by a single command.			Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object	

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Identifier: GSIDD23 Object Identifier: GSIDD24 Object Identifier: GSIDD25 Object Identifier: GSIDD32 Object Identifier: GSIDD33 Object Identifier: GSIDD34 Object Identifier: GSIDD35 Object Identifier: GSIDD36 Object Identifier: GSIDD37 Object Identifier: GSIDD38	
SCSPEC176	Stored Commands	I	The Spacecraft flight software shall uniquely identify relative-time stored command sequences.					
SCSPEC177	Stored Commands	I, T	The Spacecraft flight software shall use the unique command sequence identifier to report the status of each actively executing command sequence in telemetry.				Object Identifier: GSIDD18 Object Identifier: GSIDD19 Object Identifier: GSIDD20 Object Identifier: GSIDD21 Object Identifier: GSIDD23	

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC178	Stored Commands	I, T	The Spacecraft flight software time resolution for stored commands shall be 1 (one) second or less.		Object Identifier:MRD169		Object Identifier:GSIDD22	
SCSPEC179	Stored Commands	I, T	The Spacecraft shall continue to operate in the event of single bit memory errors.	Parent requirement for implementation schemes for memory checking, multiple FSW images on board etc. Whatever scheme will protect the software				
SCSPEC180	Software Development Maintenance System (SDMS) - Independent	I	The SDMS shall be self-contained and not require additional software or hardware to perform flight software development and verification.	The SDMS consists of the proper hardware to accurately simulate Spacecraft behavior for anomaly resolution, and to maintain and update flight software over an extended operational period of the mission. The SDVF is used pre-launch for verification activities and will continue to be used during post-launch FSW				

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
				maintenance activities.				
SCSPEC181	Software Development Maintenance System	I, T	The SDMS shall meet NPR 2810.1A IT Security requirements.	For space asset protection, the SDMS must meet the same security requirements as an operational system.	Object Identifier:MRD70			
SCSPEC182	Software Development Maintenance System	I, T	The SDMS shall interface with instrument and flight software simulators consistent with the s/c defined interfaces.	Want to be able to a least exchange data files on the ground to provide testing and interface checkout.				
SCSPEC183	Software Development Maintenance System	I	The SDMS shall have Spacecraft Flight Software installed.	To ensure the proper simulation of the on-orbit configuration				
SCSPEC184	Software Development Maintenance System	I	The SDMS shall have an engineering version of the flight spacecraft command and data handling system.	To ensure the proper simulation of the on-orbit configuration an EM C&DH is required.				
SCSPEC185	Software Development Maintenance System	I, T	The SDMS shall have an engineering version of the flight recorder capable of holding at least 2 orbits (TBR) of science and housekeeping data.	To ensure the proper simulation of the on-orbit configuration, however the SSR does not have to be full size				
SCSPEC186	Software Development Maintenance System	I	The SDMS shall provide engineering models of hardware power devices.					
SCSPEC187	Software Development Maintenance System	I, T	The SDMS shall provide simulation of solar array and batteries.	To support FSW testing of the power system. Battery and solar arrays do not need to be hardware simulations.				
SCSPEC188	Software Development Maintenance System	I	The SDMS shall provide fidelity to test the power functions performed in flight software.	In order to test FSW updates and for anomaly resolution, the SDMS must have the capability to simulate all the power functions performed in s/w				
SCSPEC189	Software Development Maintenance System	I	The SDMS shall interface with the ATLAS Instrument Simulator (IIS).	Test the instrument interface.				
SCSPEC190	Software Development Maintenance System	I	The SDMS shall contain a software simulation of the attitude and control system peripherals					
SCSPEC191	Software	I, T	The SDMS shall dynamically simulate orbit	Need to have a model based	Object			

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
	Development Maintenance System		propagation.	dynamic simulation to verify the SC ACS system.	Identifier:MRD169			
SCSPEC192	Software Development Maintenance System	I, T	The SDMS shall simulate the thermal control system of the spacecraft for command and telemetry response.					
SCSPEC193	Software Development Maintenance System	I, T	The SDMS shall simulate all fault detection and correction functions of the on-orbit spacecraft.					
SCSPEC194	Health and Safety monitoring	T	The Spacecraft shall report, in spacecraft housekeeping telemetry, the health and safety of the spacecraft and instrument.	There should be an allocation of instrument housekeeping data in the housekeeping data stream.			Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34	

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							Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC195	Hardware Decoded Commands	T	The Spacecraft onboard processor(s) shall be capable of being reset via a discrete command originated by a hard-line command from test equipment during development, or a hardware-decoded special/emergency command sent by the ground across the RF Uplink Channel.	Need a means of sending the command that is not interpreted by Flight Software. Housekeeping Telemetry			Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD14 Object Identifier:GSIDD15 Object Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD28	

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	
SCSPEC196	Real-Time Telemetry	T	The Spacecraft shall transmit real-time instrument and spacecraft housekeeping data to the ground when in contact with a ground station.	Real-time HK data is needed to monitor and control the spacecraft.			Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35	

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC197	Data Retention	I	The Spacecraft shall preserve instrument and spacecraft housekeeping telemetry until the ground operations center has verified its receipt, or sends an explicit command to erase or write over it.	To account for missed passes, back orbit data, etc. This happens all the time.			Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34	
SCSPEC198	Real-Time Telemetry	T	The Spacecraft shall be capable of concurrent storage of real-time housekeeping telemetry and transmission of real-time and/or stored housekeeping telemetry.	The FOT can select this capability in any permutation.				
SCSPEC199	Real-Time Commands	T	The Spacecraft shall report command acceptance or rejection in housekeeping telemetry upon receipt.				Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25	

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC200	Real-Time Commands	T	The Spacecraft shall report command identification information in housekeeping telemetry when the command is executed.	When a stored command or a real-time command is executed this information should be written off into the HK data.			Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25	

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC201	Housekeeping Playback	T	The Spacecraft shall play back stored housekeeping data while in any mode.	This supports all modes of operation and is critical for debugging why you got to safehold.			Object Identifier:GSIDD21 Object Identifier:GSIDD36	
SCSPEC202	Telemetry Rates	I, T	The Spacecraft shall change the housekeeping telemetry data acquisition rates autonomously and via ground command.	To support transition of rates for safehold mode and times when additional data is needed.			Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD14 Object Identifier:GSIDD15	

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD26 Object Identifier:GSIDD27 Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	
SCSPEC203	Housekeeping Storage	I, A, T	The Spacecraft shall be capable of storing at least 24 hours of Spacecraft and instrument housekeeping data at the maximum onboard telemetry rate.	Size the mass storage to support all systems needing storage.				
SCSPEC204	Commands	T	The Spacecraft shall authenticate all received commands.	Source authentication to ensure the data originates from an ICESat-2 MOC and not from some outside source. Note: encryption is not required for this mission though is an acceptable implementation.	Object Identifier:MRD90			
SCSPEC205	Commands	T	The Spacecraft shall execute only commands that are command authenticated	To help prevent hijacking of the spacecraft.	Object Identifier:MRD90		Object Identifier:GSIDD13 Object Identifier:GSIDD17	
SCSPEC206	Commands	I	The Spacecraft shall support Communication Operations Procedure-1 protocol as defined in CCSDS 232.1-B-1.	Should use COP1 for commanding.			Object Identifier:GSIDD1	
SCSPEC207	Commands	T	The Spacecraft shall reject invalid commands.	The Spacecraft should be able to recognize and reject invalid or improperly constructed commands to prevent accidental actions being taken by the Spacecraft.	Object Identifier:MRD90			

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SCSPEC208	Commands	T	The Spacecraft shall identify rejected commands in housekeeping telemetry.	To provide the FOT with status information about each command sent to the Spacecraft. Commands should not be echoed back to the ground for security reasons.			Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC209	Commands	I, T	The Spacecraft shall implement hazardous and mission critical commands with at least two separate command sequences.	Critical commands need to have a two step process to initiate.				

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SCSPEC210	Commands	I, T	The Spacecraft shall identify executed commands in housekeeping telemetry.	To provide the FOT with status information about each command sent to the Spacecraft. Commands should not be echoed back to the ground for security reasons.			Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36 Object Identifier:GSIDD37 Object Identifier:GSIDD38	

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SCSPEC211	Commands	I, T	The Spacecraft shall validate, process, and execute flight software commands and table data loads.				Object Identifier:GSIDD1 Object Identifier:GSIDD13 Object Identifier:GSIDD17	
SCSPEC212	Commands	I, T	The Spacecraft shall accept command loads across multiple contacts.	Large table uploads, etc. may take more than one pass to complete.				
SCSPEC213	Flight Software Loads	I, T	The Spacecraft shall accept flight software loads across multiple contacts.	S/W patches, etc. may take more than one pass to complete.				
SCSPEC214	Flight Software Patches	I, T	The Spacecraft shall accept flight software patches.	Don't want to have to load a whole FSW load.				
SCSPEC215	Commands	I	The Spacecraft shall use unique commands to change state and condition, not toggle commands.	Using toggle commands can leave the star of a switch, box, etc unknown. It is better to have enables and disables be unique commands and not just toggle back and forth.				
SCSPEC216	Commands	I, A, T	The Spacecraft shall support all nominal operations with no more than 45 minutes of command uplink every 72 hours.		Object Identifier:MRD89			
SCSPEC217	Commands		The Spacecraft shall be capable of issuing an instrument command at a frequency of 1-10 Hz.					
SCSPEC218	Commands		The Spacecraft shall be capable of forwarding a command to the instrument within 1 second of command receipt on the spacecraft.					
SCSPEC219	Storage	I, A, T	The Spacecraft shall have storage for 580 gigabits of science data.	Want the capability to store data for one day in case there are missed contacts.	Object Identifier:MRD55			
SCSPEC220	Storage	T	The Spacecraft shall be capable of retransmitting recorded science and housekeeping data as long as the data remains on the recorder	In the event the data was not received by the ground need to be able to retransmit as often as necessary to get the data down.				
SCSPEC221	Storage	T	The Spacecraft mass storage shall be power cycled independently from any other Spacecraft subsystem or instrument.	The mass storage will need to be checked out, tested and diagnosed independently from the instrument, other equipment and be capable of being powered off.				
SCSPEC222	Storage	I, T	The Spacecraft shall retain all stored data when transitioning into and out of any operational mode, unless power is cycled off.	Do not lose data stored in the mass storage during any operational mode transition				

