



Interface Control Document Science Instrument Envelope GLOBAL_09

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Interface Control Document Science Instrument Envelope, GLOBAL_09

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12/08/2014

Date

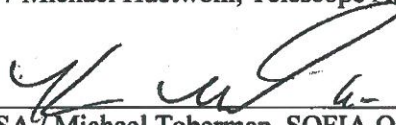
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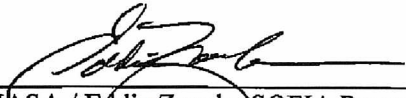
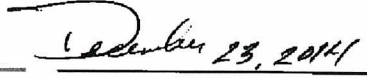
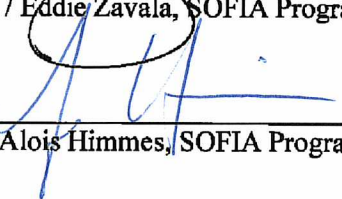
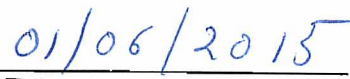


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12/3/2014

Date

APPROVAL:

 _____ NASA / Eddie Zavala, SOFIA Program Manager	 _____ September 23, 2014 Date
 _____ DLR / Alois Himmes, SOFIA Program Manager	 _____ 01/06/2015 Date

Revision History

Revisions to this document since the initial Rev. 0 baseline are summarized in this table. Please refer to the Document Change Record starting on page iv for changes to this ICD (RAIS document 96145070-000) prior to this initial NASA SPO baseline release.

REV	DATE	DESCRIPTION	APPROVAL
0	12/17/01	Initial NASA SPO Release of USRA Final ICD Global_09, Revision C, Dated 17 August 2001. (RAIS Document Number: 96145070-000, USRA DR: SE03-002.)	/s/ J. Logan
1	3/28/03	Reduced envelopes to accommodate the TA Raised Ceiling installation and the Cabin Side Lifting Device, as described in SOF-DCR-0196.	/s/ J. Logan
2	11/24/14	Incorporated PRG-CCR-178: Revised SI dynamic, static, and installation envelope dimensions in Par ID 3.1a, b, c.	PMB

Document Change Record

REV	DATE	DESCRIPTION	APPROVAL
A	11/13/97	<p>Incorporated ECN51634:</p> <p>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.</p>	
B	02/10/00	<p>Incorporated ECN 51644:</p> <p>Extensive rewrite due to dynamic and static envelope changes for maximum SI space allowances.</p> <p>Revised dynamic envelope based on discussion at 4/16/99 ICD ICWG.</p> <p>Revised dynamic envelope based upon SI equipment rack installation on the TA counterweight plate</p> <p>Updated dynamic envelope to incorporate additional volume which was deleted due to SI CW rack struts.</p> <p>Updated installation envelope to incorporate additional volume on upper end of envelope for a blunt edge corner versus a radiused edge.</p> <p>Incorporated NASA/OSC comments received from Ted Brown on 12/3/99 and 12/20/99.</p> <p>Incorporated DLR comments received from Heiner Witte on 1/31/00.</p>	

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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).	TRK

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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 envelope excludes the portions of SI components aft of the envelope that mount to the pressure coupler/optical window interface or hardpoints on the GVPP—the applicable interface requirements for these interfaces are defined in ICD TA_SI_02. 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 is the space allocated to science instrument teams to work within and around the science instrument. During 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 transport into the aircraft during installation. This volume is also to include the installation cart.

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. 4 Systems Interface Requirements

2.3 Other Related Documents

96158600	Cabin Side Lifting Device Installation
APP-DF-DWG-SE02-2924	Layout of Personnel Accommodations - Main Deck
APP-DF-DWG-SE02-3466	SI Dynamic Envelope
APP-DF-DWG-SE02-3467	SI Static/Service Envelope
APP-DF-DWG-SE02-3468	SI Installation Envelope
DI-E-30141	Interface Specification
PD-2003, Rev. 0	Interface Reference Document
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-DA-ICD-SE03-037	TA_SI_02, Telescope Assembly/Science Instrument Mounting Interface
SOF-DA-ICD-SE03-045	Global_05, SOFIA Coordinate Systems
SOF-DA-ICD-SE03-051	TA_SI_05, SI Equipment Rack/TA Counterweight Interface
SOF-DF-ICD-SE03-008	TA_AS_09, Aircraft Cavity/Telescope Assembly Envelope
SOF-DF-ICD-SE03-017	TA_AS_10, Aircraft Cabin/Telescope Assembly Envelope
SOF-DF-PD-PD-2009	SOFIA Lexicon
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 TA_AS_10 envelope borders the ICD GLOBAL_09 SI static envelope.

