ICESat-2 Project Controlled Document
Released by: N. Brown 09/23/2011

Ice, Cloud, and Land Elevation Satellite (ICESat-2) Project

ATLAS Thermal Interface Control Document (ICD) ICESat-2-THM-IFACE-0214

Revision F

Effective Date: 09/23/2011

Expiration Date: 09/23/2016

Released Version

Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and Space Administration

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Released: September 23, 2011

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 -	09/09/2010	SCoRe 0030	09/09/2010	All	Initial release of document.
Rev A	11/02/2010	SCoRe 0088	11/02/2010	3, 11, 15, 16, 17, 24, 38, 39	Interfaces added and level 3 upgraded
Rev B	03/11/2011	0066	03/01/2011	Section 3	Update requirement changes.
Rev C	03/18/2011	0082	03/16/2011	Applicability Section	Eliminating TICD200 and 201, and changing the applicability from subsystems to components
Rev D	04/04/2011	0089	04/04/2011	Page 9	Correct Table 2
Rev E	06/13/2011	0093/0097	6/13/2011	Reqmt Changes	Impacts of linkages
Rev F	09/23/2011	0105	09/23/2011	Reqmt Changes	Add new requirements, provide new links, allocation to Fiber Optics and text changes

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1 Introduction

1.1 Purpose and Scope

This document provides configuration control for all interfaces for the thermal control system of the Ice, Cloud, and Land Elevation Satellite-2 (ICESAT-2) Advanced Topographic Laser Altimeter (ATLAS) instrument. Spacecraft interfaces are not included in this document. This document also details the ATLAS Thermal Control System requirements that are flowed down to instrument subsystems. It contains a baseline for demonstrating by test and analysis the satisfactory performance of hardware in the expected mission environments, and that minimum workmanship standards have been met. It elaborates on those requirements, gives guideline test levels, provides guidance in the choice of test options, and describes acceptable test and analytical methods for implementing the requirements.

The requirements within this document are level 3 interface controls within the instrument architecture. Each requirement within this document must be allocated to one or more instrument level 4 requirements.

1.2 Applicability and Limitation

These requirements apply to the ATLAS thermal control system and all ATLAS components that interface to it.

1.3 Definitions

The following are level of assembly definition used in this document. For more information refer to Goddard Environmental Verification Standards (GEVS) (GSFC-STD-7000) Section 1.8.

Assembly: A functional subdivision of a component consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole. Examples are a power amplifier and gyroscope.

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

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

Module: A major subdivision of the payload that is viewed as a physical and functional entity for the purposes of analysis, manufacturing, testing, and recordkeeping. Examples include spacecraft bus, science payload, and upper stage vehicle.

Part: A hardware element that is not normally subject to further subdivision or disassembly without destruction of design use. Examples include resistor, integrated circuit, relay, connector, bolt, and gaskets.

Payload: An integrated assemblage of modules, subsystems, etc., designed to perform a specified mission in space. For the purposes of this document, "payload" and "spacecraft" are used interchangeably. Other terms used to designate this level of assembly are Laboratory, Observatory, Satellite and System Segment.

Spacecraft: See Payload. Other terms used to designate this level of assembly are Laboratory, Observatory, and satellite.

Section: A structurally integrated set of components and integrating hardware that form a subdivision of a subsystem, module, etc. A section forms a testable level of assembly, such as components/units mounted into a structural mounting tray or panel-like assembly, or components that are stacked.

Subassembly: A subdivision of an assembly. Examples are wire harness and loaded printed circuit boards.

Subsystem: A functional subdivision of a payload consisting of two or more components. Examples are structural, attitude control, electrical power, and communication subsystems. Also included as subsystems of the payload are the science instruments or experiments.

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

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1.4 Responsibility For Administration

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

1.5 Configuration Control and Distribution

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

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2 Documentation

2.1 Applicable Documents

The ATLAS instrument and components will meet all requirements of the following documents. In cases of conflict between this document and the higher level documents, the higher level documents take precedence. Contractors will use the current version in effect at the time of procurement.

1. ICESat-2-SYS-REQ-0329, ATLAS Instrument Requirements Document
2. ICESat-2-SYS-REQ-0189, ATLAS Electrical Systems Requirements
3. ICESat-2-ATSYS-REQ-0517, ATLAS Component Environmental Requirements Document

2.2 Reference Documents

The following documents are referenced in this document. In cases of conflict, this document will take precedence.

1. ICESat-2-THM-SPEC-0217, ATLAS Thermal Hardware Specification
2. ICESat-2-THM-RPT-0212, ATLAS Thermal Model Delivery Report Template
3. ICESat-2-THM-LIST-0520, ATLAS Thermal Analysis Approved Optical Properties List
4. ICESat-2-SYS-ANYS-0474, Definition of ICESat-2 Reference Frame
5. NASA GSFC S-311-P-079, Procurement Specification for Thermofoil Heaters
6. NASA GSFC S-311-641, Switches, Thermostatic, General Requirements
7. NASA GSFC S-311-P-018, Specification for Thermistor, Insulated and Uninsulated, Negative Temperature Coefficient
8. GSFC-STD-7000, General Environmental Verification Standard (GEVS) for GSFC Flight Programs and Projects

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TICD141	3.1	Types of Temperature Limits	Survival Limits will be defined as the minimum and maximum non-operating temperatures that may be experienced without inflicting damage or permanent performance degradation.	Components may dwell at their survival temperature range when the instrument is unpowered.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR60 Object Text:The ATLAS structure shall meet TICD141. Object Identifier:TRD169 Object Text:The TCS shall define internal temperature limits in accordance with TICD6, TICD7, TICD8, TICD9, TICD10 and TICD141. Object Identifier:TAMS60 Object Text:The ATLAS TAMS LS shall meet TICD141. Object Identifier:BSM127 Object Text:The BSM shall comply with TICD141. Object Identifier:DAA241 Object Text:The DAA shall comply with the Types of Temperature Limits requirement as written in TICD141 Object Identifier:LRS186 Object Text:The ATLAS LRS Team shall use the definition from TICD141. Object Identifier:LSA24 Object Text:The ATLAS LSA shall survive, without damage, temperatures as defined in TICD42, TICD61, TICD62, and TICD41. Object Identifier:LTR20 Object Text:The ATLAS Transmit LTR shall, per ICESat-2-THM-IFACE-0214, meet the Survival temperature limits -40 to 50 degrees C	Object Identifier:GCS2 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:MEB111 Object Text:The MEB shall comply with the Survival Temperature Limits as defined in TICD141 Object Identifier:OFA34 Object Text:Survival Limits will be defined as the minimum and maximum non-operating temperatures that may be experienced without inflicting damage or permanent performance degradation. Object Identifier:OFA192 Object Text:OFA shall comply with TICD141 Object Identifier:PDU209 Object Text:The PDU shall comply with TICD141 (Survival Limits defined). Object Identifier:RTA87 Object Text:The RTA shall meet TICD141. Object Identifier:SPD36 Object Text:The ATLAS Start Pulse Detector shall comply with the Types of Temperature Limits requirement as written in TICD141.		
TICD6	3.1	Types of Temperature Limits	Qualification Limits will be defined as the minimum and maximum temperatures over which the responsible hardware manager has proven the components meet all performance requirements through qualification testing.	Qualification testing provides margin on the system performance at extreme temperatures.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR61 Object Text:The ATLAS structure shall meet TICD6. Object Identifier:TRD169 Object Text:The TCS shall define internal temperature limits in accordance with TICD6, TICD7, TICD8, TICD9, TICD10 and TICD141. Object Identifier:TAMS61	Object Identifier:GCS2 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Text:The ATLAS TAMS LS shall meet TICD6. Object Identifier:BSM128 Object Text:The BSM shall comply with TICD6. Object Identifier:DAA242 Object Text:The DAA shall comply with the Types of Temperature Limits requirement as written in TICD6 Object Identifier:FO44 Object Text:The fiber optics shall meet TICD6 Object Identifier:LRS187 Object Text:The ATLAS LRS Team shall use the definition from TICD6. Object Identifier:LSA25 Object Text:The ATLAS LSA shall meet all performance requirements while being exposed to Qualification Temperature Limits as defined in TICD6 and TICD42. Object Identifier:MEB112 Object Text:The MEB shall comply with the Qualification Temperature Limits as defined in TICD6 Object Identifier:OFA35 Object Text:Qualification Limits will be defined as the minimum and maximum temperatures over which the responsible hardware manager has proven the components meet all performance requirements through qualification testing.		

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						Object Identifier:OFA193 Object Text:OFA shall comply with TICD6 Object Identifier:PDU210 Object Text:The PDU shall comply with TICD6 (Qualification Limits defined). Object Identifier:RTA88 Object Text:The RTA shall meet TICD6. Object Identifier:SPD37 Object Text:The ATLAS Start Pulse Detector shall comply with the Types of Temperature Limits requirement as written in TICD6.		
TICD7	3.1	Types of Temperature Limits	Acceptance Limits will be defined as the minimum and maximum temperatures over which the responsible hardware manager has proven the components meet all performance requirements if the same design component has been qualified in a relevant environment to ATLAS.	Qualification testing of non-flight units may reduce the testing burden on the flight component.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR62 Object Text:The ATLAS structure shall meet TICD7. Object Identifier:TRD169 Object Text:The TCS shall define internal temperature limits in accordance with TICD6, TICD7, TICD8, TICD9, TICD10 and TICD141. Object Identifier:TAMS62 Object Text:The ATLAS TAMS LS shall meet TICD7. Object Identifier:BSM129 Object Text:The BSM shall comply with TICD7. Object Identifier:DAA243 Object Text:The DAA shall comply with the Types of Temperature Limits requirement as written in TICD7 Object Identifier:FO45	Object Identifier:GCS2 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Text:The fiber optics shall meet TICD7 Object Identifier:LRS188 Object Text:The ATLAS LRS Team shall use the definition from TICD7. Object Identifier:LSA26 Object Text:The ATLAS Laser Sampling Assembly shall meet the Acceptance Temperature Limits per TICD7 and TICD42. Object Identifier:LTR22 Object Text:The ATLAS Transmit LTR shall, per ICESat-2-THM-IFACE-0214, meet the Acceptance Temperature Limits - 25 to 40 degrees C Object Identifier:MEB113 Object Text:The MEB shall comply with the Acceptance Temperature Limits as defined in TICD7 Object Identifier:OFA36 Object Text:Acceptance Limits will be defined as the minimum and maximum temperatures over which the responsible hardware manager has proven the components meet all performance requirements if the same design component has been qualified in a relevant environment to ATLAS. Object Identifier:OFA195 Object Text:OFA shall comply with TICD7 Object Identifier:PDU211 Object Text:The PDU shall comply with		

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						TICD7 (Acceptance Limits defined). Object Identifier:RTA89 Object Text:The RTA shall meet TICD7. Object Identifier:SPD38 Object Text:The ATLAS Start Pulse Detector shall comply with the Types of Temperature Limits requirement as written in TICD7.		
TICD8	3.1	Types of Temperature Limits	Flight Operational Limits will be defined as the minimum and maximum temperature range at the thermal interface that the component will see during flight.	These provide the bounding design requirements for the instrument TCS.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR63 Object Text:The ATLAS structure shall meet TICD8. Object Identifier:TRD169 Object Text:The TCS shall define internal temperature limits in accordance with TICD6, TICD7, TICD8, TICD9, TICD10 and TICD141. Object Identifier:TAMS63 Object Text:The ATLAS TAMS LS shall meet TICD8. Object Identifier:BSM130 Object Text:The BSM shall comply with TICD8. Object Identifier:DAA244 Object Text:The DAA shall comply with the Types of Temperature Limits requirement as written in TICD8 Object Identifier:FO46 Object Text:The fiber optics shall meet TICD8 Object Identifier:LRS189 Object Text:The ATLAS LRS Team shall	Object Identifier:GCS2 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						use the definition from TICD8. Object Identifier:LSA27 Object Text:The ATLAS Laser Sampling Assembly shall meet the Flight Temperature Operational Limits per TICD8, TICD9, TICD10 and TICD42. Object Identifier:LTR23 Object Text:The ATLAS Transmit LTR shall, per ICESat-2-THM-IFACE-0214, meet the Flight Temperature Operational Limits -20 to 35 degrees C Object Identifier:MEB114 Object Text:The MEB shall comply with the Operational Temperature Limits as defined in TICD8 Object Identifier:OFA37 Object Text:OFA shall comply with TICD8 Object Identifier:OFA196 Object Text:OFA shall comply with TICD8 Object Identifier:PDU212 Object Text:The PDU shall comply with TICD8 (Flight Operational Limits defined). Object Identifier:RTA90 Object Text:The RTA shall meet TICD8. Object Identifier:SPD39 Object Text:The ATLAS Start Pulse Detector shall comply with the Types of Temperature Limits requirement as written in TICD8.		

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TICD9	3.1	Types of Temperature Limits	Flight Operational Limits will be at least 10C inside the qualification limits except for actively-controlled components, which will be at least 5C inside the qualification limits	These definitions are provided by GEVS. The laser thermal control system and the LRS Optics are the only components on the instrument that have an active thermal control system.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR64 Object Text:The ATLAS structure shall meet TICD9. Object Identifier:TRD169 Object Text:The TCS shall define internal temperature limits in accordance with TICD6, TICD7, TICD8, TICD9, TICD10 and TICD141. Object Identifier:TAMS64 Object Text:The ATLAS TAMS LS shall meet TICD9. Object Identifier:BSM131 Object Text:The BSM shall comply with TICD9. Object Identifier:DAA245 Object Text:The DAA shall comply with the Types of Temperature Limits requirement as written in TICD9 Object Identifier:FO47 Object Text:The fiber optics shall meet TICD9 Object Identifier:LRS190 Object Text:ATLAS LRS Electronics and Sunshade Components shall comply with TICD9 Object Identifier:LRS191 Object Text:ATLAS LRS Optics Component shall comply with TICD10. Object Identifier:LSA27 Object Text:The ATLAS Laser Sampling Assembly shall meet the Flight	Object Identifier:GCS2 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Temperature Operational Limits per TICD8, TICD9, TICD10 and TICD42. Object Identifier:MEB115 Object Text:The MEB shall comply with the Operational Temperature Limit Ranges relative to the Qualification Limits as defined in TICD9 Object Identifier:OFA38 Object Text:OFA shall comply with TICD9 Object Identifier:OFA197 Object Text:OFA shall comply with TICD9 Object Identifier:OPT14 Object Text:The ATLAS Transmitter Optics shall meet the Flight Temperature Acceptance Limits per TICD9 Object Identifier:PDU213 Object Text:The PDU shall comply with TICD9 (Flight Operational Limits defined). Object Identifier:RTA91 Object Text:The RTA shall meet TICD9. Object Identifier:SPD40 Object Text:The ATLAS Start Pulse Detector shall comply with the Types of Temperature Limits requirement as written in TICD9.		
TICD10	3.1	Types of Temperature Limits	Flight Operational Limits will be at least 5C inside the acceptance limits except for actively-controlled components.	These definitions are provided by GEVS	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA,	Object Identifier:STR65 Object Text:The ATLAS structure shall meet TICD10. Object Identifier:TRD169 Object Text:The TCS shall define internal	Object Identifier:GCS2 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the

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					MEB, PDU, Structure, Thermal, Fiber Optics	temperature limits in accordance with TICD6, TICD7, TICD8, TICD9, TICD10 and TICD141. Object Identifier:TAMS65 Object Text:The ATLAS TAMS LS shall meet TICD10. Object Identifier:BSM132 Object Text:The BSM shall comply with TICD10. Object Identifier:DAA246 Object Text:The DAA shall comply with the Types of Temperature Limits requirement as written in TICD10 Object Identifier:FO48 Object Text:The fiber optics shall meet TICD10 Object Identifier:LSA27 Object Text:The ATLAS Laser Sampling Assembly shall meet the Flight Temperature Operational Limits per TICD8, TICD9, TICD10 and TICD42. Object Identifier:LSA28 Object Text:The ATLAS Laser Sampling Assembly shall meet the Flight Temperature Acceptance Limits per TICD10 and TICD42 Object Identifier:MEB116 Object Text:The MEB shall comply with the Operational Temperature Limit Ranges relative to the Acceptance Limits as defined in TICD10		spacecraft thermal control system.

