INTERFACE CONTROL DOCUMENT

SE 03-002
Revision C

SCIENCE INSTRUMENT ENVELOPE - FINAL
GLOBAL_09

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY
(SOFIA)

Contract NAS2-97001

INTERFACE CONTROL DOCUMENT

SE 03-002
Revision C

SCIENCE INSTRUMENT ENVELOPE - FINAL
GLOBAL_09

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INTERFACE CONTROL DOCUMENT GLOBAL_09
FOR THE SOFIA SYSTEM
SCIENCE INSTRUMENT ENVELOPE - FINAL

DOCUMENT NUMBER: 96145070-000
REVISION: C
17 August 2001

DR: SE03-002

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REVISIONS

Revisions to the document from the previous issue are denoted by vertical bars in the margin of the page.

REV	DATE	DESCRIPTION	APPROVAL
A	11/13/97	Incorporated ECN51634: Added Global_05 to Section 2.1.1 Fixed U,V,W directions in Section 5.0a. Fixed Nasmyth tube center location on drawing 96145071-000.	
B	02/10/00	Incorporated ECN 51644: Extensive rewrite due to dynamic and static envelope changes for maximum SI space allowances. Revised dynamic envelope based on discussion at 4/16/99 ICD ICWG. Revised dynamic envelope based upon SI equipment rack installation on the TA counterweight plate Updated dynamic envelope to incorporate additional volume which was deleted due to SI CW rack struts. Updated installation envelope to incorporate additional volume on upper end of envelope for a blunt edge corner versus a radiused edge. Incorporated NASA/OSC comments received from Ted Brown on 12/3/99 and 12/20/99. Incorporated DLR comments received from Heiner Witte on 1/31/00.	

REV	DATE	DESCRIPTION	APPROVAL
C	08/17/01	Incorporated ECO C72447: 1) Removed TBD for identification of NASA configuration controlled site for model/drawings (ref: e-mail from NASA/Ramsey Melugin dated 11/17/00). 2) Updated Applicable documents sections for the ICD per agreed wording (ref: e-mail from NASA/Jeff Logan dated 5/21/01). 3) Incorporated minor clarification to Figures 3.1-1 through 3.1-3. 4) Update Safety, QA and Verification paragraphs for the ICD per NASA/DLR/TA-C/USRA agreed wording (ref: e-mail from NASA/Ann Dinger dated 8/14/01). 5) Incorporated comments from DLR (ref: e-mail from DLR/Heiner Witte dated 1/30/01).	

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1.0 SCOPE

1.1 Purpose

The science instrument envelope ICD controls the science instrument spatial interface with the AS and the TA. The ICD defines 3 envelopes that follow the science instrument installation process. During these three phases, the telescope motions are specified. While mated to the telescope, the science instrument volume begins at the vertical plane of the telescope's science instrument flange and extends forward. The SI volume also includes a volume segment which extends aft of the flange and fits within the TA Nasmyth tube while not extending aft of the telescope's gate valve.

a. The dynamic instrument volume - this envelope is the stay-in volume for the science instrument such that motions of the telescope assembly (e.g. changes in telescope elevation) do not cause the science instrument to interfere with stationary objects within the aircraft. The expected range of telescope motion is dictated by the normal telescope operations while the observatory is airborne.

b. The static instrument volume (otherwise known as the stay out-envelope) - TA and aircraft systems are to avoid this area which also includes space to allow science instrument teams to work within and around the science instrument. During this phase of the science instrument installation, the telescope is expected to remain fixed in position (40 degrees elevation). This envelope is based upon the location of the TA science instrument flange but also includes the SI volume which is permitted to extend forward of the flange interface.

c. The installation volume - this refers to the volume of the science instrument or subsystem during installation on the aircraft. This volume is also to include the installation cart.

1.2 Contractors

Principal – USRA
- Raytheon Company Aircraft Integration Systems
- United Airlines

Participant – TA Consortium
- MAN Technologie
- Kayser Threde

2.0 APPLICABLE DOCUMENTS

The data referenced in this ICD represents the latest version at the time of issuance of this ICD, unless otherwise stated, and forms a part of these requirements to the extent specified herein.

2.1 Order of Precedence

In the event of a conflict between the text of this ICD and the references cited herein, the text of this ICD takes precedence. Nothing in this ICD, however, supercedes contractual requirements unless a specific exemption has been obtained and approved. As appropriate, reference is made to other project documentation for use as guidance in developing the content of this ICD and as such forms a basis for requirements to the extent specified herein.