The aircraft must allow sufficient room for science instrument components that 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 envelopes 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 counterweight rack attached (see ICD TA_SI_05). These are based on the ranges of motion the telescope can go through when uncaged as stated in ICD TA_AS_09 and ICD TA_AS_10. 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 TA_AS_09 and ICD TA_AS_10. 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 ICD TA_SI_02. 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 counterweight rack. The dynamic envelope includes a volume that extends to a cylindrical surface 6.75 inches [171.5 mm] long, forward of the telescope flange that is 41 inches in diameter, centered on the IR beam. This cylindrical volume was originally allocated for a SI flange and an observatory-provided SI rotator; however, development of a SI rotator was later de-scoped and this entire volume is now made available for SI use.

As mentioned in Section 1, the dynamic envelope includes a volume inside the flange assembly, between the instrument mounting flange and the telescope's gate valve, available for use by the SI. The volume is comprised of two cylindrical sections; a section 1.5 inches [38.1 mm] long with a diameter of 31.1 inches [789.9 mm] from the telescope instrument mounting flange interface plane and another section 13.85 inches [351.7 mm] long with a diameter of 30.0 inches [762 mm]. The diameter of the longer section is established such that there is 0.75 inches of clearance radially between the envelope and INF tub insulation to accommodate small adjustments expected to be made to instrument position during installation as an instrument is guided towards the telescope instrument flange on its SI cart. The shorter section allows for a slightly wider diameter as instrument position becomes constrained once the TA IMF dowel pins are engaged. It is recommended SI Assembly components inside the INF tub have rounded edges and corners to prevent damage to the tub insulation during instrument installation and removal. 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. The envelope is the space available for SI installation operations, including positioning the instrument and cart before being guided towards the telescope instrument mounting flange, cart removal, and other operations such as cryogen servicing of instruments. This ICD assumes the telescope will remain stationary during the science instrument installation. Please note that the static envelope is fixed relative to the aircraft and begins at the telescope assembly instrument mounting flange at fuselage STA1480 and extends forward in the aircraft. Please refer to Figures 3.1-2A through 3.1-2D.

Note if the 96158600 Cabin Side Lifting Device Installation has been performed, the static envelope will be temporarily reduced (e.g. to below approximately WL 324.5, excluding the lift hook). The Cabin Side Lifting Device is used for certain TA repair or modification activities. The lifting device is installed as needed and is typically not present on the aircraft.

- 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, and the height available rolling down the SI cart path on the AS toward the rear of the aircraft (aft of the doorway). The 41 inches [1041.1 mm] horizontal dimension allows 0.25 inches [6.35 mm] clearance on either side of the SI to get through the door. The distance from outside the aircraft doorsill to the stairs is 83 inches [2108.2 mm] and the distance from inside the doorsill to the stairs is 73 inches [1854.2 mm]. The length of the SI was established in SOF-1030. The sides of the envelope have a height of 64 inches [1625.6 mm], established to maintain 2 inches [50.8 mm] of clearance between the envelope and the aircraft light cover structures along the SI cart path. An additional rectangular volume of 79 x 19 x 7 inches (LxWxH) centered at the top of the envelope is established to accommodate instrument hardware that has a height greater than 64 inches [1625.6 mm]; this allocated volume is intended only for instrument hardware such as pressure-relief devices and cryostat neck tube assemblies. The height and width of this sub-volume are defined such that there are at least 2 inches [50.8 mm] of clearance between an instrument and the top of the door 1L doorsill, as well as between an instrument and the planned DVDS monitor installations along the SI cart path. An SI using the top sub-volume of the installation envelope should be designed such that cart operators can maintain good visibility over the instrument during cart operations and instrument transport. Please refer to Figures 3.1-3A through 3.1-3C.

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 BRACKET "[]" ARE EXPRESSED IN MILLIMETERS.

2. DIMENSION TOLERANCES:

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

3. ALL STATION, WATER, AND BUTTOCK LINES ARE EXPRESSED IN INCHES, IN ACCORDANCE WITH INTERFACE CONTROL DOCUMENT SOFIA COORDINATE SYSTEM GLOBAL_05 (SOF-DA-ICD-SE03-045).

4. DIMENSIONS SYMMETRIC ABOUT ϕ .

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).