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SCSPEC223	Storage	I, T	The spacecraft shall write protect selected areas of the data storage when commanded by the ground.	Want to be able to save areas of the storage that may have critical data on it for subsequent download.				
SCSPEC224	Storage	I, T	The Spacecraft shall over-write unprotected older data if the spacecraft buffers become full if commanded by the ground.					
SCSPEC225	Storage	I, T	The Spacecraft shall stop writing data to the recorder if the spacecraft buffers become full if commanded by the ground.					
SCSPEC226	Ancillary Data	I, T	The Spacecraft shall time tag mission ancillary ephemeris data to within 50 microseconds of GPS time.	Spacecraft ancillary data must be tagged (time, counter, etc.) to the instrument data to ensure proper correlation for data reconstruction	Object Identifier MRD10 Object Identifier:MRD11 Object Identifier:MRD12 Object Identifier:MRD66 Object Identifier:MRD159 Object Identifier:MRD174			
SCSPEC227	Ancillary Data	I, T	The Spacecraft shall time tag mission ancillary attitude data to within 50 microseconds of GPS time.	Spacecraft ancillary data must be tagged (time, counter, etc.) to the instrument data to ensure proper correlation for data reconstruction.	Object Identifier:MRD10 Object Identifier:MRD11 Object Identifier:MRD12 Object Identifier:MRD66 Object Identifier:MRD174			
SCSPEC228	Ancillary Data	I, T	The Spacecraft shall time tag non-specific Mission Ancillary data to the spacecraft time reference with an accuracy of 80 microseconds, 1 sigma.	Spacecraft ancillary data must be tagged (time, counter, etc.) to the instrument data to ensure proper	Object Identifier:MRD66			

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				correlation for data reconstruction.				
SCSPEC229	Ancillary Data	I	The Spacecraft ancillary data shall include information regarding Spacecraft attitude, altitude rate, timing and telemetry housekeeping parameters as defined in the Instrument to Spacecraft Interface Control Document (temperature, voltage, operational configuration information, mechanism states etc.…).	The S/C contractor and the GSFC will need to identify the necessary telemetry data to ensure proper data reconstruction.	Object Identifier:MRD66			
SCSPEC230	Ancillary Data	I	The spacecraft shall include the unprocessed spacecraft gyro sensor observations in the observatory ancillary data stream for use in ground processing.	To improve upon the real-time attitude knowledge by performing post-pass in ground processing using the full rate gyro data.	Object Identifier:MRD13 Object Identifier:MRD159		Object Identifier:GSIDD44	
SCSPEC231	Ancillary Data	I	The spacecraft shall supply to the ground the star tracker observation, at the full attitude sensor data rate, for ground processing of data.	To improve upon the real-time attitude knowledge by performing post-pass in ground processing using the full rate star tracker data.	Object Identifier:MRD159		Object Identifier:GSIDD44	
SCSPEC232	Ancillary Data	I, T	The Spacecraft shall acquire Mission Ancillary data while collecting science data.	Spacecraft ancillary data acquisition should be independent of acquisition, maintaining the same resolution as that required during operations.				
SCSPEC233	Ancillary Data	I, T	The Spacecraft shall packetize mission ancillary data into unique CCSDS packets.	Mission ancillary data shall be packetized separately from the spacecraft housekeeping data and provided by unique APID.			Object Identifier:GSIDD1	
SCSPEC234	Ancillary Data	I, T	The Spacecraft shall produce a complete update of the mission ancillary data at least once every 1 second during instrument operations	The ancillary (s/c+instr) data needs to be frequently refreshed. Ancillary data will contain parameters that have a 100-Hz reporting frequency down to data that has a 1 Hz.				
SCSPEC235	Ancillary Data	I, T	The Spacecraft shall have the capability to ingest and store Spacecraft generated ancillary data independently of instrument operations.	Ancillary data, spacecraft HK data generated by the spacecraft will be available when the instrument is not operating.				
SCSPEC236	Science Data	I, T	The Spacecraft shall ingest and store instrument data in the formats and rates as specified in the SC IDD 116.	Capture all instrument data produced continuously through the orbits.		Object Identifier:IDD116		
SCSPEC237	Science Data	I	The Spacecraft shall format the data for downlink as defined in the Spacecraft-Ground IDD.	Instrument data is sent to the s/c in asynchronous variable sized CCSDS packets which need to be			Object Identifier:GSIDD1	

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
				put into VCDUS for downlink.			Object Identifier:GSIDD42	
SCSPEC238	Science Data	I	The Spacecraft shall reserve at a minimum 50 CCSDS Packet Application IDs for instrument housekeeping and science data.	To ensure sufficient packet ids are available to the instrument for data formatting.			Object Identifier:GSIDD1	
SCSPEC239	Science Data	I, T	The Spacecraft shall ingest and store all ancillary data associated with the instrument data collection.	The mass storage shall accommodate any necessary data reconstruction data from the spacecraft and instrument.				
SCSPEC240	Science Data	I, T	The Spacecraft shall ingest and store all calibration data from the instrument.	Calibration data must be stored and downlinked to the ground				
SCSPEC241	Recording and Playback	I, T	The Spacecraft shall concurrently record real-time science data while playing back stored science data.	This capability can be selected in any permutation of record and playback.				
SCSPEC242	Recording and Playback	I, T	The Spacecraft shall playback Spacecraft and instrument generated housekeeping data independently of science data.	Playback data acquired during periods when instrument are off or some other mode or just need to replay housekeeping data				
SCSPEC243	Recording and Playback	I, T	The Spacecraft shall retransmit selective portions of the recorder upon command.	The size of a portion is vendor specific.				
SCSPEC244	Recording and Playback	I, T	The spacecraft shall repeat playbacks of stored data upon command.	To ensure data reaches the ground the ability to retransmit stored data is required.				
SCSPEC245	Recording and Playback	I	The Spacecraft shall playback based on ground schedules.	The ground will be able to establish playback schedules.				
SCSPEC246	Recording and Playback	I, T	The Spacecraft shall playback on receipt of realtime command.				Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD14 Object Identifier:GSIDD15 Object	

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD18 Object Identifier:GSIDD19 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD23 Object Identifier:GSIDD24 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD35 Object Identifier:GSIDD36	

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD37 Object Identifier:GSIDD38	
SCSPEC247	Recording and Playback	I, T	The Spacecraft shall provide incrementally increasing Virtual Channel Data Units (VCDU) counts.	Repeatedly is when portions of a data must be sent a second or third time to recover a partial playback of the first playback/read out attempt.				
SCSPEC248	Science Data Diagnostics, Fault Detection and Correction		The Spacecraft shall identify inoperable mass storage locations and disable those areas when commanded.	Access processor memory, data storage locations, identify bad memory, etc.				
SCSPEC249	Science Data Diagnostics, Fault Detection and Correction	I, T	The Spacecraft shall have autonomous internal fault detection and correction capabilities to address single event upsets for the mass storage.					
SCSPEC250	Science Data Diagnostics, Fault Detection and Correction	I, T	The Spacecraft shall incur no more than one uncorrectable/uncorrected error in 10^13-bits per 24 hour period in the mass storage.	The bit error rate is to limit the number of bad bits before transfer to the downlink interface.				
SCSPEC251	Science Data Diagnostics, Fault Detection and Correction	I, T	The Spacecraft shall provide housekeeping telemetry indicating that stored data has been corrected.	Help to identify when and where problems may start to occur.				
SCSPEC252	Science Data Diagnostics, Fault Detection and Correction	I, T	The Spacecraft shall provide housekeeping telemetry data indicating that non-correctable bit errors have been detected and the location of each non-correctable error(s).					
SCSPEC253	Science Data Diagnostics, Fault Detection and Correction	I, T	The Spacecraft mass storage shall generate a predetermined test data pattern that is stored in the recorder's memory at the full data rate sufficient to fill the available capacity of the mass storage.	To provide a predefined test pattern that can be used on the ground for diagnostics.				
SCSPEC254	Science Data Diagnostics, Fault Detection and Correction	I, T	The Spacecraft mass storage shall play back stored or test data to the downlink output interface while simultaneously recording test data.	To provide a predefined test pattern that can be used on the ground for diagnostics				
SCSPEC255	Science Data Diagnostics, Fault Detection and Correction	I, T	The Spacecraft diagnostics shall generate a pseudo random noise (PN, PRN) pattern of 32,767 bits length (PN15, 2^15 - 1) to the downlink output interface for bit error rate (BER) testing of each downlink channel.	To put test pattern on the downlink to test the BER during compatibility testing			Object Identifier:GSIDD14 Object Identifier:GSIDD24	

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD31 Object Identifier:GSIDD38 Object Identifier:GSIDD47	
SCSPEC258	Science Data Diagnostics, Fault Detection and Correction	I	The Spacecraft shall be capable of performing retrograde propulsion maneuvers.	ICESAT-2 mission may be required to maneuver out of the way of orbital debris.				
SCSPEC259	Science Data Diagnostics, Fault Detection and Correction	I	The Spacecraft shall maintain attitude control for all propulsive maneuvers including the last de-orbit maneuver.	Attitude control is required for all maneuvers. The deorbit maneuvers may be long and are likely to be effected by atmospheric drag. Attitude control is necessary to minimize impact dispersions.				
SCSPEC260	Payload Center of Mass	I	The Spacecraft shall be designed to accommodate the payload center of mass as described in SC ATLAS IDD 103.	The center of mass of the ATLAS instrument system, including IMSC, will lie within the limits in AIDD		Object Identifier:IDD103		
SCSPEC261	Science Data Diagnostics, Fault Detection and Correction	I	The on-orbit location of the observatory center-of-mass shall be known to 2cm in the radial, along-track and cross-track directions with respect to the spacecraft reference frame.		Object Identifier:MRD68 Object Identifier:MRD159			
SCSPEC489	Attitude Maneuvers		During nominal operations, the spacecraft shall point in one of two target yaw positions. 0 degree and 180 degrees in the + or - X axes as defined in ICESat-2-SYS-ANYS-0174	The ops con calls for two yaw positions to give the instrument a cold side for it's primary radiator. The actual target yaw positions are dependent on spot spacing, which is addressed in the yaw tolerance requirement.	Object Identifier:MRD17			
SCSPEC263	Attitude Maneuvers - Pitch Bias	I, A, (T)	The nominal instrument boresight during science data acquisition shall be towards local geodetic nadir with a 0 to 0.5 degrees forward pitch.	Pitch bias is to prevent specular reflection of beam.	Object Identifier:MRD49			
SCSPEC264	Attitude Maneuvers	A, M, (T)	The spacecraft shall meet all thermal requirements while pointing off-nadir up to 5 degrees.	The spacecraft is to remain thermally stable, under stable attitude control, and fully				