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						Object Identifier:OFA39 Object Text:OFA shall comply with TICD10 Object Identifier:OFA198 Object Text:OFA shall comply with TICD10 Object Identifier:PDU214 Object Text:The PDU shall comply with TICD10 (Flight Operational Limits defined). Object Identifier:RTA92 Object Text:The RTA shall meet TICD10. Object Identifier:SPD41 Object Text:The ATLAS Start Pulse Detector shall comply with the Types of Temperature Limits requirement as written in TICD10.		
TICD142	3.1	Thermal Interface Definitions	All powered components will be designed to reject dissipated power through their conductive interface to the instrument TCS.	The instrument TCS will not be designed to transport heat by radiation.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal	Object Identifier:STR75 Object Text:The ATLAS structure shall meet TICD142. Object Identifier:TRD32 Object Text:The TCS shall maintain the temperatures of all components within the allowable operational temperature limits for the allocated and CBE powers defined in the ICESat-2-ATSYS-REQ-0479 technical resource budget. Object Identifier:TAMS66 Object Text:The ATLAS TAMS LS shall meet TICD142. Object Identifier:BSM133 Object Text:The BSM shall comply with	Object Identifier:GCS8 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits for the laser power associated with the maximum laser output power and the expected beginning-of-life efficiency.	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						TICD142. Object Identifier:DAA108 Object Text:The DAA shall comply with the Thermal Interface Definitions requirement as written in TICD142. Object Identifier:FO49 Object Text:The fiber optics shall meet TICD142 Object Identifier:LRS193 Object Text:All ATLAS LRS powered components shall comply with TICD142. Object Identifier:MEB117 Object Text:The MEB shall comply with dissipated power rejection as defined in TICD142 Object Identifier:OFA40 Object Text:OFA shall comply with TICD142 Object Identifier:OFA199 Object Text:OFA shall comply with TICD142 Object Identifier:PDU215 Object Text:The PDU shall comply with TICD142 (Thermal Interface defined). Object Identifier:RTA93 Object Text:The RTA shall meet TICD142. Object Identifier:SPD42 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Interface Definitions requirement as written		

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						in TICD142.		
TICD143	3.2	Thermal Interface Definitions	The thermal interface for the MEB will be the mounting interface to the radiator as shown in the MEB Radiator MICD (drawing 2153106).	Powered components require a thermal interface to the thermal control system to remove waste heat.	MEB, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:MEB118 Object Text:The MEB shall comply with the thermal interface as defined in TICD143		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD144	3.2	Thermal Interface Definitions	The thermal interface for the PDU will be the mounting interface to the radiator as shown in the PDU Radiator MICD (drawing 2153107).	Powered components require a thermal interface to the thermal control system to remove waste heat.	PDU, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:PDU216 Object Text:The PDU shall comply with TICD144 (Thermal Interface defined).		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD145	3.2	Thermal Interface Definitions	The thermal interface for the lasers will be the mounting interface to the heat pipes as shown in the Laser MICD (drawing 2153301)	Powered components require a thermal interface to the thermal control system to remove waste heat.	Laser, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD146	3.2	Thermal Interface Definitions	The thermal interface for the DAA PM will be the mounting interface to the radiator as shown in the DAA MICD (drawing 2153310).	Powered components require a thermal interface to the thermal control system to remove waste heat.	DAA, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:DAA109 Object Text:The DAA shall comply with the Thermal Interface Definitions requirement as written in TICD146.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD275	3.2	Thermal	The thermal interface for the DAA	Powered components	DAA, Thermal	Object Identifier:TRD51		Object Identifier:IRD51

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		Interface Definitions	Electronics will be the mounting interface to the radiator as shown in the DAA MICD (drawing 2153310).	require a thermal interface to the thermal control system to remove waste heat.		Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:DAA255 Object Text:The DAA shall comply with the Thermal Interface Definitions requirement as written in TICD275		Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD147	3.2	Thermal Interface Definitions	The thermal interface for the SPD will be the mounting interface to the structure as shown in the SPD MICD (drawing 2153316).	Powered components require a thermal interface to the thermal control system to remove waste heat.	SPD, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD18	3.2	Thermal Interface Definitions	The thermal interface for the LSA will be the mounting interface to the structure as shown in the LSA MICD (drawing 2153304)	Powered components require a thermal interface to the thermal control system to remove waste heat.	LSA, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD19	3.2	Thermal Interface Definitions	The thermal interface for the LRS Optics will be the mounting interface to the radiator as shown in the LRS Optics MICD (TBD07 document number).	Powered components require a thermal interface to the thermal control system to remove waste heat.	LRS, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:LRS194 Object Text:The ATLAS LRS Team shall use the definition from TICD19.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD20	3.2	Thermal Interface Definitions	The thermal interface for the LRS Electronics will be the mounting interface to the radiator as shown in	Powered components require a thermal interface to the thermal control	LRS, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal		Object Identifier:IRD51 Object Text:The ATLAS instrument

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			the LRS Electronics Radiator MICD (drawing 2153109).	system to remove waste heat		interfaces for all components on the ATLAS instrument. Object Identifier:LRS195 Object Text:The ATLAS LRS Team shall use the definition from TICD20.		thermal control system shall operate independently of the spacecraft thermal control system.
TICD21	3.2	Thermal Interface Definitions	The ATLAS TCS will provide a suitable view to space for the LRS Sunshade radiator as specified in the LRS Sunshade MICD (drawing 2153314).	Powered components require a thermal interface to the thermal control system to remove waste heat. The backload on this surface is given in TICD59.	LRS, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:LRS196 Object Text:The ATLAS LRS shall meet specifications when the ATLAS TCS complies with TICD21.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD22	3.2	Thermal Interface Definitions	The thermal interface for the LRS Sunshade will be the mounting interface to the optical bench as shown in the LRS Sunshade MICD (drawing 2153314).	The LRS Sunshade will be isolated from the optical bench, but this interface determines the magnitude of thermal isolation that must be provided by the LRS.	LRS, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:LRS197 Object Text:The ATLAS LRS Team shall use the definition from TICD22.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD23	3.2	Thermal Interface Definitions	The thermal interface for the OFA will be the temperature reference point on the exterior of each of the 7 OFA ovens the OFA oven as shown in the OFA MICD (drawing 2153309).	The temperature control for the OFA will use feedback from one of two possible temperature sensors, which are the reference point for the OFA.	OFA, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:OFA41 Object Text:OFA shall comply with TICD23 Object Identifier:OFA200 Object Text:The thermal interface for the OFA will be the temperature reference point on the exterior of the OFA oven		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						(TBR1) as shown in the OFA MICD (drawing TBD5).		
TICD276	3.2	Thermal Interface Definitions	The thermal interface for the OFA Detector and electronics will be the mounting interface to the structure as shown in the OFA MICD (drawing 2153309).	Powered components require a thermal interface to the thermal control system to remove waste heat	OFA, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD24	3.2	Thermal Interface Definitions	The thermal interface for the BSM will be the mounting interface to the structure as shown in the BSM MICD (drawing 2153307).	Powered components require a thermal interface to the thermal control system to remove waste heat	BSM, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:BSM134 Object Text:The BSM shall comply with TICD24.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD25	3.2	Thermal Interface Definitions	The thermal interface for the telescope will be the mounting interface to the structure as shown in the Telescope MICD (drawing 2153407).	Optical component temperatures must be maintained to ensure performance.	RTA, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:RTA94 Object Text:The RTA shall meet TICD25.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD27	3.2	Thermal Interface Definitions	The thermal interface for the optical fibers will be tie-down points of the optical fibers to the structure	Optical component temperatures must be maintained to ensure performance	RTA, Thermal, Fiber Optics	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:FO50 Object Text:The fiber optics shall meet TICD27		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD28	3.2	Thermal Interface Definitions	The thermal interface for the fold mirrors will be the mounting interface to the structure as shown	Optical component temperatures must be maintained to ensure	Transmit Optics, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal		Object Identifier:IRD51 Object Text:The ATLAS instrument

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			in the Fold Mirror MICD (drawing 2153302).	performance.		interfaces for all components on the ATLAS instrument. Object Identifier:OPT15 Object Text:The Thermal Interface for the ATLAS Transmitter Optics shall be the mounting interface to the structure per TICD272, 29, 28, 31 and 30 Object Identifier:OPT137 Object Text:The thermal interface for the fold mirrors will be the mounting interface to the structure as shown in the Fold Mirror MICD (drawing 2153302).		thermal control system shall operate independently of the spacecraft thermal control system.
TICD29	3.2	Thermal Interface Definitions	The thermal interface for the polarizing beam combiner (PBC) will be the mounting interface to the structure as shown in the PBC MICD (drawing 2153303).	Optical component temperatures must be maintained to ensure performance.	Transmit Optics, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:OPT15 Object Text:The Thermal Interface for the ATLAS Transmitter Optics shall be the mounting interface to the structure per TICD272, 29, 28, 31 and 30 Object Identifier:OPT139 Object Text:The transmitter optics shall meet TICD29		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD30	3.2	Thermal Interface Definitions	The thermal interface for the DOE will be the mounting interface to the structure as shown in the DOE MICD (drawing 2153306).	Optical component temperatures must be maintained to ensure performance	Transmit Optics, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:OPT15 Object Text:The Thermal Interface for the ATLAS Transmitter Optics shall be the mounting interface to the structure per		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						TICD272, 29, 28, 31 and 30		
TICD31	3.2	Thermal Interface Definitions	The thermal interface for the beam expander will be the mounting interface to the structure as shown in the Beam Expander MICD (drawing 2153305).	Optical component temperatures must be maintained to ensure performance.	Transmit Optics, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:OPT15 Object Text:The Thermal Interface for the ATLAS Transmitter Optics shall be the mounting interface to the structure per TICD272, 29, 28, 31 and 30 Object Identifier:OPT135 Object Text:The thermal interface for the beam expander will be the mounting interface to the structure as shown in the Beam Expander MICD (drawing 2153305).		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD33	3.2	Thermal Interface Definitions	The thermal interface for the Transmit LTR will be the mounting interface to the LTR support tube as shown in the Transmit LTR MICD (drawing 2153312).	Optical component temperatures must be maintained to ensure performance	LTR, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:LTR24 Object Text:The Thermal Interface for the ATLAS Transmit LTR shall, per ICESat-2-THM-IFACE-0214, be the mounting interface to the LTR support tube as shown in Transmit LTR MICD drawing 2153312		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD34	3.2	Thermal Interface Definitions	The thermal interface for the TAMS LTR will be the mounting interface to the LTR support tube as shown in the TAMS LTR MICD (drawing 2153313).	Optical component temperatures must be maintained to ensure performance	LTR, Thermal	Object Identifier:RTA37 Object Text:The RTA shall meet all functional performance requirements over a 0°C to +35°C operational thermal range Object Identifier:RTA40 Object Text:The RTA shall survive a -40°C to +50°C thermal environment		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument.		
TICD35	3.2	Thermal Interface Definitions	The thermal interface for the aft optics will be the mounting interface to the telescope as shown in the Aft Optics Assembly MICD (drawing 2153308).	Optical component temperatures must be maintained to ensure performance	RTA, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:RTA95 Object Text:The RTA shall meet TICD35.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD36	3.2	Thermal Interface Definitions	The thermal interface for the ATLAS primary structure will be defined as the exposed surface of the primary structure.	The ATLAS structure temperature limits apply to the entire structure, but they will only be assessed and measured at areas that are exposed enough for temperature sensors to be installed	Structure, Thermal	Object Identifier:STR76 Object Text:The ATLAS structure shall meet TICD36. Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD37	3.2	Thermal Interface Definitions	The thermal interface for the TAMS Light Source will be the mounting interface to the structure as shown in the TAMS Light Source MICD (drawing 2153311).	Optical component temperatures must be maintained to ensure performance.	TAMS, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:TAMS67 Object Text:The ATLAS TAMS LS shall meet TICD37.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD272	3.2	Thermal Interface Definitions	The thermal interface for the Beam Dump will be the mounting interface to the structure as shown in the Beam Dump MICD (drawing 2153315).	Optical component temperatures must be maintained to ensure performance.	Transmit Optics, thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:OPT15 Object Text:The Thermal Interface for the		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						ATLAS Transmitter Optics shall be the mounting interface to the structure per TICD272, 29, 28, 31 and 30		
TICD42	4.1	Thermal Interface Temperature Requirements	All instrument TCS thermal interfaces will meet the temperature limits given in Table 1. **Table 1: ATLAS Thermal Interface Temperature Limits**	This provides the operational, survival, qualification and acceptance limits for all components listed in the above Thermal Interface Definition section.	Laser, SPD, LSA, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:RTA39 Object Text:The RTA telescope primary mirror thermal gradient shall be < 1°C Object Identifier:STR77 Object Text:The ATLAS structure shall meet TICD42. Object Identifier:TRD4 Object Text:The TCS shall maintain the temperatures of all instrument components within the allowable operational and survival temperature limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214). Object Identifier:TAMS68 Object Text:The ATLAS TAMS LS shall meet TICD42. Object Identifier:BSM135 Object Text:The BSM shall comply with TICD42. Object Identifier:DAA110 Object Text:The DAA shall comply with the Thermal Interface Temperature Requirements requirement as written in TICD42. Object Identifier:FO51 Object Text:The fiber optics shall meet TICD42 Object Identifier:LRS198 Object Text:The ATLAS LRS shall meet	Object Identifier:GCS2 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						specifications when the instrument TCS complies with TICD42. Object Identifier:LSA24 Object Text:The ATLAS LSA shall survive, without damage, temperatures as defined in TICD42, TICD61, TICD62, and TICD41. Object Identifier:LSA25 Object Text:The ATLAS LSA shall meet all performance requirements while being exposed to Qualification Temperature Limits as defined in TICD6 and TICD42. Object Identifier:LSA26 Object Text:The ATLAS Laser Sampling Assembly shall meet the Acceptance Temperature Limits per TICD7 and TICD42. Object Identifier:LSA27 Object Text:The ATLAS Laser Sampling Assembly shall meet the Flight Temperature Operational Limits per TICD8, TICD9, TICD10 and TICD42. Object Identifier:LSA28 Object Text:The ATLAS Laser Sampling Assembly shall meet the Flight Temperature Acceptance Limits per TICD10 and TICD42 Object Identifier:LTR21 Object Text:The ATLAS Transmit LTR shall, per ICESat-2-THM-IFACE-0214, meet the Qualification Temperature Limits -30 to 45 degrees C		

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						Object Identifier:MEB119 Object Text:The MEB shall comply with the temperature limits as defined in TICD42 Object Identifier:OFA42 Object Text:OFA shall comply with TICD42 Object Identifier:OFA202 Object Text:OFA shall comply with TICD42 Object Identifier:OPT113 Object Text:All transmit optics TCS thermal interfaces shall meet the temperature limits given in TICD42. Object Identifier:PDU217 Object Text:The PDU shall comply with TICD42 (Thermal Interface Temperature Requirements). Object Identifier:RTA37 Object Text:The RTA shall meet TICD42. Object Identifier:SPD28 Object Text:The ATLAS Start Pulse Detector shall operate at temperature range of -10 degrees Celsius to +40 degrees Celsius. Object Identifier:SPD29 Object Text:The ATLAS Start Pulse Detector shall perform qualification testing within temperature range of -25 degrees Celsius to +55 degrees Celsius.		

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						Object Identifier:SPD30 Object Text:The ATLAS Start Pulse Detector shall survive during operation within temperature range of -20 degrees Celsius to +50 degrees Celsius.		
TICD43	4.1	Thermal Interface Temperature Requirements	The thermal interface to the lasers will be capable of controlling to any temperature +/- 1C (TBR25) within its operational temperature range when the laser is operating.	Laser operation requires that the lasers be adjusted to a temperature where they can meet all performance requirements	Laser, Thermal	Object Identifier:TRD18 Object Text:The TCS shall adjust the temperature of the laser thermal interfaces to any setpoint within their operational temperature range.	Object Identifier:GCS5 Object Text:The GCS shall adjust the temperature of the lasers to any setpoint within their operational temperature range with an accuracy of +/- 1C.	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD44	4.1	Thermal Interface Temperature Requirements	The thermal interface to each of the 7 OFAs will be capable of controlling to any orbit-average temperature +/- 0.1C (TBR26) within its operational temperature range when the OFA is operating.	OFA wavelength is tunable by adjusting or maintaining the temperature of the etalon.	OFA, Thermal	Object Identifier:TRD7 Object Text:The TCS shall adjust the temperature of the OFA thermal interfaces to any setpoint within their operational temperature range assuming the thermal isolation given in TICD277. Object Identifier:OFA43 Object Text:OFA shall comply with TICD44 Object Identifier:OFA203 Object Text:OFA shall comply with TICD44		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD46	4.2	Thermal Interface Temporal Gradient Requirements	All instrument TCS thermal interfaces will have temporal gradients less than the values given in Table 2 while the instrument is operating. **Table 2: ATLAS Thermal Interface Temporal gradient Requirements**	Some components may be sensitive to short-term variations in temperature.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR78 Object Text:The ATLAS structure shall meet TICD46. Object Identifier:TRD6 Object Text:The TCS shall maintain all thermal interfaces within the temporal temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:GCS4 Object Text:The GCS shall be designed to maintain the thermal interfaces of the lasers within the temporal temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:TAMS69 Object Text:The ATLAS TAMS LS shall meet TICD46. Object Identifier:BSM136 Object Text:The BSM shall comply with TICD46. Object Identifier:DAA111 Object Text:The DAA shall comply with the Thermal Interface Temporal Gradient Requirements requirement as written in TICD46. Object Identifier:FO52 Object Text:The fiber optics shall meet TICD46 Object Identifier:LRS199 Object Text:The ATLAS LRS shall meet specifications when the instrument TCS complies with TICD46. Object Identifier:LSA30 Object Text:The ATLAS LSA shall operate and meet requirements with a Thermal Interface Temporal gradient per TICD46 and TICD47. Object Identifier:LTR25 Object Text:The ATLAS Transmit LTR shall, per ICESat-2-THM-IFACE-0214, have a Thermal Interface Spatial Gradient of < 15 degrees C (TBR40) while instrument is operating Object Identifier:MEB120 Object Text:The MEB shall comply with the temporal gradient limits while the		

