

International Docking System Standard (IDSS) Interface Definition Document (IDD)

Revision A

May 13, 2011

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REVISION LOG

Document Revision	Effective Date	Description
IDSS IDD	09/21/2010	Initial release
Revision A	4/27/2011	Revised, rearranged, and added text to nearly all sections of document. Revised & renumbered figures. Added requirements on mechanical soft capture, soft capture sensors, HCS seals, hook stiffness, separation system, electrical bonding, environments, and materials. Added Docking Performance section, and Appendix A.

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1 INTRODUCTION

This International Docking System Standard (IDSS) Interface Definition Document (IDD) is the result of a collaboration by the International Space Station membership to establish a recommended standard docking interface to enable on-orbit crew rescue operations and joint collaborative endeavors utilizing different spacecraft. It is based on validated designs and new technologies.

The IDSS IDD details the physical geometric mating interface and design loads requirements; these physical geometric requirements must be strictly followed to ensure physical spacecraft mating compatibility. This includes all defined components and areas that are void of components. The IDD also identifies common design parameters, e.g., docking initial conditions and vehicle mass properties. This information represents a recommended set of design values enveloping a broad set of design reference missions and conditions, which if accommodated in the docking system design, increases the probability of successful docking between different spacecraft. This IDD does not address operational procedures or off-nominal situations. It is the responsibility of the spacecraft developer to perform a final docking analysis using the initial conditions based on the vehicle's expected performance and actual mass properties to ensure the needed docking performance and to develop the final certification loads.

By providing only the requirements necessary to enable compatibility at the docking interface, this IDD allows designers the flexibility to design and build docking mechanisms to their unique program needs and requirements. While there are many other critical requirements needed in the development of a docking system such as fault tolerance, reliability, and environments (e.g. vibration, etc.), it is not the intent of the IDSS IDD to mandate all of these requirements; these requirements must be addressed as part of the specific developer's unique program, spacecraft and mission needs.

1.1 Purpose and Scope

The purpose of the IDSS IDD is to provide basic common design parameters to allow developers to independently design compatible docking systems. The IDSS is intended for uses ranging from crewed to autonomous space vehicles, and from Low Earth Orbit (LEO) to deep-space exploration missions.

This document defines docking system interface definitions supporting the following missions:

- A. International Space Station (ISS) visitation
- B. Lunar exploration
- C. Crew rescue
- D. International cooperative missions

Vehicles using this interface may include light vehicles in the range of 5-8K kg, and medium vehicles in the range of 8-25K kg. These vehicles will dock to each other, to large space complexes in the range of 100-375K kg, and to large earth departure stages in the range of 33-170K kg. The figures and tables in this document depict the features of the docking interface that are standardized. Some docking features (e.g. sensors, separation systems) are not standardized and are left to the discretion of docking system designers, though they must follow the designated striker zone requirements. Resource umbilicals are not yet standardized and are not yet defined in this standard.

1.2 Responsibility and Change Authority

Any proposed changes to the IDSS by the participating partners of this agreement shall be brought forward to the IDSS committee for review.

Configuration control of this document is the responsibility of the International Space Station (ISS) Multilateral Control Board (MCB), which is comprised of the international partner members of the ISS. The National Aeronautics and Space Administration (NASA) will maintain the IDSS IDD under ISS Configuration Management, until an appropriate International Standards Body is identified and mutually agreed.

2 APPLICABLE AND REFERENCE DOCUMENTS

None.

3 INTERNATIONAL DOCKING SYSTEM STANDARD

3.1 General

The following subsections describe the system interfaces for the IDSS.

3.1.1 System Description

3.1.1.1 Docking

The IDSS IDD defines a 2-stage approach to docking. The first stage establishes the initial capture of the docking vehicles, and is performed by the Soft Capture System (SCS). During the capture phase, the active docking mechanism stabilizes the newly joined spacecraft. The soft capture system then pulls the docking spacecraft together in order to initiate the second stage of docking, performed by the Hard Capture System (HCS). The HCS performs structural latching and sealing at the docking interface in order to transfer structural loads between the spacecraft and to create a transfer tunnel which can be pressurized for crew and cargo transfer for joint mission operations. The docking operation needs to be completed within a maximum time to ensure a safe docking operation.

The IDSS docking interface is fully androgynous about one axis, meaning the interface configuration is capable of mating to an identical configuration. During docking, one androgynous soft capture interface must be active (active mode), while the other androgynous soft capture interface remains locked in place, or passive (passive mode). The active interface controls the soft capture function and all sequences of docking up until hard capture. *Figure 3-1: Androgynous Docking Interface - Axial View* and *Figure 3-2: Androgynous Docking Interface - Cross Section* depict the Androgynous IDSS interface.

The SCS interface consists of a capture ring, guide petals, magnets, and or mechanical latches, magnetic striker plates, mechanical latch strikers, sensors and sensor strikers. The term “striker” refers to the area on the passive side of the mating interface which is intended to be a contact surface for an active component on the active side of the mating interface. Docking system designers may choose to implement either magnetic or mechanical soft capture latches, but all docking systems must implement both magnetic and mechanical strikers to be fully IDSS compatible. Only general areas are designated for the mechanical latches and strikers in this IDD; more detail will be added when it becomes available.

During docking soft capture, the guide petals are the first element to make contact. The SCS then responds to correct the lateral and angular misalignment between the two opposing interfaces. Soft capture is complete when electromagnetic attachment of the magnets to the striker plates on the opposing capture ring occurs. Similarly, for systems using a mechanical latch, soft capture is complete when the active mechanical latches capture the passive latch strikers on the opposing capture ring and the two rings are in contact.

The SCS then aligns the two mating vehicles and retracts to bring the two hard capture interfaces into hard capture range. Fine alignment is accomplished by a combination of SCS retraction and HCS guide pins.

The HCS uses active hooks to engage opposing passive hooks to provide the structural connection and pressure seal compression. The HCS interface consists of a tunnel, 12 active/passive hook pairs on each side, dual concentric pressure seals, fine alignment guide pins and holes, sensors, sensor strikers, separation system, and resource umbilicals.

The docking operation is complete when the mechanical hooks and resource umbilicals are fully engaged.

3.1.1.2 Berthing

Berthing spacecraft together using a mechanical robot arm has been a crucial capability for spaceflight operations. This capability has been used extensively as part of the United States Space Shuttle and ISS programs. This international docking standard interface will not preclude robotic assisted berthing by the ISS Space Station Remote Manipulator System (SSRMS) if the total force required to enable soft capture is less than 150N. The primary method for berthing utilizes a fully functional soft capture system.

3.1.2 Engineering Units of Measure

All dimensions are in millimeters. All angular dimensions are in degrees. Unless otherwise specified, the dimensional tolerance is implied as follows:

xx implies $xx \pm 1 \text{ mm}$

xx.x implies $xx.x \pm 0.5 \text{ mm}$

xx° implies $xx^\circ \pm 30'$

3.1.3 Coordinate System

The IDSS utilizes a reference frame for cross reference between figures illustrated in this document. Two reference lines are a Line of Androgyny and a Line of Symmetry as shown in *Figure 3-1: Androgynous Docking Interface - Axial View*. An Axial Axis is defined as shown in *Figure 3-2: Androgynous Docking Interface - Cross Section*.

3.2 Mating Interface Definition

An overview of the IDSS interface is shown in *Figure 3-1: Androgynous Docking Interface - Axial View* and *Figure 3-2: Androgynous Docking Interface - Cross Section*. The Hard Capture System (HCS) Mating Plane is defined as the seal plane between two docking system's HCS Tunnels when structurally mated.

The Soft Capture System (SCS) Mating plane is defined as the plane normal to the Soft Capture Ring's axis which intersects the conic outline of the Guide Petals at a diameter of 1045 mm [TBC].

In the case of Magnetic Soft Capture, when the Soft Capture Ring is stowed in the passive mode, the magnetic Strikers are co-planar with the SCS Mating Plane. When the Soft Capture Ring is in the active mode, the Magnets are co-planar with the SCS Mating Plane and the Strikers shall be at least 1.5 mm below this plane.

Unless otherwise stated, all of the dimensions and features called out in this section shall be implemented on IDSS-compatible systems; these are considered requirements which must be met to ensure docking interface compatibility.

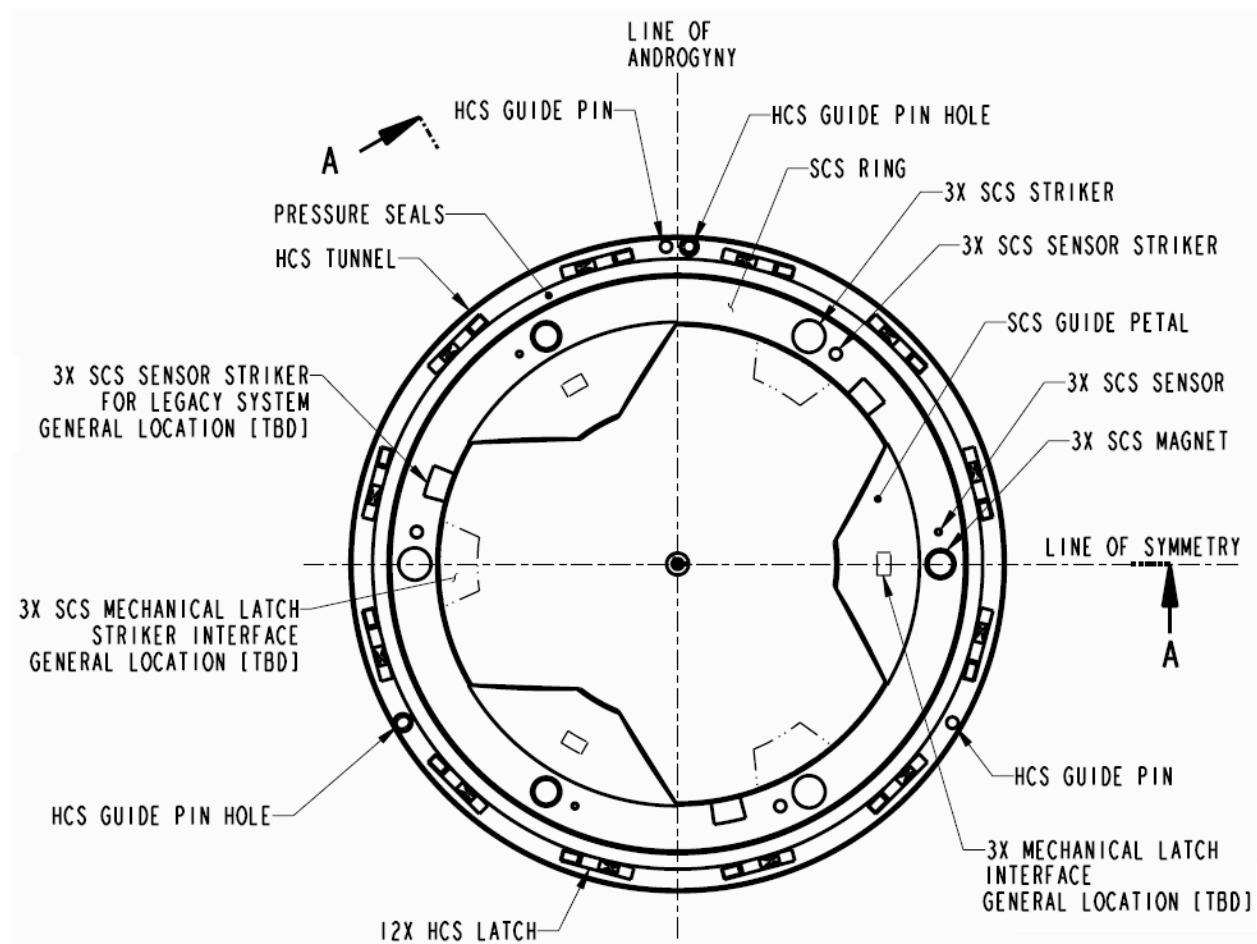
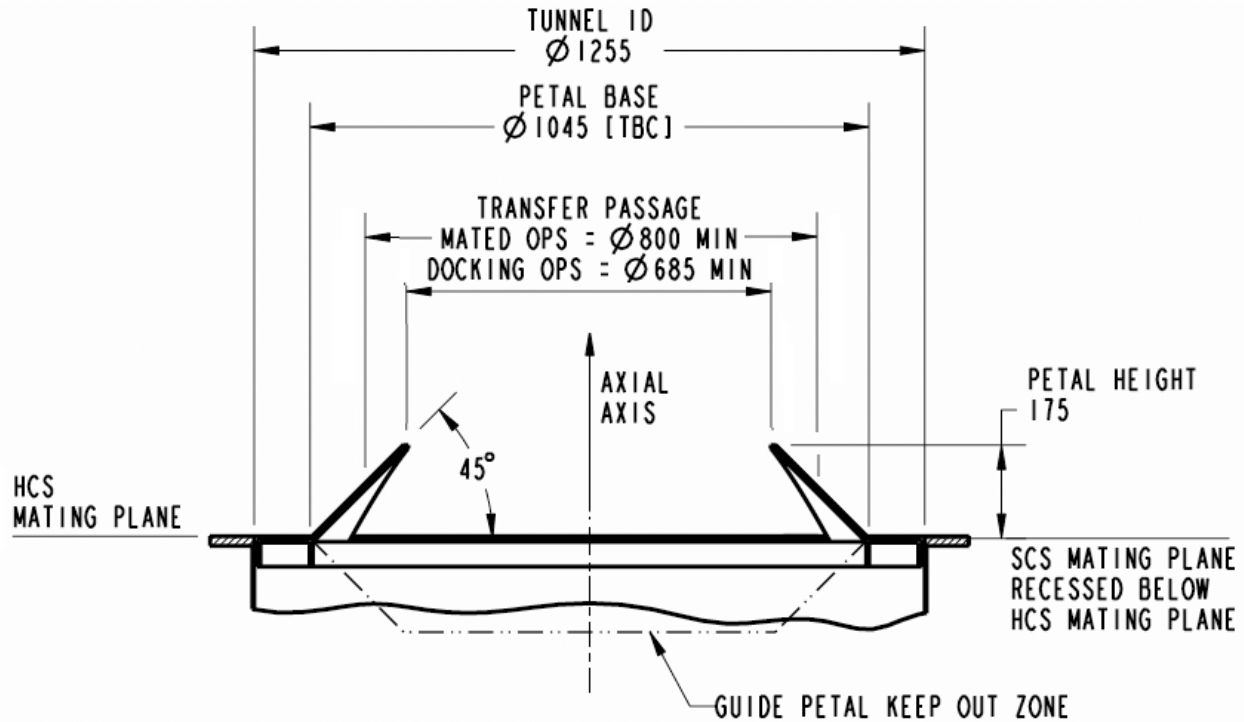