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
				functional in off-nadir pointing attitudes.				
SCSPEC265	Attitude Maneuvers	A, M, (T)	The Spacecraft shall maneuver to the desired off-nadir pointing within 1 minute.	This duration minimizes the time the spacecraft is maneuvering.	Object Identifier:MRD19 Object Identifier:MRD21			
SCSPEC266	Attitude Maneuvers	A, M, (T)	The Spacecraft shall maneuver back from the off-nadir attitude to the normal Earth pointing attitude within 1 minute.	To return from the off-nadir attitude to the nominal Earth point, yaw steering, fully stable attitude ready to go.	Object Identifier:MRD19 Object Identifier:MRD21			
SCSPEC267	Attitude Maneuvers	I, A, M	The Spacecraft shall prevent the instrument boresight from entering a cone of half-angle 30 degree to the spacecraft-to-sun line during nominal operations.	To protect the instrument from the sun during operations and maneuvers.	Object Identifier:MRD51			
SCSPEC268	Attitude Maneuvers	I, A, M	The Spacecraft may impinge on the 30-degree stay-out cone during entry into safehold and during safehold operations.		Object Identifier:MRD52			
SCSPEC269	Attitude Maneuvers	I, A, M	When sweeping through the sun exclusion zone, the rotation rate of the Observatory shall be greater than 0.5 deg/sec.	Protection of the instrument.	Object Identifier:MRD53			
SCSPEC270	GPS - Receivers	I	The Spacecraft shall have two GPS receivers.	GPS is vital to meeting mission requirements. One may be in cold redundancy in nominal operations.	Object Identifier:MRD10 Object Identifier:MRD11 Object Identifier:MRD12 Object Identifier:MRD13 Object Identifier:MRD174			
SCSPEC271	Gyro - Angle White Noise	I	The Spacecraft gyro shall have Angle White Noise less than or equal to 0.003 arcsec/Hz^0.5 (1 sigma)	Gyro data needed for ground processing must meet these requirements	Object Identifier:MRD10 Object Identifier:MRD11 Object Identifier:MRD12			

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
					Object Identifier:MRD159 Object Identifier:MRD167			
SCSPEC272	Gyro - Rate Random Walk	I	The Spacecraft gyro shall have Rate Random Walk less than or equal to 0.0000125 arcsec/sec^1.5 (1 sigma)	Gyro data needed for ground processing must meet these requirements	Object Identifier:MRD10 Object Identifier:MRD11 Object Identifier:MRD12 Object Identifier:MRD159 Object Identifier:MRD167			
SCSPEC273	Gyro - Angle Random Walk	I	The Spacecraft gyro shall have Angular Random Walk less than or equal to 0.00015 deg/hr^0.5 (1 sigma)	Gyro data needed for ground processing must meet these requirements	Object Identifier:MRD10 Object Identifier:MRD11 Object Identifier:MRD12 Object Identifier:MRD159 Object Identifier:MRD167			
SCSPEC274	Gyro - Bias Stability	I	The Spacecraft gyro shall have Bias Stability less than or equal to 0.00133 deg/hr (1 sigma)	Gyro data needed for ground processing must meet these requirements	Object Identifier:MRD10 Object Identifier:MRD11 Object Identifier:MRD12 Object			

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
					Identifier:MRD159 Object Identifier:MRD167			
SCSPEC275	Gyro	I	The spacecraft gyro system shall provide redundant rate information for each of the spacecraft three axes.	Gyro data needed for ground processing must meet these requirements				
SCSPEC276	GPS - Antennas	I	The Spacecraft shall have two GPS receiver antennas.	GPS is vital to meeting mission requirements.	Object Identifier:MRD174			
SCSPEC277	GPS	I, T	The Spacecraft GPS receiver shall record carrier phase and pseudo-range data on at least two frequencies (at least L1 & L2) from a minimum of 8 GPS satellites.		Object Identifier:MRD10 Object Identifier:MRD11 Object Identifier:MRD12 Object Identifier:MRD13 Object Identifier:MRD174			
SCSPEC278	GPS	T	The Spacecraft Carrier-phase shall be recorded at one second intervals.		Object Identifier:MRD10 Object Identifier:MRD11 Object Identifier:MRD12 Object Identifier:MRD13 Object Identifier:MRD174			
SCSPEC279	GPS	T	The Spacecraft pseudo-range shall be recorded at a rate of 10seconds or faster.		Object Identifier:MRD10 Object Identifier:MRD11 Object			

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
					Identifier:MRD12 Object Identifier:MRD13 Object Identifier:MRD174			
SCSPEC280	GPS	T	The Spacecraft carrier-phase precision shall be less than or equal to 5mm on each frequency.		Object Identifier:MRD13 Object Identifier:MRD174			
SCSPEC281	GPS	T	The Spacecraft pseudo-range precision shall be better than 300mm for pseudo-ranges.		Object Identifier:MRD13 Object Identifier:MRD174			
SCSPEC282	GPS	T	The Spacecraft carrier-phase and pseudo-range measurement time-tags shall be traceable to GPS-system time through the pseudo-ranges.		Object Identifier:MRD13 Object Identifier:MRD174			
SCSPEC284	GPS	I, A	The Spacecraft GPS antennas and ground-planes shall be placed to minimize multipath effects.					
SCSPEC285	GPS	I, T	The spacecraft GPS subsystem shall meet all its performance specifications given nominal orientations for s/c deployables.		Object Identifier:MRD174			
SCSPEC286	GPS	I, T	The Spacecraft reference phase center of each GPS antenna, with its ground plane, shall be fully characterized as a function of azimuth & elevation with respect to a fixed point on the antenna system to an accuracy of <5mm.		Object Identifier:MRD174			
SCSPEC287	GPS	I, T	The spacecraft location of the fixed point on the GPS antenna system used for the reference phase center shall be measure to <5mm with respect to the spacecraft reference frame.		Object Identifier:MRD174			
SCSPEC288	GPS	I	The GPS shall generate a "One pulse per second" signal derived from the real-time solution.		Object Identifier:MRD174			
SCSPEC289	GPS	I, T	The "One pulse per second" signal at the instrument interface shall be accurate to 50ns (1 sigma) with respect to GPS time.	Accurate timing is required to meet science requirements"	Object Identifier:MRD159 Object Identifier:MRD167			

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
SCSPEC290	Ephemeris	I	The Spacecraft shall use the UTC time as the spacecraft time reference.	Consistent with ground system, eliminates need for conversions.				
SCSPEC291	Ephemeris	I, T	The Spacecraft shall synchronize the spacecraft time to the GPS time with an accuracy of 0.005 seconds.		Object Identifier:MRD174			
SCSPEC292	Ephemeris	I	The Spacecraft shall use the CCSDS 301.0-B-3, Section 2.3 CCSDS Day Segmented Time Code (CDS) in the time message.	The use of an unambiguous time stamp for data synchronization.				
SCSPEC293	Ephemeris	I	The Spacecraft shall generate an on-board ephemeris based on the Global Positioning System (GPS).	GPS ephemeris is required to meet science performance requirements.				
SCSPEC294	Ephemeris	I	The Spacecraft shall include the GPS carrier phase and pseudo range values in the spacecraft ancillary data stream.	GPS observables will be used to generate a definitive ephemeris file in support of data ground data processing.				
SCSPEC295	Ephemeris	I, T	The Spacecraft shall be capable of receiving a ground based ephemeris update.	As a contingency, ground will provide ephemeris updates for the contingency of something being wrong with the on-board propagator			Object Identifier:GSIDD10 Object Identifier:GSIDD11 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD14 Object Identifier:GSIDD15 Object Identifier:GSIDD16 Object Identifier:GSIDD17 Object Identifier:GSIDD26 Object Identifier:GSIDD27	

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
							Object Identifier:GSIDD28 Object Identifier:GSIDD29 Object Identifier:GSIDD30 Object Identifier:GSIDD31	
SCSPEC296	Ephemeris	I, T	The Spacecraft shall be capable of propagating the on-board state for at least 72 hours.	Provides the ability to have lights out operation in the MOC. No command uploads will be performed during lights out operations, thus the spacecraft needs to operate without intervention from the ground for 72 hours	Object Identifier:MRD89			
SCSPEC297	Ephemeris	I, T	The spacecraft shall meet science operations performance for up to 72-hours from an on-board ephemeris.	The spacecraft must meet performance requirements over the 72 hours where the orbit will be propagated without ephemeris uploads from the ground. This requires the spacecraft to have auto navigation abilities.				
SCSPEC298	Ephemeris	I, T	The Spacecraft shall provide to the instrument the orbital position accurate to 100m radial, 100m in-track, and 100m cross-track - all values are 1 sigma.	Used in DEM and range gate in the ATLAS.		Object Identifier:IDD155		
SCSPEC299	Ephemeris	I, T	The Spacecraft shall be capable of receiving a ground base Spacecraft reference time and time correction coefficients	Whenever the GPS is not available it may be necessary to update the Spacecraft reference time and any associated timing coefficients such as the timer biases and offsets.				
SCSPEC300	Ephemeris	I	The Spacecraft shall provide the orbital position and velocity in the Earth Centered Inertial (ECI) of Epoch J2000.0 coordinate frame.	Consistent coordinate system used in the spacecraft and instrument.	Object Identifier:MRD15	Object Identifier:IDD100		
SCSPEC301	Ephemeris	I, T	The Spacecraft shall provide an estimate of position and velocity time-tagged to an accuracy of +/- 50 microseconds or more accurate to the spacecraft reference time.	Constrains the timing-induced along-track positional error (due to orbital velocity) to be less than the allowable jitter error.				