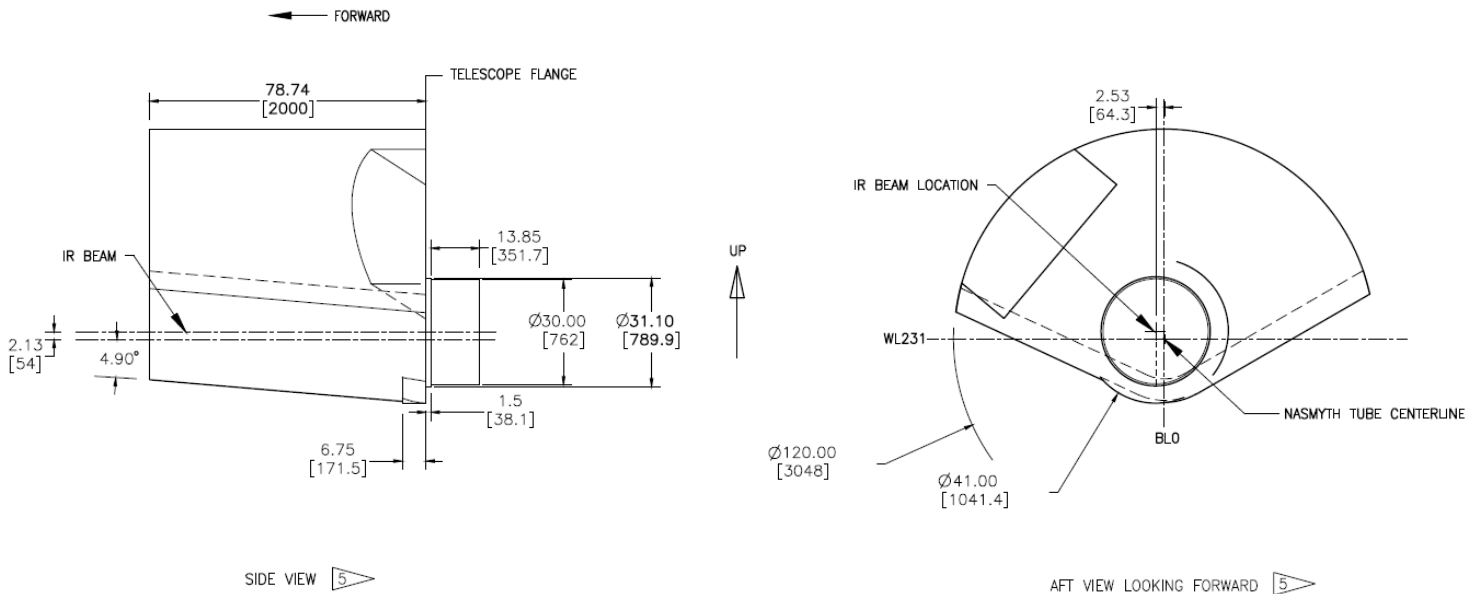


Figure 3.1-1A. SI Dynamic Envelope

Side and Rear Views

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

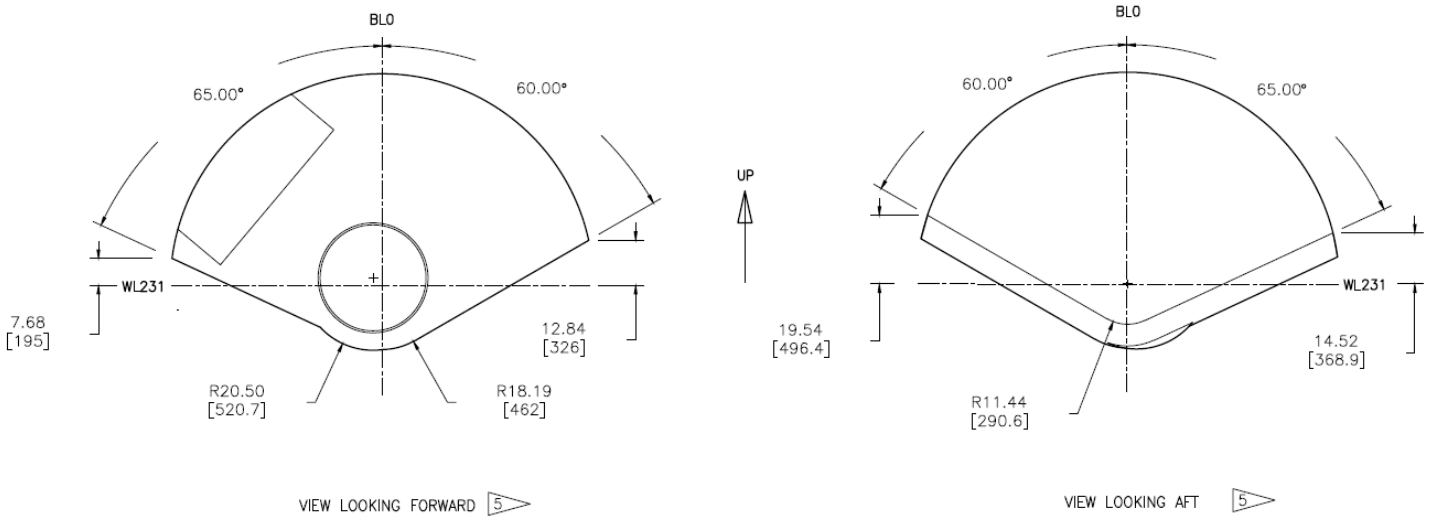


Figure 3.1-1B. SI Dynamic Envelope