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						instrument is operating as defined in TICD46 Object Identifier:OFA44 Object Text:OFA shall comply with TICD46 Object Identifier:OFA204 Object Text:OFA shall comply with TICD46 Object Identifier:PDU218 Object Text:The PDU shall comply with TICD46 (Thermal Interface Temporal Gradient Requirements). Object Identifier:RTA96 Object Text:The RTA shall meet TICD46. Object Identifier:SPD31 Object Text:The ATLAS Start Pulse Detector shall have a thermal interface temporal gradient of less than 45 deg. C./ hour(TBR) while instrument is operating.		
TICD47	4.2	Thermal Interface Temporal Gradient Requirements	All temporal gradient requirements will be assessed over a minimum time range of 6 minutes (TBR28).	A minimum time window eliminates the need to analyze or test high-frequency temperature fluctuations, which will be damped by mass in the built system	Laser, LSA, Transmit Optics, LRS, SPD, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR79 Object Text:The ATLAS structure shall meet TICD47. Object Identifier:TRD6 Object Text:The TCS shall maintain all thermal interfaces within the temporal temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214). Object Identifier:TAMS70 Object Text:The ATLAS TAMS LS shall meet TICD47.	Object Identifier:GCS4 Object Text:The GCS shall be designed to maintain the thermal interfaces of the lasers within the temporal temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:BSM137 Object Text:The BSM shall comply with TICD47. Object Identifier:DAA112 Object Text:The DAA shall comply with the Thermal Interface Temporal Gradient Requirements requirement as written in TICD47. Object Identifier:FO53 Object Text:The fiber optics shall meet TICD47 Object Identifier:LRS200 Object Text:All temporal gradient requirements will be assessed over a minimum time range given in TICD47. Object Identifier:LSA30 Object Text:The ATLAS LSA shall operate and meet requirements with a Thermal Interface Temporal gradient per TICD46 and TICD47. Object Identifier:MEB121 Object Text:The MEB shall comply with the temporal gradient limits over the time range defined in TICD47 Object Identifier:OFA45 Object Text:OFA shall comply with TICD47 Object Identifier:OFA205 Object Text:OFA shall comply with TICD47 Object Identifier:OPT114		

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						Object Text:The transmitter optics shall meet TICD47 Object Identifier:PDU219 Object Text:The PDU shall comply with TICD47 (Thermal Interface Temporal Gradient Requirements). Object Identifier:RTA97 Object Text:The RTA shall meet TICD47. Object Identifier:SPD43 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Interface Temporal Gradient Requirements requirement as written in TICD47.		
TICD148	4.2	Thermal Interface Temporal Gradient Requirements	The TCS will limit the orbital variation of the MEB thermal interface to be no more than 3C while in the nominal science orbit given a constant power dissipation within the MEB.	A stable thermal environment is necessary for ensuring short-term frequency stability of the Ultra Stable Oscillator during science collection.	MEB, Thermal	Object Identifier:TRD6 Object Text:The TCS shall maintain all thermal interfaces within the temporal temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214). Object Identifier:MEB122 Object Text:The MEB shall comply with the temperature variation over an orbit as defined in TICD148	Object Identifier:GCS4 Object Text:The GCS shall be designed to maintain the thermal interfaces of the lasers within the temporal temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD49	4.3	Thermal Interface Spatial Gradient Requirements	All instrument TCS thermal interfaces will have spatial gradients less than the values given in Table 3. **Table 3: ATLAS Thermal Interface Spatial Gradient Requirements**	Spatial gradients can impact the thermal condition and pointing of some components	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR80 Object Text:The ATLAS structure shall meet TICD49. Object Identifier:TRD5 Object Text:The TCS shall maintain all thermal interfaces within the spatial temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214). Object Identifier:TAMS71	Object Identifier:GCS3 Object Text:The GCS shall maintain the thermal interfaces of the lasers within the spatial temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Text:The ATLAS TAMS LS shall meet TICD49. Object Identifier:BSM138 Object Text:The BSM shall comply with TICD49. Object Identifier:DAA113 Object Text:The DAA shall comply with the Thermal Interface Spatial Gradient Requirements requirement as written in TICD49. Object Identifier:FO54 Object Text:The fiber optics shall meet TICD49 Object Identifier:LRS201 Object Text:The ATLAS LRS shall meet specifications when the instrument TCS complies with TICD49. Object Identifier:LSA31 Object Text:The ATLAS LSA shall operate and meet requirements with a Thermal Interface Spatial gradient per TICD49. Object Identifier:MEB123 Object Text:The MEB shall comply with the spacial gradient limits as defined in TICD49 Object Identifier:OFA46 Object Text:OFA shall comply with TICD49 Object Identifier:OFA206 Object Text:OFA shall comply with TICD49		

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						Object Identifier:OPT115 Object Text:The transmitter optics shall meet TICD49 Object Identifier:PDU221 Object Text:The PDU shall comply with TICD49 (Thermal Interface Spacial Gradient Requirements). Object Identifier:RTA98 Object Text:The RTA shall meet TICD49. Object Identifier:SPD32 Object Text:The ATLAS Start Pulse Detector shall have a thermal interface spacial gradient of less than 15 deg. C.(TBR).		
TICD50	4.3	Thermal Interface Spatial Gradient Requirements	The instrument TCS will control the temperature gradient of the telescope secondary mirror tower to be no more than 2C, with a goal of 0.5C.	Temperature gradients up the telescope tower can defocus the telescope mirrors	RTA, Thermal	Object Identifier:TRD5 Object Text:The TCS shall maintain all thermal interfaces within the spatial temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214). Object Identifier:RTA38 Object Text:The RTA shall meet TICD50.	Object Identifier:GCS3 Object Text:The GCS shall maintain the thermal interfaces of the lasers within the spatial temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD51	4.3	Thermal Interface Spatial Gradient Requirements	The instrument TCS will control the radial temperature gradient across the primary mirror to be no more than 1C	Temperature gradients across the primary mirror can defocus the telescope mirrors	RTA, Thermal, Structure	Object Identifier:STR25 Object Text:The telescope sunshade shall be thermally decoupled from the +Z panel of the structure doghouse. Object Identifier:TRD5 Object Text:The TCS shall maintain all thermal interfaces within the spatial temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:GCS3 Object Text:The GCS shall maintain the thermal interfaces of the lasers within the spatial temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:RTA39 Object Text:The RTA shall meet TICD51.		
TICD53	4.4	Thermal Interface Flux Requirements	Components that have a thermal interface to a cold plate or panel will have a flux at that interface of no more than 1 W/in2 (0.000645 W/m2) (TBR31).	Fluxes higher than this will require a thermal doubler	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal	Object Identifier:STR81 Object Text:The ATLAS structure shall meet TICD53. Object Identifier:TRD5 Object Text:The TCS shall maintain all thermal interfaces within the spatial temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214). Object Identifier:TAMS72 Object Text:The ATLAS TAMS LS shall meet TICD53. Object Identifier:BSM139 Object Text:The BSM shall comply with TICD53. Object Identifier:DAA114 Object Text:The DAA shall comply with the Thermal Interface Flux Requirements requirement as written in TICD53. Object Identifier:FO55 Object Text:The fiber optics shall meet TICD53 Object Identifier:LRS202 Object Text:The ATLAS LRS components shall have a flux at their panel interfaces of no more than the value given in TICD53. Object Identifier:LSA32 Object Text:The ATLAS LSA shall have a flux per TICD53 [if thermal interface to a coldplate or panel].	Object Identifier:GCS3 Object Text:The GCS shall maintain the thermal interfaces of the lasers within the spatial temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:LTR26 Object Text:In the event that the ATLAS Transmit LTR is fitted with a cold plate, or panel, the thermal Interface to said cold plate, or panel shall have a flux of no more than 1 W/in^2 (0.000645 W/m^2) TBR31 Object Identifier:MEB124 Object Text:The MEB shall comply with the thermal interface flux requirement as defined in TICD53 Object Identifier:OFA47 Object Text:OFA components that have a thermal interface to a cold plate or panel will have a flux at that interface of no more than what specified in TICD53 Object Identifier:OFA207 Object Text:OFA shall comply with TICD53 Object Identifier:OPT17 Object Text:The ATLAS Transmitter Optics shall have a flux at a cold plate interface per TICD53 Object Identifier:PDU222 Object Text:The PDU shall comply with TICD53 (Thermal Interface Flux Requirements). Object Identifier:RTA99 Object Text:The RTA shall meet TICD53. Object Identifier:SPD44 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal		

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						Interface Flux Requirements requirement as written in TICD53.		
TICD54	4.4	Thermal Interface Flux Requirements	Components that have a thermal interface to a heat pipe will have a flux at that interface of no more than 25W (TBR32) per linear inch of pipe.	Fluxes higher than this may dry out the heat pipe wick.	Laser, Thermal	Object Identifier:TRD5 Object Text:The TCS shall maintain all thermal interfaces within the spatial temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:GCS3 Object Text:The GCS shall maintain the thermal interfaces of the lasers within the spatial temperature gradient limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD277	4.5	Thermal Isolators	Each OFA will have a thermal coupling between the OFA and the structure of no more than 0.01 W/C (TBR).	Precision OFA thermal control cannot be maintained without adequate thermal isolation.	OFA, Thermal	Object Identifier:TRD7 Object Text:The TCS shall adjust the temperature of the OFA thermal interfaces to any setpoint within their operational temperature range assuming the thermal isolation given in TICD277.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD56	5.0	Thermal Radiation Environment	The TCS will provide an average thermal radiation environment for all components mounted to the -Z side of the optical bench between -15C and +35C (TBR33) when the instrument is operational except for surface that view space.	Thermal radiation provides a secondary impact for component temperatures. The average thermal radiation environment is expected to be independent of direction.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, RTA, OFA, Structure, Thermal, Fiber Optics	Object Identifier:STR82 Object Text:The ATLAS structure shall meet TICD56. Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:TAMS73 Object Text:The ATLAS TAMS LS shall meet TICD56. Object Identifier:BSM140 Object Text:The BSM shall comply with TICD56. Object Identifier:FO56 Object Text:The fiber optics shall meet TICD56		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:LRS203 Object Text:The ATLAS LRS shall meet specifications when the instrument TCS complies with TICD56, TICD57, TICD58, and TICD59. Object Identifier:OFA48 Object Text:OFA shall comply with TICD56 Object Identifier:OFA208 Object Text:OFA shall comply with TICD56 Object Identifier:OPT116 Object Text:The transmitter optics shall meet TICD56 Object Identifier:RTA100 Object Text:The RTA shall meet TICD56. Object Identifier:SPD45 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Radiation Environment requirement as written in TICD56.		
TICD57	5.0	Thermal Radiation Environment	The TCS will provide an average radiation environment for all components mounted to the -Z side of the optical bench between -30C and +40C (TBR34) when the instrument is not operational except for surface that view space.	Thermal radiation provides a secondary impact for component temperatures. The average thermal radiation environment is expected to be independent of direction	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, RTA, OFA, Structure, Thermal, Fiber Optics	Object Identifier:STR83 Object Text:The ATLAS structure shall meet TICD57. Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:TAMS74 Object Text:The ATLAS TAMS LS shall		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						meet TICD57. Object Identifier:BSM141 Object Text:The BSM shall comply with TICD57. Object Identifier:FO57 Object Text:The fiber optics shall meet TICD57 Object Identifier:LRS203 Object Text:The ATLAS LRS shall meet specifications when the instrument TCS complies with TICD56, TICD57, TICD58, and TICD59. Object Identifier:OFA49 Object Text:OFA shall comply with TICD57 Object Identifier:OFA209 Object Text:OFA shall comply with TICD57 Object Identifier:OPT117 Object Text:The transmitter optics shall meet TICD57 Object Identifier:RTA101 Object Text:The RTA shall meet TICD57. Object Identifier:SPD46 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Radiation Environment requirement as written in TICD57.		
TICD58	5.0	Thermal Radiation Environment	The TCS will provide an average thermal radiation environment for the portions of the LRS on the +Z	Thermal radiation provides a secondary impact for component temperatures.	LRS, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal		Object Identifier:IRD51 Object Text:The ATLAS instrument

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			side of the optical bench LRS Optics laser window between -5C and +30C (TBR35).			interfaces for all components on the ATLAS instrument. Object Identifier:LRS203 Object Text:The ATLAS LRS shall meet specifications when the instrument TCS complies with TICD56, TICD57, TICD58, and TICD59.		thermal control system shall operate independently of the spacecraft thermal control system.
TICD59	5.0	Thermal Radiation Environment	The total backload on the LRS Sunshade radiator will be between TBD36 and TBD36 W/m2.	This backload range will encompass the total environmental variability of the LRS sunshade radiator. This includes heat loads from the environment, the instrument and the spacecraft.	LRS, Thermal	Object Identifier:TRD51 Object Text:The TCS shall provide suitable thermally-conductive and radiative thermal interfaces for all components on the ATLAS instrument. Object Identifier:LRS203 Object Text:The ATLAS LRS shall meet specifications when the instrument TCS complies with TICD56, TICD57, TICD58, and TICD59.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD61	6.0	Survival Conditions	When powered off, each component will be capable of surviving indefinitely when its temperatures are within survival limits without damage or permanent performance degradation.	Components must be able to dwell at a survival temperature when the instrument is unpowered. If necessary, the instrument TCS will use survival heater circuits to maintain the survival temperature range.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR84 Object Text:The ATLAS structure shall meet TICD61. Object Identifier:TRD4 Object Text:The TCS shall maintain the temperatures of all instrument components within the allowable operational and survival temperature limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214). Object Identifier:TAMS75 Object Text:The ATLAS TAMS LS shall meet TICD61. Object Identifier:BSM142 Object Text:The BSM shall comply with TICD61.	Object Identifier:GCS2 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:DAA115 Object Text:The DAA shall comply with the Survival Conditions requirement as written in TICD61. Object Identifier:FO58 Object Text:The fiber optics shall meet TICD61 Object Identifier:LRS204 Object Text:The ATLAS LRS shall comply with TICD61. Object Identifier:LSA24 Object Text:The ATLAS LSA shall survive, without damage, temperatures as defined in TICD42, TICD61, TICD62, and TICD41. Object Identifier:MEB125 Object Text:When unpowered, the MEB shall comply with the Survival Temperature Conditions as defined in TICD61 Object Identifier:OFA50 Object Text:When powered off, each component will be capable of surviving indefinitely when its temperatures are within survival limits without damage or permanent performance degradation. Object Identifier:OFA210 Object Text:OFA shall comply with TICD61 Object Identifier:OPT118 Object Text:Thr transmitter optics shall meet TICD61		

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						Object Identifier:PDU223 Object Text:The PDU shall comply with TICD61 (Survival Conditions). Object Identifier:RTA40 Object Text:The RTA shall meet TICD61. Object Identifier:SPD47 Object Text:The ATLAS Start Pulse Detector shall comply with the Survival Conditions requirement as written in TICD61.		
TICD62	6.0	Survival Conditions	When powered on, each component will be capable of surviving indefinitely when its temperatures are between the cold survival and hot qualification limits without damage or permanent performance degradation.	The instrument TCS will not be designed to raise all components to their operational temperature range before component turn-on.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal	Object Identifier:STR85 Object Text:The ATLAS structure shall meet TICD62. Object Identifier:TRD4 Object Text:The TCS shall maintain the temperatures of all instrument components within the allowable operational and survival temperature limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214). Object Identifier:TAMS76 Object Text:The ATLAS TAMS LS shall meet TICD62. Object Identifier:BSM143 Object Text:The BSM shall comply with TICD62. Object Identifier:DAA116 Object Text:The DAA shall comply with the Survival Conditions requirement as written in TICD62. Object Identifier:FO59 Object Text:The fiber optics shall meet	Object Identifier:GCS2 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits as defined in the ATLAS Thermal Control System ICD (ICESat-2-THM-IFACE-0214).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						TICD62 Object Identifier:LRS205 Object Text:The ATLAS LRS shall comply with TICD62. Object Identifier:LSA24 Object Text:The ATLAS LSA shall survive, without damage, temperatures as defined in TICD42, TICD61, TICD62, and TICD41. Object Identifier:MEB126 Object Text:When powered, the MEB shall comply with the Cold Survival Temperature Conditions and the Hot Qualification Temperature Conditions as defined in TICD62 Object Identifier:OFA51 Object Text:When powered on, each component will be capable of surviving indefinitely when its temperatures are between the cold survival and hot qualification limits without damage or permanent performance degradation. Object Identifier:OFA211 Object Text:OFA shall comply with TICD62 Object Identifier:OPT119 Object Text:The transmitter optics shall meet TICD62 Object Identifier:PDU224 Object Text:The PDU shall comply with TICD62 (Survival Conditions).		

