

**ICESat-2 Controlled Document  
Released by: P. Everson 6/1/2011**

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

**Flight Telescope  
Statement of Work (SOW)  
ICESat-2-OPT-SOW-0073**

**Revision B**

**Effective Date: June 1, 2011**



**Goddard Space Flight Center  
Greenbelt, Maryland**

**National Aeronautics and  
Space Administration**

CHECK <https://icesat-2mis.gsfc.nasa.gov>  
TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.

## CM FOREWORD

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

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

Questions or comments concerning this document should be addressed to:

ICESat-2 Configuration Management Office  
Mail Stop 425  
Goddard Space Flight Center  
Greenbelt, Maryland 20771

\*\*\* Signatures are available on-line at: <https://icesat-2mis.gsfc.nasa.gov> \*\*\*



## Table of Contents

1.0	Introduction.....	1
1.1	General Requirements.....	1
1.2	Government Furnished Equipment (GFE).....	1
1.3	Technical Specifications.....	2
1.3.1	Witness Samples.....	2
1.4	List of Final Tests.....	2
1.5	Applicable Documents.....	3
2.0	Management, Reporting, Documentation and Reviews.....	4
2.1	Management and Reporting.....	4
2.2	Documentation.....	4
2.3	Reviews and Meetings.....	4
2.3.1	Critical Design Review (CDR):.....	4
2.3.2	Pre-Ship Review (PSR).....	5
2.3.3	Technical Interchange Meetings (TIM):.....	6
2.4	Notification to NASA/GSFC Contracting Officer and Contracting Officer Technical Representative.....	6
3.0	Engineering.....	8
3.1	General Requirements.....	8
3.1.1	Manufacturing Requirements.....	8
3.2	Engineering Documentation.....	8
3.2.1	Interface Control Document (ICD).....	8
3.2.2	Drawing Package.....	8
3.2.3	Critical Design Review Presentation Package.....	9
3.2.4	Data Delivery Package.....	9
3.2.5	Verification Test Plan.....	10
3.2.6	Verification Test Procedures.....	11
3.2.7	Verification Test Report.....	12
3.2.8	Verification Inspection Report.....	12
3.2.9	Contamination Control Plan.....	12
3.2.10	Fracture Control Plan.....	12
3.2.11	Metrology Plan.....	13
3.3	Thermal Analysis.....	13
3.4	Structural Analysis.....	13
3.5	Failure Modes & Effects Analysis (FMEA).....	14
4.0	Development Flow.....	15
4.1	Design Development.....	16
4.2	Hardware Manufacture.....	16
5.0	Quality Assurance.....	17
5.1	General Requirements.....	17
5.1.1	Quality Assurance Plan/Manual.....	17
5.1.2	Surveillance of the Contractor.....	17

5.1.3	Configuration Management.....	18
5.1.4	Anomaly Reporting.....	19
5.2	System Safety Requirements.....	20
5.2.1	Beryllium Safety Plan.....	20
5.3	Ground Support Equipment (GSE).....	20
5.4	Design Verification Requirements.....	20
5.4.1	Verification Requirements.....	20
5.4.2	Analysis/Trending/Reporting of Test Data.....	21
5.5	Workmanship Standards and Processes.....	21
5.5.1	Workmanship: Use of Contractors Workmanship Standards.....	21
5.5.2	Training and Certification of Contractor Personnel.....	22
5.5.3	Hardware Handling, Cleaning and Packaging.....	22
5.6	Parts Control.....	22
5.6.1	Parts/Material Age Control.....	22
5.6.2	Reuse of Parts and Materials.....	22
5.6.3	Part Notification of Failure.....	22
5.7	Materials, and Processes Requirements.....	23
5.7.1	Materials Selection Requirements.....	23
5.7.2	Vacuum Outgassing of Polymeric Materials.....	23
5.7.3	Stress Corrosion Cracking of Inorganic Materials.....	24
5.7.4	Manufacturing Process Selection Requirements.....	24
5.7.5	Hardware.....	24
5.7.6	Materials Procurement Requirements.....	24
5.7.7	Dissimilar Metals.....	25
5.7.8	Fungus Inert Material.....	25
6.0	Contamination Control Requirements.....	26
7.0	Handling, Storage, Packaging, Preservation, and Delivery.....	27
7.1	Handling, Storage, Packaging, Preservation, and Delivery Plan.....	27
7.2	Quality Requirements.....	27
7.3	Hardware Deliverables.....	29
7.4	Documentation Deliverables.....	29
APPENDIX A Abbreviations and Acronyms.....		32
APPENDIX B List of Applicable Documents.....		34

**List of Figures**

<u>Figure</u>	<u>Page</u>
Figure 4-1 – A schematic of ATLAS telescope project life cycle .....	15

**List of Tables**

<u>Table</u>	<u>Page</u>
Table 1-1 - A list of Witness Samples to be provide by the Contractor .....	2
Table 7-1 – A list of hardware deliverables .....	29
Table 7-2 – A list of documentation deliverables .....	31

Released Version

## 1.0 Introduction

This document will serve as the legal contract between NASA Goddard Space Flight Center (GSFC) and the contract awardee for the design, fabrication, testing and delivery, henceforth referred to as the production cycle, of two receiver telescopes for use on the Advanced Topographic Laser Altimeter System (ATLAS) instrument that will fly onboard the ICESat-2 spacecraft.

Among other things, this document will clearly define the roles and responsibilities of each party, the expectations of the Contractor and the requirements governing the production cycle of each telescope.

Should any questions arise at any point during the production cycle of the telescopes, the Contractor is instructed to contact GSFC for guidance.

### 1.1 General Requirements

The new ATLAS telescopes will be based on the beryllium telescope design used on GLAS. The ATLAS telescopes will differ from the GLAS telescopes in many respects including size, optical prescription and optical performance requirements. For more information regarding the technical specifications and requirements of the telescopes, refer to the ATLAS Receiver Telescope Optical Specification (ICESat-2-OPT-SPEC-0331). We plan to accommodate the better performance using a specially built aft optics assembly and the Ritchey–Chrétien configuration.

Although the ATLAS telescope designs will be based on the GLAS telescopes, the Contractor will ultimately be responsible, with Goddard Space Flight Center's (GSFC) oversight, for the design and fabrication of the telescope. Furthermore, it will be the responsibility of the Contractor to ensure the assembled telescopes meet all specifications and requirements.

### 1.2 Government Furnished Equipment (GFE)

The ICESat-2 project has purchased I-220-H Beryllium billets from Brush Wellman to furnish to the Contractor selected to build two telescopes. These billets are complete as of this writing. The billets can be shipped to the Contractor or near-net shape machined by Brush Wellman in time for delivery to the selected Contractor after contract award. A preliminary cut plan has been developed for the Beryllium Billets: see ICESat-2-MECH-PLAN-0614 - ATLAS 0.8 m Telescope Cut Plan.

*SOW-001* - The Contractor shall provide and GSFC shall approve a Cut Plan for the beryllium billets two (2) weeks after award of the contract.

*SOW-002* - The Contractor shall not perform any manufacturing operations on the beryllium billets without explicit permission from GSFC.

SOW-003 - The Beryllium chips from machining shall be shipped to Brush Wellman for credit to the NASA ICESat-2 contract.