2.2 Required Documents

SOF-1030, Rev. 3	Systems Interface Requirements

2.3 Other Related Documents

96145030-000, Rev. B	Global_05, SOFIA Coordinate Systems (SE03-045)
96145071	SI Dynamic Envelope
96145072	SI Static/Service Env
96145073	SI Installation Envelope
96145190-000, Rev. A	TA_AS_09, Aircraft Cavity/Telescope Assembly Envelope (SE03-008)
96145200-000, Rev. A	TA_AS_10, Aircraft Cabin/Telescope Assembly Envelope (SE03-017)
96145560-000, Rev. -	TA_SI_05, SI Equipment Rack/TA Counterweight Interface (SE03-051)
DI-E-30141	Interface Specification
PD-2003, Rev. 0	Interface Reference Document
PD-2009, Rev. 0	SOFIA Lexicon
PD96100021-000, Rev. C	Safety, Reliability, Maintainability and Quality Assurance (PM21) Plan
PD96157000-000, Rev. B	PM12-001, Observatory Integration Test and Verification Plan

PD96165004-000, Rev. A	System Safety Hazard Analysis Report (PA10-002)
SOF-ICD-KT-001, Issue 04	TA_SI_02, Telescope Assembly/Science Instrument Mounting Interface (SE03-037)
SOF-PLA-MG-0000.0.03, Issue 02	Safety, Reliability, Maintainability and Quality Assurance Plan for the Telescope Assembly
SOF-PLA-MG-0000.0.13, Issue 03	SOFIA TA Verification Plan

3.0 INTERFACE REQUIREMENTS

The TA must carry and locate the SI relative to the TA's optical focal plane. The TA developer is responsible for supporting the SI without the TA itself violating the static envelope. The ICD 96145200-000 envelope borders the ICD 96145070-000 SI static envelope.

The aircraft must allow sufficient room for science instrument components which fit through the aircraft door to move freely toward the rear of the aircraft for installation on the telescope instrument flange. Any items mounted to a science instrument cart must remain within the installation volume.

During the science instrument installation process, the observatory allocates an operational volume for science teams to work in and around the TA science instrument flange. This volume also includes any maintenance operations the science instruments may require. Permanently mounted AS and TA components must stay out of the static instrument volume.

Science instrument and telescope operations are covered by the dynamic volume. Science instruments must stay within this volume while the telescope is able to execute a free range of motions. The dynamic envelope is a subvolume of the static envelope described above.

3.1 Physical

The subsection below gives the scenario on how the dynamic, static, and installation envelope were developed.

a. The dynamic envelope is derived from the complete range of possible telescope motions during normal operations of the telescope with the SI Equipment rack attached (see ICD 96145560-000). These are based on the ranges of motion the telescope can go through when uncaged as stated in ICD 96145190-000 and ICD 96145200-000. For the generation of the envelope it was required that no SI component attached to the TA could come closer than 4 inches [101.6 mm] to any AS structure (i.e. floor, ceiling, etc.). The dynamic envelope was developed by putting the TA in its worst case conditions tilted toward the floor. These can be found in ICD 96145190-000 and ICD 96145200-000. Once this orientation was established, the telescope was run through its full range of operational motion about the U axis, from 15 degrees to 70 degrees. The stay out envelope was considered 4 inches [101.6 mm] off the floor. A cylinder with dimensions of 79 inches [2006.6 mm] in length and 120 inches [3048 mm] in diameter was attached to the TA flange.

Interface data on the TA flange can be found in SOF-ICD-KT-001. Material was added or subtracted from the SI volume to maintain the 4 inches [101.6 mm] margin off the floor. The defining envelope on the top side of the SI envelope was the unmodified 120 inches [3048 mm] diameter cylinder since it did not come within 4 inches [101.6 mm] of the modified ceiling. It also includes a 45 degree angle cut out beginning 21.11 inches [536.19 mm] forward of the TA flange and ending at the flange face. This cut out is 50 inches [1270 mm] in width (see Figure 3.1-1C). This volume was removed to allow struts to be installed with the SI equipment rack. The dynamic envelope includes a volume that extends to a cylindrical surface 6.75 inches [171.5 mm] long (consisting of 5 inches [127 mm] for the rotator and 1.75 inches [44.5 mm] for the flange) in order to accommodate the SI rotator and SI flange. This protrusion extends forward of the telescope flange and is 41 inches in diameter, centered on the IR beam. Please note that the dynamic envelope is fixed relative to the TA/SI. Please refer to Figures 3.1-1A through 3.1-1D.

b. The static envelope is defined as a stay-out area for AS and TA components. This ICD assumed the telescope will remain stationary during the science instrument installation. Please note that the static envelope is fixed relative to the aircraft. Please refer to Figures 3.1-2A and 3.1-2B.

c. The installation envelope is defined by the volume suitable for moving through the aircraft doorway, the distance to the stairs when entering door 1L is 83 inches [2108.2 mm], and the height available rolling down the SI cart path on the AS. The 41 inches [1041.1 mm] horizontal dimension allows .25 inches [6.35 mm] clearance on either side of the SI to get through the door. The height of the envelope was established at 60 inches [1524 mm] to allow clear viewing over the SI during travel through the facilities and AS and to be able to roll down the SI cart path on the AS without interfering with overhead structure. The length of the SI was established in SOF-1030. This envelope also specifies the clearance necessary for the science instrument and cart to move toward the rear of the aircraft (aft of the doorway). Please refer to Figures 3.1-3A and 3.1-3B.