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						Object Identifier:RTA102 Object Text:The RTA shall meet TICD62. Object Identifier:SPD48 Object Text:The ATLAS Start Pulse Detector shall comply with the Survival Conditions requirement as written in TICD62.		
TICD64	7.0	Component-Controlled Flight Thermal Telemetry	All temperature sensors internal to components accessible at instrument-level testing and their associated limits will be documented by diagram or figure in the end item data package prior to delivery of the component to instrument integration.	This will allow investigation into internal temperature anomalies at instrument-level thermal testing.	Laser, LRS,BSM,DAA, MEB, PDU, Thermal	Object Identifier:BSM144 Object Text:The BSM shall comply with TICD64. Object Identifier:DAA117 Object Text:The DAA shall comply with the Component-Controlled Flight Thermal Telemetry requirement as written in TICD64. Object Identifier:LRS206 Object Text:The ATLAS LRS Team shall comply with TICD64. Object Identifier:MEB127 Object Text:The MEB shall document the placement of its internal temperature sensors as defined in TICD64 Object Identifier:PDU225 Object Text:The PDU shall comply with TICD64 (Component-Controlled Flight Thermal Telemetry).		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD65	7.0	Component-Controlled Flight Thermal Telemetry	All temperature limits internal to a component will be verified prior to delivery to instrument integration assuming that the thermal interface to the instrument TCS is held at the appropriate qualification or acceptance temperatures.	Instrument-level thermal testing will not be intended to verify internal component temperatures.	Laser, LRS,BSM,DAA, MEB, PDU, Thermal	Object Identifier:BSM145 Object Text:The BSM shall comply with TICD65. Object Identifier:DAA118 Object Text:The DAA shall comply with the Component-Controlled Flight Thermal Telemetry requirement as written in		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						TICD65. Object Identifier:LRS207 Object Text:The ATLAS LRS Team shall comply with TICD65. Object Identifier:MEB128 Object Text:The MEB shall verify the temperature limits of all internal temperature sensors as defined in TICD65 Object Identifier:PDU226 Object Text:The PDU shall comply with TICD65 (Component-Controlled Flight Thermal Telemetry).		
TICD278	7.1	MEB-Read Temperature Sensors	The MEB will read 62 thermistors allocated to and installed on the TCS.	The MEB will be the electrical interface for these sensors. These sensors will be read by the MEB HKT board.	MEB, Thermal	Object Identifier:TRD62 Object Text:The TCS shall provide temperature sensors that will be read by the MEB and the spacecraft as described in TICD278 Object Identifier:MEB107 Object Text:The MEB shall read 62 thermistors from the Thermal Control Subsystem (TCS) and provide temperaure data as defined in AV111, TICD102, and TICD103 .		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD279	7.1	MEB-Read Temperature Sensors	The MEB will read 12 thermistors allocated to and installed on the PDU. This does not include any TCS thermistors, also read by the MEB, mounted on or near the PDU thermal interface, which are included in the 62 TCS thermistors.	The MEB will be the electrical interface for these sensors. These sensors will be read by the MEB HKT board.	MEB, PDU	Object Identifier:MEB396 Object Text:The MEB shall comply with TICD279.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD280	7.1	MEB-Read Temperature Sensors	The MEB will read 2 thermistors allocated to and installed on the SPD. This does not include any TCS thermistors, also read by the	The MEB will be the electrical interface for these sensors. These sensors will be read by the	MEB, SPD	Object Identifier:MEB397 Object Text:The MEB shall comply with TICD280.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system

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			MEB, mounted on or near the SPD thermal interface, which are included in the 62 TCS thermistors.	MEB HKT board.		Object Identifier:SPD189 Object Text:The ATLAS Start Pulse Detector shall comply with MEB-Read Temperature Sensors as written in TICD280		shall operate independently of the spacecraft thermal control system.
TICD281	7.1	MEB-Read Temperature Sensors	The MEB will read 12 (TBR) thermistors allocated to and installed on the DAA. This does not include any TCS thermistors, also read by the MEB, mounted on or near the DAA thermal interface, which are included in the 62 TCS thermistors.	The MEB will be the electrical interface for these sensors. These sensors will be read by the MEB HKT board.	MEB, DAA	Object Identifier:DAA253 Object Text:The DAA shall comply with the MEB-Read Temperature Sensors requirement as written in TICD281. Object Identifier:MEB398 Object Text:The MEB shall comply with TICD281.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD282	7.1	MEB-Read Temperature Sensors	The MEB will read 2 thermistors allocated to and installed on the DSM. This does not include any TCS thermistors, also read by the MEB, mounted on or near the DAA thermal interface, which are included in the 62 TCS thermistors.	The MEB will be the electrical interface for these sensors. These sensors will be read by the MEB MCE board.	MEB, DAA	Object Identifier:DAA254 Object Text:The DAA shall comply with the MEB-Read Temperature Sensors requirement as written in TICD282. Object Identifier:MEB399 Object Text:The MEB shall comply with TICD282.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD283	7.1	MEB-Read Temperature Sensors	The MEB will read 2 thermistors allocated to and installed on the BSM. This does not include any TCS thermistors, also read by the MEB, mounted on or near the BSM thermal interface, which are included in the 62 TCS thermistors.	The MEB will be the electrical interface for these sensors. These sensors will be read by the MEB MCE board.	MEB, BSM	Object Identifier:BSM263 Object Text:TBD requirement needed to link to TICD. Object Identifier:MEB400 Object Text:The MEB shall comply with TICD283.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD284	7.1	MEB-Read Temperature Sensors	The MEB will read 21 thermistors allocated to and installed on the MEB. This does not include any TCS thermistors, also read by the MEB, mounted on or near the MEB thermal interface, which are included in the 62 TCS thermistors.	The MEB will be the electrical interface for these sensors. These sensors will be read by the MEB HKT board.	MEB	Object Identifier:MEB401 Object Text:The MEB shall comply with TICD284.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD67	8.0	Instrument Controlled	All ATLAS temperature sensors and their associated limits will be	Thermal hardware specification must include	MEB, Thermal, Harness	Object Identifier:TRD62 Object Text:The TCS shall provide		Object Identifier:IRD51 Object Text:The

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		Flight Thermal Telemetry	documented in the ATLAS Thermal Hardware Specification (ICESat-2-THM-SPEC-0217).	details of all the instrument thermal hardware.		temperature sensors that will be read by the MEB and the spacecraft as described in TICD278 Object Identifier:HARN70 Object Text:The ATLAS Harness for the instrument-provided temperature sensors shall be documented in the ATLAS Thermal Hardware Specification (ICESat-2-THM-SPEC-0217). Object Identifier:MEB129 Object Text:The MEB shall provide information regarding its temperature senosrs and the associated limits as defined in TICD67		ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD68	8.0	Instrument Controlled Flight Thermal Telemetry	All instrument-controlled temperature sensors will be capable of being read over the temperature range -65C to +60C.	In-flight telemetry must be available for all temperatures expected in test and flight.	MEB, Thermal	Object Identifier:TRD168 Object Text:The TCS temperature sensors shall be capable of being read with the with the resolution and accuracy specified in TICD-069 and TICD-070 over the entire temperature range given in TICD-068 Object Identifier:MEB130 Object Text:The MEB shall support internal and external temperature sensors with the temperature ranges defined in TICD68		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD69	8.0	Instrument Controlled Flight Thermal Telemetry	All instrument-controlled flight temperature sensors will be accurate to within 1.0C over the temperature range given in TICD68.	Accuracy is important in knowing and controlling to a given temperature	MEB, Thermal	Object Identifier:AV111 Object Text:The ATLAS Avionics shall read a minimum of 62 TCS thermistorss from the Thermal Control Subsystem (TCS) and provide temperature data with accuracy accuracy compliant with TICD69 and resolution compliant with TICD70. Object Identifier:TRD168 Object Text:The TCS temperature sensors shall be capable of being read with the with	Object Identifier:FSW192 Object Text:The ATLAS SBC Flight Software Thermal Control Task shall read the Housekeeping/Thermal (HKT) board housekeeping data at a rate of 1Hz and telemeter it to the S/C via the Telemetry Output Task (STO) at a rate of 1Hz. Object Identifier:MEB107 Object Text:The MEB shall read 62 thermistors from the Thermal Control	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						the resolution and accuracy specified in TICD-069 and TICD-070 over the entire temperature range given in TICD-068 Object Identifier:MEB131 Object Text:The MEB shall support internal and external temperature sensorswith the temperature accuracy as defined in TICD69	Subsystem (TCS) and provide temperaure data as defined in AV111, TICD102, and TICD103 .	
TICD70	8.0	Instrument Controlled Flight Thermal Telemetry	All instrument-controlled temperature sensors will have a resolution of 0.1C between 0C and 50C.	Resolution is important in verifying gradient requirements and providing tight heater control, especially proportional control.	MEB, Thermal	Object Identifier:AV111 Object Text:The ATLAS Avionics shall read a minimum of 62 TCS thermistorss from the Thermal Control Subsystem (TCS) and provide temperature data with accuracy accuracy compliant with TICD69 and resolution compliant with TICD70. Object Identifier:TRD168 Object Text:The TCS temperature sensors shall be capable of being read with the with the resolution and accuracy specified in TICD-069 and TICD-070 over the entire temperature range given in TICD-068 Object Identifier:MEB132 Object Text:The MEB internal temperature sensors and associated telemetry shall support the temperature resolution as defined in TICD70	Object Identifier:FSW192 Object Text:The ATLAS SBC Flight Software Thermal Control Task shall read the Housekeeping/Thermal (HKT) board housekeeping data at a rate of 1Hz and telemeter it to the S/C via the Telemetry Output Task (STO) at a rate of 1Hz. Object Identifier:MEB107 Object Text:The MEB shall read 62 thermistors from the Thermal Control Subsystem (TCS) and provide temperaure data as defined in AV111, TICD102, and TICD103 .	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD71	8.0	Instrument Controlled Flight Thermal Telemetry	All instrument-controlled temperature sensors that are used as feedback for active heater control will be redundant.	Redundant thermistors prevent a single failure from disabling a heater circuit.	MEB, Thermal	Object Identifier:TRD62 Object Text:The TCS shall provide temperature sensors that will be read by the MEB and the spacecraft as described in TICD278 Object Identifier:MEB133 Object Text:MEB shall support redundant temperature sensors as defined in TICD71		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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TICD73	9.0	Thermal Power	The TCS will accommodate a maximum of TBD39 W of heat transfer to or from the LRS Sunshade across the sunshade flexures.	The LRS sunshade is to be thermally isolated from the instrument.	LRS, Thermal	Object Identifier:TRD121 Object Text:The TCS shall maintain the temperatures of all components in the presence of parasitic environmental heat loads as described in TICD-073 and TICD-074 Object Identifier:LRS208 Object Text:The ATLAS LRS Sunshade shall have less than the heat transfer from TICD73 across the sunshade flexures.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD74	9.0	Thermal Power	In the hot case, the TCS will accommodate a maximum environmental parasitic heat from the LRS Optics of 2.4 Watts (TBR40) at beta angles below 16°, and 0.0 Watts at beta angles above 16°.	The LRS Optics will need to reject environmental heat that is absorbed through the aperture, which has a half-angle of 12°. This is in addition to the internal power dissipation given in TICD113.	LRS, Thermal	Object Identifier:TRD121 Object Text:The TCS shall maintain the temperatures of all components in the presence of parasitic environmental heat loads as described in TICD-073 and TICD-074 Object Identifier:LRS209 Object Text:In the hot case, the ATLAS LRS Optics Component shall provide environmental parasitic heat less than the values from TICD74.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD273	9.0	Thermal Power	The TCS will accommodate between 1 and 10 W (TBR) of power on the DAA PM Radiator, including parasitic heat from the DAA and power dissipations.	The DAA PM Radiator must reject all heat from within the DAA PM, including parasitic heat not accounted for in the power allocations.	DAA, Thermal	Object Identifier:TRD121 Object Text:The TCS shall maintain the temperatures of all components in the presence of parasitic environmental heat loads as described in TICD-073 and TICD-074 Object Identifier:DAA119 Object Text:The DAA shall comply with the Thermal Power requirement as written in TICD273.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD77	10.1	Heater Circuit Design	All heaters will be able to operate at any bus voltage between 27 Vdc and 35 Vdc.	This is the expected voltage range of all primary power feeds on the spacecraft and instrument.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA,	Object Identifier:STR86 Object Text:The ATLAS structure shall meet TICD77.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate

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					OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:TRD38 Object Text:The TCS shall function nominally within a bus voltage range of 27 Vdc to 35 Vdc. Object Identifier:TAMS159 Object Text:The ATLAS TAMS LS shall meet TICD77 Object Identifier:BSM146 Object Text:The BSM shall comply with TICD77. Object Identifier:DAA121 Object Text:The DAA shall comply with the Heater Circuit Design requirement as written in TICD77. Object Identifier:LSA33 Object Text:The ATLAS Laser Sampling Assembly Heater Circuit Design shall be able to operate at any bus voltage per TICD077. Object Identifier:LTR27 Object Text:The ATLAS Transmit LTR Heater Circuit Design shall, per ICESat-2-THM-IFACE-0214, be able to operate at any bus voltage between 27 Vdc and 35 Vdc Object Identifier:MEB134 Object Text:The MEB heaters shall comply with the voltage ranges defined in TICD77 Object Identifier:MEB187 Object Text:The MEB shall send Cmd &Tlm commands to the redundant PDU over a serial bus using a Clock/Data/Latch		independently of the spacecraft thermal control system.

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						protocol and RS422 signals. Object Identifier:OFA52 Object Text:OFA shall comply with TICD77 Object Identifier:OFA212 Object Text:OFA shall comply with TICD77 Object Identifier:OPT18 Object Text:The ATLAS Transmitter Optics Heater Circuit Design shall be able to operate throughout the voltage range specified in TICD77 Object Identifier:PDU266 Object Text:The PDU shall comply with TICD77 (Heater Circuit Design). Object Identifier:RTA103 Object Text:The RTA shall meet TICD77. Object Identifier:SPD49 Object Text:The ATLAS Start Pulse Detector shall comply with the Heater Circuit Design requirement as written in TICD77.		
TICD78	10.1	Heater Circuit Design	All heaters will be sized for a maximum 70% duty cycle at the minimum bus voltage.	Required margin defined in Gold Rules.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR87 Object Text:The ATLAS structure shall meet TICD78. Object Identifier:TRD124 Object Text:All TCS heaters shall be sized for a maximum 70% duty cycle at the minumum bus voltage unless there is sufficient temperature margin as specified in TICD-144.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:TAMS160 Object Text:The ATLAS TAMS LS shall meet TICD78. Object Identifier:BSM147 Object Text:The BSM shall comply with TICD78. Object Identifier:DAA122 Object Text:The DAA shall comply with the Heater Circuit Design requirement as written in TICD78. Object Identifier:LSA34 Object Text:The ATLAS Laser Sampling Assembly Heater Circuit Design shall be sized per TICD078. Object Identifier:LTR28 Object Text:The ATLAS Transmit LTR Heater Circuit Design shall, per ICESat-2-THM-IFACE-0214, be sized for a maximum 70% duty cycle at the minimum bus voltage Object Identifier:MEB135 Object Text:The MEB heaters shall comply with the voltage and duty cycles defined in TICD78 Object Identifier:MEB187 Object Text:The MEB shall send Cmd &Tlm commands to the redundant PDU over a serial bus using a Clock/Data/Latch protocol and RS422 signals. Object Identifier:OFA53 Object Text:OFA shall comply with TICD78		

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						Object Identifier:OFA213 Object Text:OFA shall comply with TICD78 Object Identifier:OPT19 Object Text:All heaters will be sized for a maximum 70% duty cycle at the minimum bus voltage. Object Identifier:OPT120 Object Text:The transmitter optics shall meet TICD78 Object Identifier:PDU269 Object Text:The PDU shall comply with TICD78 (Heater Circuit Design). Object Identifier:RTA104 Object Text:The RTA shall meet TICD78 Object Identifier:SPD50 Object Text:The ATLAS Start Pulse Detector shall comply with the Heater Circuit Design requirement as written in TICD78.		
TICD79	10.1	Heater Circuit Design	All thermostats will be redundant in series.	Series redundant thermostats protect against a full-on heater if a single thermostat fails closed	SPD, Laser, SPD, LSA, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR88 Object Text:The ATLAS structure shall meet TICD79. Object Identifier:TRD126 Object Text:All thermostats shall be redundant in series. This does not apply to over-temperature thermostats on switched heater services. Object Identifier:TAMS161 Object Text:The ATLAS TAMS LS shall meet TICD79.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:BSM148 Object Text:The BSM shall comply with TICD79. Object Identifier:DAA123 Object Text:The DAA shall comply with the Heater Circuit Design requirement as written in TICD79. Object Identifier:LSA35 Object Text:The ATLAS Laser Sampling Assembly Heater Circuit Design Thermostats shall be redundant in series per TICD079. Object Identifier:LTR29 Object Text:The ATLAS Transmit LTR Heater Circuit Design Thermostats shall, per ICESat-2-THM-IFACE-0214, be redundant in series Object Identifier:MEB136 Object Text:The MEB shall support redundant thermostats as defined in TICD79 Object Identifier:OFA54 Object Text:OFA shall comply with TICD79 Object Identifier:OFA214 Object Text:OFA shall comply with TICD79 Object Identifier:OPT20 Object Text:The ATLAS Transmitter Optics Heater Circuit Thermostats shall be redundant in series per TICD79		

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						Object Identifier:OPT121 Object Text:The transmitter optics shall meet TICD79 Object Identifier:PDU270 Object Text:The PDU shall comply with TICD79 (Heater Circuit Design). Object Identifier:RTA105 Object Text:The RTA shall meet TICD79. Object Identifier:SPD51 Object Text:The ATLAS Start Pulse Detector shall comply with the Heater Circuit Design requirement as written in TICD79.		
TICD81	10.2	Thermistor, Heater and Thermostat Standards	All Kapton film heaters will comply with NASA GSFC S311-P-079.	All components must meet NASA standards.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR89 Object Text:The ATLAS structure shall meet TICD81. Object Identifier:TRD127 Object Text:All TCS heaters, temperature sensors and thermostats shall comply with the applicable standards as defined in TICD-081, TICD-082, TICD-083, and TICD-084. Object Identifier:TRD138 Object Text:All MLI shall be mechanically constrained at a minimum of one point or mechanically captured by another blanket or mechanical component, unless it could interfere with the optical path, in which case it shall have redundant constraints. Object Identifier:TAMS162 Object Text:The ATLAS TAMS LS shall meet TICD81.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:BSM149 Object Text:The BSM shall comply with TICD81. Object Identifier:DAA124 Object Text:The DAA shall comply with the Thermistor, Heater and Thermostat Standards requirement as written in TICD81. Object Identifier:LSA36 Object Text:The ATLAS Laser Sampling Assembly Kapton film heaters shall comply with NASA GSFC S311-P-079 per TICD081. Object Identifier:LTR30 Object Text:The ATLAS Transmit LTR Kapton film heaters shall, per ICESat-2-THM-IFACE-0214, comply with NASA GSFC S311-641 Object Identifier:MEB137 Object Text:The MEB Kapton film heaters shall comply with TICD81 Object Identifier:OFA55 Object Text:OFA shall comply with TICD81 Object Identifier:OFA215 Object Text:OFA shall comply with TICD81 Object Identifier:OPT21 Object Text:The ATLAS Transmitter Optics Kapton film heaters shall comply with NASA GSFC S311-P-079. per TICD81		