### 1.3 Technical Specifications

See the ATLAS Receiver Telescope Optical Specification (ICESat-2-OPT-SPEC-0331) for details of the required technical specifications.

#### 1.3.1 Witness Samples

SOW-004 - The Contractor shall provide the following witness samples with each telescope assembly:

	Material Witness Sample	EN Plating Witness Sample	Coating Witness Sample (532 nm)
Interface Plate Assy	Qty 3		
Primary Mirror	Qty 3	Qty 3	Qty 3
Metering Structure	Qty 3		
Secondary Mirror	Qty 3	Qty 3	Qty 3
Shipping Container Contamination Samples			Qty 3

Table 1-1 - A list of Witness Samples to be provide by the Contractor

SOW-005 - All witness samples shall have following minimum dimensions Ø1.25” x 0.25” thk.

SOW-006 - The Contractor shall also provide the appropriate documentation demonstrating traceability back to the original beryllium billet.

### 1.4 List of Final Tests

SOW-007 - In order to verify performance, the vendor shall perform the following tests on the fully assembled telescope:

- Alignment
- Line of sight
- Back focal distance adjustment at room temperature
- Telescope encircled energy
- Blur circle performance
- Off Axis Performance

Refer to ATLAS Receiver Telescope Optical Specification (ICESat-2-OPT-SPEC-0331) for more details concerning the requirements.

### ***1.5 Applicable Documents***

*SOW-008* - The ATLAS telescope shall meet all applicable requirements as specified in the documents listed in Appendix B. In the event of a conflict between this SOW and the specification, the SOW will take precedence.

Released Version

## **2.0 Management, Reporting, Documentation and Reviews**

### **2.1 Management and Reporting**

*SOW-009* - The Contractor shall designate a single individual who will be given full responsibility and authority to manage and administer all phases of the work specified by the contract and ensure that all objectives are accomplished within schedule and cost constraints.

*SOW-010* - The Contractor shall designate and identify by name a single individual who will serve as a point of contact with the GSFC Contracting Officer Technical Representative (COTR) for all technical aspects of the telescope contract.

*SOW-011* - The Contractor shall provide support for managing all resources, controlling schedules, managing all engineering, manufacturing and procurement activities, configuration management, Quality Assurance, documentation control, and distribution.

*SOW-012* - The Contractor shall prepare and present to the NASA/GSFC (COTR) monthly status via telecom and a written report including schedule updates. The report shall be a summary presentation of the period's progress, problem areas, updates to mass and volume budgets and margins, and activities on-going and planned. The Contractor shall generate a list of significant milestones that will enable the NASA/GSFC COTR to ascertain program progress.

### **2.2 Documentation**

*SOW-013* - The Contractor shall ensure the generation and delivery of all documentation as called for in the Contract (see Section 7.3 *Documents Deliverables*).

*SOW-014* - In addition to that documentation specifically called for in the Contract, upon request by the NASA/GSFC COTR, the Contractor shall make available a copy of any document or data generated during this contract performance for review by the GSFC at either the Contractor's facility or via the internet. This includes, but is not limited to, technical reports and memorandums, drawings, schematics, studies, analyses, parts and material certifications, test data, alerts, photographs, etc. Electronic copies of all documents including the revised drawings are required.

### **2.3 Reviews and Meetings**

#### **2.3.1 Critical Design Review (CDR):**

*SOW-015* - The Contractor shall organize and present a Critical Design Review to a GSFC Review Team at the Contractor's facility 2 months after contract award.

*SOW-016* - This review shall demonstrate overall conformance of the requirements specified in the ATLAS Receiver Telescope Optical Specification (ICESat-2-OPT-SPEC-0331) and this Statement of Work.

*SOW-017* - This review shall cover programmatic, technical, test and verification, and quality assurance topics.

*SOW-018* - All drawings and analyses shall be provided as part of the CDR.

*SOW-019* - The Contractor shall provide to GSFC a Critical Design Review Presentation Package and all other required deliverable data two weeks prior to the review. Refer to section 3.2.3 for the list of required deliverable data.

*SOW-020* - Review minutes shall be prepared and, as a minimum, will include attendance, action item, action item accomplishment responsibility and agreements. All items will be in sufficient detail to be self-explanatory.

*SOW-021* - A Critical Design Review Report shall be prepared within 10 days following the review and, as a minimum, contain meeting notice, agenda, review meeting minutes described above and responses to all recommendations and action item.

*SOW-022* – Fabrication shall commence once GSFC has formally agreed that all the requirements necessary for a successful CDR have been met.

### **2.3.2 Pre-Ship Review (PSR)**

*SOW-023* - The Contractor shall hold a Pre-Ship Review at the Contractor's plant with the goal of determining whether the assembled telescope is complete and meets all previously agreed upon requirements.

*SOW-024* - A PSR shall be held prior to the delivery of each of the two telescopes.

*SOW-025* - The PSR shall take place at the completion of requirement verification tests and prior to shipment of the hardware to GSFC.

*SOW-026* - At a minimum the Pre-Ship Review shall consist of the following:

- An onsite inspection by GSFC personnel of the assembled telescope prior to final sealing of the shipping container
- All required testing and analyses has been completed
- Confirmation that telescope complies with all requirements as defined in ICESat-2-OPT-SPEC-0331
- Documentation of the as-built hardware (i.e. – as-built drawings)
- Documentation of any liens, open/unresolved issues and GSFC approved plans to close/resolve the issues
- The Data Delivery Package contains all of the required documentation
- Witness of A Data Delivery Package (reference 3.2.4) shall be presented for review at the PSR

A determination of whether or not the assembled telescope meets all of the success criteria of the PSR will be made at the sole discretion of the COTR.

### **2.3.3 Technical Interchange Meetings (TIM):**

SOW-027 - The Contractor shall plan for informal, face-to-face technical interchange meetings to be held at the Contractor facilities.

SOW-028 - These TIMs shall support review and coordination of technical issues including, but not limited to, fabrication plans and procedures, parts, test plans, test procedures, anomaly report disposition, design modifications, and design analyses.

SOW-029 - Any issues or Requests For Action (RFA's) from the TIM shall incur a lien on manufacturing. At GSFC's discretion, this lien may require the cessation of all or some manufacturing activities until the lien has been resolved.

SOW-030 - The TIM meeting notice shall be seven (7) calendar days in advance of the meeting and can be initiated by GSFC or the Contractor.