Figure 3-1: Androgynous Docking Interface - Axial View



NOTE: Cross-section through mid-plane of two petals (Section A-A, Figure 3-1).

Figure 3-2: Androgynous Docking Interface - Cross Section

3.2.1 Transfer Passageway

The SCS shall maintain a minimum of a 685 mm transfer passageway in the docking configuration as shown in *Figure 3-2: Androgynous Docking Interface - Cross Section*. The SCS shall provide the capability for an 800 mm transfer passageway in the mated configuration. Petals may either be removed or folded out of the way to satisfy mated configuration transfer passageway.

3.2.2 Soft Capture System

The Soft Capture System (SCS) performs soft capture using either electromagnets with magnetic striker plates or mechanical capture latches with mechanical strikers. Refer to *Figure 3-3: SCS Interface - Capture System*. All docking systems shall implement both magnetic and mechanical strikers to be fully IDSS compatible. Soft capture is the initial low-force structural mating between the docking systems. It is the first stage of attachment in the docking sequence for the purpose of capture, dynamics arrest, and alignment, prior to hard capture system engagement.

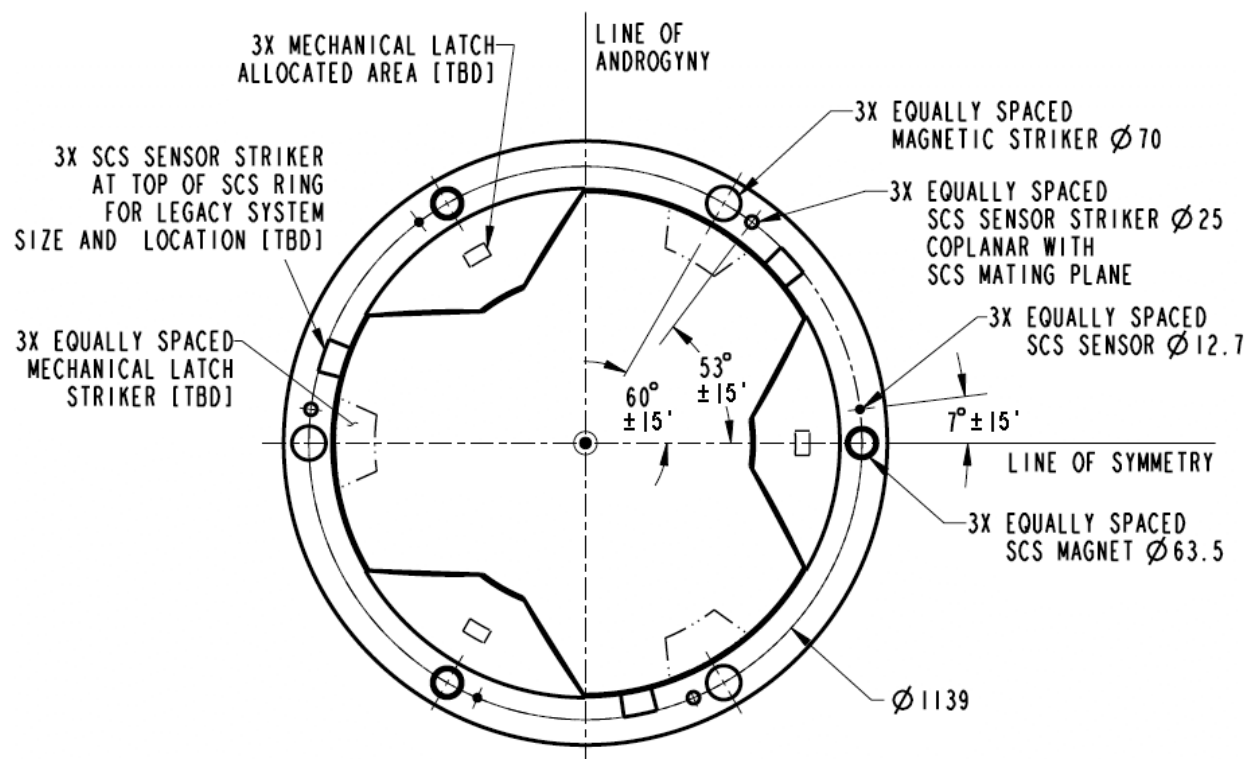
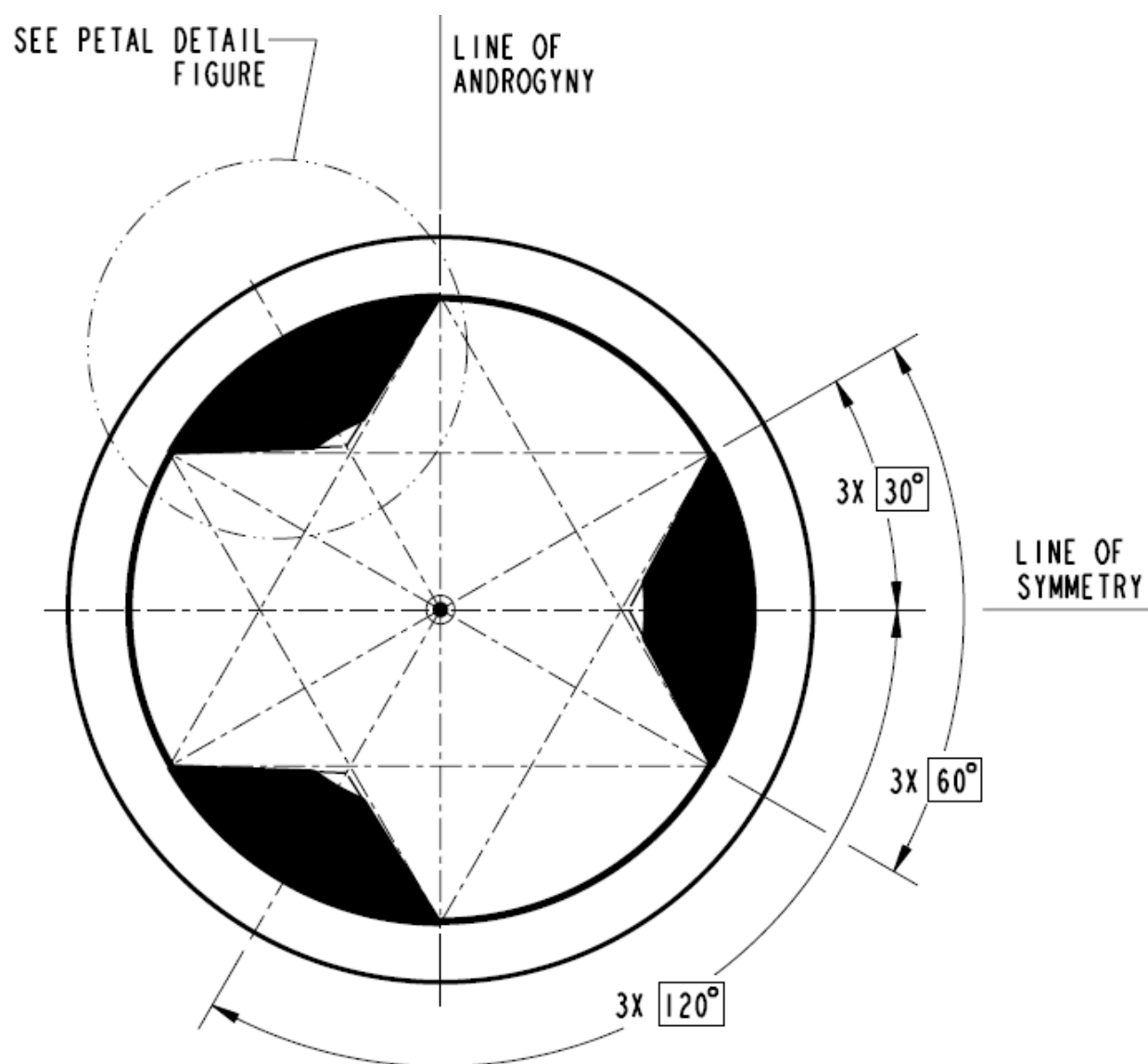


Figure 3-3: SCS Interface - Capture System

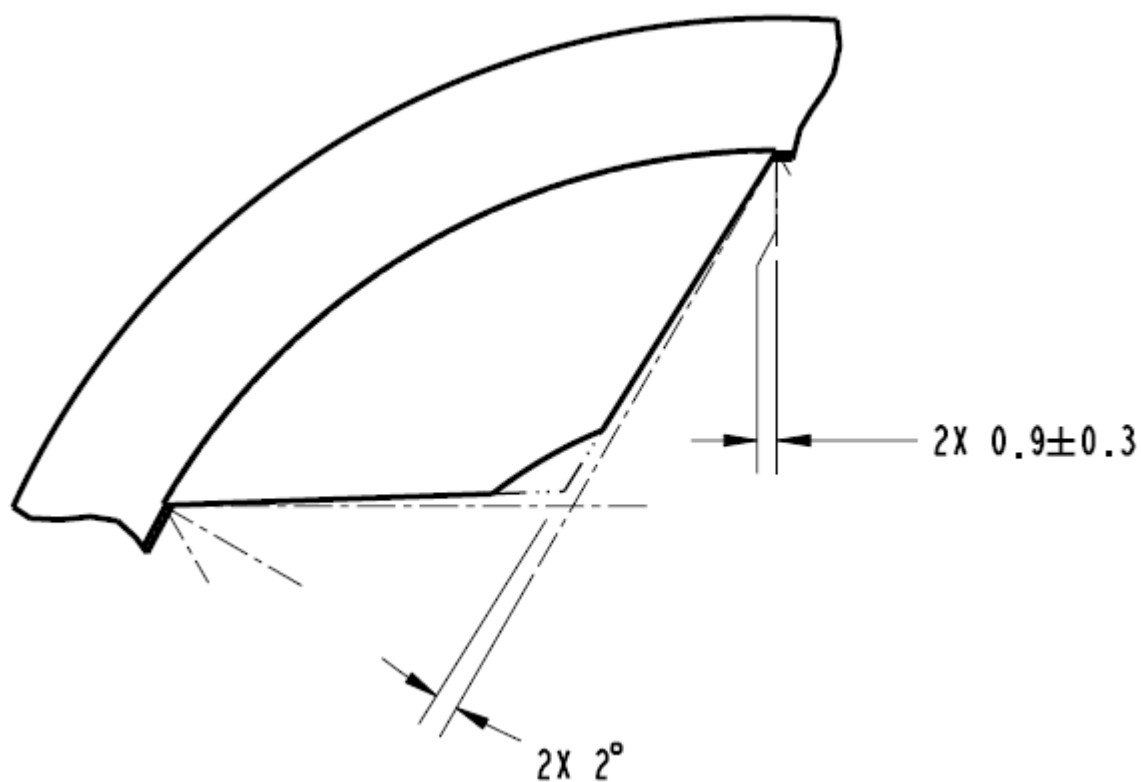
3.2.2.1 Guide Petal System

IDSS compliant systems shall implement three inward pointing guide petals integrated on the soft capture ring. The petals shall be equally spaced around the circumference of the soft capture docking ring. *Figure 3-4: SCS Interface – Guide Petal System Overview* depicts the guide petal layout. Additional SCS interface details are given in *Figure 3-5: SCS Interface – Guide Petal System Details* and *Figure 3-6: SCS Interface – Guide Petal Profile*.