Forward and Aft Looking Views

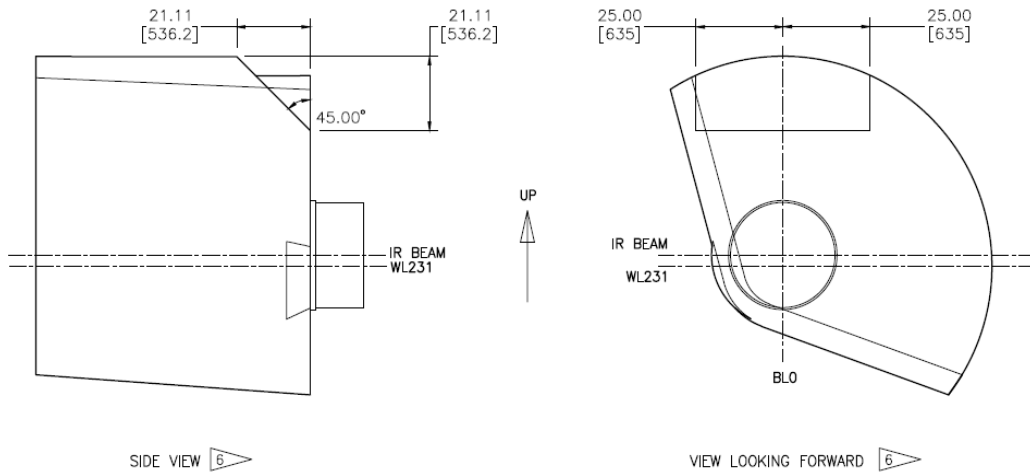


Figure 3.1-1C. SI Dynamic Envelope
Side and Rear Views with Telescope Pointing Up
Dimensions of Cut-out (for SI Counterweight Rack Struts) Included