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
SCSPEC302	Ephemeris	I, A, M (T)	The Spacecraft shall provide to the instrument the orbital velocity accurate to 0.50 m/sec radial, 0.50 m/sec in-track, and 0.50 m/sec cross track - all values are 1 sigma.	Used in DEM and range gate in the ATLAS.	Object Identifier:MRD89	Object Identifier:IDD157		
SCSPEC303	Ephemeris	I, T	The Spacecraft shall report the orbital position and velocity once per second in the spacecraft housekeeping telemetry and ancillary data.	Allows for improving the ephemeris accuracy on the ground by smoothing the individual GPS observable (measurements).				
SCSPEC304	Ephemeris	I, T	The Spacecraft shall report the Global Positioning System observables in spacecraft housekeeping telemetry and in the spacecraft ancillary data.	Allows for improving the ephemeris accuracy on the ground by smoothing the individual GPS observables (primarily pseudo-range and carrier phase measurements).			Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD22 Object Identifier:GSIDD36 Object Identifier:GSIDD44	
SCSPEC306	Attitude	I	The spacecraft shall use the Earth Centered Inertial of epoch J2000.0 coordinate frame.					
SCSPEC309	Propulsion System	I, A, M	The Spacecraft shall correct correct for launch vehicle dispersions, place the observatory in reference orbit and maintain that orbit allowing for atmospheric drag and other perturbations for 7 years, and place the observatory in a disposal orbit.	Project estimates show this to be approximately 288 m/s over 7 years				
SCSPEC310	Propulsion System	I, A, M, T	The spacecraft propulsion subsystem shall operate in both pulse and continuous modes without restriction on operational duration or duty cycles as required to complete the mission.	Provides for off pulsing, some attitude control if necessary, translational maneuvers, and inclination change maneuvers.				
SCSPEC311	SIS Compliance	I, T	The SIS shall be in compliance with the ICESat-2 MAR for connection to flight hardware.					
SCSPEC312	Propulsion System	I	The Spacecraft propulsion subsystem MEOP shall be the highest pressure that the subsystem is expected to experience during its service life and retain its functionality, including the effect of temperature, pressure transients and oscillations, vehicle quasi-steady, and dynamic accelerations and relief valve operating variability.					
SCSPEC313	Propulsion System	I, A, M	The Spacecraft propulsion subsystem thrusters shall be located and configured to minimize	This angle is for monopropellant. If bipropellant is used, the angle	Object Identifier:MRD174			

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Released: March 30, 2011

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			impingement on the ATLAS radiators by maintaining at least 20 degrees separation between the plus-y instrument radiator surface and the thrust axis.	will be 45 degrees				
SCSPEC314	Propulsion System	I	The Spacecraft propulsion subsystem shall provide, as a minimum, the following status telemetry: *Propellant tank pressure (with an accuracy of 1% of full scale) *Downstream line pressure *Catalyst bed temperatures *Thruster valve temperatures *Line temperatures *Tank temperatures *Latch valve open/close status	These are needed to support monitoring of pressurized system components.				
SCSPEC315	Propulsion System	I	The Spacecraft propulsion subsystem thruster valves and isolation valves shall be protected by internal inlet filters.					
SCSPEC316	Propulsion System	I, T	The Spacecraft propulsion subsystem nominal filter rating of the thruster valve inlet filters shall be no less than 2x above the nominal micro rating of the system filters.	System filters should provide a two stage filtering process to ensure particles do not reach the thruster valves.				
SCSPEC317	Radio Frequency Telecommunications System	I, T	The Spacecraft shall comply with National Telecommunications and Information Administration (NTIA) Spectrum Standards.	NENUG Revision 1 section 13 provides guidelines to assist with frequency requirements. Section 13.5 provides NTIA Emissions masks.			Object Identifier:GSIDD8	
SCSPEC318	Radio Frequency Telecommunications System	I, A	The Spacecraft shall comply with International Telecommunication Union (ITU) spectrum utilization and sharing requirements.	NENUG Revision 1 section 13 provides guidelines to assist with frequency requirements. ICESat-2 will use the Earth Exploration Satellite S-band and X-band frequencies, as defined in table 13.1			Object Identifier:GSIDD8	
SCSPEC319	Radio Frequency Telecommunications System	I, A, T	The Spacecraft shall comply with Space Frequency Coordination Group (SFCG) Handbook 2005 as required for NTIA spectrum compliance.	The document has requirements to which ICESat-2 must comply. In particular, 14-1R1, 14-3R7, 21-2R2 apply to emissions in S- and X-band. The last specifies the spectral mask applicable to S- and X-band. GSFC Spectrum Manager has cleared the use of Earth Coverage Antennas.			Object Identifier:GSIDD8	
SCSPEC320	Radio	I, T	The Spacecraft shall be capable of transmitting a	To test the BER on the downlink.				

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
	Frequency Telecommunications System		pseudo random noise (PRN) data pattern from all transmitters for testing purposes.					
SCSPEC321	Radio Frequency Telecommunications System	I, T	The Spacecraft RF transmit components shall not be required to operate during the corona region. The Spacecraft RF transmit components shall be designed to be immune from multi-paction effects.	Analytical tools are not accurate at predicting multi-paction / corona effects on active elements. Therefore testing will be performed as outlined in the SOW.				
SCSPEC322	Radio Frequency Telecommunications System	I, T	The Spacecraft shall maintain unswitched but fused or circuit breaker power to both S-band receivers from launch countdown and through the life of the mission.	VS - RF receiver are the only means of getting instructions into the spacecraft, all receivers shall be on unswitched power service so receivers cannot be turned off				
SCSPEC323	Radio Frequency Telecommunications System	I, T	The Spacecraft shall be capable of reception of ground commands while in any mode.	Commanding is needed to maintain control of the Spacecraft. The receiver should always be powered				
SCSPEC324	Radio Frequency Telecommunications System	I, T	The Spacecraft shall be capable of S-band transmissions in any Spacecraft operational mode.	Real-time HK data is needed to monitor and control the Spacecraft.	Object Identifier:MRD54			
SCSPEC325	Radio Frequency Telecommunications System	I, A, M, T	The Spacecraft shall close the S-band SN forward and return links for 85% of the celestial sphere	Real-time HK data is needed to monitor and control the Spacecraft with SN.				
SCSPEC326	Radio Frequency Telecommunications System	I, T	The Spacecraft shall be capable of S-band transmission and reception concurrently	Mission operations needs to receive acknowledgment of command receipt while commanding to best maintain control of the spacecraft.	Object Identifier:MRD56			
SCSPEC327	Radio Frequency Telecommunications System	I	The Spacecraft shall use the CCSDS Recommendations defined in the Spacecraft-Ground IDD 3.2.1 for the telecommunications interfaces to the Ground.	defines the standards/protocols to use in the communication			Object Identifier:GSIDD1 Object Identifier:GSIDD2 Object Identifier:GSIDD3	
SCSPEC328	Radio	I, T	The Spacecraft S-band capability shall be	Does not require a TDRS	Object		Object	

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
	Frequency Telecommunications System		compatible with TDRS as defined in the SC-Ground IDD 3.2.4 and 3.2.5 in all spacecraft modes.	transponder.	Identifier:MRD65 Object Identifier:MRD156		Identifier:GSIDD5 Object Identifier:GSIDD8	
SCSPEC329	Radio Frequency Telecommunications System	I, T	The Spacecraft S-band capability shall be compatible with the NEN as defined in the SC-Ground IDD 3.2.2.1 in all spacecraft modes.		Object Identifier:MRD56 Object Identifier:MRD57		Object Identifier:GSIDD4	
SCSPEC524	Radio Frequency Telecommunications System		The Spacecraft shall close the NENS S-band command and transmit downlink for 95% of the celestial sphere.	Real-time HK data is needed to monitor and control the Spacecraft with NENS.				
SCSPEC330	X-band	I, T	The Spacecraft X-Band data stream shall provide science data, ancillary data, and observatory housekeeping data required for science data processing to the NEN Ground Stations, as defined in the SC-Ground IDD 3.2.6, in any Spacecraft operational mode.	To downlink science data.	Object Identifier:MRD55 Object Identifier:MRD58		Object Identifier:GSIDD40 Object Identifier:GSIDD41 Object Identifier:GSIDD42 Object Identifier:GSIDD43 Object Identifier:GSIDD44 Object Identifier:GSIDD45 Object Identifier:GSIDD46 Object Identifier:GSIDD48	
SCSPEC331	RF Spectrum Protection	I, T	The maximum allowable power spectral flux-density to protect DSN in the 8400-8450 MHz band at the input of a DSN antenna shall not exceed -255.1 dB (W/m²/Hz).	DSN 8 GHz RFI Prevention Guideline," to be published in the next version of the NPR 2570.1, contains protection criteria applicable to the 8400-8450 MHz SRS (space-to-Earth) deep space band in accordance with ITU-R SA.1157.			Object Identifier:GSIDD8	