The telescope assembly, aircraft system, or science instrument shall not infringe on the SI dynamic, static and installation stay-in/stay-out envelopes defined in Figures 3.1-1 through 3.1-3 under operating conditions defined in Section 3.1.

NOTES:

1. ALL PRIMARY DIMENSIONS ARE EXPRESSED IN INCHES. ALL SECONDARY DIMENSIONS ENCLOSED IN BRACKETS "[ ]" ARE EXPRESSED IN MILLIMETERS.

2. DIMENSION TOLERANCES:

METRIC		ENGLISH	
X.X	± 1.5 MM	X.X	± .060 IN
X.XX	± .76 MM	X.XX	± .030 IN
X.XXX	± .25 MM	X.XXX	± .010 IN

3. ALL STATION, WATER, AND BUTTOCK LINES ARE EXPRESSED IN INCHES, IN ACCORDANCE WITH INTERFACE CONTROL DOCUMENT SOFIA COORDINATE SYSTEMS GLOBAL_05 (96145030-000).

4. DIMENSIONS SYMMETRIC ABOUT ℄.

5. ALL DIMENSIONS GIVEN WITH TELESCOPE CENTERED ON THE LINE OF SIGHT AND CROSS ELEVATION AXES, ROTATED ABOUT THE ELEVATION AXIS 40 DEGREES.

6. VIEWS OF GLOBAL_09 DYNAMIC ENVELOPE WHEN TA IS AT 90 DEGREE POSITION (STRAIGHT UP).

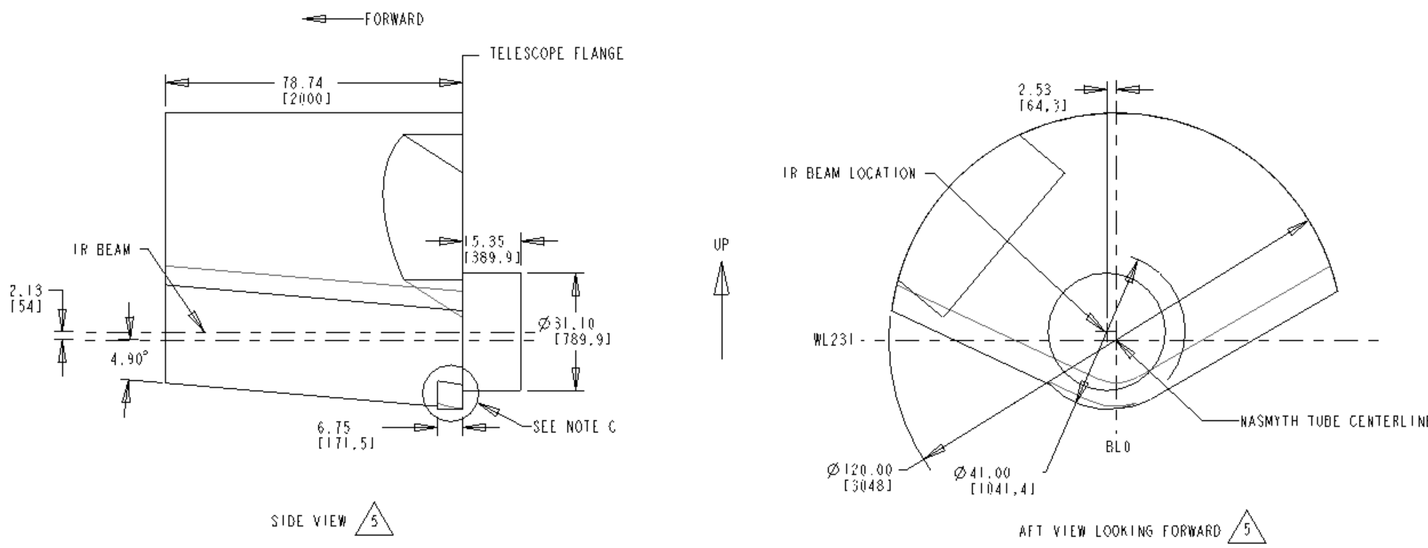
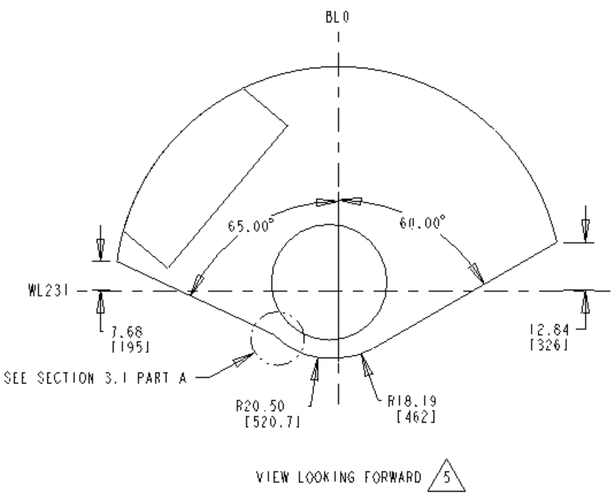
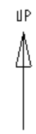