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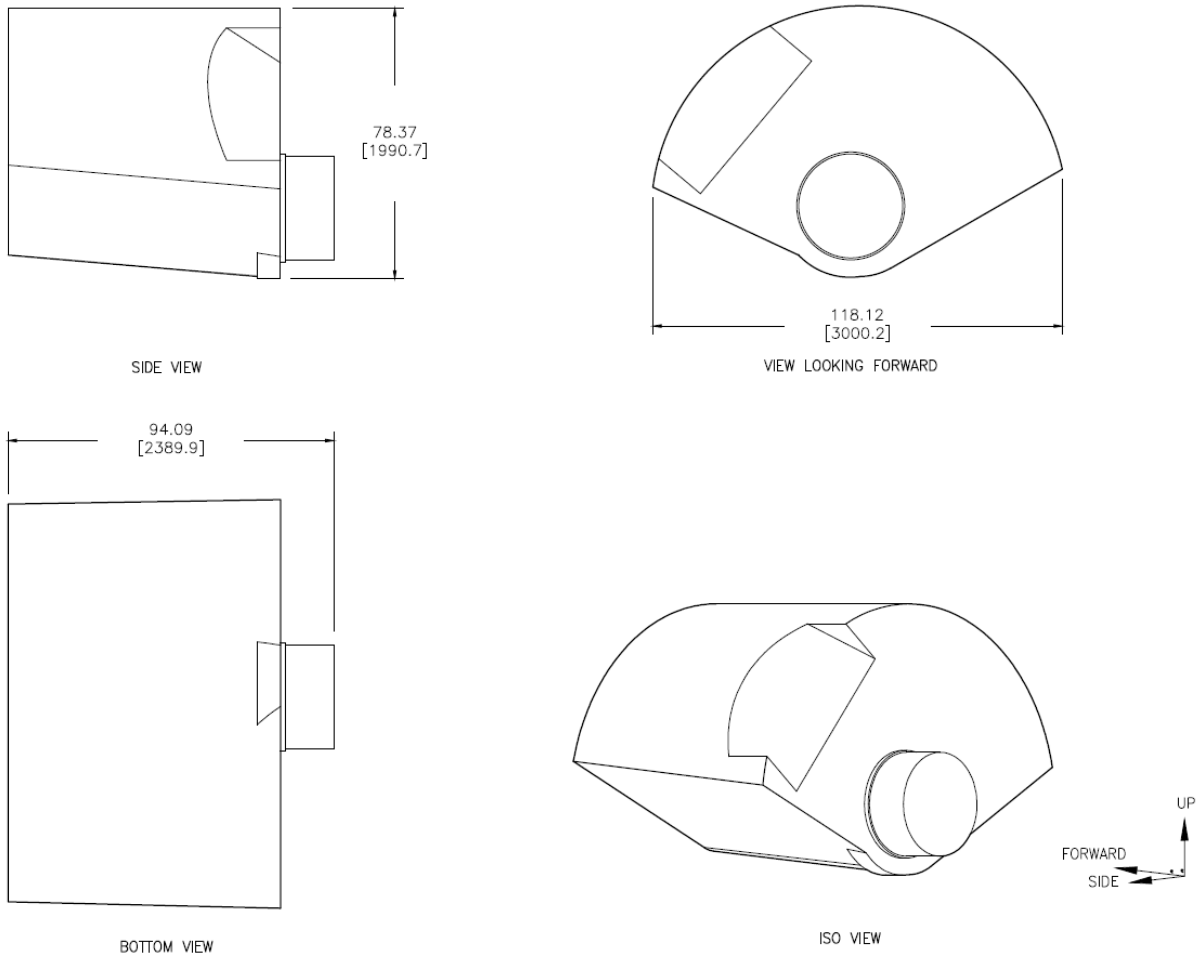


Figure 3.1-1D. SI Dynamic Envelope

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

NOTES:

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2. DIMENSION TOLERANCES:-

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

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4. DIMENSIONS SYMMETRIC ABOUT C .