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SCSPEC332	RF Spectrum Protection	I, T	The Spacecraft's integrated Power Spectral Density (PSD) outside of the necessary bandwidth shall be less than 1.0% of the integrated PSD.	To support 300 mbps ICESat might be using the entire X-band spectrum (8025-8400) designated for near earth missions. We need to ensure that our implementation will not impact DSN X-band frequency at 8400 Mhz.			Object Identifier:GSIDD8	
SCSPEC333	RF Spectrum Protection	I, T	The Spacecraft's Power Spectral Density below 8025 MHz shall be attenuated by at least 12 dB relative to the maximum PSD of the emission.	To maintain compliance with NTIA spectrum allocations below the Earth Sciences Mission spectrum allocation.			Object Identifier:GSIDD8	
SCSPEC334	RF Spectrum Protection	I, T	The maximum power flux-density (PFD) in any 4 kHz reference bandwidth anywhere on the Earth's surface within the band 8025-8400 MHz shall not exceed the levels defined in NENUG Revision 1, Table 13.3.	NENUG Revision 1 Section 13.2.3 defines Power flux density requirements.			Object Identifier:GSIDD8	
SCSPEC335	Laser Retro-reflector assembly (LRA)	I	The spacecraft shall provide a passive laser retro-reflector assembly (LRA).	To support laser tracking from the ground	Object Identifier:MRD31 Object Identifier:MRD119			
SCSPEC336	Laser Retro-reflector assembly (LRA)	I, T	The Spacecraft LRA shall be optimized for the ILRS network operational wavelength of 532 nm (green visible light).		Object Identifier:MRD119			
SCSPEC337	Laser Retro-reflector assembly (LRA)	I, A, M	The Spacecraft LRA Velocity Aberration Range shall be at least 33 mrad (20 degrees satellite elevation) to 40 mrad (90 degrees satellite elevation).		Object Identifier:MRD119			
SCSPEC338	Laser Retro-reflector assembly (LRA)	I, A, M	The Spacecraft LRA individual retro reflectors shall be spoiled via one or more dihedral angle offsets or by a finite radius of curvature on the front cube face to compensate for velocity aberration.		Object Identifier:MRD119			
SCSPEC339	Laser Retro-reflector assembly (LRA)	I, A, T	The dihedral offsets or curvature values and their associated manufacturing tolerances shall be chosen to ensure that the minimum optical cross-section requirement is met over the full range of velocity aberrations and active array FOV.		Object Identifier:MRD119			
SCSPEC340	Laser Retro-reflector assembly (LRA)	I, A, T	The Spacecraft LRA Range variations introduced by the array multicube response shall be less than +/- 2 mm anywhere within the Active Array FOV.		Object Identifier:MRD119			
SCSPEC342	Laser Retro-	I, T	The LRA shall be mounted in such a manner as to	The fixed reference point should	Object			

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
	reflector assembly (LRA)		permit accurate (+/- 1mm) pre-launch determination of its location with respect to a fixed reference point on the spacecraft.	allow post-launch determination of its location with respect to the instantaneous spacecraft Center-of-Mass to +/- 20 mm by using post processed GPS data.	Identifier:MRD119			
SCSPEC343	Laser Retro-reflector assembly (LRA)	I, T	The Spacecraft LRA Active Array FOV shall be at least +/- 61 degrees from spacecraft nadir (ground station visibility above 20 degrees elevation).		Object Identifier:MRD31 Object Identifier:MRD119			
SCSPEC344	Laser Retro-reflector assembly (LRA)	I, A, M	The Spacecraft LRA design (i.e. number diameter, VAC, and relative orientation of retro reflectors) must meet the minimum optical cross-section requirement throughout this FOV taking into account velocity aberration effects.		Object Identifier:MRD119			
SCSPEC345	Laser Retro-reflector assembly (LRA)	I, A, T	The Spacecraft LRA Unobstructed Array FOV shall be +/-68 degrees from spacecraft nadir (ground station visibility above 0 degrees elevation).	Ground station visibility above 0 degrees elevation	Object Identifier:MRD31 Object Identifier:MRD119			
SCSPEC346	Laser Retro-reflector assembly (LRA)	I, T	The Spacecraft LRA Minimum Optical Cross-Section shall be > 10^6 m2 at all aspect angles within the Active Array FOV.		Object Identifier:MRD119			
SCSPEC347	Laser Retro-reflector assembly (LRA)	I, A, M, T	The Spacecraft LRA Temperature gradients shall be less than or equal to 1 degree Celsius gradient across any single corner cube.		Object Identifier:MRD119			
SCSPEC348	Laser Retro-reflector assembly (LRA)	I, A, M, T	The Spacecraft LRA Reflector mounts cells, target support structure and baseplate, and the spacecraft interface shall be designed to minimize and/or rapidly dissipate thermal gradients		Object Identifier:MRD119			
SCSPEC349	Laser Retro-reflector assembly (LRA)	I	The Spacecraft LRA Retroreflector shall be fabricated from UV-resistent Suprasil Fused Silica to inhibit solarization.		Object Identifier:MRD119			
SCSPEC350	Laser Retro-reflector assembly (LRA)	I, T	The Spacecraft LRA surface quality shall be < λ/4 at 632.8 nm		Object Identifier:MRD119			
SCSPEC351	Laser Retro-reflector assembly (LRA)	I	The Spacecraft LRA retroreflector Scratch/Dig shall be 60/40 or better.		Object Identifier:MRD119			

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SCSPEC352	Laser Retro-reflector assembly (LRA)	I, T	The Spacecraft LRA retroreflector face coatings shall be Broadband, all-dielectric, anti-reflection coatings with high transmission efficiency (>98%) at 532 nm.		Object Identifier:MRD119			
SCSPEC353	Laser Retro-reflector assembly (LRA)	I	The Spacecraft LRA retroreflector Back Coatings shall be Space-qualified protected aluminum coatings and/or coating free (TIR).		Object Identifier:MRD119			
SCSPEC354	Spacecraft Interface Simulator (SIS)	I, T	The SIS shall provide a flight-like instrument electrical interface connection for mating to the instrument.	The SIS will mate to the flight instrument to test electrical interface. This may require multiple connectors to complete the electrical connection and will include primary and survival heater power feeds. Flight like includes if there is a redundant interface that a redundant instrument interface would be part of the simulator				
SCSPEC355	Spacecraft Interface Simulator (SIS)	I, T	The SIS shall provide a redundant power interface consistent with the Spacecraft.	To provide simulation of the redundant interfaces.				
SCSPEC356	Spacecraft Interface Simulator (SIS)	I, T	SIS shall simulate the Spacecraft responses to hardware discrete commands.	The SIS should respond in a high fidelity manner to all hardware commands including timing characteristics.				
SCSPEC357	Spacecraft Interface Simulator (SIS)	I, T	The SIS shall simulate the Spacecraft responses to messages received from the instrument across the communications bus.	The SIS should respond in a high fidelity manner to all commands consistent with the selected communication bus standards. Message acknowledged or counter changes.				
SCSPEC358	Spacecraft Interface Simulator (SIS)	I, T	The SIS shall generate realistic response characteristics for analog telemetry, housekeeping telemetry and Spacecraft ancillary data.	The SIS should respond in a high fidelity manner that replicates Spacecraft analog telemetry, including bi-level, thermistor, and passive analog telemetry. The SIS should provide expected telemetry responses to commands.				
SCSPEC359	Spacecraft Interface Simulator (SIS)	I, T	The SIS shall provide realistic pointing and position computation and realistic orbit propagation.	To provide realistic simulation of the interface to the instrument for the pointing and orbit (can be several canned orbits).				

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Released: March 30, 2011

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SCSPEC360	Spacecraft Interface Simulator (SIS)	I, T	The SIS shall record up to 24 hours of simulated mission data.	To provide simulation to record Spacecraft science and housekeeping data.				
SCSPEC361	Spacecraft Interface Simulator (SIS)	I, T	The SIS shall provide real time data output of the mission data.	To provide timely analysis by the instrument team.				
SCSPEC362	Spacecraft Interface Simulator (SIS)	I, A, T	The SIS shall generate timing pulses with the same characteristics as the Spacecraft timing signals.	To provide simulation to playback Spacecraft science and housekeeping data, for post-test analysis by the instrument provider. To provide response characteristics including 1-pulse per second and time of day messages to test Spacecraft and instrument timing				
SCSPEC364	Spacecraft Interface Simulator (SIS)	I, A, T	The SIS shall generate a timing message with the same format and characteristics as the Spacecraft timing message.	To provide time of day messages to test Spacecraft and instrument timing.				
SCSPEC365	Spacecraft Interface Simulator (SIS)	I, T	The SIS shall provide a 1553 interface to validate message exchanges.	To provide testing of the communication bus (1553) interface characteristics between Spacecraft and instrument consistent with the interface control document between instrument and the Spacecraft.				
SCSPEC366	Spacecraft Interface Simulator (SIS)	I, T	The SIS shall provide messages across the 1553 interface to simulate all data provided to the ATLAS including time, position, and quaternions.	To ensure that the SIS includes the passing of the position and quaternion information to the instrument as will be done in flight.				
SCSPEC367	Spacecraft Interface Simulator (SIS)	I, T	The SIS shall provide communication flow over the SpaceWire.	To provide testing of the science data characteristics between Spacecraft and instrument, consistent with the interface control document between instrument and the Spacecraft. (Spacewire)				
SCSPEC368	Spacecraft Interface Simulator (SIS)	I, T	The SIS shall operate using Spacecraft flight software sufficient to simulate the instrument interface functionality and testing.	Interface tests, test rehearsals, training, and simulations should be performed using the Spacecraft flight software, associated				

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
				database, limits, and conversions.				
SCSPEC370	Observatory Operations Simulator (OOS)	I, T	The OOS shall be capable of operating independently from the real-time Mission Operations Center.	For training the FOT, testing Spacecraft responses to new commands it is necessary to remove the OOS from the MOC interface and run off-line.				
SCSPEC371	Observatory Operations Simulator (OOS)	I, T	The OOS shall integrate into the Mission Operations Center.	The terminals in the MOC may be used for FOT training, to run new scripts against, etc. Therefore it is necessary that MOC and OOS communicate.				
SCSPEC372	Observatory Operations Simulator (OOS)	I, T	The OOS shall interface with the government furnished ground station Front-End Processor.	So that the OOS can talk to something that looks like a ground station but does not have RF equipment. It is necessary to tie into the digital to digital I/F i.e. no RF on S/C either. Error correction coding etc that maybe put on by the S/C transmitter or removed by the S/C receiver would need to be modeled.				
SCSPEC373	Observatory Operations Simulator (OOS)	I, A, T	The format, rate and protocols implemented on the spacecraft need to match the simulated data arriving at the front-end processor. Needs to look just like what would be generated on the spacecraft, virtual channels.	The format, rate and protocols implemented on the spacecraft need to match the simulated data arriving at the front-end processor. Needs to look just like what would be generated on the spacecraft, virtual channels.			Object Identifier:GSIDD1 Object Identifier:GSIDD2 Object Identifier:GSIDD20 Object Identifier:GSIDD21 Object Identifier:GSIDD25 Object Identifier:GSIDD36 Object Identifier:GSIDD42 Object Identifier:GSIDD44	