Figure 3.1-1A. SI Dynamic Envelope

Side and Rear Views

Note: For all figures, all primary units are in inches and all secondary units are in millimeters





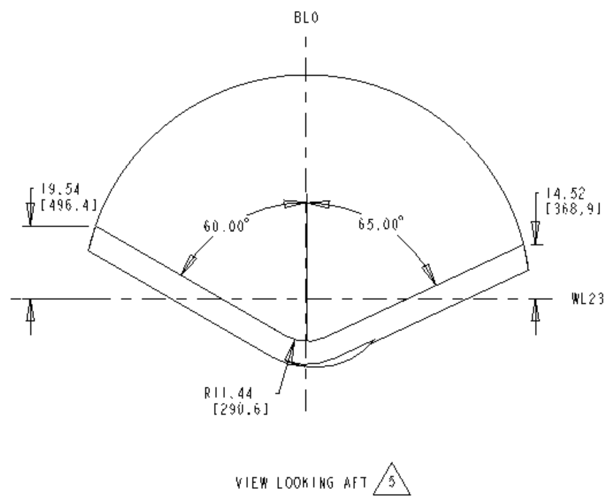
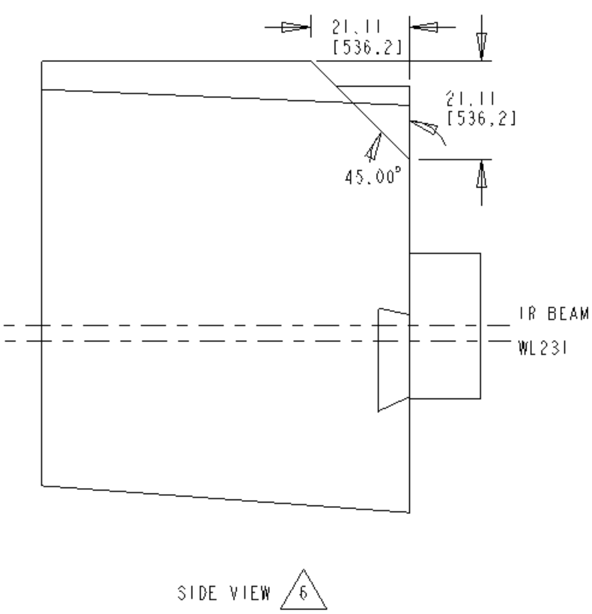
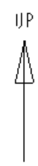


Figure 3.1-1B. SI Dynamic Envelope

Forward and Aft Looking Views





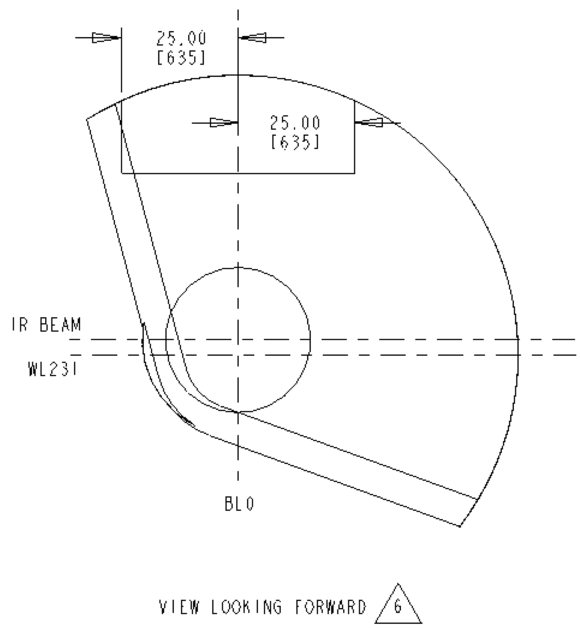


Figure 3.1-1C. SI Dynamic Envelope

Side and Rear Views with Telescope Pointing Up
Dimensions of Cut-out (for SI Rack Struts) Included