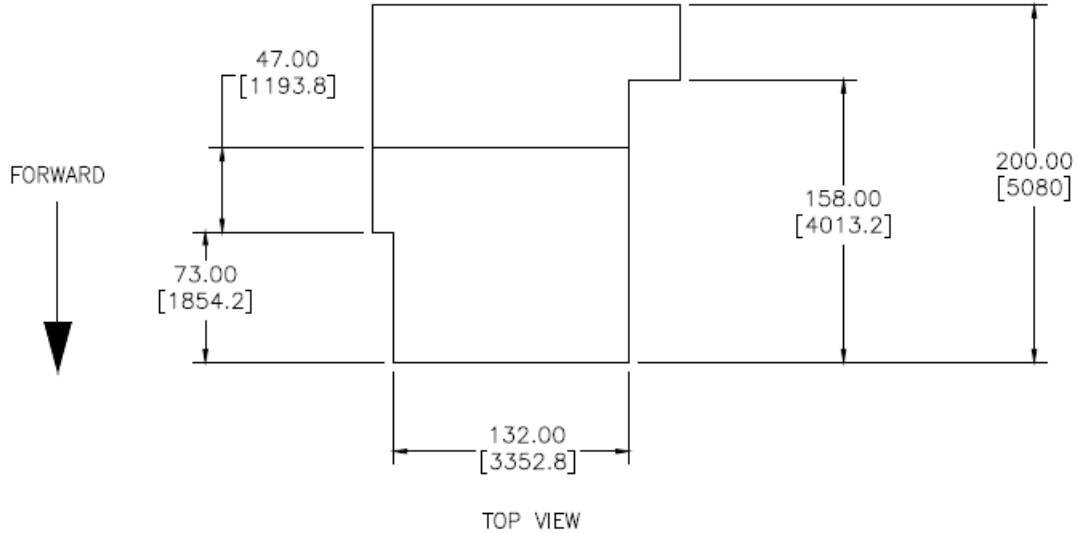


Figure 3.1-2A. SI Static/Service Envelope

Top View

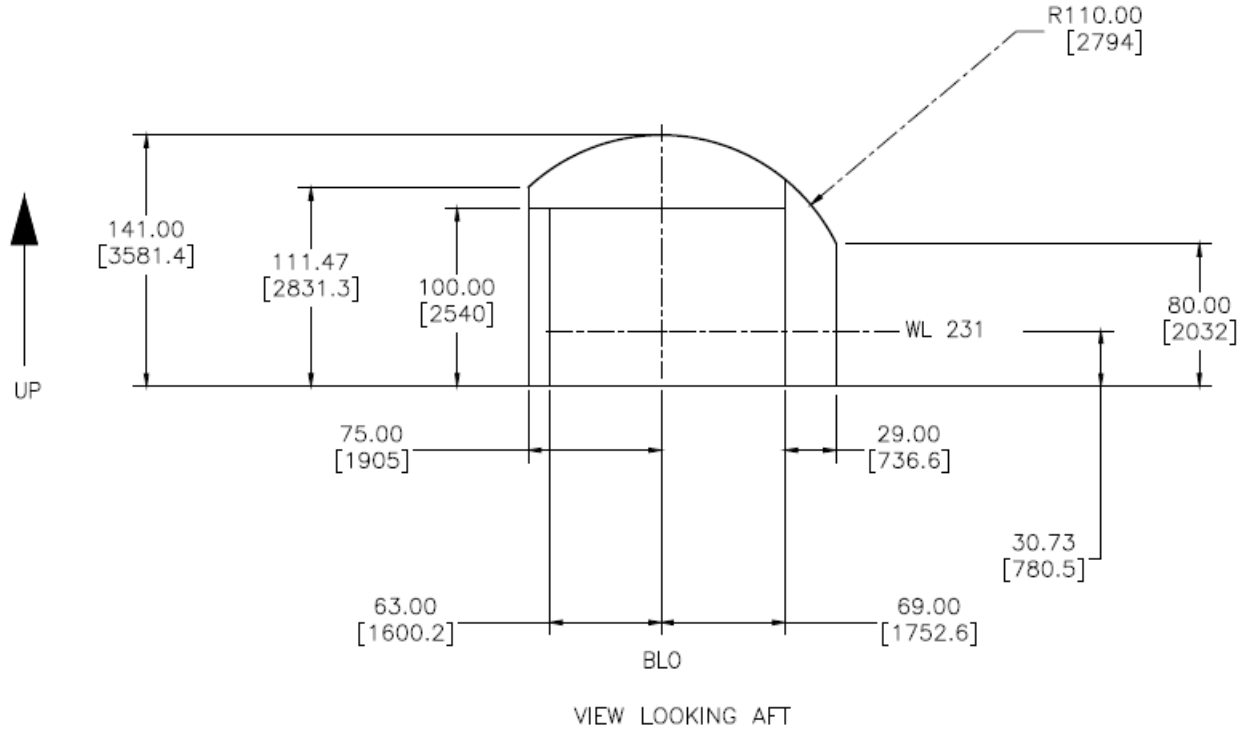


Figure 3.1-2B. SI Static/Servicing Envelope
View Looking Aft

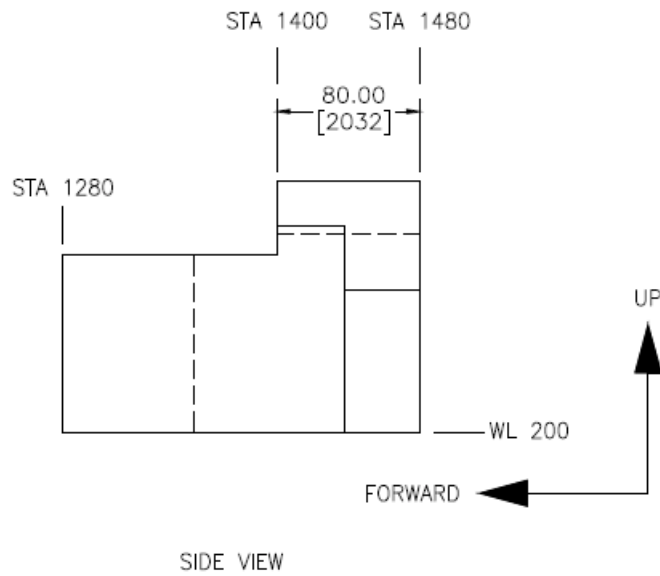


Figure 3.1-2C. SI Static/Servicing Envelope
Side View

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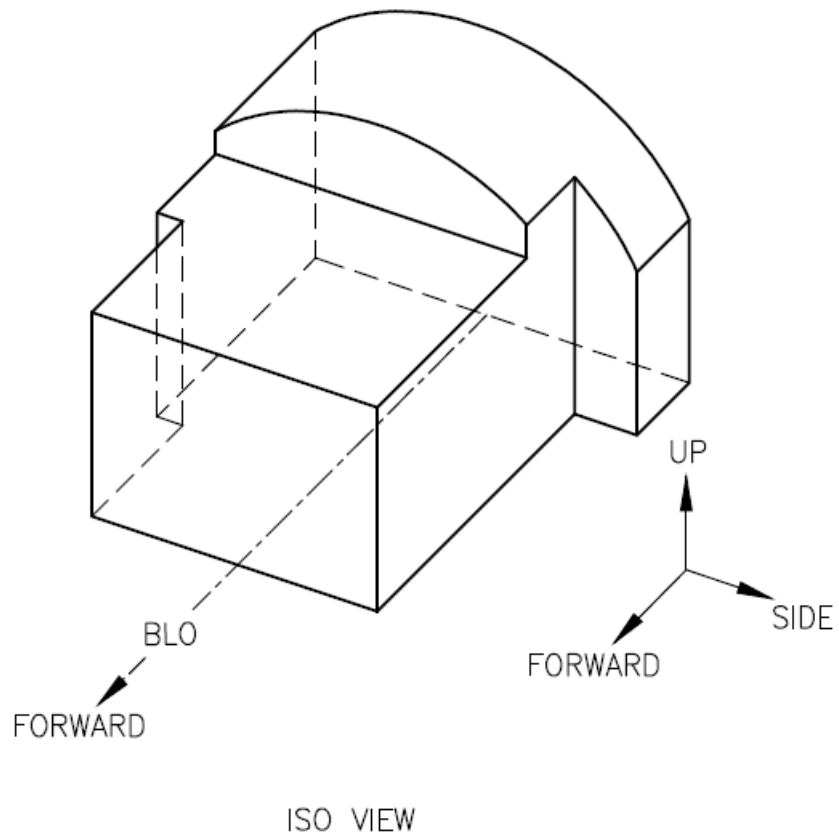


Figure 3.1-2D. SI Static/Service Envelope
Isometric 3-D View

NOTES:

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2. DIMENSION TOLERANCES:

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3. ALL STATION, WATER, AND BUTTOCK LINES ARE EXPRESSED IN INCHES, IN ACCORDANCE WITH INTERFACE CONTROL DOCUMENT SOFIA COORDINATE SYSTEM GLOBAL_05 (SOF-DA-ICD-SE03-045).

4. DIMENSIONS SYMMETRIC ABOUT ϕ .

5 TOP VOLUME (79"X19"X7") IS ONLY FOR INSTRUMENT HARDWARE SUCH AS CRYOSTAT NECK TUBE ASSEMBLIES AND PRESSURE RELIEF DEVICES THAT EXTEND ABOVE A HEIGHT OF 64".