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SCSPEC374	Observatory Operations Simulator (OOS)	I, A	The OOS shall interface with government furnished ATLAS instrument simulator.	The OOS can communicate, receive telemetry and data, and transmit digital, discrete and analog information, with the instrument simulator , through the simulated operational path i.e. through the C&DH system or whatever the s/c design uses for the instrument interface.				
SCSPEC375	Observatory Operations Simulator (OOS)	I, T	The OOS shall communicate commands to the government furnished instrument simulator.	For FOT training and instrument software updates, as applicable, the OOS should simulate all operational flight commands to the instruments, through the simulated operational path i.e. through the C&DH system or whatever the s/c design uses for the instrument interface.				
SCSPEC376	Observatory Operations Simulator (OOS)	I, T	The OOS shall receive up to one orbit of Mission Data from the government furnished instrument simulator.	For FOT training and for instruments software updates, as applicable, the OOS should ingest data from the government furnished instrument simulator and process the same as is done in flight software.				
SCSPEC377	Observatory Operations Simulator (OOS)	I, T	The OOS shall simulate the spacecraft response characteristics for the data received from the government furnished instrument simulator.	For FOT training and for instruments software updates, as applicable, the OOS should ingest data from the government furnished instrument simulator. Instrument simulator will generate telemetry; the SSR needs to be able to receive it.				
SCSPEC378	Observatory Operations Simulator (OOS)	I, T	The OOS shall simulate the response characteristics of failed Spacecraft subsystems.	For verifying any fault messaging interfacing to the instrument or the ground system.				
SCSPEC379	Observatory Operations Simulator (OOS)	I, T	The OOS shall simulate the Spacecraft's Command and Data Handling (C&DH) system.					
SCSPEC380	Observatory Operations Simulator	I, T	The OOS shall simulate the operational modes and mode transitions of the spacecraft and spacecraft systems.	Transition between the various implemented modes				

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Released: March 30, 2011

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	(OOS)							
SCSPEC381	Observatory Operations Simulator (OOS)	I, T	The OOS shall execute spacecraft flight software and databases.	Interface tests, test rehearsals, training, and simulations should be performed using the Spacecraft flight software, associated database, limits, and conversions.				
SCSPEC382	Observatory Operations Simulator (OOS)	I, T	The OOS shall simulate functional transition to the redundant side or element of the spacecraft.	Properly handle the fail-over to redundant side, telemetry of the redundant side, stored state condition of the redundant side				
SCSPEC383	Observatory Operations Simulator (OOS)	I, T	The OOS shall accept valid commands, table updates and flight software modifications.	The OOS will be used to test verify commands from the MOC to the Spacecraft and/or Spacecraft before use on the flight hardware.			Object Identifier:GSIDD1	
SCSPEC384	Observatory Operations Simulator (OOS)	I, T	The OOS shall reject all invalid commands, table updates and flight software modifications.	The OOS will be used to test verify commands from the MOC to the Spacecraft and/or Spacecraft before use on the flight hardware				
SCSPEC385	Observatory Operations Simulator (OOS)	I, T	The OOS shall receive and process commands in any valid format and data rate.	To model data flow, various data loads, tables			Object Identifier:GSIDD1 Object Identifier:GSIDD11	
SCSPEC386	Observatory Operations Simulator (OOS)	I, T	The OOS shall accurately simulate the timing of absolute time commands, relative time commands and stored time commands sequences.	During training and script develop proper handling of the commands stored onboard will be important.				
SCSPEC387	Observatory Operations Simulator (OOS)	I, T	The OOS shall accurately simulate the timing of command responses.	Verifies that relative and absolute commands will play well together.				
SCSPEC388	Observatory Operations Simulator (OOS)	I, T	The OOS shall receive, process, and execute flight software updates including but not limited to complete version updates, patches, and table updates that are identical to update commands for the flight spacecraft.	Allows testing, training, etc. of flight software loads, ephemeris updates, star catalog changes and calibration/alignment updates. We do not require an EM for the OOS, but we need the OOS to be capable of simulating a FSW update was received, authenticated and successfully loaded via the telemetry that is				

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
				received back in the simulator.				
SCSPEC389	Observatory Operations Simulator (OOS)	I, T	The OOS shall generate real-time housekeeping telemetry streams with representative spacecraft and instrument data in valid formats and data rates.	To realistically model realtime data flow / storage, and T/M generation.			Object Identifier:GSIDD1	
SCSPEC390	Observatory Operations Simulator (OOS)	I, T	The OOS shall generate stored (playback) housekeeping telemetry streams with representative Spacecraft and/or Instrument data consistent with expected on-orbit conditions in all valid formats and data rates.	This "simulated" data would include the same HK data the SC generates, stores and collects from real instrument.			Object Identifier:GSIDD1	
SCSPEC391	Observatory Operations Simulator (OOS)	I, T	The OOS shall model any redundant capabilities and functions	For procedure development, FOT training, command up load testing it is necessary that redundant Spacecraft systems be modeled				
SCSPEC392	Observatory Operations Simulator (OOS)	I, T	The OOS shall simulate the operations (commands and responses) and data formatting of the mass storage.	This is a full memory allocation for ICESat-2.				
SCSPEC393	Observatory Operations Simulator (OOS)	I, T	The OOS shall simulate the operations (commands and responses) of the attitude and orbital control system.	Model attitude and environment sensors, actuators, thrusters, valves, etc				
SCSPEC394	Observatory Operations Simulator (OOS)	I, T	The OOS shall dynamically propagate the spacecraft orbit equivalent to the flight system.	Provide sufficient accuracy to test mission planning tools and validate operational aspects of the mission (can be several canned orbits).				
SCSPEC395	Observatory Operations Simulator (OOS)	I, T	The OOS shall dynamically model spacecraft orbit maneuvers with a position accuracy equivalent to the flight system.	Provide sufficient accuracy to test mission planning tools and validate operational aspects of the mission.				
SCSPEC396	Observatory Operations Simulator (OOS)	I, T	The OOS shall dynamically model the spacecraft attitude with an angular accuracy equivalent to the flight system.	Provide sufficient accuracy to test mission planning tools and validate operational aspects of the mission.				
SCSPEC397	Observatory Operations Simulator (OOS)	I, T	The OOS shall provide the ability to simulate the GPS data input to the Spacecraft.	For functional and performance testing during operational simulations. This does not require a precise GPS simulator but something to make the OOS work.				
SCSPEC398	Observatory Operations	I, T	The OOS shall simulate the operation (commands and responses) of the power system.					

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
	Simulator (OOS)							
SCSPEC399	Observatory Operations Simulator (OOS)	I, T	The OOS shall simulate the elements of the power generation and distribution system.	Such as batteries, redundant power buses, power conditioning units, power distribution units, current limiters, shunt dissipaters and solar array.				
SCSPEC400	Observatory Operations Simulator (OOS)	I, A, M, T	The OOS shall simulate voltage fluctuations for nominal orbits.	Eclipse, off-nadir pointing, etc, can be canned profiles.				
SCSPEC401	Observatory Operations Simulator (OOS)	I, A, T	The OOS shall simulate electrical power buses.	Activation, loading and unloading on the various power distribution buses, for training and diagnostics.				
SCSPEC402	Observatory Operations Simulator (OOS)	I, A, T	The OOS shall simulate the power loading on the electrical power buses.	Activation, loading and unloading on the various power distribution buses, for training and diagnostics.				
SCSPEC403	Observatory Operations Simulator (OOS)	I, A, T	The OOS shall simulate the spacecraft thermal control system commands and responses.	Software simulation of the thermal system in order to accept and respond to commands.				
SCSPEC404	Observatory Operations Simulator (OOS)	I, A, T	The OOS shall simulate the spacecraft radio frequency (RF) communications system.	radios on /off, command response, power consumption				
SCSPEC405	Observatory Operations Simulator (OOS)	I, T	The OOS shall encode data going to the simulated Front End Processor to match the flight system.	Whatever is designed into the flight unit should be applied to the T/M streams.			Object Identifier:GSIDD18 Object Identifier:GSIDD25 Object Identifier:GSIDD32 Object Identifier:GSIDD33 Object Identifier:GSIDD34 Object Identifier:GSIDD40	

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Released: March 30, 2011

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							Object Identifier:GSIDD42 Object Identifier:GSIDD43	
SCSPEC406	Observatory Operations Simulator (OOS)	I, T	The OOS shall decode data received from the simulated Front End Processor to the OOS in a manner identical to the flight unit.	Any ground encoding that needs to be removed.			Object Identifier:GSIDD10 Object Identifier:GSIDD12 Object Identifier:GSIDD13 Object Identifier:GSIDD17	
SCSPEC407	Observatory Operations Simulator (OOS)	I, T	The OOS shall simulate the physical response characteristics of the RF communications system including but not limited to antenna tracking, power consumption and thermal effects.	Simulation of the RF system to reflect the activities the FOT will need to be proficient.				
SCSPEC408	Observatory Operations Simulator (OOS)	I, T	The OOS shall simulate the telemetry and command characteristics of the RF communications system including but not limited to antenna tracking, power consumption and thermal effects.	Simulation of the RF system to reflect the activities the FOT will need to be proficient.				
SCSPEC409	Observatory Operations Simulator (OOS)	I, T	The OOS shall provide a graphical user interface to display information and allow control of the simulation.	The operator will need to control all aspects of the simulation independent of the MOC.				
SCSPEC410	Observatory Operations Simulator (OOS)	I, T	The OOS shall simulate operator defined faults in the spacecraft.	Allows simulation operators the ability to inject faults or disable sensors, actuators or mis-configure hardware.				
SCSPEC411	Observatory Operations Simulator (OOS)	I, T	The OOS shall respond to real-time operator changes in the configuration of the simulated spacecraft.					
SCSPEC412	Observatory Operations Simulator (OOS)	I, T	The OOS shall accept inputs from the operator to set and change simulation variables.	Allows users to inject faults, vary initial conditions, etc.				
SCSPEC413	Observatory Operations	I, T	The OOS shall accept inputs from the operator to set and synchronize simulation time.	To synchronize the events on-orbit with the events in the				