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						Object Identifier:PDU271 Object Text:The PDU shall comply with TICD81 (Thermistor, Heater and Thermostat Standards). Object Identifier:RTA106 Object Text:The RTA shall meet TICD81. Object Identifier:SPD52 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermistor, Heater and Thermostat Standards requirement as written in TICD81.		
TICD82	10.2	Thermistor, Heater and Thermostat Standards	All Vishay Dale Ohm heaters will comply with Military/Established Reliability, MIL-R-39009 Qualified, Type RER, R Level, aluminum housed, and be standard (ERH).	All components must meet NASA standards	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR90 Object Text:The ATLAS structure shall meet TICD82. Object Identifier:TRD127 Object Text:All TCS heaters, temperature sensors and thermostats shall comply with the applicable standards as defined in TICD-081, TICD-082, TICD-083, and TICD-084. Object Identifier:TRD138 Object Text:All MLI shall be mechanically constrained at a minimum of one point or mechanically captured by another blanket or mechanical component, unless it could interfere with the optical path, in which case it shall have redundant constraints. Object Identifier:TAMS163 Object Text:The ATLAS TAMS LS shall meet TICD82. Object Identifier:BSM150 Object Text:The BSM shall comply with TICD82.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:DAA125 Object Text:The DAA shall comply with the Thermistor, Heater and Thermostat Standards requirement as written in TICD82. Object Identifier:LSA37 Object Text:The ATLAS Laser Sampling Assembly Vishay Dale Ohm heaters shall comply with Military/Established Reliability, MIL-R-39009 Qualified per TICD082. Object Identifier:LTR31 Object Text:The ATLAS Transmit LTR Vishay Dale Ohm heaters shall, per ICESat-2-THM-IFACE-0214, comply with Military/Established Reliability, MIL-R-39009 Qualified, Type RER, R Level, aluminun housed, and be standard (ERH) Object Identifier:MEB138 Object Text:The MEB Vishay Dale Ohm heaters shall comply with TICD82 Object Identifier:OFA56 Object Text:OFA shall comply with TICD82 Object Identifier:OFA216 Object Text:OFA shall comply with TICD82 Object Identifier:OPT22 Object Text:The ATLAS Transmitter Optics Vishay Dale Ohm heaters shall comply with Military/Established Reliability, MIL-R-39009 Qualified per TICD82		

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						Object Identifier:PDU272 Object Text:The PDU shall comply with TICD82 (Thermistor, Heater and Thermostat Standards). Object Identifier:RTA107 Object Text:The RTA shall meet TICD82 Object Identifier:SPD53 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermistor, Heater and Thermostat Standards requirement as written in TICD82.		
TICD83	10.2	Thermistor, Heater and Thermostat Standards	All mechanical thermostats will comply with NASA GSFC S311-641.	All components must meet NASA standards	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR91 Object Text:The ATLAS structure shall meet TICD83. Object Identifier:TRD127 Object Text:All TCS heaters, temperature sensors and thermostats shall comply with the applicable standards as defined in TICD-081, TICD-082, TICD-083, and TICD-084. Object Identifier:TAMS164 Object Text:The ATLAS TAMS LS shall meet TICD83. Object Identifier:BSM151 Object Text:The BSM shall comply with TICD83. Object Identifier:DAA126 Object Text:The DAA shall comply with the Thermistor, Heater and Thermostat Standards requirement as written in TICD83.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:LSA38 Object Text:The ATLAS Laser Sampling Assembly Mechanical thermostats shall comply with NASA GSFC S311-641 per TICD083. Object Identifier:LTR32 Object Text:The ATLAS Transmit LTR Mechanical thermostats shall, per ICESat-2-THM-IFACE-0214, comply with NASA GSFC S311-641 Object Identifier:MEB139 Object Text:The MEB mechanical thermostats shall comply with TICD83 Object Identifier:OFA57 Object Text:OFA shall comply with TICD83 Object Identifier:OFA217 Object Text:OFA shall comply with TICD83 Object Identifier:OPT23 Object Text:All mechanical thermostats shall comply with NASA GSFC S311-641. Object Identifier:PDU273 Object Text:The PDU shall comply with TICD83 (Thermistor, Heater and Thermostat Standards). Object Identifier:RTA108 Object Text:The RTA shall meet TICD83. Object Identifier:SPD54 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermistor,		

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						Heater and Thermostat Standards requirement as written in TICD83.		
TICD84	10.2	Thermistor, Heater and Thermostat Standards	All thermistors will comply with NASA GSFC S311-P-018. Additional testing will be done to qualify certain flight parts to operate with a minimum temperature of -70C.	All components must meet NASA standards	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR92 Object Text:The ATLAS structure shall meet TICD84. Object Identifier:TRD127 Object Text:All TCS heaters, temperature sensors and thermostats shall comply with the applicable standards as defined in TICD-081, TICD-082, TICD-083, and TICD-084. Object Identifier:TAMS165 Object Text:The ATLAS TAMS LS shall meet TICD84. Object Identifier:BSM152 Object Text:The BSM shall comply with TICD84. Object Identifier:DAA127 Object Text:The DAA shall comply with the Thermistor, Heater and Thermostat Standards requirement as written in TICD84. Object Identifier:LRS210 Object Text:The ATLAS LRS shall comply with TICD84. Object Identifier:LSA39 Object Text:The ATLAS Laser Sampling Assembly thermistors shall comply with NASA GSFC S311-P-018 per TICD084. Object Identifier:LTR33 Object Text:The ATLAS Transmit LTR thermistors shall, per ICESat-2-THM-		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						IFACE-0214, comply with NASA GSFC S311-P-018 Object Identifier:MEB140 Object Text:The MEB internal thermistors shall comply with TICD84 Object Identifier:OFA58 Object Text:OFA shall comply with TICD84 Object Identifier:OFA218 Object Text:OFA shall comply with TICD84 Object Identifier:OPT24 Object Text:All thermistors shall comply with NASA GSFC S311-P-018. Object Identifier:PDU274 Object Text:The PDU shall comply with TICD84 (Thermistor, Heater and Thermostat Standards). Object Identifier:RTA109 Object Text:The RTA shall meet TICD84. Object Identifier:SPD55 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermistor, Heater and Thermostat Standards requirement as written in TICD84.		
TICD86	10.3	Heater Flux Limits	All Kapton film heaters bonded with PSA and no aluminum over-tape will have a maximum watt density of 1 W/in2 at maximum bus voltage.	Maximum watt densities reduce the chance of heaters lifting and over-heating	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU,	Object Identifier:STR93 Object Text:The ATLAS structure shall meet TICD86. Object Identifier:TRD125 Object Text:All TCS heaters shall be sized to stay below the maximum flux density as		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal

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					Structure, Thermal, Fiber Optics	specified in TICD-086, TICD-087 and TICD-088. Object Identifier:TAMS166 Object Text:The ATLAS TAMS LS shall meet TICD86. Object Identifier:BSM153 Object Text:The BSM shall comply with TICD86. Object Identifier:DAA128 Object Text:The DAA shall comply with the Heater Flux Limits requirement as written in TICD86. Object Identifier:LSA40 Object Text:The ATLAS Laser Sampling Assembly Kapton film heaters bonded with PSA and no aluminum over-tape shall have a maximum watt density per TICD086. Object Identifier:LTR34 Object Text:The ATLAS Transmit LTR Kapton film heaters bonded with PSA and no aluminum over-tape shall have a maximum watt density of 1 W/in^2 at maximum bus voltage Object Identifier:MEB141 Object Text:The MEB Kapton film heaters bonded with PSA and no aluminum over-tape shall comply with TICD86 Object Identifier:OFA59 Object Text:OFA shall comply with TICD86 Object Identifier:OFA219		control system.

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						Object Text:OFA shall comply with TICD86 Object Identifier:OPT25 Object Text:The ATLAS Transmitter Optics Kapton film heaters bonded with PSA and no aluminum over-tape shall have a maximum watt density per TICD86 Object Identifier:PDU275 Object Text:The PDU shall comply with TICD86 (Heater Flux Limits). Object Identifier:RTA110 Object Text:The RTA shall meet TICD86 Object Identifier:SPD56 Object Text:The ATLAS Start Pulse Detector shall comply with the Heater Flux Limits requirement as written in TICD86.		
TICD87	10.3	Heater Flux Limits	All Kapton film heaters bonded with PSA and with aluminum over-tape will have a maximum watt density of 3.5 W/in2 at maximum bus voltage	Maximum watt densities reduce the chance of heaters lifting and over-heating.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR94 Object Text:The ATLAS structure shall meet TICD87. Object Identifier:TRD125 Object Text:All TCS heaters shall be sized to stay below the maximum flux density as specified in TICD-086, TICD-087 and TICD-088. Object Identifier:TAMS167 Object Text:The ATLAS TAMS LS shall meet TICD87. Object Identifier:BSM154 Object Text:The BSM shall comply with TICD87.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:DAA129 Object Text:The DAA shall comply with the Heater Flux Limits requirement as written in TICD87. Object Identifier:LSA41 Object Text:The ATLAS Laser Sampling Assembly Kapton film heaters bonded with PSA and with aluminum over-tape shall have a maximum watt density per TICD087. Object Identifier:LTR35 Object Text:The ATLAS Transmit LTR Kapton film heaters bonded with PSA and with aluminum over-tape shall have a maximum watt density of 3.5 W/in^2 at maximum bus voltage Object Identifier:MEB142 Object Text:The MEB Kapton film heaters bonded with PSA and with aluminum over-tape shall comply with TICD87 Object Identifier:OFA60 Object Text:OFA shall comply with TICD87 Object Identifier:OFA220 Object Text:OFA shall comply with TICD87 Object Identifier:OPT26 Object Text:The ATLAS Transmitter Optics Kapton film heaters bonded with PSA and with aluminum over-tape shall have a maximum watt density per TICD087		

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						Object Identifier:PDU276 Object Text:The PDU shall comply with TICD87 (Heater Flux Limits). Object Identifier:RTA111 Object Text:The RTA shall meet TICD87. Object Identifier:SPD57 Object Text:The ATLAS Start Pulse Detector shall comply with the Heater Flux Limits requirement as written in TICD87.		
TICD88	10.3	Heater Flux Limits	All Kapton film heaters bonded with Stycast or BN Arathane and with aluminum over-tape will have a maximum watt density of 10 W/in2 at maximum bus voltage.	Maximum watt densities reduce the chance of heaters lifting and over-heating.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR95 Object Text:The ATLAS structure shall meet TICD88. Object Identifier:TRD125 Object Text:All TCS heaters shall be sized to stay below the maximum flux density as specified in TICD-086, TICD-087 and TICD-088. Object Identifier:TAMS168 Object Text:The ATLAS TAMS LS shall meet TICD88. Object Identifier:BSM155 Object Text:The BSM shall comply with TICD88. Object Identifier:DAA130 Object Text:The DAA shall comply with the Heater Flux Limits requirement as written in TICD88. Object Identifier:LSA42 Object Text:The ATLAS Laser Sampling Assembly Kapton film heaters bonded with Stycast or BN Arathane and with aluminum over-tape shall have a maximum watt		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						density per TICD088. Object Identifier:LTR36 Object Text:The ATLAS Transmit LTR Kapton film heaters bonded with Stycast or BN Arathane and with aluminum over-tape shall have a maximum watt density of 10 W/in^2 at maximum bus voltage Object Identifier:MEB143 Object Text:The MEB Kapton film heaters bonded with Stycast or BN Arathane and with aluminum over-tape shall comply with TICD88 Object Identifier:OFA61 Object Text:OFA shall comply with TICD88 Object Identifier:OFA221 Object Text:OFA shall comply with TICD88 Object Identifier:OPT27 Object Text:The ATLAS Transmitter Optics Kapton film heaters bonded with Stycast or BN Arathane and with aluminum over-tape shall have a maximum watt density per TICD088 Object Identifier:PDU277 Object Text:The PDU shall comply with TICD88 (Heater Flux Limits). Object Identifier:RTA112 Object Text:The RTA shall meet TICD88. Object Identifier:SPD58 Object Text:The ATLAS Start Pulse		

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						Detector shall comply with the Heater Flux Limits requirement as written in TICD88.		
TICD90	10.4	Documentation	All heaters, including those internal to components, will be documented in the ATLAS Thermal Hardware Specification (ICESat-2-THM-SPEC-0217).	Thermal hardware specification must include details of all the instrument thermal hardware.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Harness, Fiber Optics	Object Identifier:STR96 Object Text:The ATLAS structure shall meet TICD90. Object Identifier:TRD58 Object Text:The TCS shall document all thermal hardware in the ATLAS Thermal Hardware Specification (ICESat-2-THM-SPEC-0217). Object Identifier:TAMS169 Object Text:The ATLAS TAMS LS shall meet TICD90. Object Identifier:BSM156 Object Text:The BSM shall comply with TICD90. Object Identifier:DAA131 Object Text:The DAA shall comply with the Documentation requirement as written in TICD90. Object Identifier:HARN71 Object Text:The ATLAS Harness for the Thermal Control System heaters, including those internal to components, shall be documented in the ATLAS Thermal Hardware Specification (ICESat-2-THM-SPEC-0217). Object Identifier:LSA43 Object Text:The ATLAS Laser Sampling Assembly Heaters, including those internal to components, shall be documented in the ATLAS Thermal Hardware Specification (ICESat-2-THM-SPEC-0217) per	Object Identifier:GCS10 Object Text:All GCS flight segment hardware shall be documented in the ATLAS Thermal Hardware Specification (ICESat-2-THM-SPEC-0217).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						TICD090. Object Identifier:LTR37 Object Text:The ATLAS Transmit LTR Heaters, including those internal to components, shall be documented in the ATLAS Thermal Hardware Specification (ICESat-2-THM-SPEC-0217) Object Identifier:MEB144 Object Text:The MEB heaters shall be documented as described in TICD90 Object Identifier:OFA62 Object Text:OFA shall comply with TICD90 Object Identifier:OFA222 Object Text:OFA will comply with TICD90 Object Identifier:OPT28 Object Text:The ATLAS Transmitter Optics Heaters, including those internal to Transmitter Optics, shall be documented per TICD90 Object Identifier:PDU278 Object Text:The PDU shall comply with TICD90 (Documentation). Object Identifier:RTA113 Object Text:The RTA shall meet TICD90. Object Identifier:SPD59 Object Text:The ATLAS Start Pulse Detector shall comply with the Documentation requirement as written in TICD90.		

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TICD93	11.1	Spacecraft Provided Heater Services	The TCS will include a survival heater service that receives unswitched power from the spacecraft with a maximum current of 23 amps (TBR42) at maximum bus voltage.	This service will power all thermostatically-controlled survival heaters on the instrument. All heater services are redundant.	Thermal, Harness	Object Identifier:TRD63 Object Text:The TCS shall interface with the instrument and spacecraft power subsystems for all power needs as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:HARN69 Object Text:The ATLAS Harness shall distribute primary power from the spacecraft to the ATLAS Survival Heaters.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD95	11.1	Spacecraft Provided Heater Services	The TCS will include a Loop Heat Pipe Shut-Down heater service receives switched power from the spacecraft with a maximum current of 1 amp (TBR44) at maximum bus voltage.	This service will power the thermostatically-controlled shut-down heaters on the loop heat pipes. The loops cannot function while this heater is enabled, but the heater is required to maintain survival temperature limits on the lasers when they are unpowered. All heater services are redundant.	Thermal, Harness	Object Identifier:TRD63 Object Text:The TCS shall interface with the instrument and spacecraft power subsystems for all power needs as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:HARN68 Object Text:The ATLAS Avionics shall distribute primary power from the spacecraft to the Loop Heat Pipe (LHP) Shut-down Heater.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD97	11.2	Instrument Provided Heater Services	The TCS will include two loop heat pipe control heater services that receive software-controlled power from the PDU with a maximum current of 1 amp (TBR45) per service at maximum bus voltage.	These services will actively control the temperature of the loop heat pipe compensation chamber. All heater services are redundant.	PDU, MEB, Thermal, Harness, FSW	Object Identifier:TRD63 Object Text:The TCS shall interface with the instrument and spacecraft power subsystems for all power needs as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:HARN72 Object Text:The ATLAS harness shall distribute primary power to two Loop Heat Pipe (LHP) control heater services that receive software-controlled power from the PDU with a maximum current of 1 amp (TBR45) per service at maximum bus voltage.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:MEB108 Object Text:The MEB shall provide commands to the PDU to produce on/off control of the eleven Software Controlled Heaters. Object Identifier:PDU279 Object Text:The PDU shall comply with TICD97 (Instrument Provided Heater Services).		
TICD98	11.2	Instrument Provided Heater Services	The TCS will include one DAA PM heater services that receive software-controlled power from the PDU with a maximum current of 1 amp (TBR46) at maximum bus voltage.	This service will provide warm-biased heater control for the DAA PM. All heater services are redundant.	PDU, MEB, Thermal, Harness, FSW	Object Identifier:TRD63 Object Text:The TCS shall interface with the instrument and spacecraft power subsystems for all power needs as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:HARN73 Object Text:The ATLAS Harness shall distribute primary power to one DAA PM heater services that receive software-controlled power from the PDU with a maximum current of 1 amp (TBR46) at maximum bus voltage and a maximum orbit-average power of 5W. Object Identifier:MEB108 Object Text:The MEB shall provide commands to the PDU to produce on/off control of the eleven Software Controlled Heaters. Object Identifier:PDU280 Object Text:The PDU shall comply with TICD98 (Instrument Provided Heater Services).		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD99	11.2	Instrument Provided Heater	The TCS will include three telescope heater services that receive pulse-width modulated	These services will actively control the temperature gradients of	RTA, PDU, MEB, Thermal, Harness, FSW	Object Identifier:TRD63 Object Text:The TCS shall interface with the instrument and spacecraft power		Object Identifier:IRD51 Object Text:The ATLAS instrument