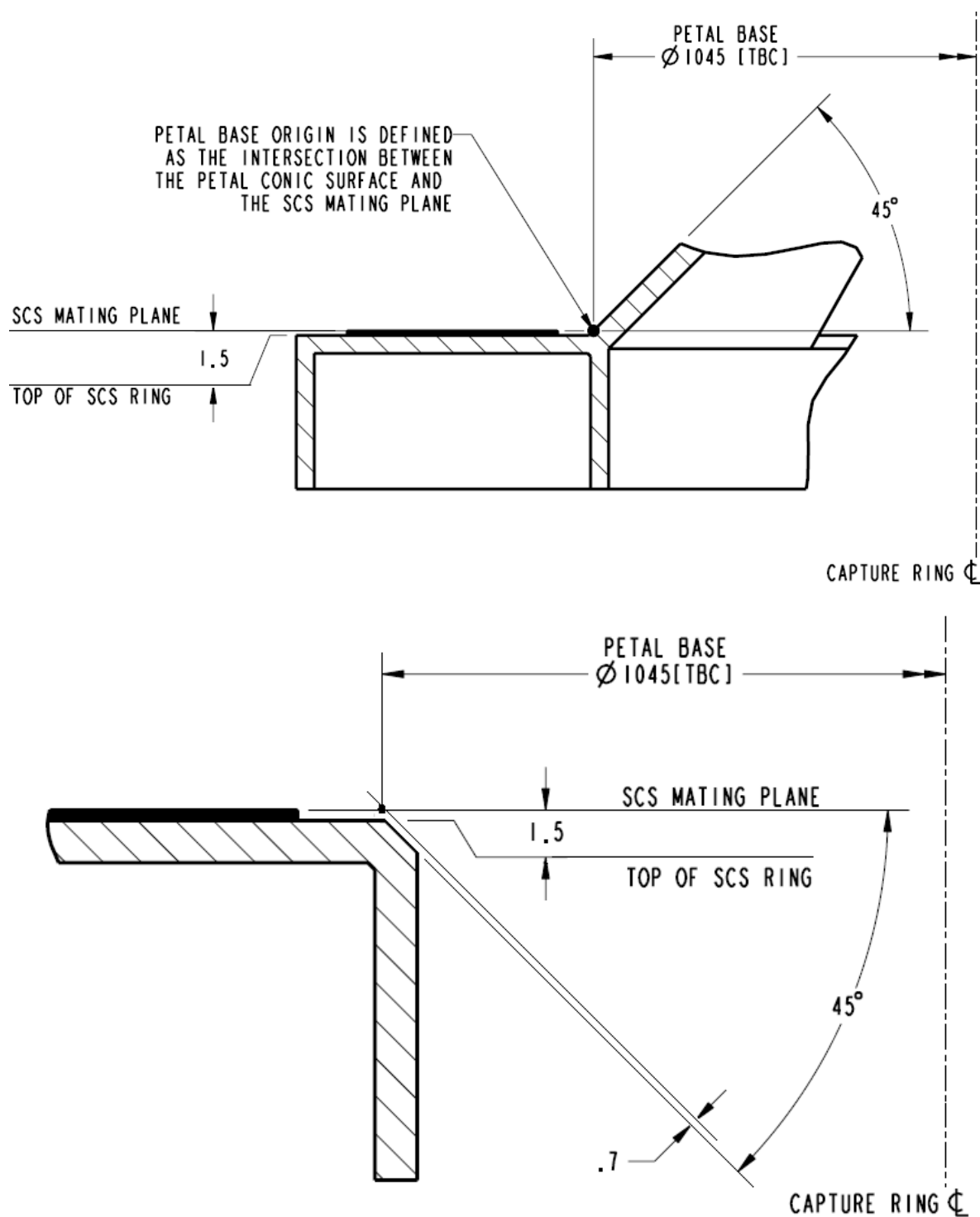
NOTE: Boxed angular dimensions are shown as Basic Dimensions that illustrate the theoretical construction lines for the petal configurations. No dimensional tolerances are to be applied to the Basic Dimensions.

Figure 3-4: SCS Interface – Guide Petal System Overview



NOTE: Dimensions projected on the SCS mating plane are shown.
Petal outline shown is on the external conic surface of the petal system.
Petal thickness is not shown for clarity.

Figure 3-5: SCS Interface – Guide Petal System Details



NOTE: Upper view indicates cross section of the capture ring through a guide petal.
Lower view indicates cross section of the capture ring between the guide petals.

Figure 3-6: SCS Interface – Guide Petal Profile

3.2.2.2 Soft Capture Ring

The SCS Ring is retracted and held firmly in place below the HCS mating plane when in passive mode. In active mode, the SCS Ring is actuated above the HCS mating plane to perform soft capture.

3.2.2.3 Magnetic Capture Latch System

The SCS shall implement three magnets and three striker plates distributed across the soft capture ring. Refer to *Figure 3-7: SCS Interface – Passive Mode Capture Ring Profile* and *Figure 3-8: SCS Interface – Active Mode Capture Ring Profile* for elevation of Strikers in active and in passive modes.

For optimal soft capture magnetic force, the magnetic capture latch system shall provide each striker with surface compliance to the mating magnet. This will ensure maximum surface contact to obtain maximum magnetic force. This compliance is to account for hardware fabrication and assembling tolerances. In addition, the material selection for the striker is crucial for obtaining the required magnetic force.