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Released: March 30, 2011

Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
	Simulator (OOS)			simulation it might be with the Flight Spacecraft clock time or ground system time.				
SCSPEC414	Observatory Operations Simulator (OOS)	I, T	The OOS shall provide the operator with the ability to speed up or slow down the simulation relative to real time.	It is understood this may depend on the capability of the hardware and may affect the fidelity of the simulated outputs. It is acceptable to use simulation checkpoints.				
SCSPEC415	Observatory Operations Simulator (OOS)	I, T	The OOS shall be capable of recording data at operator defined data rate the values from a predefined parameter list with variable name and parameter values in engineering units.	Data rate is likely to be multiples of the integration time step such that every point up to some long time step can be saved.				
SCSPEC416	Observatory Operations Simulator (OOS)	I, T	The OOS shall record report files in delimited, ASCII text files.	Better formats maybe agreed to between the developers and users during the development process.				
SCSPEC417	Observatory Operations Simulator (OOS)	I, T	The OOS shall be capable of saving an executed simulation and simulation data.	To allow trainers to establish a baseline set of training simulations, to be able reproduce a simulation.				
SCSPEC418	Observatory Operations Simulator (OOS)	I, T	The OOS shall generate and store an event log containing operator inputs and system responses.	To understand the operations of the simulation and to track operator changes, inputs, etc. a log of activities is needed.				
SCSPEC419	Observatory Operations Simulator (OOS)	I, T	The OOS shall provide operator the ability to override any telemetry value in the housekeeping telemetry stream.	To allow trainers to test individual MOC system capabilities without forcing a simulation state that provides the desired telemetry value.				
SCSPEC420	Observatory Operations Simulator (OOS)	I, T	The OOS shall be capable of running a previous executed simulation.	In support of FOT training and possible flight diagnostics.				
SCSPEC421	Observatory Operations Simulator (OOS)	I, T	The OOS shall accept predefined anomalies into the simulation.	In support of FOT training and possible flight diagnostics.				
SCSPEC422	Observatory Operations Simulator (OOS)	I, T	The OOS shall be capable of causing any spacecraft command in a pre-defined list to fail.	In support of FOT training and possible flight diagnostics.				

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Released: March 30, 2011

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SCSPEC425	Shipping/ Storage Containers	I, T	The Spacecraft vendor provided Flight Hardware Shipping & Storage Container(s) shall be reusable, water-resistant, and fire-resistant.	No wooden containers, to provide protection from the transportation environment				
SCSPEC426	Shipping/ Storage Containers	I, A, T	The Spacecraft vendor provided Flight Hardware Shipping & Storage Container(s) shall accommodate the spacecraft with the government furnished instrument integrated, for transportation and storage purposes.	The spacecraft contractor is required to ship the Observatory with the instrument integrated				
SCSPEC427	Shipping/ Storage Containers	I, T	The Spacecraft vendor provided Flight Hardware Shipping & Storage Container(s) shall be airtight with filtered pressure control system.	To provide gas purge capability to ensure that any breathing is through a filter.				
SCSPEC428	Shipping/ Storage Containers	I, T	The Spacecraft vendor provided Flight Hardware Shipping & Storage Container(s) shall incorporate means of purging.	With Class B dry nitrogen or dry air clean air that meets same cleanliness as the nitrogen				
SCSPEC429	Shipping/ Storage Containers	I, A	The Spacecraft vendor provided Flight Hardware Shipping & Storage Container(s) shall meet contamination requirements during shipment.		Object Identifier:MRD174			
SCSPEC430	Shipping/ Storage Containers	I, T	The Spacecraft vendor provided Flight Hardware Shipping & Storage Container(s) shall incorporate means of measuring and recording shocks, temperature and humidity within the container during transit	Transportation environment should be monitored at all times to help detect for unseen damage.				
SCSPEC431	Shipping/ Storage Containers	I, T	The Spacecraft vendor provided Flight Hardware Shipping & Storage Container(s) shall have external indicators for temperature, humidity, and pressure monitoring.	To provide an early indication that the transportation environment is outside of limits.				
SCSPEC432	Shipping/ Storage Containers	I, A, T	The Spacecraft vendor provided Flight Hardware Shipping & Storage Container(s) shall maintain a safe transport environment as defined in the Environmental Requirements Document.					
SCSPEC433	Shipping/ Storage Containers	I, A, T	The Spacecraft vendor provided Flight Hardware Shipping & Storage Container(s) shall be capable of being airlifted.					
SCSPEC434	Shipping/ Storage Containers	I, T	The Spacecraft vendor provided Flight Hardware Shipping & Storage Container(s) shall be suitable for use in the clean room, after cleaning.	Shipping & Storage container(s) will be in close proximity to the spacecraft so must be able to cleaned to clean room specs. This applies only to flight hardware or flight hardware critical support				

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Released: March 30, 2011

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				GSE.				
SCSPEC435	Shipping/ Storage Containers	I, A, T	The environment in the Spacecraft vendor provided Flight Hardware Shipping & Storage Container(s) shall not exceed the environments defined in the ICESat-2 Environmental Requirements Document.					
SCSPEC529	Shipping/ Storage Containers - Pressure relief and/or equalization		The Spacecraft vendor provided Flight Hardware Shipping and Storage container(s) shall provide for a pressure relief/equalization system to account for pressure differentials induced by storage, shipping, etc.	Shipping/Storage Container Pressure is monitored and the containers are airtight; however, need to ensure that pressure in the container is equal to the pressure outside the container when the container is opened.				
SCSPEC436	Interface Plane	I, T	During Observatory tests in which the instrument is powered, the ATLAS-to-Spacecraft interface plane shall be level to 0.05 degrees, for tests when the instrument is operating without GSE cooling, as defined in SC ATLAS IDD 107.	During observatory tests in which ATLAS is powered on, the ATLAS-to-Spacecraft interface plane must be level to within TBD degrees.		Object Identifier:IDD107		
SCSPEC465	Safe Mode Observatory Orientation		The spacecraft safehold attitude shall be TBP.	The spacecraft vendor shall propose a spacecraft attitude.	Object Identifier:MRD52 Object Identifier:MRD172			
SCSPEC467	Software Development Maintenance System		The Spacecraft shall comply with the interface to the Ground as defined in the SGIDD.	Capture of the interface requirements between the Spacecraft and the Ground.				
SCSPEC468	Payload Lateral Center of Mass		The Spacecraft shall be designed such that the Observatory lateral center of mass meets LSIDD68.	The observatory lateral center of mass must meet the requirements derived from the LSIDD.				Object Identifier:LSIDD68
SCSPEC469	IMSC Mass Allocation		The Spacecraft IMSC Mass shall be as defined in SC ATLAS IDD 150.	Specifically addresses IMSC component, mounts/flexures, thermal hardware and harnessing.		Object Identifier:IDD150		
SCSPEC170	Laser Centroids - LRS		The Spacecraft shall receive laser centroids from the LRS as defined in IDD131			Object Identifier:IDD131		
SCSPEC471	Star Centroids - LRS		The Spacecraft shall receive star centroids from the LRS as defined in IDD133.	Need to add requirements related to LRS in the ACS loop, per IDD131 and IDD133.		Object Identifier:IDD133		
SCSPEC472	Orbit Knowledge		The spacecraft shall generate realtime onboard orbit knowledge position with an error of 5m or less cross-track (1 sigma)	The spacecraft will point to specific targets provided in an earth-centered, earth-fixed reference frame. In order to point to these targets, the spacecraft	Object Identifier:MRD33 Object Identifier:MRD159			

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				must know its location in the orbit. The allowable error in this knowledge is related to the spacecraft pointing control error, found in SCSPEC35. ICESat-2-SYS-REQ-0450 "Geolocation Budgets" provides a detailed breakdown of the geolocation control error allocations, which includes spacecraft pointing control and the related orbital position knowledge. The spacecraft design may trade these two values against each other, so long as the top-level geolocation requirement is met, given the other allocations in the geolocation budget.				
SCSPEC473	Spacecraft High Frequency Jitter		The Spacecraft high frequency jitter above 50Hz shall be less than 1 microradian (1 sigma).		Object Identifier:MRD159			
SCSPEC474	Observatory Orientation - Instrument powered		For Observatory optical testing the orientation of the observatory shall align -X in the same direction as the gravity vector as defined in ICESat-2-SYS-ANYS-0474	Need to specify valid orientations for testing given the heat pipe operation constraints.				
SCSPEC475	IMSC Physical Mounting Location		The spacecraft star trackers and gyros shall be mounted on ATLAS as defined in SC ATLAS IDD 140.	Account for physical volume considerations for both ATLAS and OBS.	Object Identifier:MRD33 Object Identifier:MRD159	Object Identifier:IDD140		
SCSPEC481	Gyro Mounting Plane Stability		The motion between the spacecraft gyro reference fame and the mounting plane of the gyro interface on the ATLAS instrument shall be less than 25 (TBR) microradians over 3 minutes.	This is derived from the Geolocation Knowledge Budget. In order to meet the mission geolocation knowledge requirement of 6.5-meters, the motion between the gyro reference frame and the ATLAS LRS reference frame must be limited. This requirement is the portion of that motion which is the responsibility of spacecraft-supplied hardware. This is essentially a requirement on the				

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Object Identifier	Title	Verif. Meth	SRD Requirement	Rationale	MRD Links	AIDD	GSIDD	LSIDD
				stiffness and thermal-mechanical stability of the mount that connects the gyro to the ATLAS instrument.				
SCSPEC476	IMSC Thermal Interface		IMSC Thermal interface shall be as defined in SC ATLAS IDD 141and SC ATLAS IDD 142.	The spacecraft Star Trackers and gyro shall have kinematic, adiabatic interfaces. Accounts for thermal interface considerations to ensure ATLAS is isolated from thermal effects of IMSC.		Object Identifier:IDD141 Object Identifier:IDD142		
SCSPEC477	Simulator Data Archiving and Retrieval		The SIS shall archive simulation commands and data sets for subsequent retrieval and analysis.	The intent is to facilitate debugging and compatibility between lower level system bench test equipment and system level simulator usage. Explicitly call out the full expectations record commands, data sets and ensure access to archived commands and data set. Inherent retrieval function and compatible data sets/command platforms, interfaces				
SCSPEC478	Mission Operations		Mission operations procedures shall successfully run on both the OOS and the SDMS within the limitations of the simulators themselves.	Simulators will have different capabilities based on their requirements and purposes. For example, the SDMS will have single string EM Computer, making redundancy cost prohibitive. These differences will mean that not all mission operations procedures can run successfully on both the OOS and SDMS, though the procedure itself would be fine.				
SCSPEC479	Coordinate System		The observatory shall comply with the coordinate system as defined in ICESat-2 document: ICESat-2-SYS-ANYS-0474.		Object Identifier:MRD15			
SCSPEC480	Spacecraft Purge		The spacecraft provider shall support routing of a GFE purge line while mated to the launch vehicle.	Maintain cleanliness conditions for the instrument. Reference IDD136. Purge Hardware will be supplied		Object Identifier:IDD136		