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		Services	power from the PDU with a maximum current of 2 amp (TBR47) per service at maximum bus voltage.	the telescope. All heater services are redundant.		subsystems for all power needs as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:HARN74 Object Text:The ATLAS Harness shall distribute primary power to three telescope heater services that receive pulse-width modulated power from the PDU with a maximum current of 2 amp (TBR47) per service at maximum bus voltage. Object Identifier:MEB109 Object Text:The MEB shall provide commands to the PDU to produce on/off control of the three Pulse Width Modulation (PWM) Operational Heaters. Object Identifier:PDU281 Object Text:The PDU shall comply with TICD99 (Instrument Provided Heater Services). Object Identifier:RTA114 Object Text:The RTA shall meet TICD99.		thermal control system shall operate independently of the spacecraft thermal control system.
TICD100	11.2	Instrument Provided Heater Services	The TCS will include one LRS Optics control heater services that receive software-controlled power from the PDU with a maximum current of 1 amp (TBR48) per service at maximum bus voltage.	These services will actively control the temperature of the LRS Optics. All heater services are redundant	LRS, PDU, MEB, Thermal, Harness, FSW	Object Identifier:TRD63 Object Text:The TCS shall interface with the instrument and spacecraft power subsystems for all power needs as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:TRD137 Object Text:Each TCS component shall meet all performance requirements during and after exposure to the thermal vacuum protoflight test environment specified in CERD31. Component thermal cycles may occur in an air or gaseous-nitrogen	Object Identifier:GCS20 Object Text:Each GCS Flight Segment component shall meet all performance requirements during and after exposure to 4 cycles in the thermal vacuum protoflight test environment specified in CERD31. Component thermal cycles may occur in an air or gaseous nitrogen environment if the componentshave been shown by analysis to be insensitive to vacuum effects relative to temperature and gradients, and the PDL has received GSFC project approval based on the results of the thermal analysis.	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						environment if the components have been shown by analysis to be insensitive to vacuum effects relative to temperature and gradients, and the PDL has received GSFC project approval based on the results of thermal analysis. Object Identifier:HARN75 Object Text:The ATLAS Harness shall distribute primary power to one LRS Optics control heater services that receive software-controlled power from the PDU with a maximum current of 1 amp (TBR48) per service at maximum bus voltage. Object Identifier:MEB108 Object Text:The MEB shall provide commands to the PDU to produce on/off control of the eleven Software Controlled Heaters. Object Identifier:PDU282 Object Text:The PDU shall comply with TICD100 (Instrument Provided Heater Services).		
TICD101	11.2	Instrument Provided Heater Services	The TCS will include seven OFA control heater services that receive software-controlled power from the PDU with a maximum current of 1 amp (TBR49) per service at maximum bus voltage.	These services will actively control the temperature of the OFA. All heater services are redundant.	OFA, PDU, MEB, Thermal, Harness, FSW	Object Identifier:TRD63 Object Text:The TCS shall interface with the instrument and spacecraft power subsystems for all power needs as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:TRD137 Object Text:Each TCS component shall meet all performance requirements during and after exposure to the thermal vacuum protoflight test environment specified in CERD31. Component thermal cycles may occur in an air or gaseous-nitrogen	Object Identifier:GCS20 Object Text:Each GCS Flight Segment component shall meet all performance requirements during and after exposure to 4 cycles in the thermal vacuum protoflight test environment specified in CERD31. Component thermal cycles may occur in an air or gaseous nitrogen environment if the componentshave been shown by analysis to be insensitive to vacuum effects relative to temperature and gradients, and the PDL has received GSFC project approval based on the results of the thermal analysis.	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						environment if the components have been shown by analysis to be insensitive to vacuum effects relative to temperature and gradients, and the PDL has received GSFC project approval based on the results of thermal analysis. Object Identifier:HARN76 Object Text:The TCS will include seven OFA control heater services that receive software-controlled power from the PDU with a maximum current of 1 amp each (TBR49) per service at maximum bus voltage. Object Identifier:MEB108 Object Text:The MEB shall provide commands to the PDU to produce on/off control of the eleven Software Controlled Heaters. Object Identifier:OFA63 Object Text:OFA shall comply with TICD101 Object Identifier:OFA223 Object Text:The TCS will include seven OFA control heater services that receive software-controlled power from the PDU with a maximum current of 1 amp (TBR2) per service at maximum bus voltage. Object Identifier:PDU283 Object Text:The PDU shall comply with AV125 and TICD101 (Instrument Provided Heater Services).	Object Identifier:MEB183 Object Text:The MEB shall provide commands to the PDU to produce on/off control of the heater power for the OFA.	
TICD274	11.2	Instrument Provided Heater	The TCS will include one LHP Start-Up heater services that receive switched power from the PDU with	This service will be needed to begin fluid flow within the LHP.	PDU, MEB, Thermal, Harness, FSW	Object Identifier:TRD63 Object Text:The TCS shall interface with the instrument and spacecraft power		Object Identifier:IRD51 Object Text:The ATLAS instrument

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		Services	a maximum current of 2 amp (TBR49) per service at maximum bus voltage.			subsystems for all power needs as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:HARN77 Object Text:The TCS will include one LHP Start-Up heater services that receive switched power from the PDU with a maximum current of 2 amp (TBR49) per service at maximum bus voltage. Object Identifier:MEB110 Object Text:The MEB shall provide commands to the PDU to produce on/off control of the Loop Heat Pipe (LHP) Startup Heater. Object Identifier:PDU284 Object Text:The PDU shall comply with TICD274 (Instrument Provided Heater Services).		thermal control system shall operate independently of the spacecraft thermal control system.
TICD102	11.2	Instrument Provided Heater Services	The software-controlled heater services will be capable of switching power on and off based on temperature sensor feedback and programmable setpoints, with control provided by the MEB.	This defines the expectations of the software-controlled heater services.	PDU, MEB, Thermal, FSW	Object Identifier:TRD63 Object Text:The TCS shall interface with the instrument and spacecraft power subsystems for all power needs as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:MEB107 Object Text:The MEB shall read 62 thermistors from the Thermal Control Subsystem (TCS) and provide temperaure data as defined in AV111, TICD102, and TICD103 . Object Identifier:MEB108 Object Text:The MEB shall provide commands to the PDU to produce on/off control of the eleven Software Controlled		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Heaters. Object Identifier:PDU285 Object Text:The PDU shall comply with TICD102 (Instrument Provided Heater Services).		
TICD103	11.2	Instrument Provided Heater Services	The pulse-width modulated heater services will be capable of proportionally-controlling the average heater power based on temperature sensor feedback and programmable setpoints, with control provided by the MEB.	This defines the expectations of the PWM heater services	PDU, MEB, Thermal, FSW	Object Identifier:TRD63 Object Text:The TCS shall interface with the instrument and spacecraft power subsystems for all power needs as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:MEB107 Object Text:The MEB shall read 62 thermistors from the Thermal Control Subsystem (TCS) and provide temperaure data as defined in AV111, TICD102, and TICD103 . Object Identifier:MEB109 Object Text:The MEB shall provide commands to the PDU to produce on/off control of the three Pulse Width Modulation (PWM) Operational Heaters. Object Identifier:PDU286 Object Text:The PDU shall comply with TICD103 (Instrument Provided Heater Services).		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.
TICD105	12.0	Multi-Layer Insulation	All MLI blankets will be mechanically constrained at a minimum of one point or mechanically captured by another blanket or mechanical component.	Blankets must be constrained to prevent excess heat leaks.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber	Object Identifier:STR97 Object Text:The ATLAS structure shall meet TICD105. Object Identifier:TAMS77 Object Text:The ATLAS TAMS LS shall meet TICD105. Object Identifier:BSM157		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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					Optics	Object Text:The BSM shall comply with TICD105. Object Identifier:DAA133 Object Text:The DAA shall comply with the Multi-Layer Insulation requirement as written in TICD105. Object Identifier:FO60 Object Text:The fiber optics shall meet TICD105 Object Identifier:LRS211 Object Text:The ATLAS LRS shall provide connection points needed to satisfy TICD105, TICD106, and TICD107. Object Identifier:LSA44 Object Text:The ATLAS Laser Sampling Assembly MLI blankets shall be mechanically constrained per TIC105. Object Identifier:LTR38 Object Text:The ATLAS Transmit LTR MLI blankets shall be mechanically constrained at a minimum of one point or mechanically captured by another blanket or mechanical component Object Identifier:MEB145 Object Text:The MEB MLI blankets shall be mechanically constrained as documented in TICD105 Object Identifier:OFA64 Object Text:OFA shall comply with TICD105		

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						Object Identifier:OFA224 Object Text:OFA shall comply with TICD105 Object Identifier:OPT29 Object Text:The ATLAS Transmitter Optics MLI blankets shall be mechanically constrained per TICD105 Object Identifier:PDU227 Object Text:The PDU shall comply with TICD105 (Multi-Layer Insulation). Object Identifier:RTA115 Object Text:The RTA shall meet TICD105 Object Identifier:SPD60 Object Text:The ATLAS Start Pulse Detector shall comply with the Multi-Layer Insulation requirement as written in TICD105.		
TICD106	12.0	Multi-Layer Insulation	All MLI blankets that could interfere with the incoming or outgoing beam optical path will have redundant mechanical constraints.	Blankets must be prevented from coming loose and impeding the science capability of the instrument.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR98 Object Text:The ATLAS structure shall meet TICD106. Object Identifier:TAMS78 Object Text:The ATLAS TAMS LS shall meet TICD106. Object Identifier:BSM158 Object Text:The BSM shall comply with TICD106 Object Identifier:DAA134 Object Text:The DAA shall comply with the Multi-Layer Insulation requirement as written in TICD106.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:FO61 Object Text:The fiber optics shall meet TICD106 Object Identifier:LRS211 Object Text:The ATLAS LRS shall provide connection points needed to satisfy TICD105, TICD106, and TICD107. Object Identifier:LSA45 Object Text:The ATLAS Laser Sampling Assembly MLI blankets that could interfere with the incoming or outgoing beam optical path shall have redundant mechanically constraints per TICD106. Object Identifier:LTR39 Object Text:The ATLAS Transmit LTR MLI blankets that could interfere with the incoming or outgoing beam optical path shall have redundant mechanically constraints Object Identifier:MEB146 Object Text:The MEB MLI blankets shall have redundant mechanical constraints as documented in TICD106 Object Identifier:OFA65 Object Text:OFA shall comply with TICD106 Object Identifier:OFA225 Object Text:OFA shall comply with TICD106 Object Identifier:OPT30 Object Text:The ATLAS Transmitter Optics MLI blankets that could interfere		

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						with the incoming or outgoing beam optical path shall have redundant mechanically constraints per TICD106 Object Identifier:PDU228 Object Text:The PDU shall comply with TICD106 (Multi-Layer Insulation). Object Identifier:RTA116 Object Text:The RTA shall meet TICD106. Object Identifier:SPD61 Object Text:The ATLAS Start Pulse Detector shall comply with the Multi-Layer Insulation requirement as written in TICD106.		
TICD107	12.0	Multi-Layer Insulation	All thermal hardware will be built so that the launch depressurization rate of 0.9 psi per second does not detach any thermal blankets or hardware.	Depressurization is often the bounding load case for MLI.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR99 Object Text:The ATLAS structure shall meet TICD107. Object Identifier:TRD159 Object Text:Each TCS component shall survive exposure to a maximum depressurization rate of 6.2 kiloPascal (kPA)/second (s), 0.9 pounds per square inch (PSI)/s, experienced during launch and ascent, without any damage or degradation of performance. Object Identifier:TAMS79 Object Text:The ATLAS TAMS LS shall meet TICD107. Object Identifier:BSM159 Object Text:The BSM shall comply with TICD107. Object Identifier:DAA135 Object Text:The DAA shall comply with	Object Identifier:GCS41 Object Text:Each GCS Flight Segment component shall be designed to meet all performance requirements while operating at a pressure of 1.01 x 10^5 N/m2 (760 Torr).	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						the Multi-Layer Insulation requirement as written in TICD107. Object Identifier:FO62 Object Text:The fiber optics shall meet TICD107 Object Identifier:LRS211 Object Text:The ATLAS LRS shall provide connection points needed to satisfy TICD105, TICD106, and TICD107. Object Identifier:LSA46 Object Text:The ATLAS Laser Sampling Assembly Thermal hardware shall be built per TICD107. Object Identifier:LTR40 Object Text:The ATLAS Transmit LTR Thermal hardware shall be built so that the launch depressurization rate of 0.9 psi per second does not detach any thermal blankets or hardware Object Identifier:MEB147 Object Text:The MEB MLI blankets shall not detach as documented in TICD107 Object Identifier:OFA66 Object Text:OFA shall comply with TICD107 Object Identifier:OFA226 Object Text:OFA shall comply with TICD107 Object Identifier:OPT31 Object Text:The ATLAS Transmitter Optics Thermal hardware shall be built per		