### **2.4 Notification to NASA/GSFC Contracting Officer and Contracting Officer Technical Representative**

SOW-031 - The Contractor shall notify the NASA/GSFC Contracting Officer Technical Representative (COTR) at least seven (7) calendar days in advance of all mandatory hardware inspections, test activities, and deliveries at either the Contractor's or a sub-contractor's facility to allow timely participation by the NASA/GSFC Quality Assurance personnel. Mandatory hardware inspection points include but are not limited to:

- Arrival of government furnished equipment (GFE) Beryllium billets from Brush Wellman at the Contractor
- Design technical interchange meeting (TIM) with GSFC optics personnel for agreement on manufacturing plan
- Acceptance of secondary mirror null corrector
- Acceptance of Primary mirror computer-generated hologram (CGH)
- Completion of machining of the primary mirror of flight model telescope #1 (FM1)
- Completion of machining of the primary mirror of flight model telescope #2 (FM2)
- Completion of machining of the metering structure of FM1
- Completion of machining of the metering structure of FM2
- Completion of all Beryllium machining of FM1 – Metrology review
- Completion of all Beryllium machining of FM2 – Metrology review
- Preparation of Electroless Nickel (EN) plating
- Metrology review after EN plating FM1
- Metrology review after EN plating FM2

- Figure review after diamond point turning (DPT) of Primary Mirror (PM) and Secondary Mirror (SM) for FM1
- Figure review after diamond point turning (DPT) of Primary Mirror (PM) and Secondary Mirrors (SM) for FM2
- Authorization to Proceed (ATP) with polishing of PM and SM for FM1
- Authorization to Proceed (ATP) with polishing of PM and SM for FM2
- Interferometric test of the Assembled telescope (FM1)
- Interferometric test of the Assembled telescope (FM2)
- Data review of blur circle, effective focal length and back focal distance for FM1
- Data review of blur circle, effective focal length and back focal distance for FM2
- Inspection of shipping container for FM1
- Inspection of shipping container for FM2

Released Version

## **3.0 Engineering**

### **3.1 General Requirements**

*SOW-032* - The Contractor shall perform an analysis of the technical and environmental requirements specified in the ATLAS Receiver Telescope Optical Specification (ICESat-2-OPT-SPEC-0331) to ensure compliance of the hardware fabrication and to assemble the documentation necessary to ensure its usability by NASA/GSFC users. ATLAS Component Environmental Requirements (ICESat-2-ATSYS-REQ-0517) will apply here, in 3.2.5, and in 3.2.5.1.

#### **3.1.1 Manufacturing Requirements**

*SOW-033* - The Contractor shall provide for the machining of all materials, including the beryllium, to ensure that the material is free of internal stresses induced during manufacturing and machining.

*SOW-034* - The Contractor shall provide for the machining of beryllium material to ensure that all components are etched and heat treated as required to remove any residual stresses or damage.

### **3.2 Engineering Documentation**

The system engineering analysis of the detailed design and subsequent fabrication and assembly, test, and inspection of the telescopes will result, as a minimum, in the following technical documentation, as required in the Contract. Contractor format is suitable for this documentation.

#### **3.2.1 Interface Control Document (ICD)**

*SOW-035* - The Contractor shall provide a document or documents that define, in detail, all performance specifications, functional specifications, environmental specifications, and mechanical interfaces.

#### **3.2.2 Drawing Package**

*SOW-036* - The Contractor shall produce the following mechanical drawings:

- Detailed manufacturing drawings of each component using Geometric Dimensioning and Tolerancing
- Assembly drawings
- Fabrication drawings
- Mechanical Interface Control Drawing
- Ground Support Equipment drawings
- Test Fixture drawings

### 3.2.3 Critical Design Review Presentation Package

*SOW-037* - The Contractor shall provide a Critical Design Review Presentation Package prior to the manufacturing program. This review shall occur no more than two months after the award of the contract.

*SOW-038* - The Critical Design Review data package shall address all program management, design, analysis, manufacturing, test, and quality assurance activities outlined in this SOW and the ATLAS Receiver Telescope Optical Specification (ICESat-2-OPT-SPEC-0331) in sufficient detail to ensure that the proposed design conforms to all requirements and is ready for fabrication to begin.

*SOW-039* - At a minimum, the design package shall cover the following areas:

- Critical Design Review Agenda
- Program Management
- Quality Assurance
- Contamination Control
- Risks
- Mechanical specifications
- Manufacturing flow with mandatory inspection points (MIPS)
- Facilities
- Verification test plan (Including Performance Test Description)
- Materials, Fabrication and Processes Plan
- Thermal analysis
- Mechanical/Structural analysis
- Mass/Volume budgets & margins
- Failure Modes & Effects Analysis
- Optical Analysis
- Verification Matrix
- Performance Analysis (preliminary)
- Drawing package
- CAD models
- Optical models (if applicable)

### 3.2.4 Data Delivery Package

*SOW-040* - The Data Delivery Package shall be made available for review two weeks before pre-ship reviews. This package shall also be delivered with the end item with the level of detail required of that item.

*SOW-041* - The package shall be comprised of, but not limited to, the following data:

- The CDR package
- Any items (i.e. – CAD Models, drawings, reports, documents, etc.) that have been updated since the CDR
- As-Built vs. As Designed Parts List, (includes serialization/revisions)
- Final Drawing Package (including rework instructions, if any)
- Trended Parameters List (TPL)
- Problem/anomaly reporting (complete copies of reports & correspondences)
- Deviations/Waivers/open item/nonconformances and their dispositions,
- Class I MRBs (complete copies of reports)
- Class I FRBs (complete copies of reports)
- List of Materials and Processes used,
- Verification matrix, test data and reports (including qualification test report)
- Post- plating thickness map of EN plating (i.e. - after EN plating but before diamond turning) of Primary and Secondary Mirrors (front and back)
- Pre-polishing thickness map of EN plating (i.e. - after diamond turning but before polishing) of Primary and Secondary Mirrors (front and back)
- Post-polishing thickness map of EN plating (i.e. - after final polishing) of Primary and Secondary Mirrors (front and back)
- Photographic Documentation (Pre-Assembly and Assembled)
- Material Certifications
- Certificates of Conformance
- Results of the Final Test(s)
- List of Open Item with reason for item(s) being open and proposed closure date
- Contamination Control Plan
- Fracture Control Plan
- Optical models (final)
- Thermal models (final)
- Optical Performance Analysis (final)
- Calibration data (if any)
- Fracture Control Report
- Contamination test results from witness samples
- Proof load data (handles, crane supports, shipping container)
- Temporary installation and removal records (red tag and green tag items)
- Packaging, Storing, Transport and Handling Procedures
- As-Built Materials and Processes List (ABMPL)

### **3.2.5 Verification Test Plan**

*SOW-042* - A Verification Test Plan shall be generated by the Contractor to perform verification tests identified in the ATLAS Receiver Telescope Optical Specification (ICESat-2-OPT-SPEC-

0331). Verification tests must demonstrate acceptable performance over the specified range of performance requirements, measure performance parameters and reveal inadequacies in manufacturing and assembly such as workmanship or material problems.

*SOW-043* - The Verification Test Plan shall state the purpose of the test, state acceptance criteria, describe in detail the test method and instrumentation, and give the sequence of the tests.

*SOW-044* - The Verification Test Plan shall include a test matrix summarizing all tests that will be performed on the assembled telescope.

*SOW-045* – The Verification Test Plan shall explicitly state the test equipment that will be required to perform each test and whether or not the Contactor currently owns the test equipment.

*SOW-046* – The Verification Test Plan shall clearly state the Contractor’s plan for acquiring any required test equipment not currently in their possession.

*SOW-047* – The Verification Test Plan shall be a Contractor controlled document and shall indicate all changes made after the initial approval by the GSFC.

*SOW-048* – Once GSFC has approved the Verification Test Plan, no changes shall be made without written NASA GSFC COTR approval.