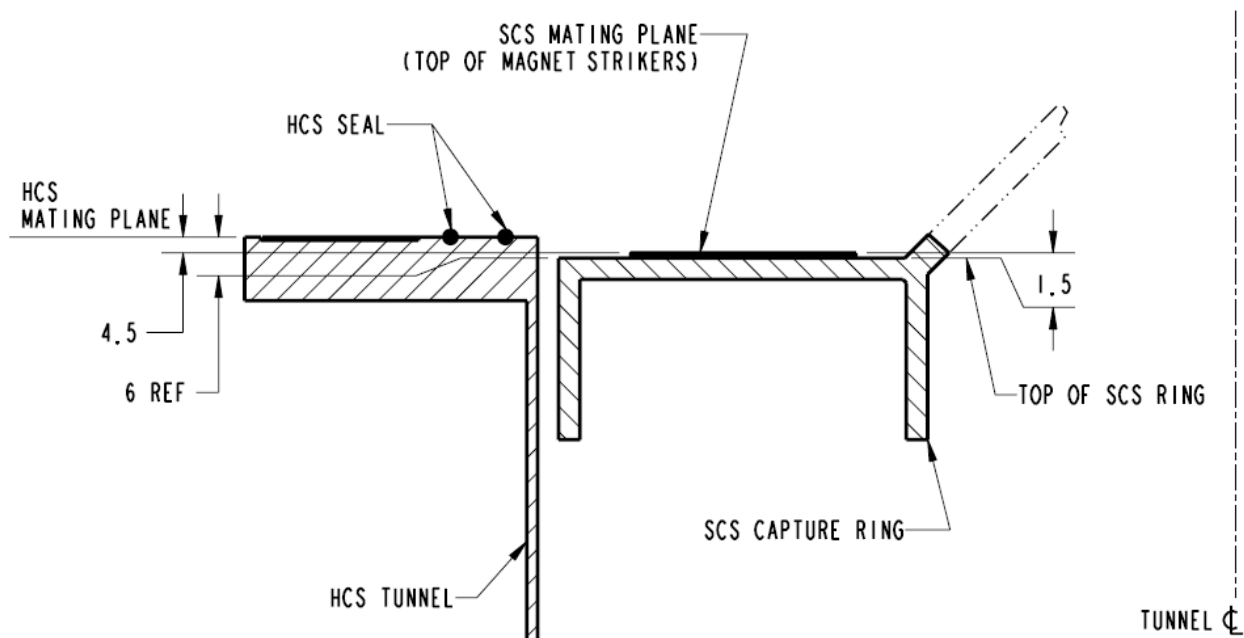


Figure 3-7: SCS Interface – Passive Mode Capture Ring Profile

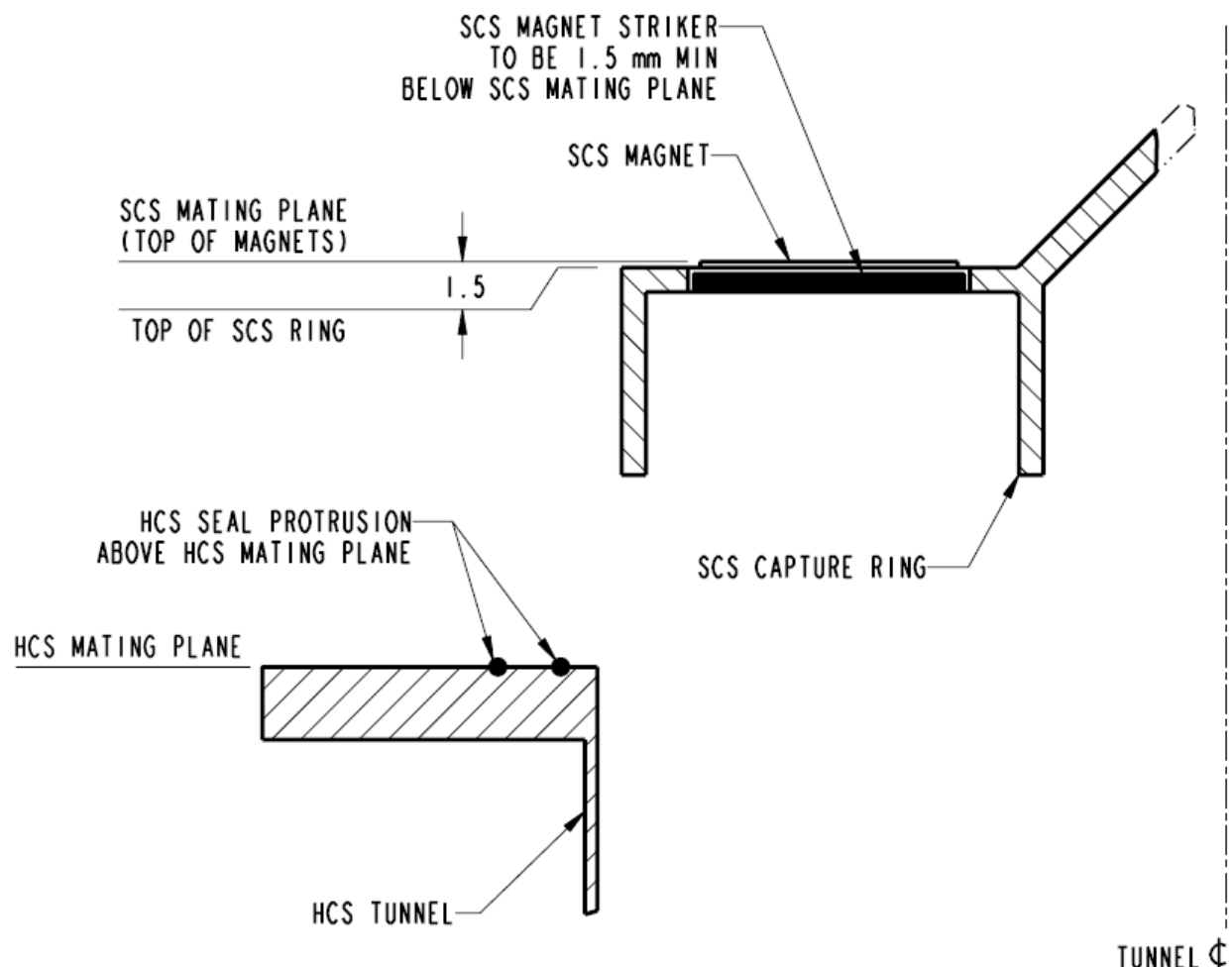
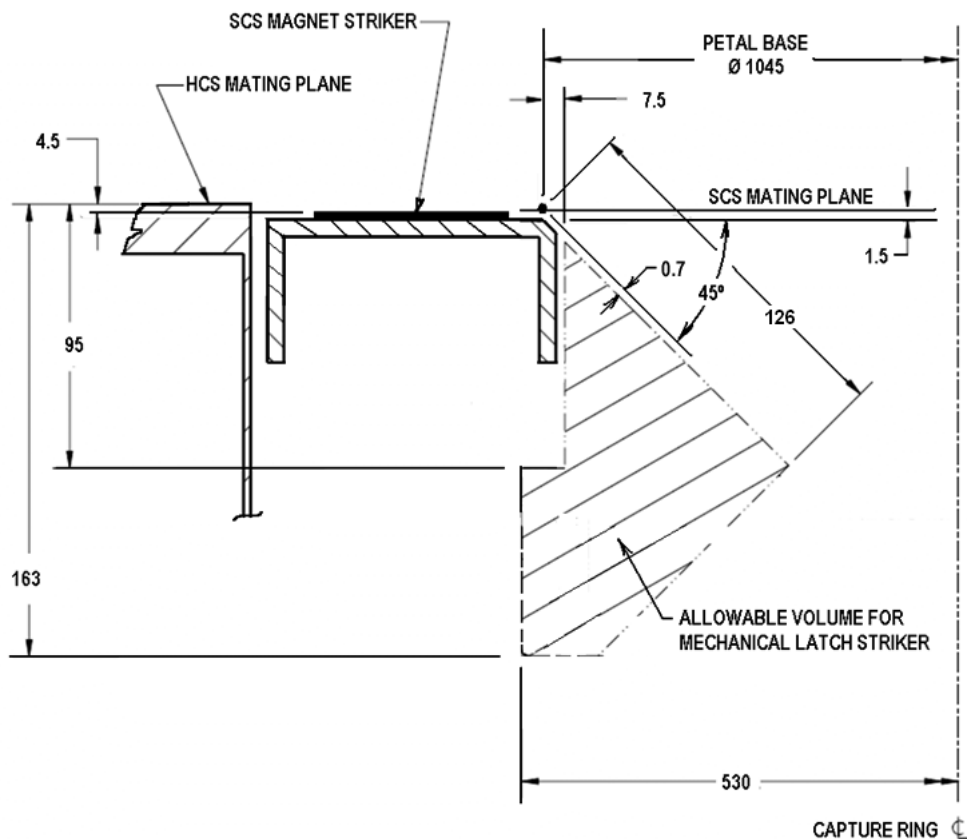


Figure 3-8: SCS Interface – Active Mode Capture Ring Profile

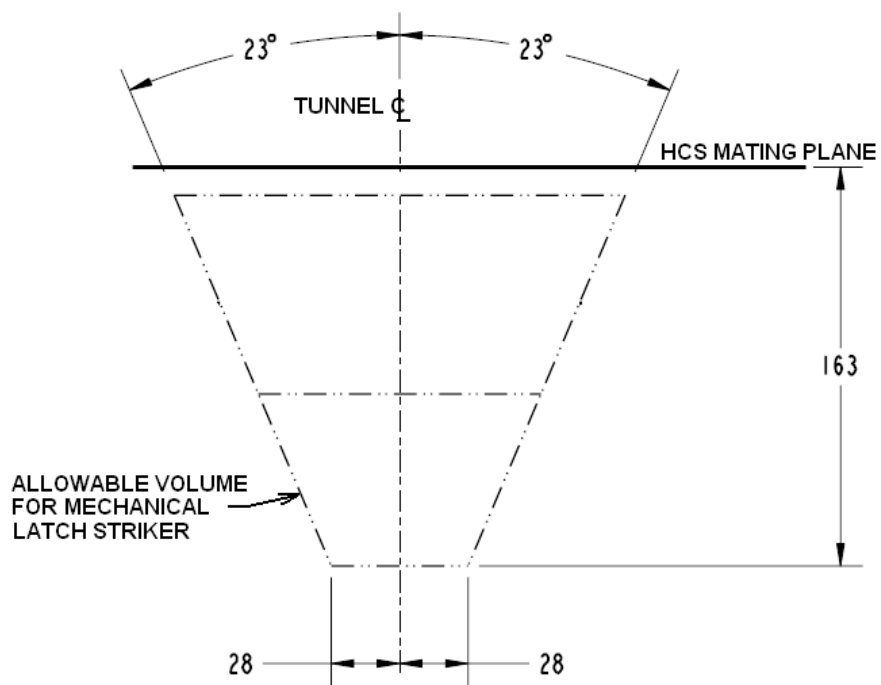
3.2.2.4 Mechanical Capture Latch System

The IDSS SCS interface includes designated volumes for implementation of mechanical latch strikers to accommodate mechanical latching systems. Refer to *Figure 3-3: SCS Interface - Capture System* and *Figure 3-9: Mechanical Latch Striker Reserved Volume (TBD)*.

The reserved volume is defined by revolving the cross sectional area about the Capture Ring center line shown in the Cross Sectional View and bounding the revolute volume with two side planes as shown in the Radial View.



Cross Sectional View



Radial View

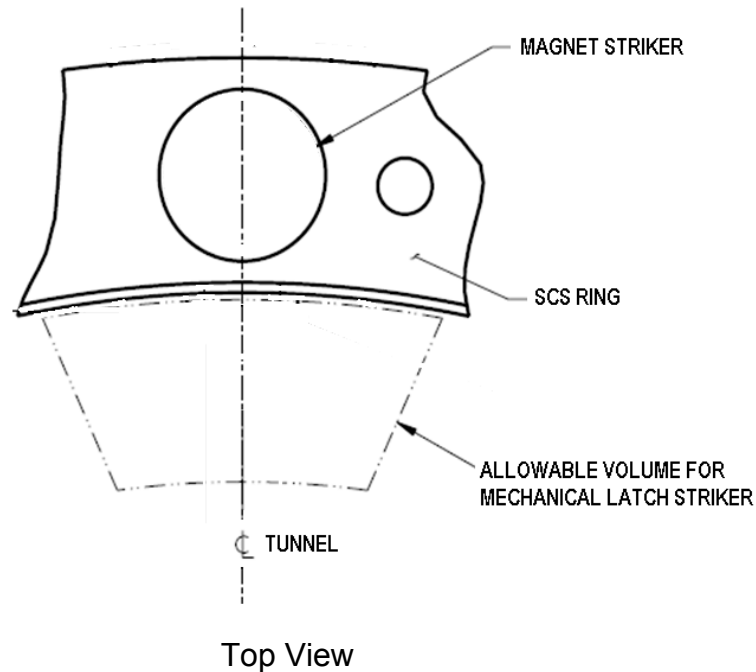


Figure 3-9: Mechanical Latch Striker Reserved Volume (TBD)

3.2.2.5 Soft Capture Sensor Force

To ensure successful soft capture performed by various active docking systems that may utilize different technologies, a limit on the total force resistance produced by SCS sensors on a passive system is to be defined as follows:

The force to simultaneously depress all SCS sensors to full stroke shall be $\leq 42\text{N}$.

To maximize the benefits of low impact docking, designers of systems which utilize force feedback to minimize the contact loads at soft capture are encouraged to further reduce this force to the lowest possible value.

3.2.2.6 Soft Capture Sensor Strikers

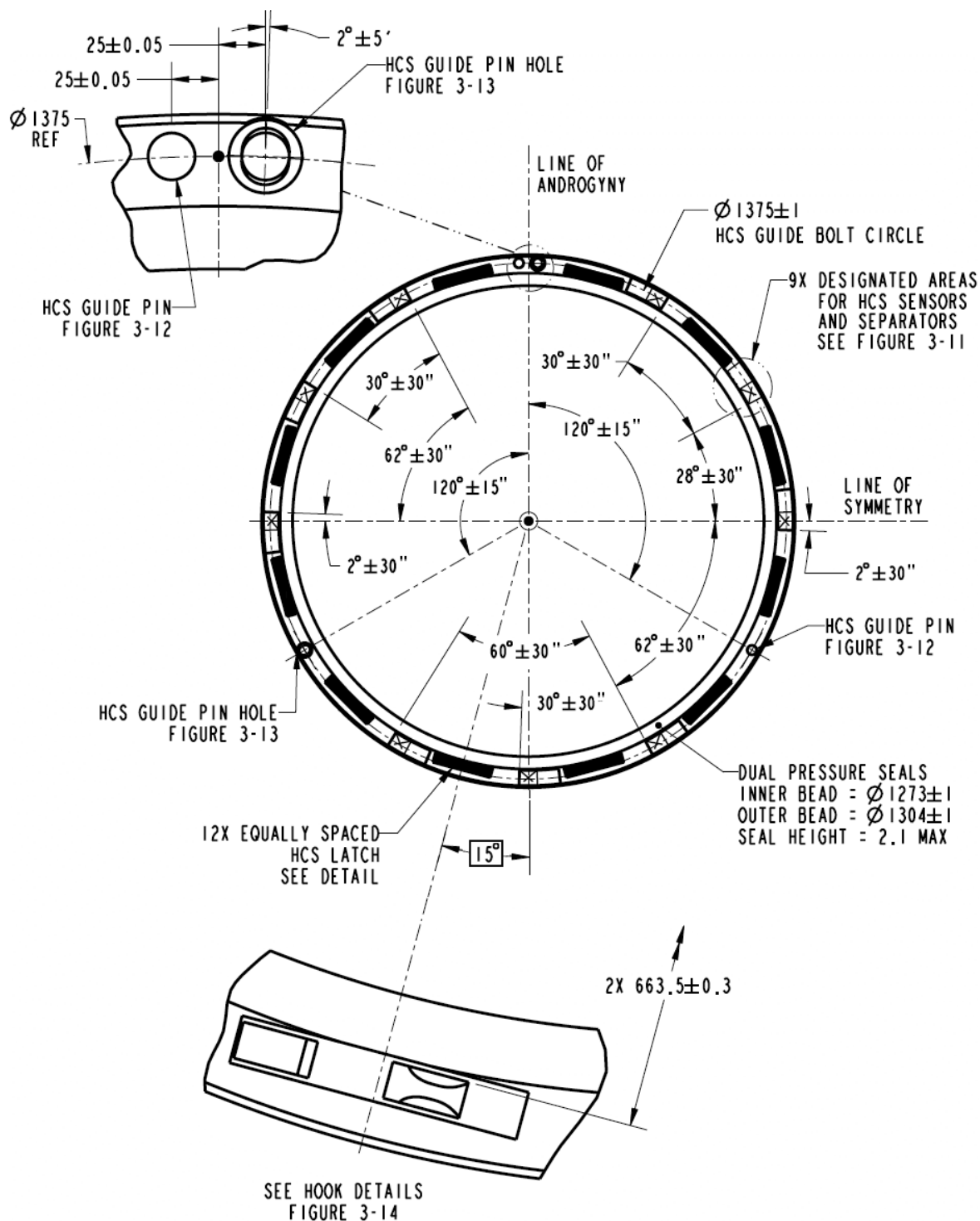
Designated areas for striker zones used by all SCS sensors from the opposing docking system are defined as shown in *Figure 3-3: SCS Interface - Capture System*.

3.2.3 Hard-Capture System

The Hard Capture System (HCS) performs the final structural mating between the two vehicles.