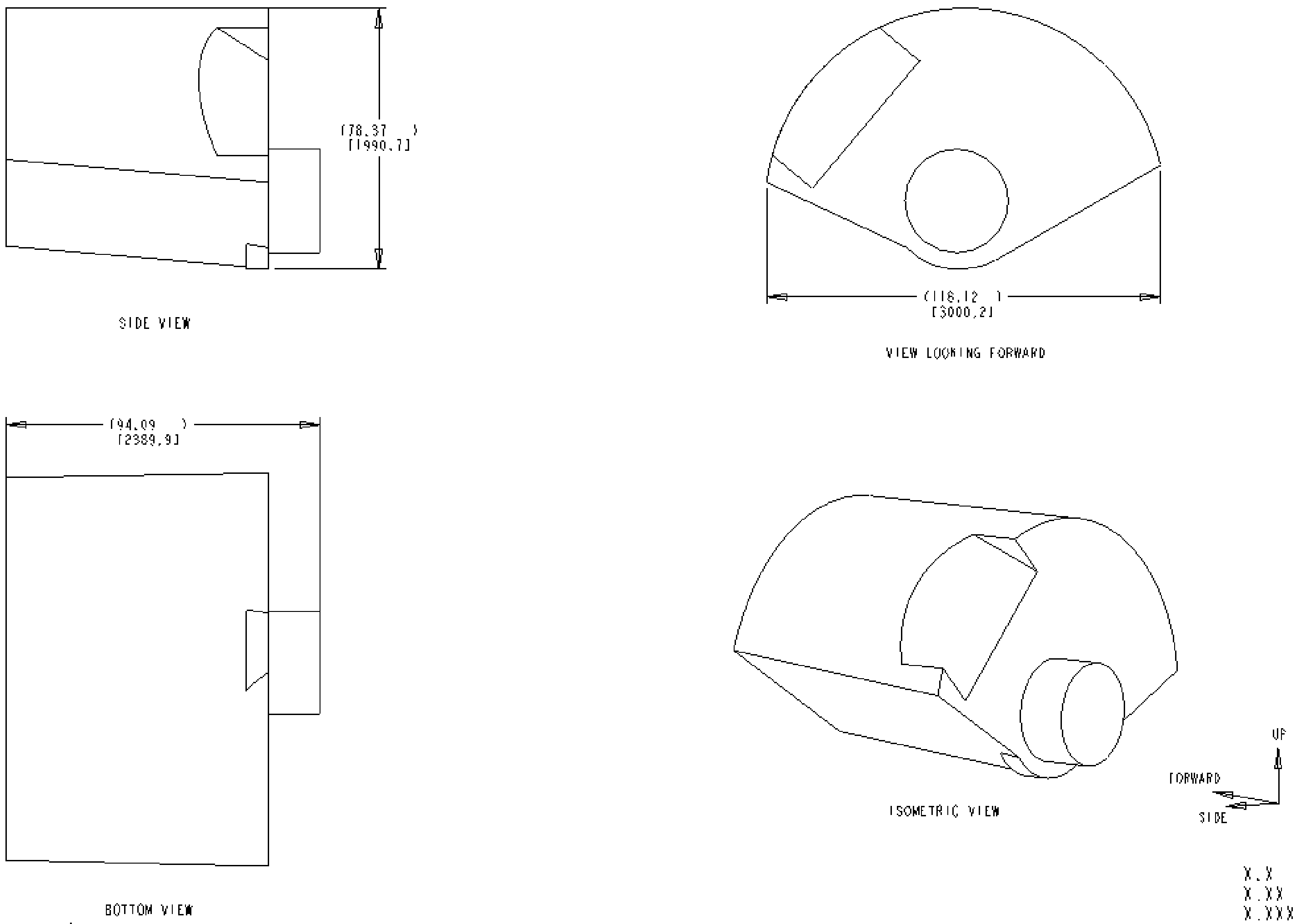


Figure 3.1-1D. SI Dynamic Envelope

3-view Solid Model Drawing with 3-D Isometric View Included

NOTES:

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X.XX	± .76 MM	X.XX	± .030 IN
X.XXX	± .25 MM	X.XXX	± .010 IN

3. ALL STATION, WATER, AND BUTTOCK LINES ARE EXPRESSED IN INCHES, IN ACCORDANCE WITH INTERFACE CONTROL DOCUMENT SOFIA COORDINATE SYSTEMS GLOBAL_05 (96145030-000).