### **3.2.5.1 Verification Test Plan Tests**

*SOW-049* – At a minimum, the Verification Test Plan shall include the following tests:

- Interferograms of Primary mirror
- Interferograms of Secondary mirror
- Interferometric test of the Assembled telescopes
- Data review of blur circle, effective focal length and back focal distance measurements
- Inspection and test of Be plating coupons of EN plating
- Inspection and test of Be coating coupons after polishing and protected Al coating
- Non-Destructive Examination (NDE) of the machined metering structure

### **3.2.6 Verification Test Procedures**

*SOW-050* - The Contractor shall generate Verification Test Procedures. The verification procedures will be step-by-step instructions for performing tests outlined by the Verification Test Plan.

*SOW-051* - The procedures shall incorporate the environmental conditions as defined in the ICESat-2-OPT-SPEC-0331, required equipment and facilities, test constraints, use of diagnostic

or performance test software, operating conditions, tolerance on all input stimuli, data to be recorded and pass/fail limits.

*SOW-052* - Verification test procedures shall be Contractor controlled documents and shall indicate all changes made after the initial release for review to NASA.

### **3.2.7 Verification Test Report**

*SOW-053* - The Contractor shall generate a Verification Test Report for each of the verification tests performed. Each report will clearly state the name of the item being tested, the goal of the test, the test criteria and the results of the test.

*SOW-054* - This report shall be generated and provided to GSFC within 30 days of test completion.

### **3.2.8 Verification Inspection Report**

*SOW-055* – The Contractor shall provide a separate Verification Inspection Report for any requirements verified through inspection.

*SOW-056* – All Verification Inspection Reports shall be provided to the COTR five (5) calendar days prior to PSR.

### **3.2.9 Contamination Control Plan**

*SOW-057* - The Contractor shall furnish their Contamination Control Plan to GSFC for review.

*SOW-058* – At a minimum, the Contamination Control Plan shall include the following:

- Appropriate cleanliness requirements developed by the vendor to prevent any degradation in the performance of the telescope due to contamination
- A method of ensuring the telescope and its components are free of contaminants during the manufacturing process
- In the event of contamination, a plan for removing any contaminants that does not negatively impact the performance of the telescope

It should be noted that different stages of manufacturing may have different contamination requirements.

*SOW-059* - This plan shall be delivered to the COTR Ten (10) calendar days before CDR.

### **3.2.10 Fracture Control Plan**

*SOW-060* - The Contractor shall furnish their Fracture Control Plan to GSFC for review.

*SOW-061* - This plan shall be delivered to the COTR Ten (10) calendar days before CDR.

### **3.2.11 Metrology Plan**

*SOW-062* - The Contractor shall provide a metrology plan to GSFC for review.

*SOW-063* - The metrology plan shall use Coordinate Measuring Machines (CMMs) to verify all dimensional requirements have been met.

*SOW-064* - In addition, the plan shall explicitly state the methods the Contractor will use to ensure accurate measurements and the limitations involved with such methods.

*SOW-065* - Finally, the plan shall note any items the Contractor will need to procure (i.e. – equipment, expertise, etc.) in order to implement the metrology plan.

*SOW-066* - This plan shall be delivered to the COTR Ten (10) calendar days before CDR.

### **3.3 Thermal Analysis**

*SOW-067* - The Contractor shall perform thermal analysis on the telescope.

*SOW-068* - The analysis shall demonstrate the impact to form, fit or function throughout the telescope's operational and survival temperature limits.

*SOW-069* - Also, the analysis shall identify the location, magnitude and impact of any thermal gradients.

Operational temperatures, survival temperatures and maximum allowable thermal gradients (i.e. – temporal, spatial, etc.) are defined in the Thermal Interface Control Document (ICESat-2-THM-IFACE-0214). It should be noted that NASA GSFC will use heater systems to control gradients on the metering structure.

*SOW-070* - Vendor optical testing of the assembled telescope shall be performed at room temperature and thermal gradients shall comply with ICESat-2-THM-IFACE-0214.

*SOW-071* - Finally, the vendor shall review the NASA GSFC thermal analysis of the telescope design.

*SOW-072* - The results of the analysis and the review shall be summarized in Contractor-format for the Thermal Analysis Report, which shall be provided to the NASA COTR for review.

### **3.4 Structural Analysis**

*SOW-073* - The Contractor shall perform structural analysis on the telescope structure to demonstrate positive Margins of Safety under all loading conditions. Refer to the ATLAS Component Environmental Requirements Document (ICESat-2-ATSYS-REQ-0517) for applicable launch loads and ascent loads, as well as the appropriate Factors of Safety.

*SOW-074* - The results of this review shall be summarized in a Contractor format Mechanical Analysis Report that will be provided to the NASA GSFC COTR for review.

### **3.5 Failure Modes & Effects Analysis (FMEA)**

*SOW-075* - The Contractor shall perform an FMEA on the telescope to identify potential failure modes, the likelihood the failure will occur and the impact if the failure were to occur.

*SOW-076* - This analysis shall be delivered to the COTR Ten (10) calendar days before CDR.

Released Version

## 4.0 Development Flow

After award, the contract will enter dual simultaneous phases: one for planning, long-lead item procurement, design refinement, delivery of the GFE Beryllium billets and the other for actual fabrication, assembly and testing. At the end of the development phase, summary slides are produced for the CDR. The successful completion of the CDR will mark the end of the development phase and the beginning of the fabrication phase.

Once the telescopes have successfully completed the PSR, they will be ready for transportation to GSFC. The government will accept the telescope after NASA in-house performance testing including mechanical dynamic testing and thermal vacuum testing. Acceptance of the telescope will be indicated by NASA's sign-off of the DD250. The Contractor shall support Goddard in-house acceptance testing.

Figure 4-1 shows schematically the flow from procurement to final acceptance.

### ATLAS Flight Telescope Delivery to Flight I&T High Level Timeline

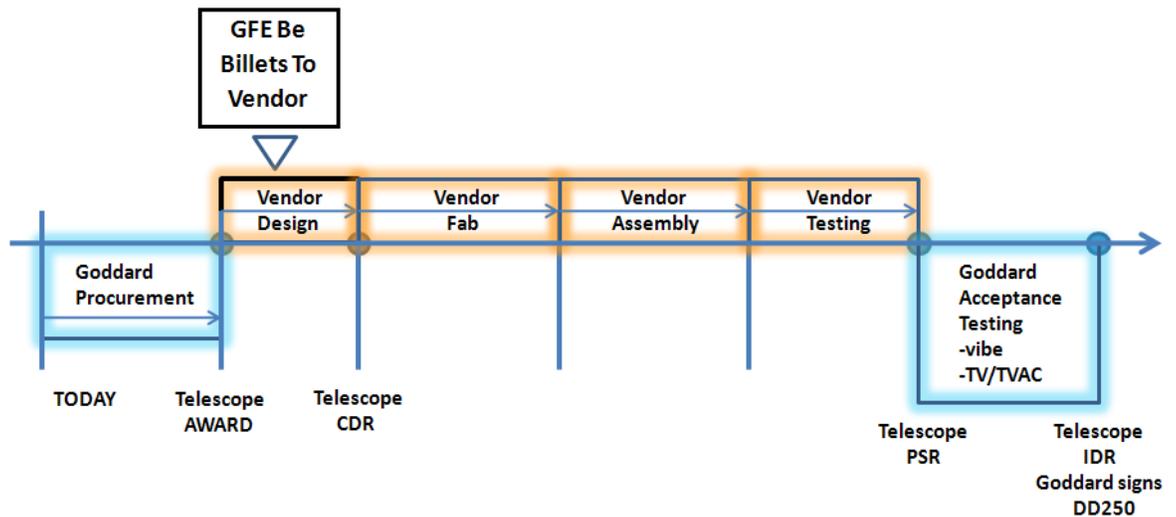


Figure 4-1 – A schematic of ATLAS telescope project life cycle

SOW-077 - The Contractor shall manage and deliver an integrated network schedule for the delivery of the flight and then spare telescope. The schedule updates shall be sent to Goddard ten(10) calendar days following the month being reported.