The HCS is depicted in *Figure 3-10: HCS Interface - Axial View* and *Figure 3-11: HCS Interface - Sensor Striker Zone*. HCS components that are not critical for transferring mated loads or maintaining pressurization are intentionally omitted. Designated striker regions are identified for participants to configure peripheral hardware (e.g. separation system and sensors).

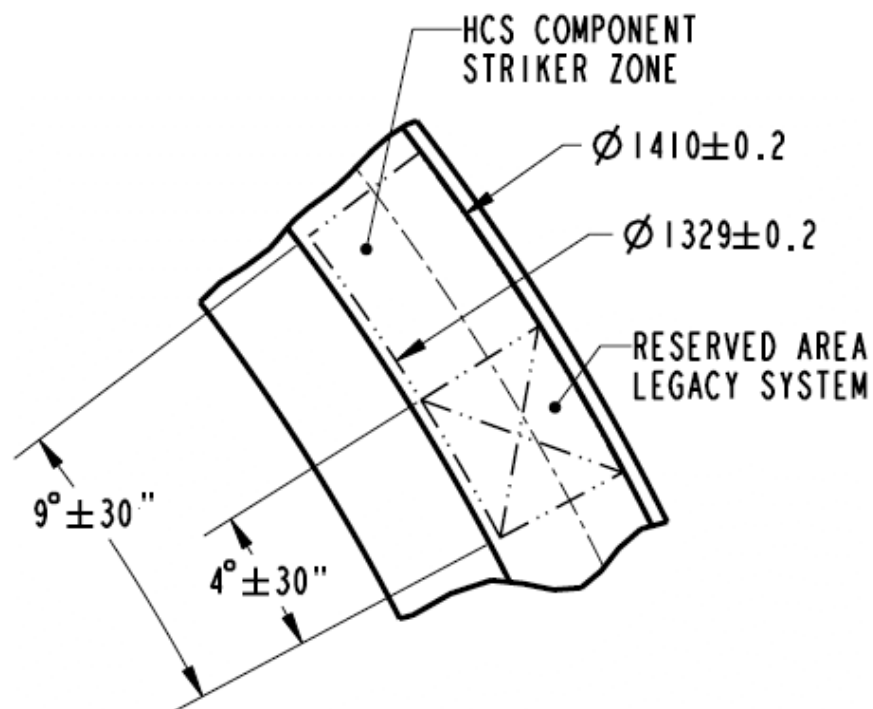
The HCS Component Striker Zones shall be recessed 1 ± 0.15 mm below the HCS mating plane.



NOTES:

1. Boxed angular dimensions are shown as Basic Dimensions that illustrate the theoretical construction lines. No dimensional tolerances are to be applied to the Basic Dimensions.
2. Separation systems shall be retracted below the HCS mating plane prior to closure of HCS interface.

Figure 3-10: HCS Interface - Axial View



NOTES:

- "HCS Component Striker Zone" is to depict the area for any international partner's components to strike. This zone provides the area for HCS sensors and separation mechanisms to contact.
- "Reserved Area" is the area inside the "HCS Component Striker Zone" for legacy HCS components and strikes. Refer to Appendix A for details.
- "HCS Component Striker Zone" and "Reserved Area" are recessed 1 ± 0.15 mm from HCS mating plane
- HCS Component Striker Zone may contain features that require accommodation. See Appendix A for details.

Figure 3-11: HCS Interface - Sensor Striker Zone

3.2.3.1 Tunnel

The tunnel is the main housing of the docking system that includes the interface flange for structural mating.

3.2.3.2 Seal

The HCS shall implement two concentric pressure seals that accommodate seal-on-seal mating. For seal diametral dimensions, refer to *Figure 3-10: HCS Interface - Axial View*. The pressure seals are located internally with respect to the tangential hook location. Seal parameters shall be as defined below. Also see *Table 3-6: HCS Maximum Mated Loads* for seal compression force.

Total seal adhesion force for concentric seals ≤ 900 N

Seal protrusion height in a free state above the HCS mating plane ≤ 2.1 mm

“Seal adhesion force” is defined as the force that is required to pull the docking pressure seals apart after they have been pressed together.

3.2.3.3 Guide Pins and Receptacles

The HCS shall implement two guide pins and two guide pin receptacles, as illustrated in *Figure 3-12: Guide Pin Details* and *Figure 3-13: Guide Pin Hole Details* for final alignment features of the hard-mate interface.

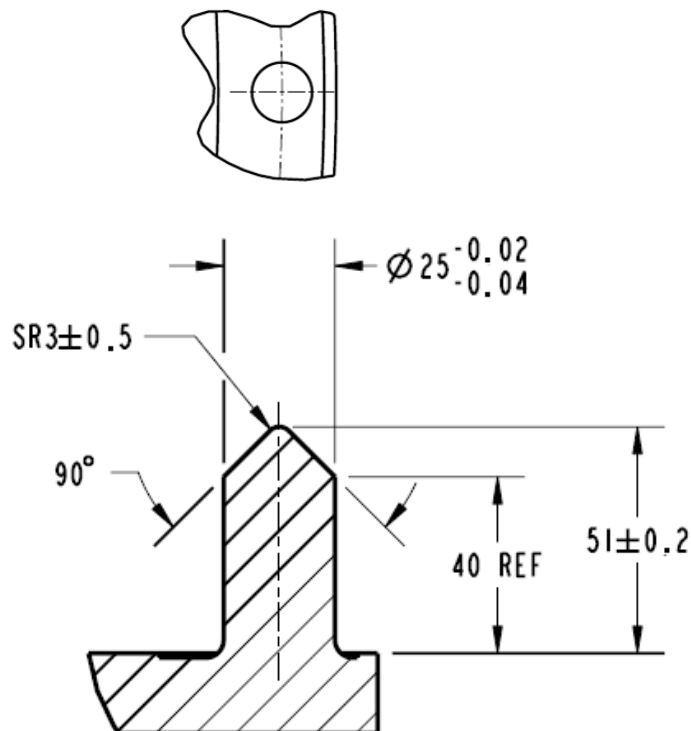


Figure 3-12: Guide Pin Details

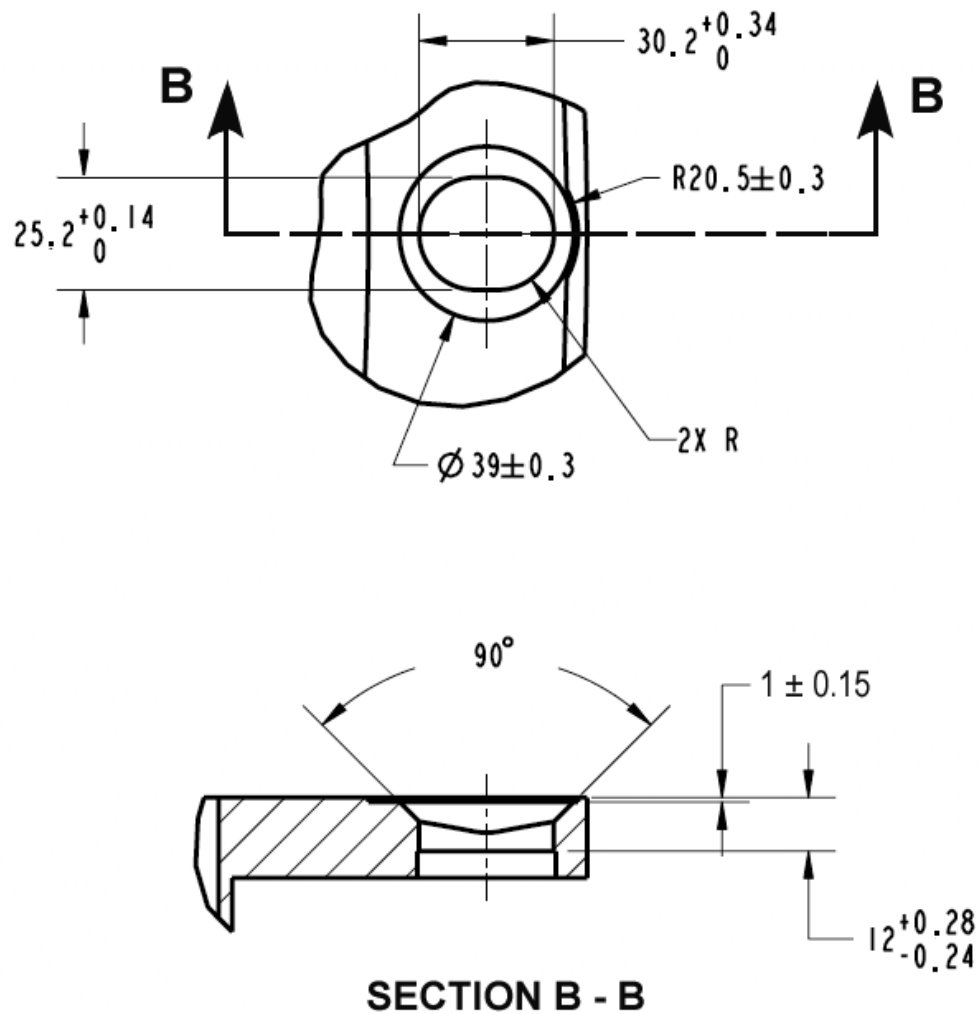


Figure 3-13: Guide Pin Hole Details

3.2.3.4 Hard Capture Hooks

The HCS shall implement tangential hooks arranged in 12 pairs of one active and one passive hook assembly for a total of 24 possible attachment points. To carry nominal loads, 12 active hooks on one docking system shall engage 12 passive hooks on an opposing docking system interface. On a fully androgynous system, the 12 active hooks on each side of the interface may be engaged with the 12 passive hooks on the opposing interface for a total of 24 active hook engagements. Although engaging 24 hooks is not a requirement, this capability can be used to carry additional mated interface loads. The HCS implements a passively compliant passive hook. Refer to *Figure 3-14: HCS Hooks - Side View*, *Figure 3-15: HCS Active Hook*, and *Figure 3-16: HCS Passive Hook*. The motion of the active hook shall be bounded by the envelope shown in *Figure 3-17: HCS Active Hook Motion Envelope*.