4. DIMENSIONS SYMMETRIC ABOUT ℄.

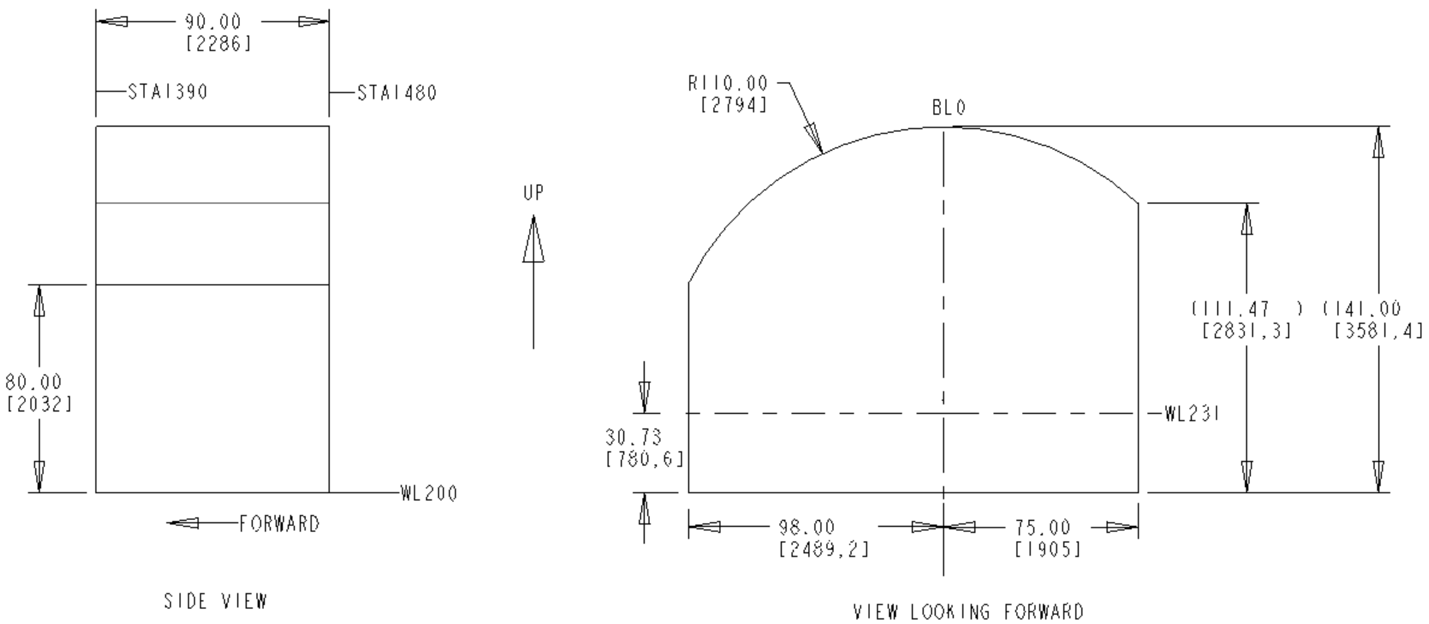

Figure 3.1-2A. SI Static/Servicing Envelope

Side and Rear Views

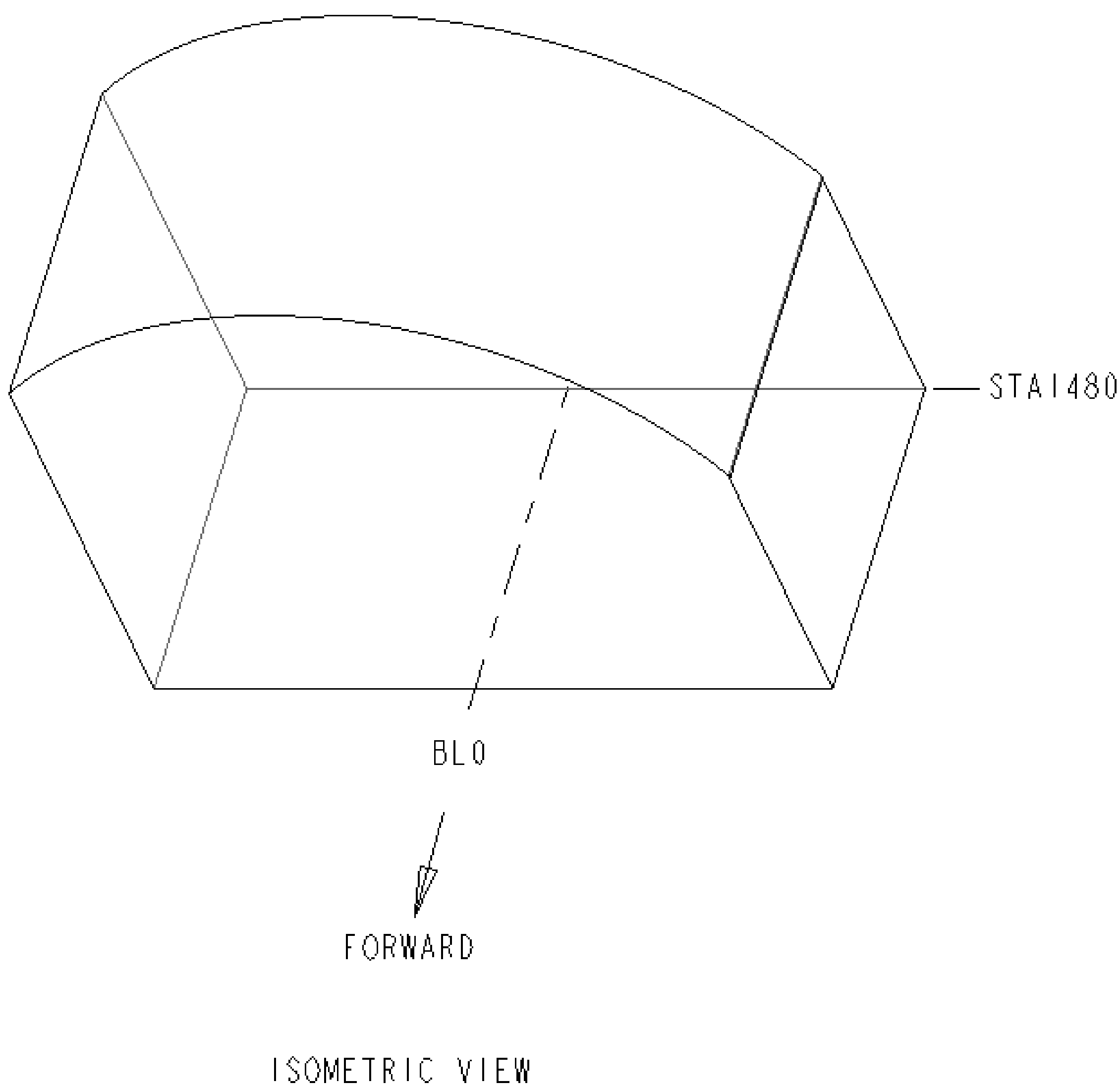

Figure 3.1-2B. SI Static/Servicing Envelope
Isometric 3-D View

NOTES:

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2. DIMENSION TOLERANCES:

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X.XXX	± .25 MM	X.XXX	± .010 IN

3. ALL STATION, WATER, AND BUTTOCK LINES ARE EXPRESSED IN INCHES, IN ACCORDANCE WITH INTERFACE CONTROL DOCUMENT SOFIA COORDINATE SYSTEMS GLOBAL_05 (96145030-000).

4. DIMENSIONS SYMMETRIC ABOUT ℄.

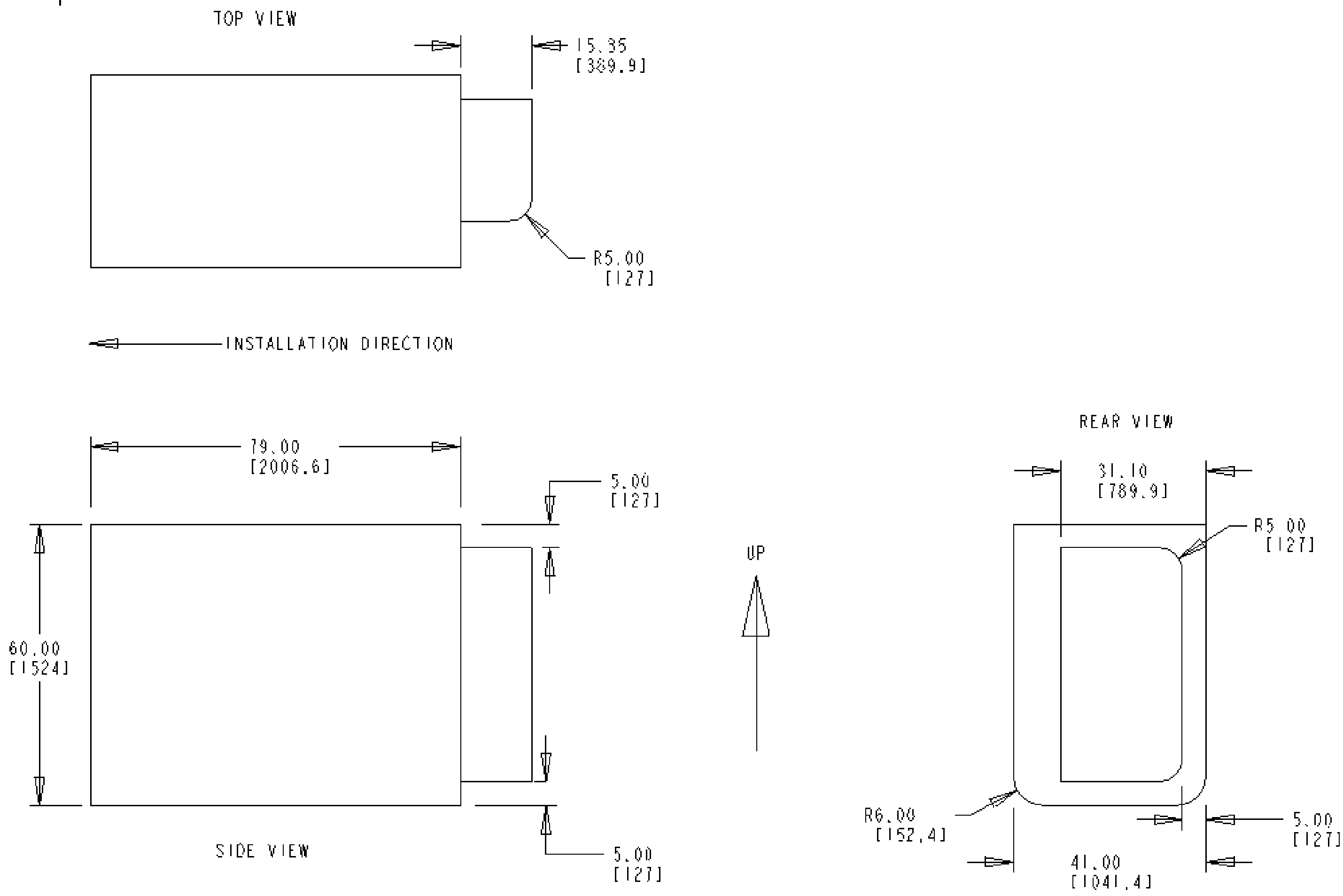

Figure 3.1-3A. SI Installation Envelope
3-view Solid Model Drawing

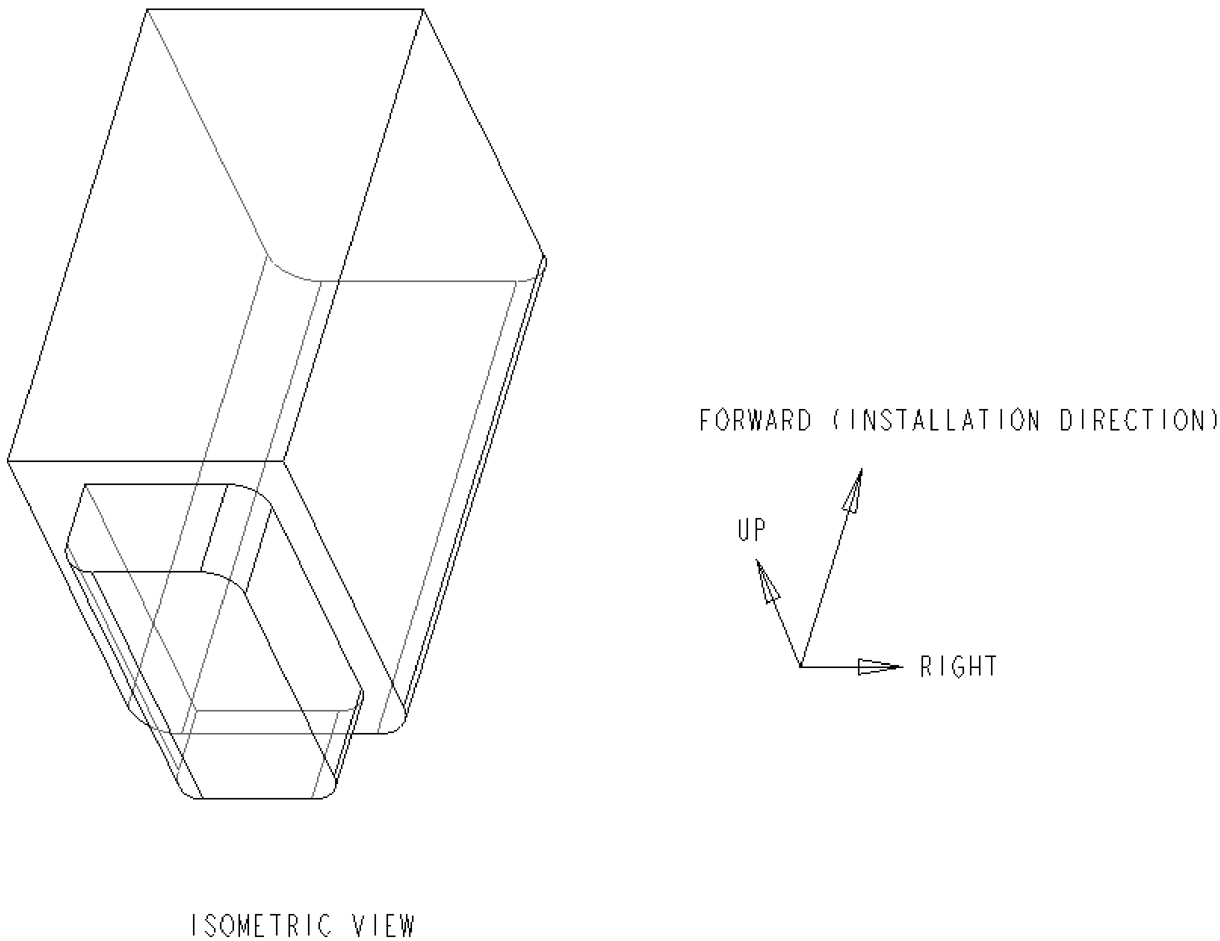

Figure 3.1-3B. SI Installation Envelope
Isometric 3-D view

3.2 Functional

3.2.1 Electronic

Not Applicable

3.2.2 Electrical

Not Applicable

3.2.3 Hydraulic and Pneumatic

Not Applicable

3.3 Environmental

Not Applicable

3.4 Safety

This ICD does not contain interface design information attributed to the design control of hazards identified in PD96165004-000 (PA10-002, The Observatory Hazard Analysis).

4.0 QUALITY ASSURANCE PROVISIONS

Quality Assurance will verify each hardware interface to the drawing, and participate in testing by reviewing and verifying plans and procedures; witnessing tests; and approving reports in accordance with PD96100021-000 (PM21), for the USRA side of the ICD, and SOF-PLA-MG-0000.0.03 Safety, Reliability, Maintainability and Quality Assurance (SRM & QA) Plan, for the TA-C side of the ICD, respectively.

Verification plan for this interface is documented in PD96157000-000 (PM12, SOFIA Observatory Integration, Test and Verification Plan), for the USRA side of the ICD, and in SOF-PLA-MG-0000.0.13 (SOFIA Telescope Assembly Verification Plan), for the TA-C side of the ICD, respectively.

5.0 DEFINITIONS, ABBREVIATIONS, ACRONYMS

The definitions, abbreviations, and acronyms used in this document are referenced in the SOFIA Lexicon, PD-2009.

6.0 NOTES