#### **4.1 Design Development**

*SOW-078* - Immediately after award, the Contractor shall develop and initiate procurement of long-lead item, such as the Primary Mirror CGH, a null corrector for the secondary mirror, fixturing, materials, tools, etc.

*SOW-079* - Also during this time, the Contractor, GSFC and their consultants shall collaborate to refine the design, review analysis, plan for fabrication, review vendor-specific fabrication techniques and procedures and agree upon a fabrication path forward. It is anticipated that this design development phase last no longer than 2 months.

#### **4.2 Hardware Manufacture**

Once the design and fabrication plan is established and drawings and procedures are approved, manufacturing may commence upon GSFC's concurrence through a Telescope CDR (Critical Design Review).

*SOW-080* - The Contractor shall not begin manufacturing without GSFC's explicit permission.

Released Version

## **5.0 Quality Assurance**

### **5.1 General Requirements**

#### **5.1.1 Quality Assurance Plan/Manual**

*SOW-081* - The Contractor shall implement a Quality Management System that meets the intent of the requirements of American National Standards Institute (ANSI)/ISO/ American Society for Quality (ASQ) Q9001 (1994 or 2000 version) or equivalent.

*SOW-082* - GSFC shall be notified of any changes to the QA program.

#### **5.1.2 Surveillance of the Contractor**

*SOW-083* - The work activities and operations of the Contractor, sub-contractors, and suppliers shall be subject to evaluation, review, survey, and inspection by GSFC representative.

*SOW-084* - The Contractor shall provide the GSFC representative with documents, records, equipment, calibrations and workings areas within their facilities that are required by the representative to perform their overview activities.

##### **5.1.2.1 Government Source Inspection**

The Government may elect to perform inspections at a supplier's plant.

*SOW-085* - The following statement shall be included on all procurement documents: "All work on this order is subject to inspection and test by the Government at any time and place".

*SOW-086* - The Government quality representative who has been delegated NASA quality assurance functions on this procurement shall be notified immediately upon Contractor receipt of any supplier / sub-contractor orders.

*SOW-087* - The Government representative shall also be notified 7 calendar days in advance of the time that articles or materials are ready for inspection or test.

##### **5.1.2.2 Contractor Source Inspection**

*SOW-088* - The Contractor shall ensure that its procurement documents impose the applicable requirements on sub-contractors and other suppliers.

*SOW-089* - The sub-contractor and other suppliers shall in turn impose the same requirements on their procurement sources.

*SOW-090* - The Contractor shall perform source inspection at the sub-contractor's or supplier's facilities in accordance with the procurement documentation or when one or more of the following conditions exist:

- In process, end item controls, or tests that are destructive in nature prevent the developer from verifying quality after delivery to the developer's facility.
- It is not feasible or economical for the Contractor to determine the quality of procured articles solely by inspections or tests performed at the Contractor's facility.
- Qualification tests are to be performed by the sub-contractor or supplier.
- Products are shipped directly from the source to NASA GSFC, by-passing the Contractor's inspection facilities only after prime Contractor Quality Auditor (CQA) of:
  - o Rework
  - o In-Process/Final Assembly
  - o Data Package

*SOW-091* - Deliveries shall be shipped on a DD1149 and receive final Government acceptance via a DD250. NASA will return a signed copy of the DD250 to close out the contract's delivery.

### **5.1.3 Configuration Management**

*SOW-092* - The Contractor's Configuration Management (CM) system shall control the design and hardware by means of drawings, specifications, and other documents.

*SOW-093* – The Contractor's CM system shall ensure all applicable changes are reviewed in a systematic manner to determine the validity and impact on performance, schedule and cost.

*SOW-094* - The Contractor's CM system shall have a change classification and impact assessment process that ensures Class I changes are forwarded to the COTR for approval prior to release/incorporation. Class I changes are defined as changes that affect form, fit, function, external interfaces, or requirements as stated within this document and ATLAS Receiver Telescope Optical Specification (ICESat-2-OPT-SPEC-0331).

*SOW-095* - All other changes are considered to be Class II changes and shall be controlled and dispositioned by the Contractor.

*SOW-096* - All Class II changes shall be provided monthly to the COTR for review purposes. NASA/GSFC reserves the right to review all Class II changes for technical content to ensure the proper classification has been assigned.

*SOW-097* - Any flight item that is found to be non-compliant with the quality, workmanship and performance requirements of the contract shall be dispositioned via a waiver or MRB, unless the affected item is reworked to restore compliance or is replaced with a fully compliant item.

*SOW-098* - The Contractor shall submit Waivers and MRB's to the COTR for final approval.

*SOW-099* - A Contractor Quality Assurance (CQA) representative shall be a member of the vendor's Configuration Control Board. The QA activities shall be defined in the Configuration Management Plan and described in detail in the QA Plan. Related portions of the plans will be cross-referenced.

*SOW-100* - The Contractor's CM system and plan shall be available for review upon request.

#### **5.1.4 Anomaly Reporting**

*SOW-101* - Reporting of hardware anomalies to the NASA/GSFC COTR shall begin no later than the start of billet machining.

*SOW-102* - The NASA GSFC COTR shall be notified within 24 hours of the anomaly.

*SOW-103* - The Contractor shall convene an MRB/FRB within 5 days of the anomaly.

*SOW-104* - The Contractor's processes for review, disposition and approval of anomaly reports shall be described in their quality plan/manual or provided as a supplement document.

*SOW-105* - In addition, the Contractor's anomaly reporting document shall list the members of the Material Review Board (MRB) and Failure Review Board (FRB) and their affiliations.

*SOW-106* - The MRB and FRB shall include ATLAS GSFC participation. These processes will ensure that positive corrective action has been taken to preclude recurrence and that appropriate audits and tests are performed to verify the implementation of the corrective action.

*SOW-107* - The Contractor shall routinely inform the ATLAS Project of MRB and FRB meeting schedules and agendas with sufficient notice to permit ATLAS Project participation.

At the Contractor's facility, NASA/Government representatives may participate in MRB/FRB activities as deemed appropriate by Government management or contract.

The NASA GSFC COTR reserves disapproval rights on MRB and FRB decisions.

*SOW-108* - To assure process consistency, the Contractor shall provide the ATLAS Project on-line access to their anomaly-reporting database.

*SOW-109* - The Contractor shall provide, as part of the monthly report, a list of all open anomaly reports and a separate list of the anomaly reports closed during the month.