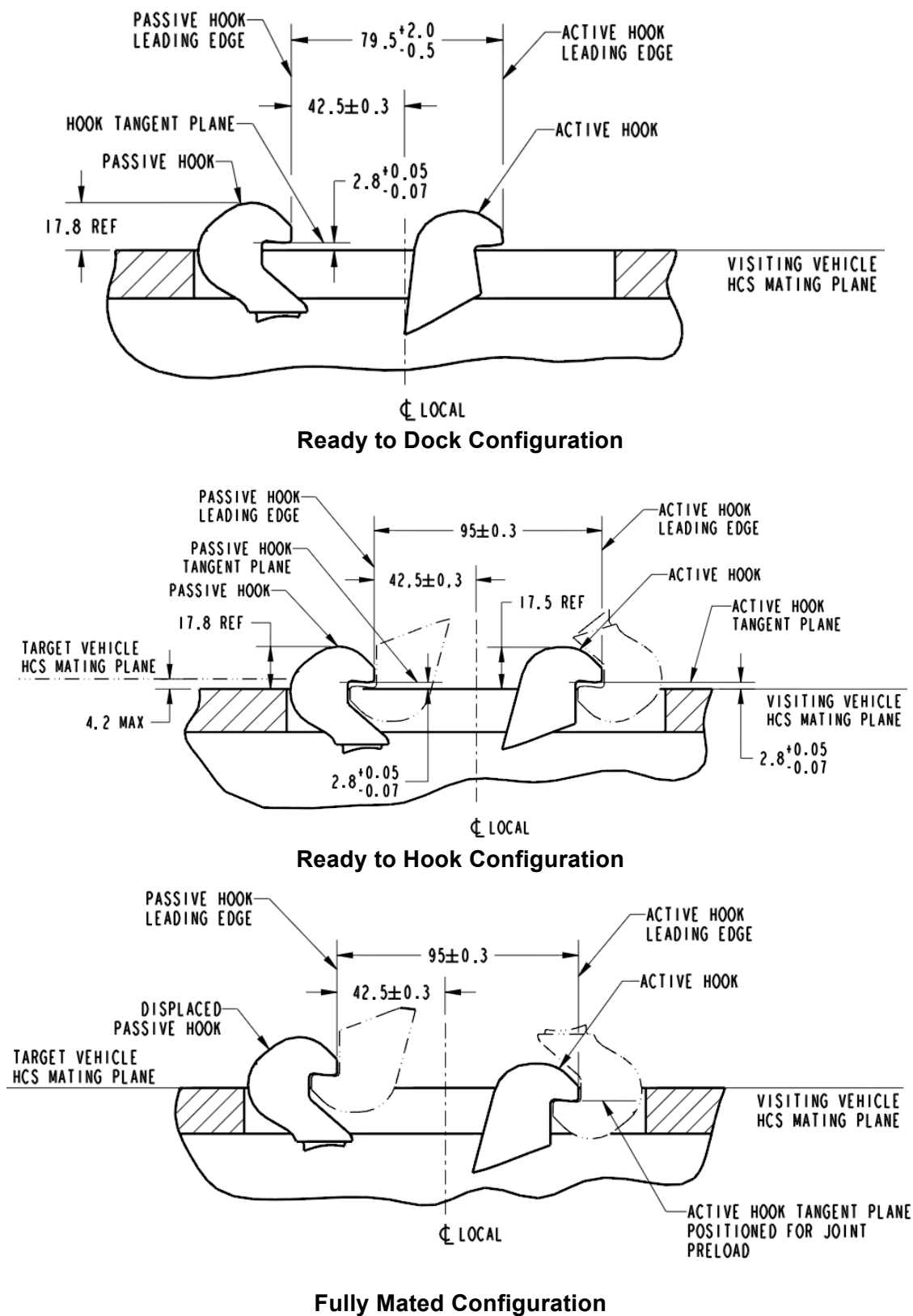


Figure 3-14: HCS Hooks - Side View

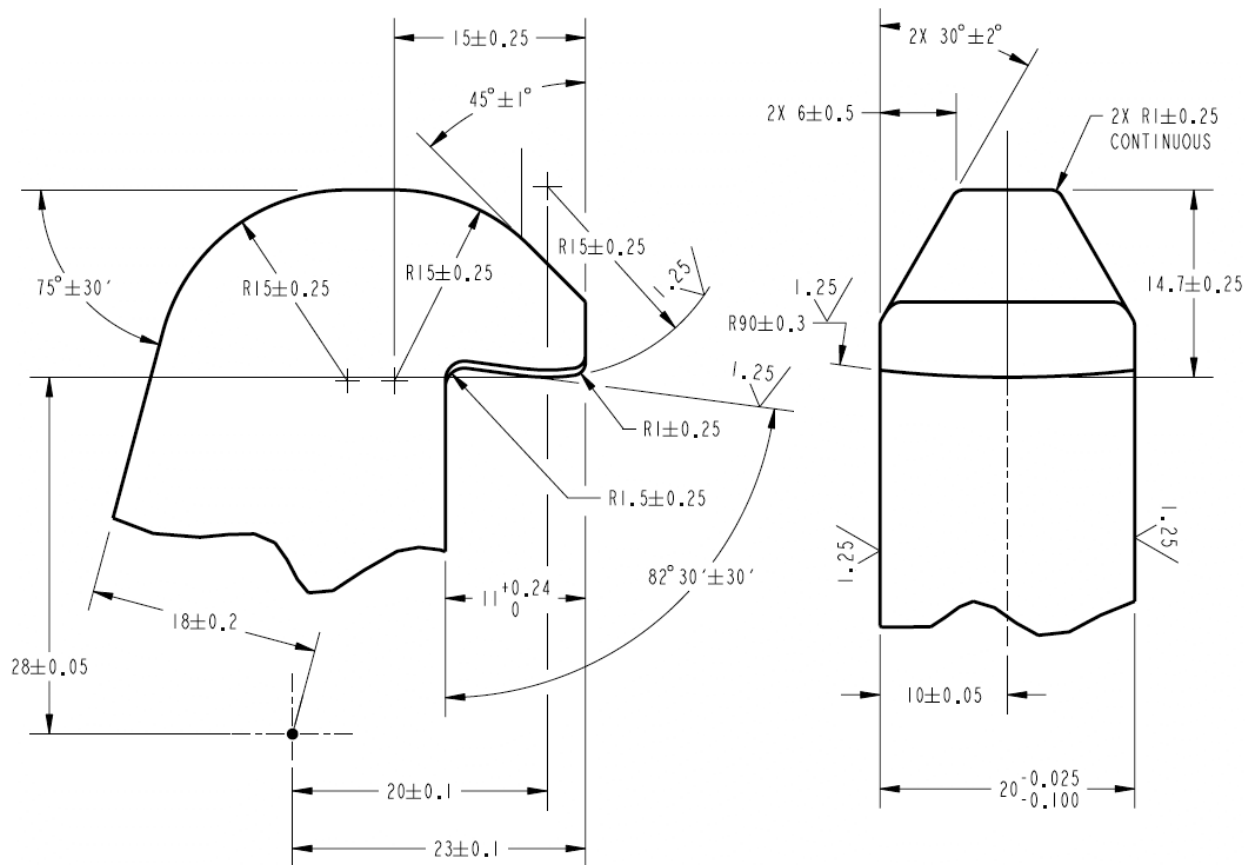


Figure 3-15: HCS Active Hook

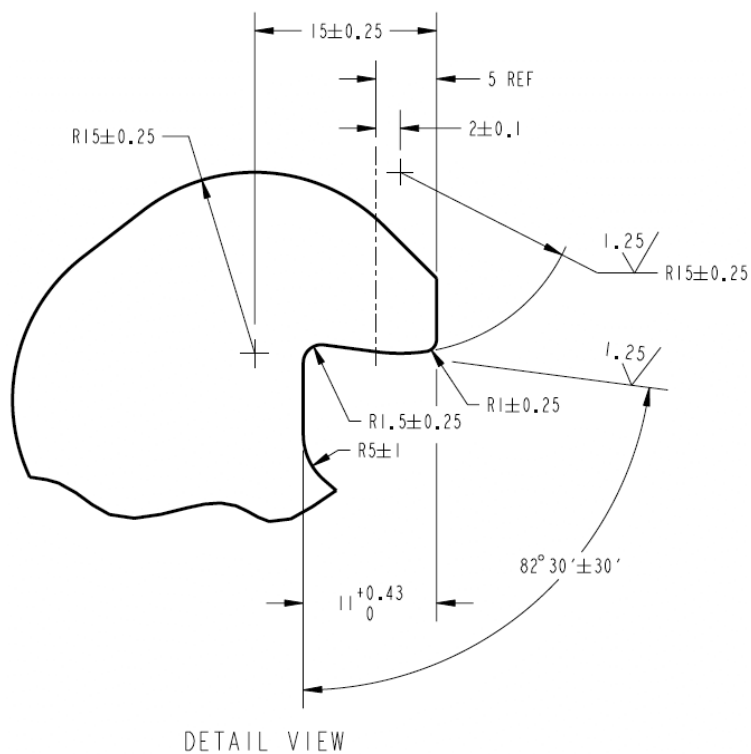
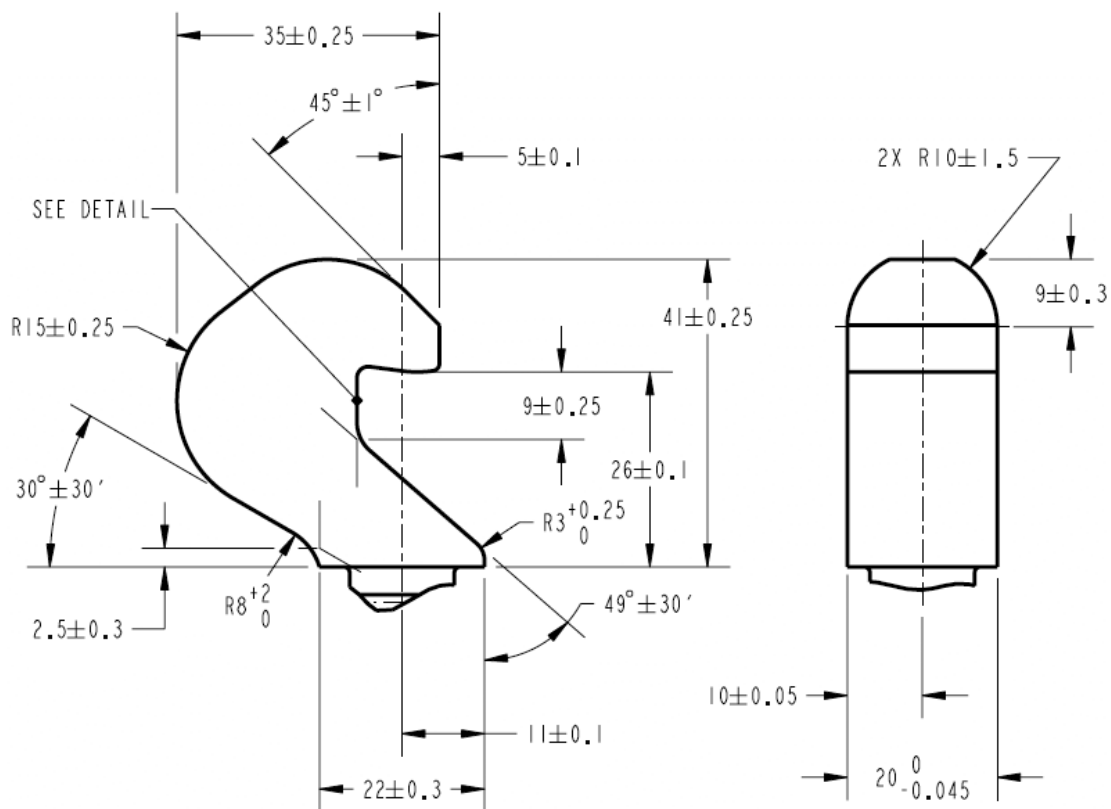


Figure 3-16: HCS Passive Hook

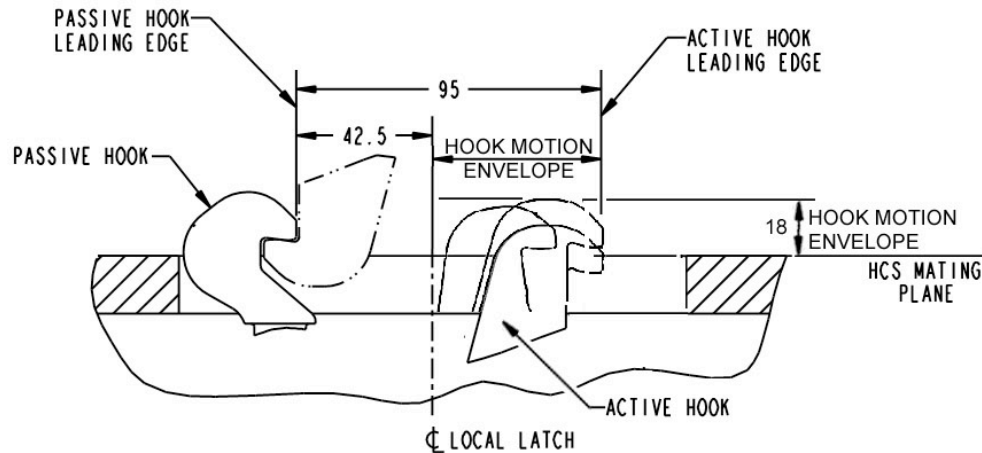


Figure 3-17: HCS Active Hook Motion Envelope

The Hook System is defined as the serial combination of the Active Hook Mechanism, Passive Hook Mechanism and the structural elements that are in compression.

- a) The Preload of the Hook System after locking shall be between the following values:

Minimum Preload of Hook System after locking	= 31 300 N
Maximum Preload of Hook System after locking	= 44 340 N

- b) The Design Limit Capability of the Active and Passive Hook element shall be = 50 000 N

- c) The load response (stiffness) of the Active Hard Capture Hook Mechanism shall be between the upper and lower curves as defined in *Figure 3-18: Load Response of Active Hook Mechanism*.