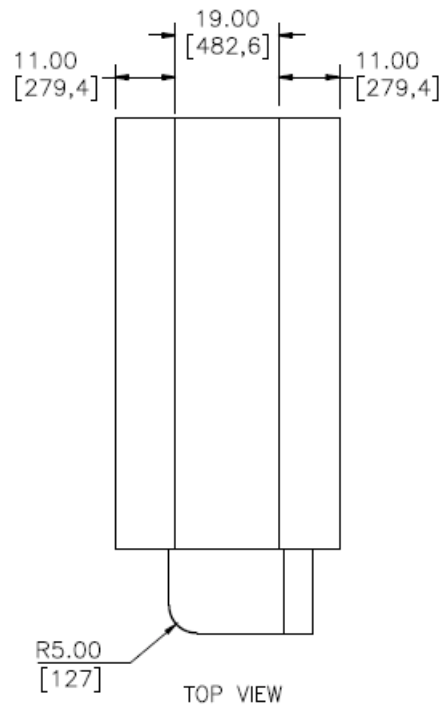


Figure 3.1-3A. SI Installation Envelope
Top View

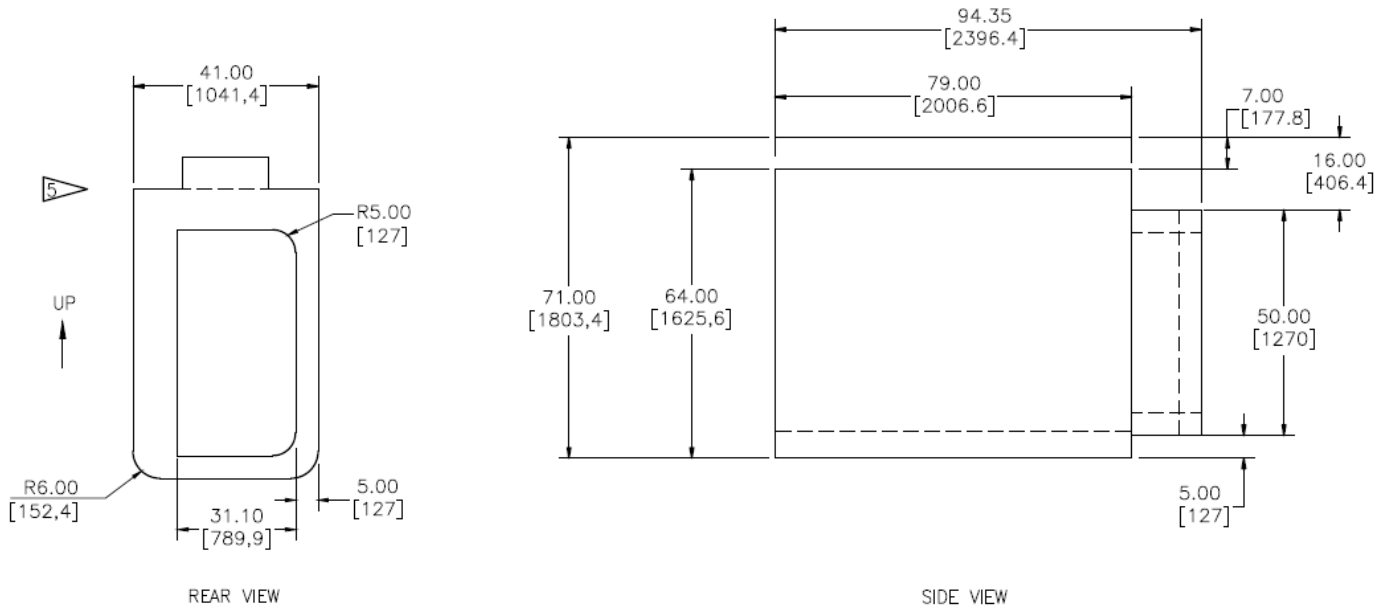


Figure 3.1-3B. SI Installation Envelope
Rear and Side Views

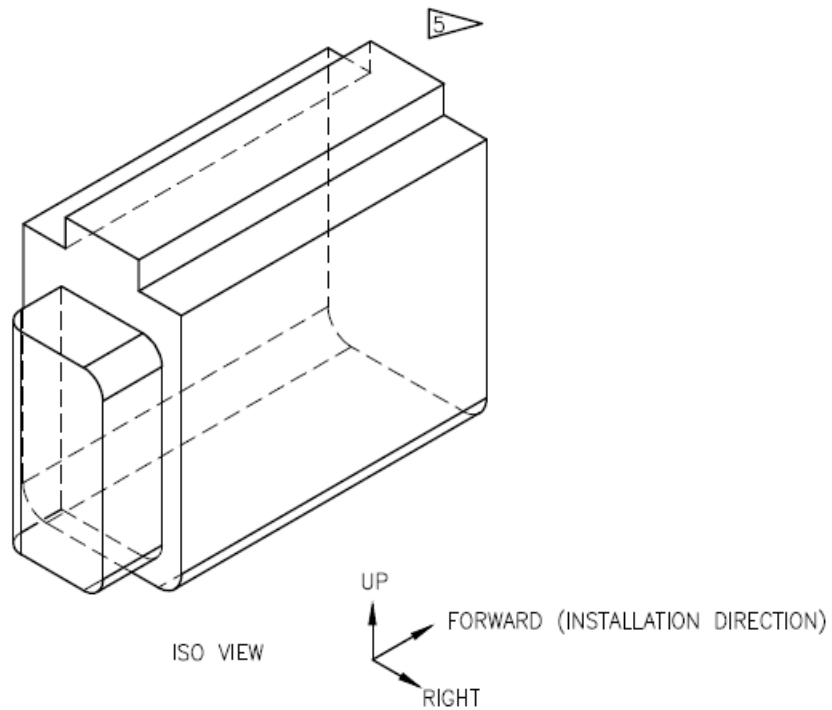


Figure 3.1-3C. SI Installation Envelope
Isometric 3-D view

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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