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						TICD107 Object Identifier:PDU229 Object Text:The PDU shall comply with TICD107 (Multi-Layer Insulation). Object Identifier:RTA73 Object Text:The RTA shall meet CERD26. Object Identifier:SPD62 Object Text:The ATLAS Start Pulse Detector shall comply with the Multi-Layer Insulation requirement as written in TICD107.		
TICD109	13.0	Thermal Analysis	The ATLAS TCS will meet all requirements in the thermal environment given in Table 4. The thermal analysis margin required by Gold Rules will be assessed at the instrument level and does not need to be included in component-level analysis. **Table 4: ATLAS Thermal Environment Definitions**	The on-orbit thermal environment drives the design of the TCS.	Laser, LRS, BSM, SPD, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD40 Object Text:The TCS shall meet all requirements in the thermal environment given in Table 1. **Table 1: ATLAS Thermal Environment Definition** Object Identifier:DAA136 Object Text:The DAA shall comply with the Thermal Analysis requirement as written in TICD109. Object Identifier:MEB148 Object Text:The MEB shall meet all requirements in the thermal environment documented in TICD109 Object Identifier:OFA67 Object Text:OFA shall comply with TICD109 Object Identifier:OFA227 Object Text:OFA shall comply with TICD109		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:PDU230 Object Text:The PDU shall comply with TICD109 (Thermal Analysis). Object Identifier:SPD63 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Analysis requirement as written in TICD109.		
TICD110	13.0	Thermal Analysis	The ATLAS TCS will meet all requirements in a 496 km circular polar orbit with beta angles between -90° and +90°, with +Z pointing nadir, and the velocity vector pointing +X in positive beta angles and -X in negative beta angles.	The on-orbit thermal environment drives the design of the TCS	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD41 Object Text:The TCS shall maintain all instrument components within their allowable temperature limits in the science orbit, which is a 496 km circular polar orbit with beta angles between -90° and +90°. . Object Identifier:DAA137 Object Text:The DAA shall comply with the Thermal Analysis requirement as written in TICD110. Object Identifier:MEB149 Object Text:The MEB shall meet all requirements in the on-orbit thermal environment documented in TICD110 Object Identifier:OFA68 Object Text:OFA shall comply with TICD110 Object Identifier:OFA228 Object Text:OFA shall comply with TICD110 Object Identifier:PDU231 Object Text:The PDU shall comply with TICD110 (Thermal Analysis).		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:SPD64 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Analysis requirement as written in TICD110.		
TICD111	13.0	Thermal Analysis	MLI blankets will be analyzed using an effective emissivity equal to 0.005 or 0.03, case specific, that yields the worst case bounding thermal cases. These values may be superseded in the presence of test data or design knowledge of the specific blankets.	Blanket variation must be accounted for in thermal analysis	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD166 Object Text:MLI blankets shall be analyzed using an effective emissivity equal to 0.005 or 0.03, case specific, that yields the worst case bounding thermal cases. These values may be superseded in the presence of test data or design knowledge of the specific blankets. Object Identifier:BSM160 Object Text:The BSM shall comply with TICD111. Object Identifier:DAA138 Object Text:The DAA shall comply with the Thermal Analysis requirement as written in TICD111. Object Identifier:LRS212 Object Text:The ATLAS LRS Team shall comply with TICD111. Object Identifier:MEB150 Object Text:The MEB MLI blanket thermal Test shall comply with TICD111 Object Identifier:OFA69 Object Text:OFA shall comply with TICD111 Object Identifier:OFA229 Object Text:OFA shall comply with TICD111		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:PDU232 Object Text:The PDU shall comply with TICD111 (Thermal Analysis). Object Identifier:SPD65 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Analysis requirement as written in TICD111.		
TICD112	13.0	Thermal Analysis	All thermal analyses will use only the optical properties documented in the ATLAS Thermal Analysis Approved Optical Properties List (ICESat-2-THM-LIST-0520).	All optical properties must be verified by the NASA GSFC Coatings Committee	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD55 Object Text:The TCS thermal models shall use only optical properties that are approved by the NASA Goddard Coatings Committee, listed in the ATLAS Thermal Analysis Approved Optical Properties List (ICESat-2-THM-LIST-0520). Object Identifier:BSM161 Object Text:The BSM shall comply with TICD112. Object Identifier:DAA139 Object Text:The DAA shall comply with the Thermal Analysis requirement as written in TICD112. Object Identifier:LRS213 Object Text:The ATLAS LRS Team shall comply with TICD112. Object Identifier:MEB151 Object Text:The MEB thermal Test shall comply with TICD112 Object Identifier:OFA70 Object Text:OFA shall comply with TICD112		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:OFA230 Object Text:OFA shall comply with TICD112 Object Identifier:PDU233 Object Text:The PDU shall comply with TICD112 (Thermal Analysis). Object Identifier:SPD66 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Analysis requirement as written in TICD112.		
TICD113	13.0	Thermal Analysis	Hot case thermal analysis will assume maximum allocated power for the appropriate mode on all components.	Hot case analysis should be done at the largest power possible.	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD32 Object Text:The TCS shall maintain the temperatures of all components within the allowable operational temperature limits for the allocated and CBE powers defined in the ICESat-2-ATSYS-REQ-0479 technical resource budget. Object Identifier:BSM162 Object Text:The BSM shall comply with TICD113. Object Identifier:DAA140 Object Text:The DAA shall comply with the Thermal Analysis requirement as written in TICD113. Object Identifier:LRS214 Object Text:The ATLAS LRS Team shall comply with TICD113. Object Identifier:MEB152 Object Text:The MEB Hot case thermal Test shall comply with TICD113	Object Identifier:GCS8 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits for the laser power associated with the maximum laser output power and the expected beginning-of-life efficiency.	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:OFA71 Object Text:OFA shall comply with TICD113 Object Identifier:OFA231 Object Text:OFA shall comply with TICD113 Object Identifier:PDU234 Object Text:The PDU shall comply with TICD113 (Thermal Analysis). Object Identifier:SPD67 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Analysis requirement as written in TICD113.		
TICD114	13.0	Thermal Analysis	Cold case thermal analysis will assume the current best estimate of the minimum power dissipation for the appropriate mode on all components	Cold case analysis should be done at the lowest realistic power possible.	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD32 Object Text:The TCS shall maintain the temperatures of all components within the allowable operational temperature limits for the allocated and CBE powers defined in the ICESat-2-ATSYS-REQ-0479 technical resource budget. Object Identifier:BSM164 Object Text:The BSM shall comply with TICD114. Object Identifier:DAA141 Object Text:The DAA shall comply with the Thermal Analysis requirement as written in TICD114. Object Identifier:LRS215 Object Text:The ATLAS LRS Team shall comply with TICD114.	Object Identifier:GCS8 Object Text:The GCS shall maintain the temperatures of the lasers within the allowable operational limits for the laser power associated with the maximum laser output power and the expected beginning-of-life efficiency.	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:MEB153 Object Text:The MEB Cold case thermal Test shall comply with TICD114 Object Identifier:OFA72 Object Text:OFA shall comply with TICD114 Object Identifier:OFA232 Object Text:OFA shall comply with TICD114 Object Identifier:PDU235 Object Text:The PDU shall comply with TICD114 (Thermal Analysis). Object Identifier:SPD68 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Analysis requirement as written in TICD114.		
TICD117	14.1	Reduced Thermal Models Details	All powered instrument components with internal temperature limits will provide a reduced thermal model for integration into the instrument thermal model.	Reduced thermal model deliveries are expected from the lasers, detectors, MEB, and LRS.	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD167 Object Text:Instrument-level thermal analysis shall utilize reduced thermal models of components as they become available, as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:BSM163 Object Text:The BSM shall comply with TICD117. Object Identifier:DAA142 Object Text:The DAA shall comply with the Reduced Thermal Models Details requirement as written in TICD117.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:LRS216 Object Text:The ATLAS LRS Team shall comply with TICD117. Object Identifier:MEB154 Object Text:The MEB reduced thermal model shall comply with TICD117 Object Identifier:OFA73 Object Text:OFA shall comply with TICD117 Object Identifier:OFA233 Object Text:OFA shall comply with TICD117 Object Identifier:PDU236 Object Text:The PDU shall comply with TICD117 (Reduced Thermal Models Details). Object Identifier:SPD69 Object Text:The ATLAS Start Pulse Detector shall comply with the Reduced Thermal Models Details requirement as written in TICD117.		
TICD118	14.1	Reduced Thermal Models Details	Component reduced thermal models will have no more than 100 nodes.	This is a large bound for the definition of a reduced model. Typical models are 20-40 nodes	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD167 Object Text:Instrument-level thermal analysis shall utilize reduced thermal models of components as they become available, as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:BSM165 Object Text:The BSM shall comply with TICD118.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:DAA143 Object Text:The DAA shall comply with the Reduced Thermal Models Details requirement as written in TICD118. Object Identifier:LRS217 Object Text:The ATLAS LRS Team shall comply with TICD118. Object Identifier:MEB155 Object Text:The MEB reduced thermal model nodes shall comply with TICD118 Object Identifier:OFA74 Object Text:OFA shall comply with TICD118 Object Identifier:OFA234 Object Text:OFA shall comply with TICD118 Object Identifier:PDU237 Object Text:The PDU shall comply with TICD118 (Reduced Thermal Models Details). Object Identifier:SPD70 Object Text:The ATLAS Start Pulse Detector shall comply with the Reduced Thermal Models Details requirement as written in TICD118.		
TICD119	14.1	Reduced Thermal Models Details	Component reduced thermal models will be in either Thermal Desktop or SINDA/TSS formats.	The models must be in a format usable to the instrument model. Thermal Desktop is preferred, but other formats can be negotiated with the Instrument Thermal Engineer if needed	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD167 Object Text:Instrument-level thermal analysis shall utilize reduced thermal models of components as they become available, as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214).		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:BSM166 Object Text:The BSM shall comply with TICD119. Object Identifier:DAA144 Object Text:The DAA shall comply with the Reduced Thermal Models Details requirement as written in TICD119. Object Identifier:LRS218 Object Text:The ATLAS LRS Team shall comply with TICD119. Object Identifier:MEB156 Object Text:The MEB reduced thermal model format shall comply with TICD119 Object Identifier:OFA75 Object Text:OFA shall comply with TICD119 Object Identifier:OFA235 Object Text:OFA shall comply with TICD119 Object Identifier:PDU238 Object Text:The PDU shall comply with TICD119 (Reduced Thermal Models Details). Object Identifier:SPD71 Object Text:The ATLAS Start Pulse Detector shall comply with the Reduced Thermal Models Details requirement as written in TICD119.		
TICD120	14.1	Reduced Thermal Models Details	Component reduced thermal model deliveries will be accompanied by a thermal model description document in the format and	The model must include documentation that adequately describes the delivery.	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU,	Object Identifier:TRD167 Object Text:Instrument-level thermal analysis shall utilize reduced thermal models of components as they become		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system

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			including all information listed in the ATLAS Thermal Model Delivery Report Template (ICESat-2-THM-RPT-0212).		Thermal	available, as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:BSM167 Object Text:The BSM shall comply with TICD120. Object Identifier:DAA145 Object Text:The DAA shall comply with the Reduced Thermal Models Details requirement as written in TICD120. Object Identifier:LRS219 Object Text:The ATLAS LRS Team shall comply with TICD120. Object Identifier:MEB157 Object Text:The MEB reduced thermal model shall be documented as described in TICD120 Object Identifier:OFA76 Object Text:OFA shall comply with TICD120 Object Identifier:OFA236 Object Text:OFA shall comply with TICD120 Object Identifier:PDU239 Object Text:The PDU shall comply with TICD120 (Reduced Thermal Models Details). Object Identifier:SPD72 Object Text:The ATLAS Start Pulse Detector shall comply with the Reduced Thermal Models Details requirement as		shall operate independently of the spacecraft thermal control system.

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						written in TICD120.		
TICD121	14.1	Reduced Thermal Models Details	The component reduced thermal models will be capable of running upon delivery, and must include an analysis case to verify that the as-delivered model replicates the results obtained by the model developer.	Thermal model deliveries must be fully-functional at the time of delivery.	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD167 Object Text:Instrument-level thermal analysis shall utilize reduced thermal models of components as they become available, as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:BSM168 Object Text:The BSM shall comply with TICD121. Object Identifier:DAA146 Object Text:The DAA shall comply with the Reduced Thermal Models Details requirement as written in TICD121. Object Identifier:LRS220 Object Text:The ATLAS LRS Team shall comply with TICD121. Object Identifier:MEB158 Object Text:The MEB reduced thermal model functionality shall comply with TICD121 Object Identifier:OFA77 Object Text:OFA shall comply with TICD121 Object Identifier:OFA237 Object Text:OFA shall comply with TICD121 Object Identifier:PDU240 Object Text:The PDU shall comply with TICD121 (Reduced Thermal Models Details).		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:SPD73 Object Text:The ATLAS Start Pulse Detector shall comply with the Reduced Thermal Models Details requirement as written in TICD121.		
TICD122	14.1	Reduced Thermal Models Details	Component reduced thermal models will reflect the latest known power levels and mechanical configuration.	Models should represent the current design.	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD167 Object Text:Instrument-level thermal analysis shall utilize reduced thermal models of components as they become available, as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:BSM169 Object Text:The BSM shall comply with TICD122. Object Identifier:DAA147 Object Text:The DAA shall comply with the Reduced Thermal Models Details requirement as written in TICD122. Object Identifier:LRS221 Object Text:The ATLAS LRS Team shall comply with TICD122. Object Identifier:MEB159 Object Text:The MEB reduced thermal model shall reflect the current design as described in TICD122 Object Identifier:OFA78 Object Text:OFA shall comply with TICD122 Object Identifier:OFA238 Object Text:OFA shall comply with TICD122		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:PDU241 Object Text:The PDU shall comply with TICD122 (Reduced Thermal Models Details). Object Identifier:SPD74 Object Text:The ATLAS Start Pulse Detector shall comply with the Reduced Thermal Models Details requirement as written in TICD122.		
TICD124	14.2	Reduced Thermal Model Correlation	Component reduced thermal models will correctly represent the temperature of any internal temperature sensors.	The goal of the reduced thermal models is to predict the temperature of internal components in the system-level model.	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD167 Object Text:Instrument-level thermal analysis shall utilize reduced thermal models of components as they become available, as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:BSM170 Object Text:The BSM shall comply with TICD124. Object Identifier:DAA148 Object Text:The DAA shall comply with the Reduced Thermal Model Correlation requirement as written in TICD124. Object Identifier:LRS222 Object Text:The ATLAS LRS Team shall comply with TICD124. Object Identifier:MEB160 Object Text:The MEB reduced thermal model correlation shall comply with TICD124 Object Identifier:OFA79 Object Text:OFA shall comply with TICD124		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:OFA239 Object Text:OFA shall comply with TICD124 Object Identifier:PDU242 Object Text:The PDU shall comply with TICD124 (Reduced Thermal Model Correlation). Object Identifier:SPD75 Object Text:The ATLAS Start Pulse Detector shall comply with the Reduced Thermal Model Correlation requirement as written in TICD124.		
TICD127	14.2	Reduced Thermal Model Correlation	After component-level thermal testing, component thermal models will be correlated to accurately represent the temperature of all internal temperature sensors to within 2C of the value measured in all thermal balance tests.	The reduced models must be correlated prior to final delivery to the instrument.	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD167 Object Text:Instrument-level thermal analysis shall utilize reduced thermal models of components as they become available, as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:BSM171 Object Text:The BSM shall comply with TICD127. Object Identifier:DAA149 Object Text:The DAA shall comply with the Reduced Thermal Model Correlation requirement as written in TICD127. Object Identifier:LRS223 Object Text:The ATLAS LRS Team shall comply with TICD127. Object Identifier:MEB161 Object Text:The MEB reduced thermal model correlation shall support the accuracy defined in TICD127		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:OFA80 Object Text:OFA shall comply with TICD127 Object Identifier:OFA240 Object Text:OFA shall comply with TICD127 Object Identifier:PDU243 Object Text:The PDU shall comply with TICD127 (Reduced Thermal Model Correlation). Object Identifier:SPD76 Object Text:The ATLAS Start Pulse Detector shall comply with the Reduced Thermal Model Correlation requirement as written in TICD127.		
TICD128	14.3	Reduced Thermal Model Milestones	Up-to-date component reduced thermal models will be delivered to the Instrument Thermal Engineer two weeks prior to the component CDR and delivery to instrument integration, and also any time that the Instrument Thermal Engineer requests a delivery due to a significant design change.	Minimum delivery dates are required.	Laser, LRS, SPD, BSM, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD167 Object Text:Instrument-level thermal analysis shall utilize reduced thermal models of components as they become available, as described in the ATLAS Thermal ICD (ICESat-2-THM-IFACE-0214). Object Identifier:BSM172 Object Text:The BSM shall comply with TICD128. Object Identifier:DAA150 Object Text:The DAA shall comply with the Reduced Thermal Model Milestones requirement as written in TICD128. Object Identifier:LRS224 Object Text:The ATLAS LRS Team shall comply with TICD128.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:MEB162 Object Text:The MEB reduced thermal model shall be delivered in accordance with TICD128 Object Identifier:OFA81 Object Text:OFA shall comply with TICD128 Object Identifier:OFA241 Object Text:OFA shall comply with TICD128 Object Identifier:PDU244 Object Text:The PDU shall comply with TICD128 (Reduced Thermal Model Milestones). Object Identifier:SPD77 Object Text:The ATLAS Start Pulse Detector shall comply with the Reduced Thermal Model Milestones requirement as written in TICD128.		
TICD129	15.1	Thermal Balance Testing	The target temperatures for thermal tests will be specified as a result of a test model analysis.	Thermal test models are necessary to show that a test will not harm the hardware and to generate a correlated thermal model.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR100 Object Text:The ATLAS structure shall meet TICD129. Object Identifier:TRD137 Object Text:Each TCS component shall meet all performance requirements during and after exposure to the thermal vacuum protoflight test environment specified in CERD31. Component thermal cycles may occur in an air or gaseous-nitrogen environment if the components have been shown by analysis to be insensitive to vacuum effects relative to temperature and gradients, and the PDL has received GSFC project approval based on the results of	Object Identifier:GCS20 Object Text:Each GCS Flight Segment component shall meet all performance requirements during and after exposure to 4 cycles in the thermal vacuum protoflight test environment specified in CERD31. Component thermal cycles may occur in an air or gaseous nitrogen environment if the componentshave been shown by analysis to be insensitive to vacuum effects relative to temperature and gradients, and the PDL has received GSFC project approval based on the results of the thermal analysis.	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						thermal analysis. Object Identifier:TAMS80 Object Text:The ATLAS TAMS LS shall meet TICD129. Object Identifier:BSM173 Object Text:The BSM shall comply with TICD129. Object Identifier:DAA151 Object Text:The DAA shall comply with the Thermal Balance Testing requirement as written in TICD129. Object Identifier:FO63 Object Text:The fiber optics shall meet TICD129 Object Identifier:LRS154 Object Text:The LRS shall meet TICD129. Object Identifier:LSA47 Object Text:The ATLAS Laser Sampling Assembly Target Temperatures for thermal tests shall be specified per TICD129. Object Identifier:LTR41 Object Text:The ATLAS Transmit LTR Target Temperatures for thermal tests shall be specified as a result of a test model analysis Object Identifier:MEB163 Object Text:The MEB target temperatures for thermal tests shall comply with TICD129		

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						Object Identifier:OFA82 Object Text:OFA shall comply with TICD129 Object Identifier:OFA242 Object Text:OFA shall comply with TICD129 Object Identifier:OPT32 Object Text:The ATLAS Transmitter Optics Target Temperatures for thermal tests shall be specified per TICD129 Object Identifier:PDU190 Object Text:The PDU shall comply with TICD129 (Thermal Balance Testing). Object Identifier:RTA117 Object Text:The RTA shall meet TICD129. Object Identifier:SPD78 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Balance Testing requirement as written in TICD129.		
TICD131	15.1	Thermal Balance Testing	Prior to delivery to instrument integration, all components that dissipate power will undergo a thermal balance test that simulates hot operational, cold operational and cold survival conditions.	Thermal balance testing is necessary to show proper design margins and to correlate thermal models against observed performance.	Laser, LSA, LRS, SPD, TAMS, BSM, RTA, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TAMS81 Object Text:The ATLAS TAMS LS shall meet TICD131. Object Identifier:BSM174 Object Text:The BSM shall comply with TICD131. Object Identifier:DAA152 Object Text:The DAA shall comply with the Thermal Balance Testing requirement as written in TICD131.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:LRS155 Object Text:Prior to delivery to instrument integration, all ATLAS LRS components that dissipate power will undergo a thermal balance test that complies with CERD30 and TICD131. Object Identifier:MEB164 Object Text:The MEB shall undergo thermal balance tests as defined in TICD131 Object Identifier:OFA83 Object Text:OFA shall comply with TICD131 Object Identifier:OFA243 Object Text:OFA shall comply with TICD131 Object Identifier:PDU191 Object Text:The PDU shall comply with TICD131 (Thermal Balance Testing). Object Identifier:RTA118 Object Text:The RTA shall meet TICD131. Object Identifier:SPD79 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Balance Testing requirement as written in TICD131.		
TICD132	15.1	Thermal Balance Testing	If the component is sensitive to orbital transient temperature changes, component performance will be monitored during test transitions at a rate similar to that expected in flight.	Necessary to show performance in a flight-like condition	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU,	Object Identifier:STR101 Object Text:The ATLAS structure shall meet TICD132. Object Identifier:TAMS82 Object Text:The ATLAS TAMS LS shall meet TICD132.		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal

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					Structure, Thermal, Fiber Optics	Object Identifier:BSM175 Object Text:The BSM shall comply with TICD132. Object Identifier:DAA153 Object Text:The DAA shall comply with the Thermal Balance Testing requirement as written in TICD132. Object Identifier:FO64 Object Text:The fiber optics shall meet TICD132 Object Identifier:LRS156 Object Text:ATLAS LRS components shall comply with TICD132 where applicable. Object Identifier:LSA48 Object Text:If the ATLAS LSA is sensitive to orbital transient temperature changes, the LSA's performance shall be monitored per TICD132. Object Identifier:LTR42 Object Text:If The ATLAS Transmit LTR Components are sensitive to orbital transient temperature changes components performance shall be monitored during test transitions at a rate similar to that expected in flight Object Identifier:MEB165 Object Text:The MEB components that are sensitive to orbital transient temperature changes shall be tested as defined in TICD132 Object Identifier:OFA84 Object Text:OFA shall comply with		control system.