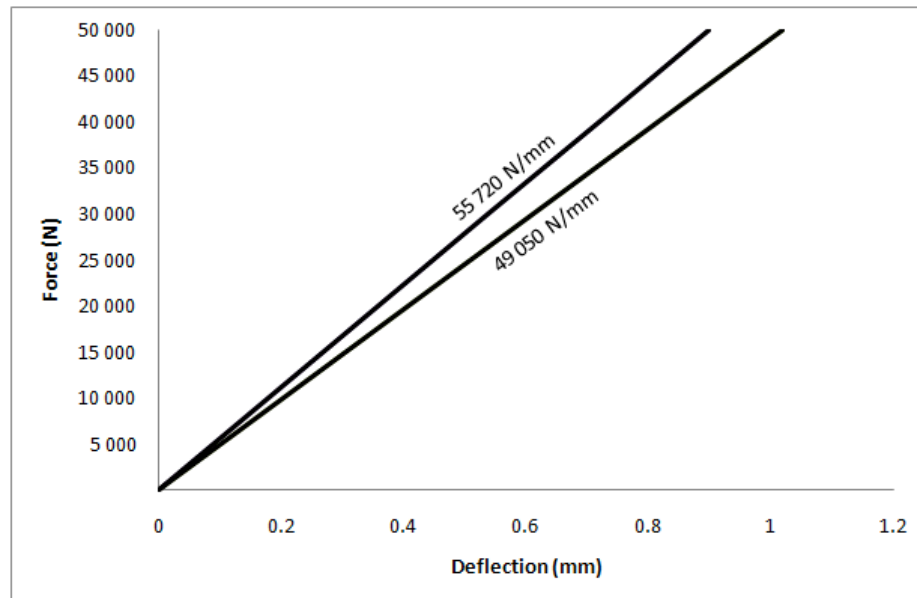


Figure 3-18: Load Response of Active Hook Mechanism

- d) The load response (stiffness) of the Passive Hard Capture Hook Mechanism shall be between the upper and lower curves as defined in *Figure 3-19: Load Response of Passive Hook Mechanism (including Spring Washer Stack)*.

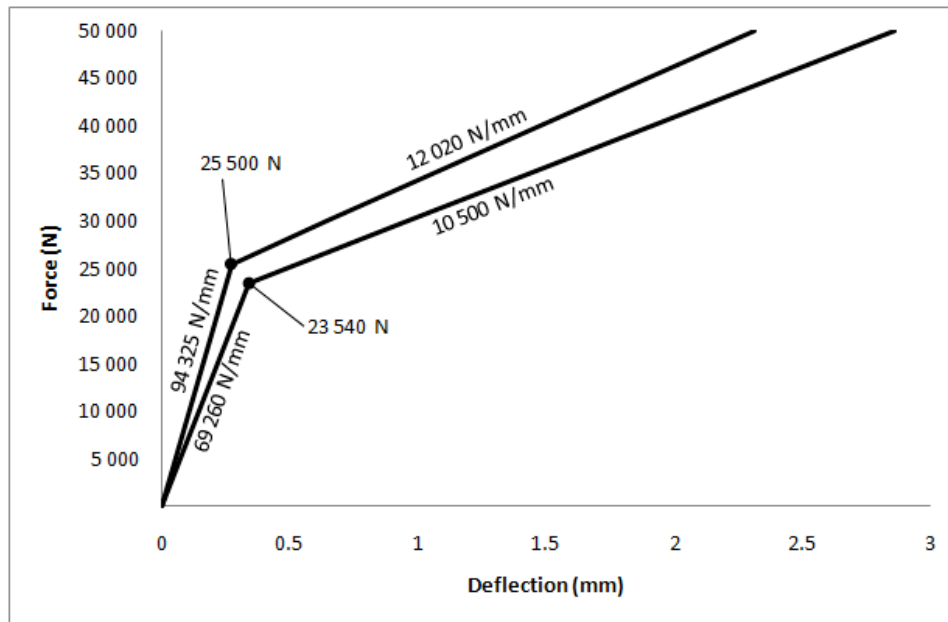


Figure 3-19: Load Response of Passive Hook Mechanism (including Spring Washer Stack)

3.2.3.5 Hard Capture Striker Areas

The HCS has designated areas for striker zones used by the opposing docking system. These striker areas can be used for various HCS sensory components or other subsystems such as separation system push-off devices. IDSS compliant systems shall abide by the designated striker zones defined in *Figure 3-10: HCS Interface - Axial View* and *Figure 3-11: HCS Interface - Sensor Striker Zone*.

3.2.3.6 Separation System

IDSS compliant systems shall implement a retractable separation system that can be remotely commanded to fully retract below the interface plane without application of external forces. The separation system may consist of a set of plungers. The number of plungers is a choice left to the docking system designer, provided that they comply with to the Hard Capture Striker designated areas (see Section 3.2.3.5).

Total separation force ≥ 3400 N at 4.2 mm above the HCS Mating Plane.

3.2.3.7 Resource Transfer Umbilical

The resource transfer umbilicals are not yet standardized in the IDSS. Umbilical connectors transfer resources between the mated vehicles. These resources may include power, data, and ground safety wire, water source and water return, fuel, tank pressurization, and oxidizer.

3.2.4 Electrical Bonding

3.2.4.1 Soft Capture System (Magnetic only)

IDSS compliant systems shall establish bond paths to mitigate electrical hazards on the integrated subsystem interfaces.

IDSS compliant mechanisms protect against electrostatic discharge through the soft capture system. The bond path may be through any metal to metal contact provisions for this purpose. The requirement is from initial contact to hard capture during the docking operation.

Bonding resistance for the SCS after magnetic soft capture shall be 1 ohm or less.

3.2.4.2 Hard Capture System

IDSS compliant mechanisms are to be protected against RF emissions. The bond path is through metal to metal contact on the seal interface between two IDSS compliant HCS mechanisms.

Bonding resistance for the HCS after latching shall be 2.5 milliohms or less.

3.2.5 Environments

Materials used in the construction of the docking interface shall allow proper mating while experiencing the following conditions:

- a) Temperature difference between the two mating interfaces of up to 55°C
- b) External pressure environment $< 1.0 \times 10^{-4}$ Pa

3.2.6 Materials and Surface Finishes

In general, the interface features defined herein, except for the pressure seals, should have stiffness and hardness comparable to commonly used metal alloys. Maintaining a generic requirement without specifying actual numerical values required for each property allows flexibility for the designers. It is assumed that good design practice and the certification program of the user's own docking system are sufficient to ensure satisfactory compatibility at the contact surfaces.

By the same reasoning, specific material selection for the pressure seals will be at the designer's discretion as well.

3.3 Docking Performance

In addition to the physical geometric interface requirements, a set of common design parameters enveloping the reference missions and conditions is provided. For the SCS, this set includes interface loads, vehicle mass properties, and initial contact conditions. For the HCS, this set includes mated loads. Of these common design parameters, only the loads have been defined as requirements. The other common design parameters, if accommodated in the docking system design, increase the probability of successful docking between different spacecraft.

3.3.1 Soft Capture System

The SCS docking performance is defined by the mechanism's ability to capture and attenuate. During the capture phase, the mechanism is contending with the spacecraft misalignment to achieve capture. During the attenuation phase, the mechanism is limiting the relative motion and limiting the loads.

3.3.1.1 Initial Contact Conditions

To increase the probability of successful docking between different spacecraft, it is recommended that IDSS-compliant mechanisms capture and attenuate vehicles within the initial contact conditions shown in *Table 3-1: Initial Contact Conditions*. The set of limiting initial contact conditions provided in *Table 3-1: Initial Contact Conditions* represents the values used in the derivation of the loads defined in *Table 3-4: SCS Maximum Interface Loads* and *Table 3-5: SCS Maximum Component Loads* and represents the achievable capture envelope provided by an IDSS-compatible mechanism's passive interface.

Table 3-1: Initial Contact Conditions

Initial Condition	Limiting Value
Closing (axial) rate	0.05 to 0.10 m/sec
Lateral (radial) rate	0.04 m/sec
Pitch/Yaw rate	0.15 deg/sec (vector sum of pitch/yaw rate)
Roll rate	0.40 deg/sec
Lateral (radial) misalignment	0.11 m
Pitch/Yaw misalignment	5.0 deg (vector sum of pitch/yaw)
Notes: 1. Values are 3 σ maxima and shall apply simultaneously in a statistically appropriate manner, provided that the reach capability of the internal petals is not exceeded. 2. Closing (axial) rate may be increased to achieve necessary capture performance. 3. Post contact thrust may be used to achieve necessary capture performance. 4. Lateral (radial) rate limit includes combined lateral and rotational rates of both vehicles. 5. Lateral misalignment is defined as the minimum distance between the center of the active soft capture ring and the longitudinal axis of the passive soft capture ring at the moment of first contact between the guide petals.	

3.3.1.2 Vehicle Mass Properties

To increase the probability of successful docking between different spacecraft, it is recommended that IDSS-compliant mechanisms capture and attenuate vehicles with the mass properties shown in *Table 3-2: Vehicle Mass Properties*. The set of design case vehicle mass properties provided in *Table 3-2: Vehicle Mass Properties* represents the values used in the derivation of the loads defined in *Table 3-4: SCS Maximum Interface Loads* and *Table 3-5: SCS Maximum Component Loads*.

Table 3-2: Vehicle Mass Properties

Article	Mass (kg)	Moment of Inertia (kg*m ²)						Coordinates of Ring Center (m)		
		Ixx	Iyy	Izz	Ixy	Ixz	Iyz	X	Y	Z
IDSS-350T	3.50E+5	1.15E+8	6.20E+7	1.65E+8	-2.30E+6	5.00E+5	4.60E+5	-20.0	0	2
IDSS-25T	25000	70000	169000	169000	0	0	0	5.4	0	0
IDSS-20T	20000	55000	135000	135000	0	0	0	4.3	0	0
IDSS-15T	15000	41000	71000	71000	0	0	0	4.1	0	0
IDSS-10T	10000	17000	42000	42000	0	0	0	3.5	0	0
IDSS-5T	5000	3400	18000	18000	0	0	0	2.3	0	0
Notes: 1. Moments of inertia (MOI) are about C.G. and products of inertia (POI) are positive integral. 2. Mass properties defined in coordinate system located at C.G. with X-axis along vehicle longitudinal axis and positive toward the docking interface.										

3.3.1.3 Vehicle Motion Limits

Reserved.

Reserved.

Table 3-3: Vehicle Motion Limits

3.3.1.4 Loads

The active SCS of IDSS-compliant mechanisms shall meet all of its functional and performance requirements without exceeding the loads defined in *Table 3-4: SCS Maximum Interface Loads* and *Table 3-5: SCS Maximum Component Loads*.

Table 3-4: SCS Maximum Interface Loads

Load	Limiting Value
Tension	3900 N
Compression (Static)	3500 N
Compression (Dynamic, up to 0.1sec)	6500 N
Shear	3200 N
Bending	2800 N*m
Torsion	1500 N*m

Notes:

1. Values are design limit loads.
2. Values are defined at the center of the SCS mating plane (*Figure 3-1*).
3. Values are 3σ maxima and shall apply simultaneously, not to exceed the component values shown in *Table 3-5*.
4. Shear loads may be applied in any direction in the SCS mating plane.
5. Bending moment may be applied about any axis in the SCS mating plane.

Table 3-5: SCS Maximum Component Loads

Load	Limiting Value			
Mechanical Latch Striker Tension	3000 N			
Magnetic Latch Striker Tension	2300 N			
Striker Compression	3000 N			
Petal Edge Length	0%	10%	60%	80%
Petal Contact Loads	3500 N	2300 N	2300 N	1000 N

Notes:

1. Values are design limit loads.
2. The petal contact load can only be applied to the petal edge from the root of the petal to 80% of the petal length.
3. The petal contact load can only be applied to the outer face of the petal from the root of the petal to 60% of the petal length.

3.3.2 Hard Capture System

3.3.2.1 Mated Loads

IDSS-compliant mechanisms shall certify to the loads shown in *Table 3-6: HCS Maximum Mated Loads* and *Table 3-7: HCS Mated Load Sets* for design loads, as a minimum. These loads are applied at the center of the HCS interface, as defined in *Figure 3-10: HCS Interface - Axial View*.