*SOW-110* - For the reported anomaly or nonconformance, there shall be a report that documents the investigation and engineering analysis needed to determine the cause and corrective action(s) to disposition the nonconformance, and identify any closed problem reports that do not have a definitive cause or corrective action.

*SOW-111* - Reports shall be submitted to the NASA GSFC COTR for review and approval of the disposition.

*SOW-112* - The supplier shall establish and maintain documented procedures to ensure a product that does not conform to specific requirements is prevented from unintended use or installation.

*SOW-113* - This control shall provide for identification, documentation, evaluation, segregation (when practical), disposition of nonconforming product, and for notification to the functions concerned.

## **5.2 System Safety Requirements**

*SOW-114* - The Contractor shall supply detailed descriptions of the design, test, operation and inspection requirements for all flight hardware and materials, ground support equipment, and their interfaces necessary for a valid identification, assessment, control and mitigation of documented hazards. This includes technical information concerning hazardous and safety critical equipment, systems, operations, handling and materials.

*SOW-115* - For all identified hazards, the Contractor shall also document hazard controls, verifications and tracking methods.

### **5.2.1 Beryllium Safety Plan**

*SOW-116* - The Contractor shall operate according to the Beryllium Safety Plan (ICESat-2-SMA-PLAN- 0032) listed in Appendix B.

## **5.3 Ground Support Equipment (GSE)**

*SOW-117* - Mechanical Ground Support Equipment (GSE) that directly interfaces with flight deliverable item shall be assembled and maintained to mitigate potential risk to flight hardware. Parts and materials selection and reporting requirements are exempted as long as deliverable flight item contamination requirements are not compromised.

*SOW-118* - All GSE interfaces to flight hardware shall be flight quality (i.e. lifting fixtures, adapter plates, lift slings, etc.).

*SOW-119* – All GSE shall be required to be designed and certified to minimum of twice the predicted load.

## **5.4 Design Verification Requirements**

### **5.4.1 Verification Requirements**

*SOW-120* - The Contractor shall implement a program to verify all requirements specified in the ATLAS Receiver Telescope Optical Specification (ICESat-2-OPT-SPEC-0331).

*SOW-121* - The Contractor shall provide a verification matrix defining the method of verification for the specific requirement of this contract.

*SOW-122* - The Contractor shall use one or more of the following methods to verify requirements:

- Inspection: Designated as (I) and represents inspection of the physical hardware by a customer appointed qualified inspector for compliance. Zygo inspections shall be used wherever necessary on the Beryllium.
- Analysis: Designated as (A) and represents documentation of performance or function through detailed analysis using all applicable tools and techniques.
- Test: Designated as (T) and represents a detailed test of performance and/or functionality throughout a properly configured test setup where all critical data taken during the test period is captured for review.
- In-process production evaluation tests and environmental stress screening tests shall also be considered to be verification tests.

#### ***5.4.2 Analysis/Trending/Reporting of Test Data***

*SOW-123* - The Contractor shall properly record, maintain and analyze test information during the normal test program to assess performance and flight worthiness and to aid in the identification and analysis of flight hardware failures and problems.

*SOW-124* - The Contractor shall also perform trend analysis to track measurable parameters that relate to performance stability and repeatability.

*SOW-125* - Selected parameters shall be monitored for trends starting at component acceptance testing and continuing through the system integration and test phases. These parameters will be compiled in a Trended Parameters List (TPL).

*SOW-126* - The reports shall be delivered as part of the Data Delivery Package and presented at formal technical reviews as appropriate.

### ***5.5 Workmanship Standards and Processes***

#### ***5.5.1 Workmanship: Use of Contractors Workmanship Standards***

*SOW-127* – The Contractor shall demonstrate, through documentation and manufacturing processes, appropriate workmanship standards and processes are in place to ensure all flight hardware requirements are met.

*SOW-128* – The Contractor shall not begin manufacturing without explicit approval from the COTR that the Contractor’s workmanship standards and processes are acceptable.

*SOW-129* - The Contractor shall provide the COTR with their Workmanship Standards documentation ten (10) calendar days before CDR.

### ***5.5.2 Training and Certification of Contractor Personnel***

*SOW-130* - All personnel performing work on flight hardware requiring a prerequisite set of skills and competency shall be certified as having completed the required training, appropriate to their involvement.

*SOW-131* - The Contractor shall provide the COTR with Proof of Certification or a suitable Training Plan for personnel performing work on flight hardware ten (10) calendar days before CDR.

### ***5.5.3 Hardware Handling, Cleaning and Packaging***

*SOW-132* - The handling of flight hardware shall be performed by qualified personnel in accordance with approved procedures that address cleaning, handling, packaging, tent enclosures, shipping containers, bagging, and purging.

*SOW-133* – The Contractor shall use suitable packaging to ensure that hardware is not contaminated or otherwise degraded during shipping or storage.

*SOW-134* - All personnel working on flight hardware shall be certified as having completed the required training and competency certifications prior to handling any flight hardware. This includes, but is not limited to, workmanship, clean room and Beryllium handling courses.

## ***5.6 Parts Control***

### ***5.6.1 Parts/Material Age Control***

*SOW-135* – Parts and materials more than 5 years old shall require COTR concurrence prior to use.

*SOW-136* – When seeking permission to use parts or materials more than 5 years old, the Contractor shall present justification for using the parts with inspection and test requirements.

### ***5.6.2 Reuse of Parts and Materials***

*SOW-137* - Any parts and materials, which have been installed in an assembly, and removed for any reason, shall not be used again for flight unless approved by the COTR.

### ***5.6.3 Part Notification of Failure***

*SOW-138* - The Contractor shall provide failure-reporting data to COTR within 24 hours of part failure determination.

## **5.7 *Materials, and Processes Requirements***

### **5.7.1 *Materials Selection Requirements***

*SOW-139* – At a minimum, all materials shall conform to the following applicable selection criteria as defined herein for:

- Vacuum outgassing
- Stress corrosion cracking (SCC)
- Manufacturing process selection
- Fastener integrity

*SOW-140* - The Contractor shall create and maintain a Materials and Processes Identification List (M&P).

*SOW-141* – The Contractor shall submit the proposed materials and processes for review and approval by a Goddard Materials & Processes Engineer (MPE).

*SOW-142* – The Contractor shall not use any materials or processes without the explicit permission of GSFC.

*SOW-143* - An As-Built Materials and Processes List (ABMPL) shall be included as part of the Data Delivery Package.

GSFC will supply the material certifications for the Beryllium billets.

*SOW-144* - The Contractor shall ensure proper traceability of all beryllium components once manufacturing has began (i.e. – there shall be paperwork that will allow GSFC to trace each component back to the original billet).

*SOW-145* - Furthermore, the Contractor shall provide the material certifications for all other materials/hardware used on the telescope.

*SOW-146* - Finally, the Contractor shall maintain traceability of all components and assemblies at all times.

### **5.7.2 *Vacuum Outgassing of Polymeric Materials***

*SOW-147* - The Contractor shall adhere to the outgassing requirements as stated in the ATLAS Contamination Control Plan document (ICESat-2-ATSYS-PLAN-0297).

*SOW-148* - Material vacuum outgassing shall be determined in accordance with ASTM E-595.