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				as ATLAS GFE.				
SCSPEC490	ATLAS GSE Cooling		During observatory testing in which the instrument is operating, but in which the orientation is not as described in IDD113, GSE cooling shall be provided to the instrument.	ATLAS heat pipes will not function if the ATLAS orientation is not as described in IDD113. In other orientations, ATLAS-provided GSE cooling must be used if the instrument is to be operating in a laboratory environment.		Object Identifier:IDD113		
SCSPEC191	Power Service Margin for Open Pin		Each power service's conductor and current carrying capability shall meet the derating requirements of EEE-INST-002 (Instructions for EEE Parts Selection, Screening, Qualification, and Derating) in the case of one failed conductor.			Object Identifier:IDD95		
SCSPEC492	Power Interface Overcurrent Protection		The Spacecraft shall provide resetable overcurrent protection for all ATLAS-to-spacecraft power interfaces on the spacecraft side of the interface.	All instrument power interfaces should have overcurrent protection, and it should be on the spacecraft side of the interface.		Object Identifier:IDD39		
SCSPEC493	Independent Power Returns		All ATLAS power services shall have independent returns.	All power services (where a power service is an independently monitored or switched supply with multiple conductors used to increase the overall current carrying capacity) will have independent returns (i.e. the main power return is separate from the laser power returns which are separate from the heater power returns etc.). Done as power engineering best practice		Object Identifier:IDD114		
SCSPEC494	Power and signal connectors		Spacecraft-to-ATLAS power connectors shall be separate from Spacecraft signal connectors.			Object Identifier:IDD56		
SCSPEC495	Realtime Instrument Commands		The Spacecraft shall transfer realtime commands to ATLAS.	The ground must be able to command the instrument in realtime through the spacecraft.		Object Identifier:IDD67		
SCSPEC496	1 pps Signal Delay		The Spacecraft 1 pps signal to the instrument will be based on the GPS 1 Hz signal with a delay of no more than 200 nanoseconds.	The 1 Hz pulse to the instrument should not be a tick derived from the spacecraft clock, but must be linked directly to the 1 Hz signal from GPS, with as little delay/jitter as practical.		Object Identifier:IDD134		
SCSPEC497	Time-at-tone message		The spacecraft shall provide a message to ATLAS indicating the GPS time and spacecraft clock time	ATLAS needs to know time for accurate geolocation of		Object Identifier:IDD71		

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			at the time of the last 1 pps pulse, within 100 ns of the last 1 pps pulse.	measurements.				
SCSPEC498	ATLAS 1553 Housekeeping Data Rate		The Spacecraft shall ingest instrument housekeeping data from the MIL-STD-1553 interface at a peak data rate of 7.5 kbps.	Based on current ATLAS data analysis		Object Identifier:IDD137		
SCSPEC499	Timing pulse signal delay knowledge		The value of delay between the 1 Hz pulse delivered to the instrument and the GPS 1 Hz pulse will be known to within 100 nanoseconds.	This is part of the altimetry timing budget for ATLAS.		Object Identifier:IDD149		
SCSPEC500	ATLAS Thermal Interface		The spacecraft-created thermal backloading on the ATLAS radiators shall not exceed the values given in SC ATLAS IDD112 and 130.	Backloading caused by the spacecraft on the instrument radiators must be limited to insure that the ATLAS thermal system functions as designed.		Object Identifier:IDD112 Object Identifier:IDD130		
SCSPEC501	Thermal System		The spacecraft shall control the temperature of the spacecraft side of the ATLAS-to-spacecraft mounting interface as defined in AIDD94.	The instrument thermal design requires thermal stability at the instrument-to-spacecraft interface		Object Identifier:IDD94		
SCSPEC505	Flight Plugs		The Spacecraft design shall provide access into the observatory such that flight plugs which require installation before launch can be installed at the Observatory level of integration.	The spacecraft must provide access for the installation of flight plugs prior to launch, when the observatory is fully assembled.		Object Identifier:IDD62		
SCSPEC506	IMSC Thermal		The Spacecraft IMSC surfaces that view the ATLAS optical bench shall have an average-area effective emissivity as defined in SC ATLAS IDD143.	Further defining the adiabatic interface between the IMSC and ATLAS		Object Identifier:IDD143		
SCSPEC507	IMSC Thermal		The Spacecraft IMSC shall operate within spec in the presence of an orbit-average incident backloading on the IMSC radiators from the ATLAS instrument as defined in SC ATLAS IDD144.	Constrains interaction between ATLAS and IMSC radiators.		Object Identifier:IDD144		
SCSPEC508	IMSC Thermal		The Spacecraft IMSC orbit-average incident backloading on the ATLAS LRS radiators shall not exceed the value defined in IDD145.	Constrains interaction between IMSC and nearby LRS radiators.		Object Identifier:IDD145		
SCSPEC509	SC Pointing Message		The spacecraft shall provide a message to ATLAS indicating the spacecraft pointing, position, and associated time at a rate of at least 1 Hz.	ATLAS uses this information to set the altimeter range gates.		Object Identifier:IDD99		
SCSPEC510	Spacecraft Pointing to ATLAS		The Spacecraft shall provide spacecraft pointing to ATLAS as a quaternion.	ATLAS uses this information to set the altimeter range gates.		Object Identifier:IDD101		
SCSPEC511	Structure and Mechanical Systems		The Spacecraft mounting surface for the ATLAS mounting feet shall have a co-planarity as defined in AIDD106.	Minimize distortions caused by bolting the instrument to the spacecraft.		Object Identifier:IDD106		
SCSPEC512	Structure and Mechanical		The spacecraft shall limit the coplanarity change of the ATLAS mounting interfaces due to thermal	This is to limit the amount of thermal distortion transferred into		Object Identifier:IDD11		

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	Systems		distortion, launch shifts, moisture de-sorption and zero-g shifts AIDD11.	the instrument by the spacecraft.				
SCSPEC513	Structure and Mechanical Systems		The Spacecraft shall limit the moments imparted by the spacecraft on any given instrument mounting surface due to thermal distortion, launch shifts, moisture de-sorption and zero-g shifts per AIDD151	This is to limit the amount of thermal distortion transferred into the instrument by the spacecraft.		Object Identifier:IDD151		
SCSPEC514	IMSC Mounting		The IMSC shall have kinematic mounting interfaces to the instrument.	This is to limit the amount of thermal distortion transferred into the instrument by the IMSC.		Object Identifier:IDD152		
SCSPEC516	Pointing - Medium Frequency Jitter - Roll		The spacecraft pointing control jitter about the roll axis shall be less than or equal to 4.8 microradians for jitter frequencies greater than 5 Hz and less than 50 Hz.	This is derived from the Geolocation Control budget.	Object Identifier:MRD10 Object Identifier:MRD11 Object Identifier:MRD12 Object Identifier:MRD15 Object Identifier:MRD33 Object Identifier:MRD159			
SCSPEC517	Access to Observatory - Encapsulation		The Spacecraft items that require access after encapsulation shall be accessible through a single door in the DPA structure.	Although DPA will have two doors - only one door will be allocated to the spacecraft. The second door is allocated to the instrument.				Object Identifier:LSIDD3
SCSPEC519	Telemetry and Command Interfaces - Umbilical Connector		The Spacecraft shall provide interface connectors (TBR) for telecommunications while integrated to the launch vehicle.	Launch Vehicle umbilical will interface to a connector on the spacecraft.				
SCSPEC522	Ground Operations - Observatory Integration to LV		The Spacecraft design shall support both vertical and horizontal integration of the Observatory to the Launch Vehicle.		Object Identifier:MRD157			
SCSPEC523	Safety - Propellant Off-		The Spacecraft shall off-load propellant per LSIDD95 and LSIDD100.	Capability must exist to offload propellant in an emergency or				Object Identifier:LSIDD95

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	loading and Accessability			when fully encapsulated.				Object Identifier:LSIDD100
SCSPEC525	Power System		The Spacecraft shall provide for power generation, power control, energy storage and distribution to the Spacecraft					
SCSPEC526	Power System - Load Shedding		The Spacecraft shall support load shedding of non-essential components, in the event of off-nominal operating conditions.					
SCSPEC527	Power System - Battery Reconditioning		The Spacecraft shall recondition the battery within 90 days prior to launch, except for Li-Ion chemistries. Li-Ion does not require reconditioning.					
SCSPEC528	Power System - Battery Charge Control		The Spacecraft shall collect all power system telemetry necessary to support battery charge control management to meet mission lifetime performance requirements.					
SCSPEC530	Long Term Trending - Observatory		The Spacecraft shall generate Housekeeping Telemetry to support performance trending throughout the life of the mission.	To support long-term trend analysis of observatory performance.				
SCSPEC531	Use of Metric Units		The Spacecraft shall comply with the use of metric units, with noted exceptions as defined in MRD162.	Supports common unit policy for the mission with noted exceptions; where significant cost & risk might be realized if complete SI compliance were mandated. NPD 7120.4D is mandatory, but allows exceptions.	Object Identifier:MRD162			
SCSPEC533	Spacecraft Distortion		The Spacecraft shall limit the radial displacement of the ATLAS mounting interfaces per AIDD158.			Object Identifier:IDD158		
SCSPEC534	Spacecraft Mounting - Thermal Gradient	T	The Spacecraft shall control the temperature of the spacecraft side of the ATLAS to Spacecraft mounting interface such that the gradient between any two instrument flexures per AIDD159.					
SCSPEC535	LV Separation System		The Spacecraft shall provide an interface to the launch vehicle separation system as defined in LSIDD141.		Object Identifier:MRD157			Object Identifier:LSIDD141

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