Table 3-6: HCS Maximum Mated Loads

	Mated ISS	Trans-Lunar
Maximum Design Pressure	1 100 hPa	0 h Pa
Seal Closure Force	97 150 N	97 150 N
Compressive Axial Load	17 700 N	300 000 N
Tensile Axial Load	17 700 N	100 000 N
Shear Load	16 700 N	10 000 N
Torsion Moment	15 000 Nm	15 000 Nm
Bending Moment	68 700 Nm	40 000 Nm

Table 3-7: HCS Mated Load Sets

Load Set	Case 1	Case 2	Case 3	Case 4
Design Pressure	1 100 hPa	1 100 hPa	1 100 hPa	0 hPa
Seal Closure Force	97 150 N	97 150 N	97 150 N	97 150 N
Compressive Axial	5 000 N	17 700 N	13 700 N	300 000 N
Tensile Axial Load	5 000 N	17 700 N	13 700 N	100 000 N
Shear Load	5 000 N	14 800 N	16 700 N	10 000 N
Torsion Moment	15 000 Nm	15 000 Nm	15 000 Nm	15 000 Nm
Bending Moment	65 300 Nm	39 200 Nm	68 700 Nm	40 000 Nm

Notes for Table 3-6 and Table 3-7:

- a) Values are design limit loads.
- b) Hard capture hook preload and tunnel stiffness will be such that, when under external loading within limits, there remains metal-to-metal contact in the local vicinity of the hooks.
- c) Shear loads may be applied in any direction in the HCS mating plane.
- d) Bending moment may be applied about any axis in the HCS mating plane.
- e) The outer seal bead shall be used for all pressure calculations.
- f) Load cases are defined in *Table 3-7: HCS Mated Load Sets* and *Table 3-6: HCS Maximum Mated Loads* is a summary of the maximum loads.
- g) Case descriptions:
 - i) Case 1 – Attitude control by Orbiter-sized vehicle, combined with crew activity.
 - ii) Case 2 – Interface loads due to ISS segment berthing.
 - iii) Case 3 – Orbiter-sized vehicle translation with payload attached to ODS.
 - iv) Case 4 – Unpressurized high axial tension load case; modified from Constellation Trans-lunar Injection loads analysis.

APPENDIX A

To maintain simplicity for the standard, a set of generic zones, called the HCS Component Striker Zones, are defined on the HCS mating flange (shown in *Figure 3-10: HCS Interface - Axial View*) as striker zones for various peripheral components and sensors. These zones are the passive flat surface that a docking system designer might choose to use as striker areas for the corresponding devices.

The HCS Component Striker Zones are nine identical segments around the circumference of the HCS. A reference numbering scheme for the segments is given in *Figure A-1: HCS Component Striker Zone Reference Numbers*. Each segment consists of a Free Area and a Reserved Area.

For both the Free Area and the Reserved Area, the striker area is a flat surface with a few local exceptions. These exceptions are various small holes used for the underlying subsystems (such as attach points for the Latching System), and for other purposes. Many times, these small holes will not interfere with the striking device. The details of these small holes and other features is provided herein for a designer to consider when utilizing the striker zone.

In the Free Area, the same small exceptions occur repeatedly, and these features should be easier to work around to place striking components. The Reserved Area is where legacy systems, such as APAS or NDS, have already located components which will be difficult to work around in some locations, and the use of these areas will require careful, detailed coordination with those designs to assure no interference. These features within the striker zones are shown in *Figure A-2: APAS Features within Striker Zones* and *Figure A-3: NDS Features within Striker Zones*.

In summary, using the Free Areas is recommended, though the locations of some small holes must be considered. Using the Reserved Areas will require collaboration with the relevant legacy system and/or mission specific information.

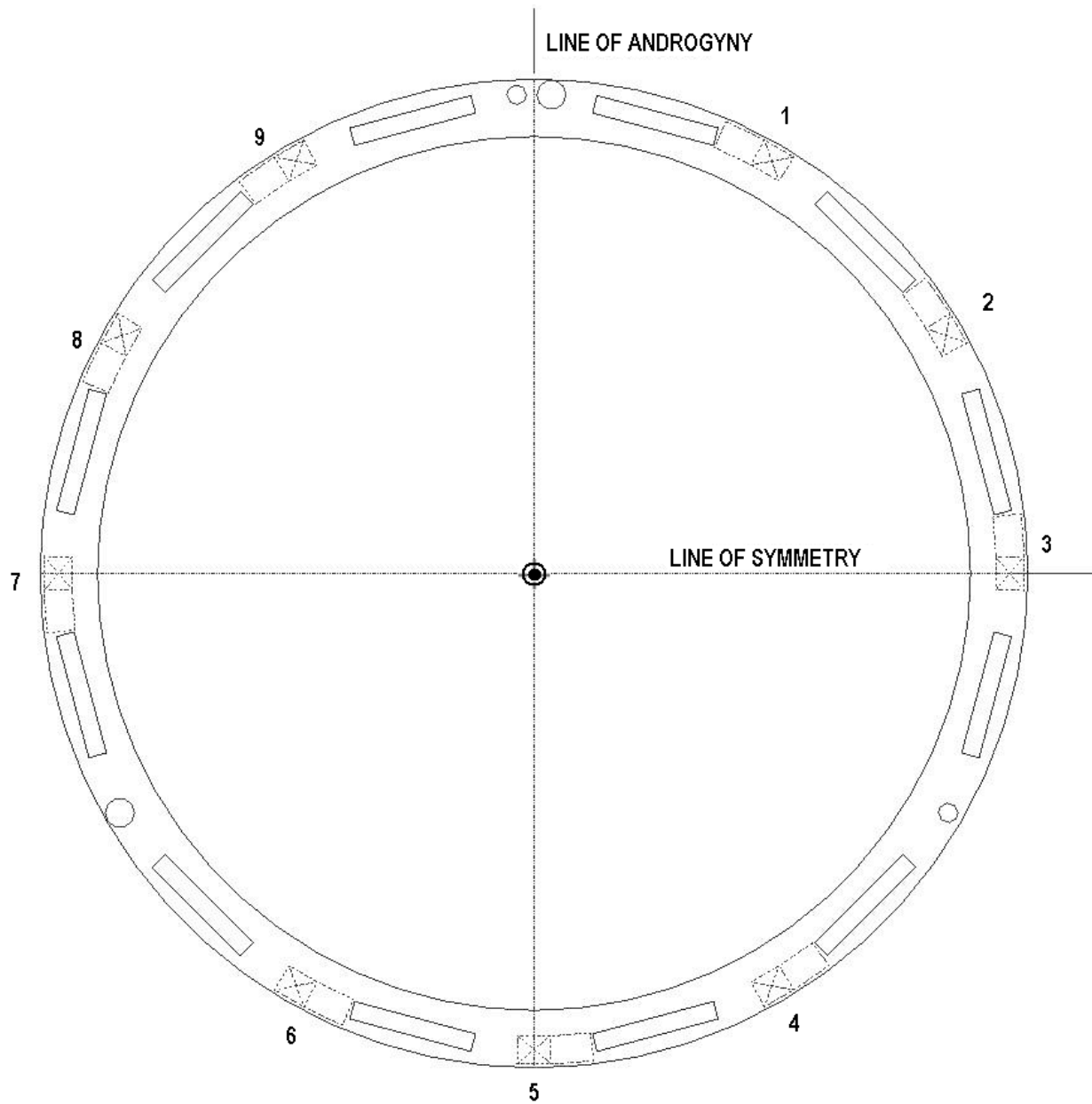
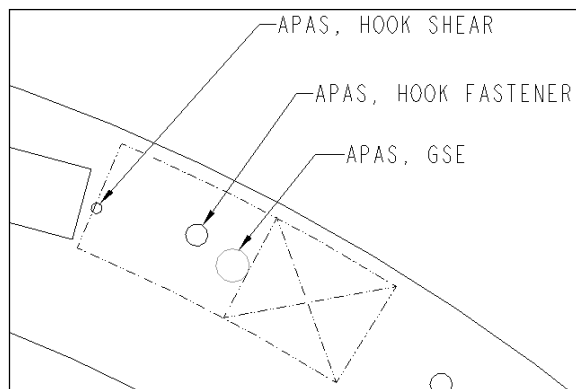
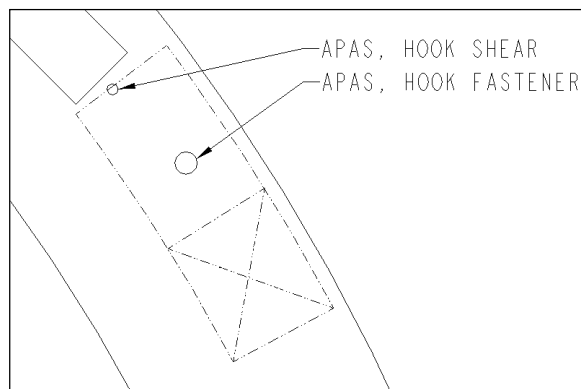


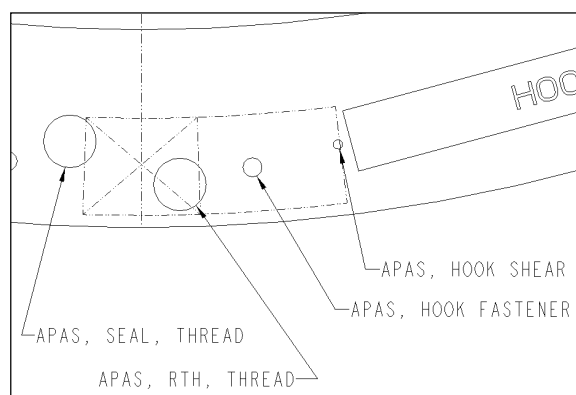
Figure A-1: HCS Component Striker Zone Reference Numbers



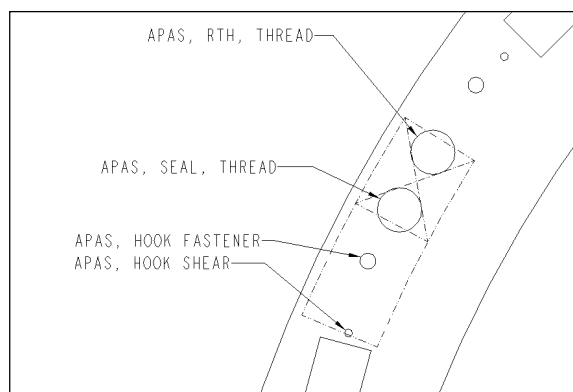
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1, 3, 4, 7, 9



Detail Applies at the following locations:
2, 6

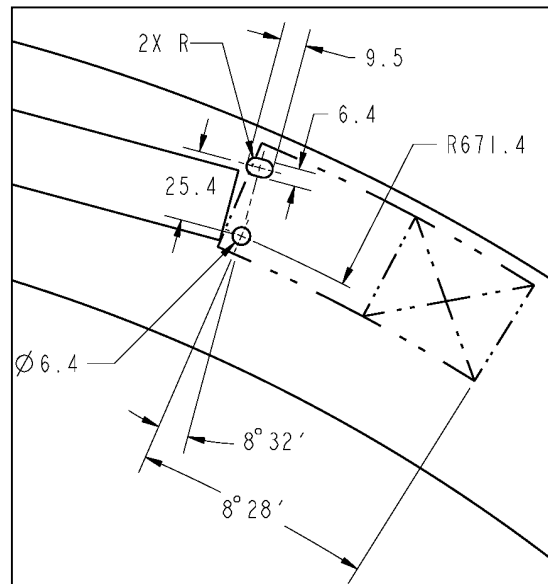


Detail Applies at the following location:
5



Detail Applies at the following location:
8

Figure A-2: APAS Features within Striker Zones



Detail Applies at all locations

Figure A-3: NDS Features within Striker Zones

APPENDIX B ACRONYMS AND ABBREVIATIONS

APAS	Androgynous Peripheral Assembly System
C	Celsius
CG	Center of Gravity
CSA	Canadian Space Agency
ESA	European Space Agency
F	Fahrenheit
HCS	Hard Capture System
hPa	Hecto Pascal(s)
IDD	Interface Definition Document
IDSS	International Docking System Standard
iLIDS	International Low Impact Docking System
ISS	International Space Station
kgf	Kilograms Force
LEO	Low Earth Orbit
M	Meters
MCB	Multilateral Control Board
MEXT	Ministry of Education, Culture, Sports, Science and Technology – Japan
MIN	Minimum
mm	Millimeters
MOI	Moments of inertia
N	Newton(s)
NASA	National Aeronautics and Space Administration
NDS	NASA Docking System
Nm	Newton-Meter(s)
ODS	Orbiter Docking System
ohm	Ohms
Pa	Pascal
POI	Products of inertia
RF	Radio Frequency
SCS	Soft Capture System
SSRMS	Space Station Remote Manipulator System
TBC	To Be Confirmed
TBD	To Be Determined