*SOW-149* - The Contractor shall replace or bring into compliance via a vacuum bake-out any materials that are found to be not compliant with the ATLAS Contamination Control Plan. In certain instances waivers may be granted at GSFC's discretion.

*SOW-150* - If a waiver is sought, the Contractor shall submit a separate Material Usage Agreement (MUA) for each non-compliant material to be reviewed and approved by the MPE.

### ***5.7.3 Stress Corrosion Cracking of Inorganic Materials***

*SOW-151* - Materials used in structural applications shall be highly resistant to stress corrosion cracking (SCC) as specified in **MSFC-STD-3029**.

*SOW-152* - A Material Usage Agreement (MUA) and a SCC evaluation form shall be submitted, Contractor format acceptable, for any material that does not comply with the **MSFC-STD-3029** SCC requirements.

### ***5.7.4 Manufacturing Process Selection Requirements***

*SOW-153* - Materials and manufacturing process information shall be provided on the material list.

#### ***5.7.4.1 Brazing/Welding***

*SOW-154* - The telescope shall not have any brazed or welded joints.

### ***5.7.5 Hardware***

*SOW-155* - The Contractor shall comply with the procurement and test requirements for flight hardware and critical ground support equipment fasteners contained in 541-PG-8072.1.2, Goddard Space Flight Center Fastener Integrity Requirements.

*SOW-156* - The Contractor shall use free running, phosphor bronze inserts for all threaded interfaces in any beryllium components.

*SOW-157* - Traceability shall be maintained for every hardware lot.

### ***5.7.6 Materials Procurement Requirements***

*SOW-158* - Raw materials purchased by the Contractor and its developers shall be accompanied by a Certificate of Compliance and, where applicable, the results of nondestructive, chemical and physical tests.

*SOW-159* – All Certificates of Compliance and test results shall be made available to the COTR upon request.

*SOW-160* - An As-Built Materials and Processes List (ABMPL) shall be provided five (5) calendar days prior to PSR.

**5.7.7 Dissimilar Metals**

*SOW-161* - To avoid electrolytic corrosion, dissimilar metals shall not be used in direct contact unless protection against corrosion has been provided in accordance with MIL-STD-889.

*SOW-162* – The Contractor shall not use any materials or combination of materials that deviate from this policy without the prior approval from the COTR.

**5.7.8 Fungus Inert Material**

*SOW-163* - All materials used in the telescope shall be fungus inert in accordance with MIL-STD-810F.

Released Version

## **6.0 Contamination Control Requirements**

*SOW-164* - The Contractor shall establish the specific cleanliness requirements to minimize performance degradation and delineate the approaches to meet the ATLAS Project requirements.

*SOW-165* – The Contractor shall provide the COTR with a Contamination Control Plan ten (10) calendar days before CDR.

Released Version

## 7.0 Handling, Storage, Packaging, Preservation, and Delivery

### 7.1 Handling, Storage, Packaging, Preservation, and Delivery Plan

*SOW-166* – The Contractor shall provide a plan/procedure documenting the steps/methods that will be used to ensure the product(s) shall be stored, preserved, marked, labeled, packaged, and packed to prevent loss of marking, deterioration, contamination, excessive condensation and moisture, or damage during all phases of the program.

*SOW-167* - Stored and stocked item shall be controlled in accordance with documented procedures and be subject to quality surveillance.

*SOW-168* - This plan shall be delivered to the COTR Ten (10) calendar days before CDR.

### 7.2 Quality Requirements

*SOW-169* - The Contractor shall provide/procure flight parts conforming to GSFC quality standards.

*SOW-170* - The Contractor shall provide a shipping container, constructed of aluminum, for the telescope that protects the hardware appropriately.

*SOW-171* - The shipping container shall be equipped for purging with UPC N<sub>2</sub>.

*SOW-172* – The shipping container shall have fully contained silica gel desiccants.

*SOW-173* – The desiccants shall be secured during shipping in such a way as to prevent damage to the telescope.

*SOW-174*- The shipping container shall have coating witness samples mounted inside the shipping container to collect contaminants.

*SOW-175* - The shipping container shall be equipped with a means of monitoring shock loads throughout transportation. Shock monitoring may be done via redundant shock sensors covering a range of shock loads or a continuous monitoring device. GSFC may be able to supply GFE for continuous monitoring.

*SOW-176* - The shipping container shall be equipped with humidity indicators capable of handling prolonged shipping conditions.

*SOW-177* - The shipping container shall protect the telescope against the expected vibration spectrum.

*SOW-178* – The shipping container shall have exterior handles.

*SOW-179* – The shipping container shall have latches for securing the lid.

*SOW-180* – The shipping container shall have an O-ring seal.

*SOW-181* - The Contractor shall document any action NASA GSFC is to take if the sensors are tripped when hardware arrives at the NASA GSFC receiving area.

*SOW-182* - A copy of this document shall be included with shipping documentation.

*SOW-183* - The vendor shall ship to GSFC via a freight shipping service that can provide humidity and the expected vibration spectrum recording accelerometers.

*SOW-184* - Prior to shipping, quality assurance and Optics Branch personnel shall ensure that:

- The Contractor shall have the optical quality of the mirrors inspected by the same Optics Branch personnel who will repeat the inspection upon receipt at Goddard.
- Fabrication, inspection, and test operations have been completed and accepted.
- All products are identified and marked in accordance with requirements.
- The shipping container shall be purged for 30 minutes with UPC N2 after the lid is in place.
- The accompanying documentation (Contractor's shipping and property accountability form) has been reviewed for completeness, identification, and quality approvals.
- Evidence exists that preservation and packaging are in compliance with requirements.
- Packaging and marking of products, as a minimum comply with Interstate Commerce Commission rules and regulations and are adequate to ensure safe arrival and ready identification at their destinations.
- The loading and transporting methods are in compliance with those designated in the shipping documents.
- Integrity seals are on shipping containers and externally observable. Shock and humidity monitors do not show excessive environmental exposure.
- In the event of unscheduled removal of a product from its container, the extent of re-inspection and retest shall be as authorized by NASA or its representative.
- Special handling instructions for receiving activities, including observation and recording requirements for shipping-environment monitors are provided where appropriate.

*SOW-185* - The Contractor's quality assurance organization shall verify prior to shipment that the above requirements have been met.

*SOW-186* – The Contractor shall sign off on appropriate shipping documents to provide evidence of this verification.

*SOW-187* - The Contractor shall ship Freight On Board (F.O.B.) Destination.

SOW-188 - The Contractor shall be responsible for any damage incurred during shipment.