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						TICD132 Object Identifier:OFA244 Object Text:OFA shall comply with TICD132 Object Identifier:OPT33 Object Text:If The ATLAS Transmitter Optics Transmitter Optics are sensitive to orbital transient temperature changes Transmitter Optics performance shall be monitored per TICD132 Object Identifier:PDU192 Object Text:The PDU shall comply with TICD132 (Thermal Balance Testing). Object Identifier:RTA119 Object Text:The RTA shall meet TICD132. Object Identifier:SPD80 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Balance Testing requirement as written in TICD132.		
TICD134	15.2	Thermal Test Documentation	Prior to a thermal test, a thermal analysis report will be released that gives the details of the test thermal model and shows the predicted performance for all conditions expected in the test.	This is needed in order for systems to buy off on the validity of the test.	Laser, LSA, LRS, SPD, TAMS, BSM, RTA, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD113 Object Text:All tests of TCS components shall be preceded by pre-test reviews wherein readiness of flight hardware, facilities and test equipment, and procedures are verified. For minor tests, reviews are conducted by the key test personnel. For major tests, formal reviews are conducted and chaired by the Integration and Test (I&T) Manager or the designated representative. Tests requiring formal reviews will be designated by the ICESAT-2 Project.	Object Identifier:GCS13 Object Text:All test of GCS Flight Segment flight components shall be preceeded by pre-test reviews wherein readiness of flight hardware, facilities and test equipment, and procedures are verified. For minor tests, reviews are conducted by the key test personnel.	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Identifier:TAMS83 Object Text:The ATLAS TAMS LS shall meet TICD134. Object Identifier:BSM176 Object Text:The BSM shall comply with TICD134. Object Identifier:DAA154 Object Text:The DAA shall comply with the Thermal Test Documentation requirement as written in TICD134. Object Identifier:FO65 Object Text:The fiber optics shall meet TICD134 Object Identifier:LRS157 Object Text:The ATLAS LRS team shall comply with TICD134. Object Identifier:MEB166 Object Text:The MEB shall generate a thermal Test report as defined in TICD134 Object Identifier:OFA85 Object Text:OFA shall comply with TICD134 Object Identifier:OFA245 Object Text:OFA shall comply with TICD134 Object Identifier:PDU193 Object Text:The PDU shall comply with TICD134 (Thermal Test Documentation). Object Identifier:RTA120 Object Text:The RTA shall meet TICD134.		

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						Object Identifier:SPD81 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Test Documentation requirement as written in TICD134.		
TICD151	15.2	Thermal Test Documentation	After a thermal test, a thermal model correlation report will be released that shows the results against the initial predictions, what updates were made to the model, and how the updated model compares against the measured temperatures for each thermal balance.	This is used to provide traceability in case the instrument-level thermal model does not perform as expected in the instrument thermal testing.	Laser, LSA, LRS, SPD, TAMS, BSM, RTA, OFA, DAA, MEB, PDU, Thermal	Object Identifier:TRD114 Object Text:Post-test reviews of TCS component testing shall be held wherein test data are reviewed to determine conformance with test requirements. Object Identifier:TAMS84 Object Text:The ATLAS TAMS LS shall meet TICD151. Object Identifier:BSM177 Object Text:The BSM shall comply with TICD151. Object Identifier:DAA155 Object Text:The DAA shall comply with the Thermal Test Documentation requirement as written in TICD151. Object Identifier:FO66 Object Text:The fiber optics shall meet TICD151 Object Identifier:LRS158 Object Text:The ATLAS LRS team shall cmply with TICD151. Object Identifier:MEB167 Object Text:The MEB shall generate a thermal Test correlation report as defined in TICD151 Object Identifier:OFA86 Object Text:OFA shall comply with	Object Identifier:GCS14 Object Text:Post-test reviews of GCS Flight Segment component testing shall be held wherein test data are reviewed to determine conformance with test requirements.	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						TICD151 Object Identifier:OFA246 Object Text:OFA shall comply with TICD151 Object Identifier:PDU194 Object Text:The PDU shall comply with TICD151 (Thermal Test Documentation). Object Identifier:RTA121 Object Text:The RTA shall meet TICD151. Object Identifier:SPD82 Object Text:The ATLAS Start Pulse Detector shall comply with the Thermal Test Documentation requirement as written in TICD151.		
TICD136	15.3	Ambient Pressure Performance	All components will be capable of operating in ambient air, 15-25C, without active cooling or degradation of performance. This does not include the lasers.	A GSE ground cooling system will be provided to cool the lasers. High-power electronics such as the PDU and MEB may not be able to dissipate their energy in air without the radiators installed	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal, Fiber Optics	Object Identifier:STR102 Object Text:The ATLAS structure shall meet TICD136. Object Identifier:TRD73 Object Text:The TCS shall provide GSE to the instrument to ensure that temperatures are controlled within limits in any 1-g orientation not listed in TRD69. Object Identifier:TAMS85 Object Text:The ATLAS TAMS LS shall meet TICD136. Object Identifier:BSM178 Object Text:The BSM shall comply with TICD136. Object Identifier:DAA156 Object Text:The DAA shall comply with the Ambient Pressure Performance	Object Identifier:GCS1 Object Text:The Ground Cooling System (GCS) shall consist of two segments: the flight segment and the ground segment. Object Identifier:GCS6 Object Text:The GCS shall meet all requirements at any instrument orientation relative to gravity. Object Identifier:GCS7 Object Text:The GCS chiller shall circulate fluid through the flight segment heat exchangers assuming that there is no more than 13.0 m (TBR) of fluid transport lines, round trip, from the chiller to the instrument test connector panel and back, and with a total elevation change of no more than 4.5 m (TBR). The total line length does not include transport lines on the flight segment. Object Identifier:GCS11	Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						requirement as written in TICD136. Object Identifier:FO67 Object Text:The fiber optics shall meet TICD136 Object Identifier:LRS225 Object Text:The ATLAS LRS Team shall comply with TICD136. Object Identifier:LSA49 Object Text:The ATLAS LSA shall be capable of operating in ambient air per TICD136. Object Identifier:LTR43 Object Text:The ATLAS Transmit LTR components shall be capable of operating in ambient air, 15 - 25 degrees C, without active cooling or degradation of performance Object Identifier:MEB168 Object Text:The MEB shall operate in ambient pressure and without active cooling as defined in TICD136 Object Identifier:OFA87 Object Text:OFA shall comply with TICD136 Object Identifier:OFA247 Object Text:OFA shall comply with TICD136 Object Identifier:OPT34 Object Text:The ATLAS Transmitter Optics Transmitter Optics shall be capable of operating in ambient air per TICD136	Object Text:The GCS shall be in its flight configuration during instrument- and spacecraft-level thermal balance testing. Object Identifier:GCS48 Object Text:The GCS flight segment shall not have any rigid couplings between the lasers or between any laser and the structure.	

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						Object Identifier:PDU195 Object Text:The PDU shall comply with TICD136 (Ambient Pressure Performance). Object Identifier:RTA122 Object Text:The RTA shall meet TICD136. Object Identifier:SPD83 Object Text:The ATLAS Start Pulse Detector shall comply with the Ambient Pressure Performance requirement as written in TICD136.		
TICD137	15.4	In-Gravity Performance	Heat pipes, if used, will be maintained at a slope of no more than 0.1 inches over their length when in thermal vacuum testing. This does not include heat pipes operating in reflux.	CCHPs and VCHPs must be level to operate in a gravity environment.	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA, MEB, PDU, Structure, Thermal	Object Identifier:STR103 Object Text:The ATLAS structure shall meet TICD137. Object Identifier:TRD69 Object Text:The TCS shall be fully functional during TB/TV testing so that temperatures are controlled within limits in the 1-g environment with gravity in the -X direction, level to within 0.05 degrees (TBR23). Object Identifier:TAMS170 Object Text:The ATLAS TAMS LS shall meet TICD137. Object Identifier:DAA157 Object Text:The DAA shall comply with the In-Gravity Performance requirement as written in TICD137. Object Identifier:LSA50 Object Text:The ATLAS Laser Sampling Assembly Heat pipes, if used, shall be maintained per TICD137. Object Identifier:LTR44		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the spacecraft thermal control system.

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						Object Text:The ATLAS Transmit LTR Heat pipes, if used, shall be maintained at a slope of no more then 0.1 inch over their length when in thermal vacuum testing. This does not include heat pipes operating in reflux. Object Identifier:MEB169 Object Text:The MEB shall comply with the heat pipe slope requirement as defined in TICD137 Object Identifier:OFA88 Object Text:OFA shall comply with TICD137 Object Identifier:OPT35 Object Text:The ATLAS Transmitter Optics Heat pipes, if used, shall be maintained per TICD137 Object Identifier:PDU196 Object Text:The PDU shall comply with TICD137 (In-Gravity Performance). Object Identifier:RTA123 Object Text:The RTA shall meet TICD137. Object Identifier:SPD84 Object Text:The ATLAS Start Pulse Detector shall comply with the In-Gravity Performance requirement as written in TICD137.		
TICD152	15.4	In-Gravity Performance	All components will be capable of operating in the thermal vacuum configuration where gravity is in the -X direction at the instrument level or above.	The TCS will be designed to operate in this orientation. The coordinate system is shown in Figure 1, and is controlled in Definition of ICESat-2	Laser, LSA, SPD, Transmit Optics, LRS, TAMS, BSM, LTR, RTA, OFA, DAA,	Object Identifier:STR104 Object Text:The ATLAS structure shall meet TICD152. Object Identifier:TRD69 Object Text:The TCS shall be fully		Object Identifier:IRD51 Object Text:The ATLAS instrument thermal control system shall operate independently of the

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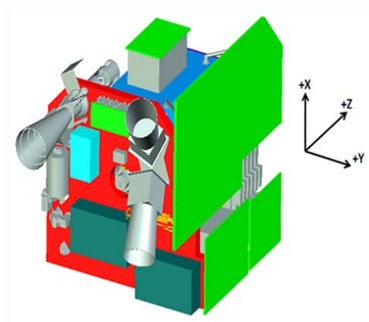
			Figure 1: ATLAS Coordinate System Definition  	Reference Frame (ICESat-2-SYS-ANYS-0474).	MEB, PDU, Structure, Thermal	functional during TB/TV testing so that temperatures are controlled within limits in the 1-g environment with gravity in the -X direction, level to within 0.05 degrees (TBR23). Object Identifier:TAMS86 Object Text:The ATLAS TAMS LS shall meet TICD152. Object Identifier:BSM180 Object Text:The BSM shall comply with TICD152. Object Identifier:DAA158 Object Text:The DAA shall comply with the In-Gravity Performance requirement as written in TICD152. Object Identifier:FO68 Object Text:The fiber optics shall meet TICD152 Object Identifier:LRS226 Object Text:The ATLAS LRS Team shall comply with TICD152. Object Identifier:LSA51 Object Text:The ATLAS Laser Sampling Assembly shall be capable of operating in the Thermal Vacuum configuration per TICD152. Object Identifier:LTR45 Object Text:The ATLAS Transmit LTR compenents shall be capable of operating in the Thermal Vacuum configuration where gravity is in the -X direction at the instrument level or above.		spacecraft thermal control system.

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						Object Identifier:MEB170 Object Text:The MEB shall operate in a gravity environment as defined in TICD152 Object Identifier:OFA89 Object Text:OFA shall comply with TICD152 Object Identifier:OFA248 Object Text:OFA shall comply with TICD152 Object Identifier:OPT36 Object Text:The ATLAS Transmitter Optics components shall be capable of operating in the Thermal Vacuum configuration per TICD152 Object Identifier:PDU197 Object Text:The PDU shall comply with TICD152 (In-Gravity Performance). Object Identifier:RTA124 Object Text:The RTA shall meet TICD152. Object Identifier:SPD85 Object Text:The ATLAS Start Pulse Detector shall comply with the In-Gravity Performance requirement as written in TICD152.		

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Table 1: ATLAS Thermal Interface Temperature Limits

Thermal Interface	Operational Limits (°C)	Qualification Limits (°C)	Survival Limits (°C)	Acceptance Limits (°C)
MEB	-10 to 40	-20 to 50	-25 to 55	N/A
PDU	-10 to 40	-20 to 50	-25 to 55	N/A
Laser 1	10 to 30	5 to 35	-10 to 40	N/A
Laser 2	10 to 30	5 to 35	-10 to 40	N/A
DAA Electronics	-10 to 40	-20 to 50	-25 to 55	N/A
DAA PM	-10 to 16 (TBR)	-20 to 26 (TBR)	-25 to 40	N/A
LSA	-10 to 40	-20 to 50	-25 to 55	N/A
SPD	-10 to 40	-20 to 50	-25 to 55	N/A
LRS Optics	15 to 25 (TBR)	10 to 30 (TBR)	-5 to 30 (TBR)	N/A
LRS Electronics	-10 to 40 (TBR)	-20 to 50 (TBR)	-25 to 55 (TBR)	N/A
LRS Sunshade	-20 to 35	-30 to 45	-40 to 50	N/A
OFA	30 to 55	25 to 60	-30 to 65	N/A
OFA Detectors	-5 to 40	-15 to 50	-25 to 55	N/A
BSM	0 to 40	-10 to 50	-20 to 55	N/A
Optical Fibers	-20 to 55	-30 to 65	-40 to 70	N/A
Fold Mirror	-20 to 35	-30 to 45	-40 to 50	N/A
PBC	-20 to 35	-30 to 45	-40 to 50	N/A
DOE	-20 to 35	-30 to 45	-40 to 50	N/A
Beam Expander	-20 to 35	-30 to 45	-40 to 50	N/A
Beam Dump	-20 to 35	-30 to 45	-40 to 50	N/A
Transmit LTR	-15 to 45	-25 to 55	-35 to 60	N/A
TAMS LTR	-15 to 45	-25 to 55	-35 to 60	N/A
TAMS LS	-5 to 35	-15 to 45	-20 to 50	N/A
Telescope	0 to 35	-10 to 45	-40 to 50	N/A
Aft Optics Assembly	0 to 35	-10 to 45	-40 to 50	N/A
Primary Structure	-40 to 45	-50 to 55	-55 to 60	N/A
Telescope Sunshade	-80 to 165	-90 to 175	-90 to 175	N/A

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Table 2: ATLAS Thermal Interface Temporal gradient Requirements

Thermal Interface	Temporal Gradient Requirement (°C/hour)
MEB	30 (TBR)
PDU	40 (TBR)
Laser 1	30 (TBR)
Laser 2	30 (TBR)
DAA Electronics	30 (TBR)
DAA PM	30 (TBR)
LSA	45 (TBR)
SPD	45 (TBR)
LRS Optics	30 (TBR)
LRS Electronics	35 (TBR)
LRS Sunshade	40 (TBR)
OFA	30 (TBR)
OFA Detectors	45 (TBR)
BSM	30 (TBR)
Optical Fibers	60 (TBR)
Fold Mirror	45 (TBR)
PBC	45 (TBR)
DOE	40 (TBR)
Beam Expander	40 (TBR)
Beam Dump	40 (TBR)
Transmit LTR	30 (TBR)
TAMS LTR	30 (TBR)
TAMS LS	45 (TBR)
Telescope	30 (TBR)
Aft Optics Assembly	30 (TBR)
Primary Structure	30 (TBR)
Telescope Sunshade	240 (TBR)

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Table 3: ATLAS Thermal Interface Spatial Gradient Requirements

Thermal Interface	Spatial Gradient Requirement (°C)
MEB	15 (TBR)
PDU	15 (TBR)
Laser 1	15 (TBR)
Laser 2	15 (TBR)
DAA Electronics	15 (TBR)
DAA PM	15 (TBR)
LSA	15 (TBR)
SPD	15 (TBR)
LRS Optics	15 (TBR)
LRS Electronics	15 (TBR)
LRS Sunshade	15 (TBR)
OFA	15 (TBR)
OFA Detectors	15 (TBR)
BSM	15 (TBR)
Optical Fibers	None (TBR)
Fold Mirror	15 (TBR)
PBC	15 (TBR)
DOE	15 (TBR)
Beam Expander	15 (TBR)
Beam Dump	15 (TBR)
Transmit LTR	15 (TBR)
TAMS LTR	15 (TBR)
TAMS LS	15 (TBR)
Telescope	See TICD50 and TICD51
Aft Optics Assembly	15 (TBR)
Primary Structure	None (TBR)
Telescope Sunshade	None (TBR)

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Table 4: ATLAS Thermal Environment Definitions

Parameter	Hot Case	Cold Case
Solar Flux (W/m2)	1420	1280
Albedo	0.35	0.25
Planetary IR (W/m2)	265	208

Released Version