### 7.3 Hardware Deliverables

SOW-189 – In accordance with the terms of this Statement of Work, the Contractor shall deliver the hardware listed in Table 7-1 to GSFC:

Item #	Description	Reference	Quantity	Delivery Date
1	Flight Telescope	Section 1.3	1	~ 48 weeks after contract award
2	3 Material Witness Samples for each of all 4 telescope components	Section 1.3.1	12	Delivered with Item #1
3	3 Plating Witness Samples for PMs and SMs	Section 1.3.1	6	Delivered with Item #1
4	3 Coating witness samples for primary and secondary mirrors	Section 1.3.1	6	Delivered with Item #1
5	Beryllium chips from machining the blanks	Section 1.2		Delivered with Item #1 to Brush Wellman
6	Spare Telescope	Section 1.3	1	~ 68 weeks after contract award
7	3 Material Witness Samples for each of all 4 telescope components	Section 1.3.1	12	Delivered with Item #6
8	3 Plating Witness Samples for PMs and SMs	Section 1.3.1	6	Delivered with Item #6
9	3 Coating witness samples for primary and secondary mirrors	Section 1.3.1	6	Delivered with Item #6
10	Beryllium chips from machining the blanks	Section 1.2		Delivered with Item #6 to Brush Wellman

Table 7-1 – A list of hardware deliverables

### 7.4 Documentation Deliverables

SOW-190 – In accordance with the terms of this Statement of Work, the Contractor shall deliver the documentation listed in Table 7-2 to GSFC:

Item #	Description	Reference	Delivery Date
1	Monthly Status Report and Schedule Update	Section 2.1	Ten(10) calendar days following the month being reported
2	Critical Design Review	Section	Two (2) months after award of

		2.3.1	contract
3	CDR Agenda	Section 2.3.1	Ten (10) Calendar days before CDR
4	Critical Design Review Report	Section 2.3.1	Ten (10) calendar days after completion of CDR
5	Flight Unit Pre-Shipment Review (PSR) for flight telescope #1	Section 2.3.2	Five (5) calendar days prior to delivery of the flight unit
6	Flight Unit Pre-Shipment Review (PSR) for spare telescope #2	Section 2.3.2	Five (5) calendar days prior to delivery of the spare flight unit
7	PSR Agenda for each telescope	Section 2.3.2	Five (5) calendar days before PSR for each
8	Draft Interface Control Document (ICD)	Section 3.2.1	One (1) month after start of contract
9	ICD	Section 3.2.1	Ten (10) calendar days before CDR
10	Drawing Package	Section 3.2.2	Ten (10) calendar days before CDR
11	Critical Design Review Presentation Package	Section 3.2.3	Ten (10) calendar days before CDR
12	Data Delivery Package	Section 3.2.4	With the delivered Flight Units
13	Verification Test Plan	Section 3.2.5	Ten (10) calendar days before CDR
14	Verification Test Procedures	Section 3.2.6	Thirty (30) calendar days before start of testing and as changes occur
15	Data from individual optical tests for Primary and Secondary mirrors	Section 5.4.2	with items #1 & #2
16	Optical test data for the assembled telescope	Section 3.2.4	with items #1 & #2
17	Data Delivery Package with ABMPL included	Section 5.7.6	with item #1 & #2
18	Contamination Control Plan	Section 3.2.9	Ten (10) calendar days before CDR
19	Fracture Control Plan	Section 3.2.10	Ten (10) calendar days before CDR
20	Thermal Analysis/Model	Section 3.3	Ten (10) calendar days before CDR
21	Structural Analysis	Section 3.4	Ten (10) calendar days before CDR
22	Quality Assurance Plan	Section	Twenty-eight (28) calendar days

		5.1.1	after contract award
23	Class I Configuration Management (CM) Changes	Section 5.1.3	Five (5) calendar days after Vendor CM Review
24	Class II CM Changes	Section 5.1.3	Five (5) calendar days after Vendor CM Review
25	Anomaly Reports and MRB	Section 5.1.4	Twenty four (24) hours after Vendor Anomaly Review Process determines disposition
26	Safety Package	Section 5.2	Preliminary Ten (10) calendar days before CDR. Final thirty (30) calendar days before PSR.
27	Contractor Workmanship Standards	Section 5.5.1	Ten (10) calendar days before CDR
28	Training Plan	Section 5.5.2	Ten (10) calendar days before CDR
29	Materials Selection Requirements	Section 5.7.1	Ten (10) calendar days before CDR
30	As-Built Materials & Processes List	Section 5.7.6	Five (5) calendar days prior to PSR
31	Cut Plan for Be Billets	Section 1.4	Two (2) weeks after contract award
32	Metrology Plan	Section 3.2.11	Ten (10) calendar days before CDR
33	Verification Inspection Report	Section 3.2.8	Five (5) calendar days prior to PSR
34	Handling, Storage, Packaging, Preservation, and Delivery Plan	Section 7.1	Ten (10) calendar days before CDR
35	Failure Modes & Effects Analysis (FMEA)	Section 3.5	Ten (10) calendar days before CDR

Table 7-2 – A list of documentation deliverables

## APPENDIX A Abbreviations and Acronyms

<b>Abbreviation/ Acronym</b>	<b>DEFINITION</b>
ABML	As-Built Materials List
ABMPL	As-Built Materials and Processes List
ANSI	American National Standards Institute /ISO/
ASQ	American Society for Quality
ATLAS	Advanced Topographic Laser Altimeter System
ATP	Authorization to Proceed
Be	Beryllium
CDR	Critical Design Review
CGH	Computer-Generated Hologram
CM	Configuration Management
CO	Contracting Officer
COTR	Contracting Officer Technical Representative
CQA	Contractor Quality Auditor
CTE	Coefficient of Thermal Expansion
CVCM	Collected Volatile Condensable Mass
CDR	Critical Design Review
DFS	Design Factor of Safety
DPT	Diamond Point Turning
EDM	Electrical Discharge Machining
EIDP	End Item Data Package
EN	Electroless Nickel
FM1	Flight Model one
FM2	Flight Model two
FOB	Freight on Board
FRB	Failure Review Board
GFE	Government Furnished Equipment
GLAS	Geoscience Laser Altimeter System
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
ICESat	Ice, Cloud and land Elevation Satellite
ICESat-2	ICE, Cloud and land Elevation Satellite-2
IRD	Instrument Delivery Review
M&P	Materials and Processes Identification List
MIPS	Government Mandatory Inspection Points
MPE	Materials & Processes Engineer
MRB	Material Review Board
MS	Margin of Safety
MUA	Material Usage Agreement

NASA	National Aeronautics and Space Administration
NDE	Non-Destructive Examination
PM	Primary Mirror
PSR	Pre-Ship Review
QA	Quality Assurance
Rx	Optical Prescription
SCC	Stress Corrosion Cracking
SM	Secondary Mirror
SOW	Statement of Work
TB	Thermal Balance
TIM	Technical Interchange Meeting
TML	Total Mass Loss
TPL	Trended Parameters List
TVAC	Thermal Vacuum

Released Version

## **APPENDIX B List of Applicable Documents**

### **Applicable Documents**

- 1) ICESat-2-ATSYS-PLAN-0297, ATLAS Contamination Control Plan
- 2) ICESat-2-SMA-PLAN-0032, Beryllium Safety Plan
- 3) 541-PG-8072.1.2, Critical Ground Support Equipment Fasteners
- 4) MIL-STD-810F, Fungus Inert Materials
- 5) ICESat-2-OPT-SPEC-0331, ATLAS Receiver Telescope Optical Specification
- 6) ICESat-2-ATSYS-REQ-0517, ATLAS Component Environmental Requirements
- 7) ICESat-2-THM-IFACE-0214, ATLAS Thermal Interface Control Document
- 8) MIL-STD-889, Protection against Corrosion
- 9) MSFC-STD-3029, Stress Corrosion Cracking
- 10) GSFC-STD-1000, Rules for Design, Development, Verification and Operation of Flight Systems