JSC-63686F

# International Low Impact Docking System (iLIDS) Project Technical Requirements Specification

**System Architecture and Integration Office**
**Engineering Directorate**

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**International Low Impact Docking System (iLIDS)**
**Project Technical Requirements Specification**

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# Change Record

| Status | Revision No. | Change No. | Description | Release Date |
|---|---|---|---|---|
| Baseline | | | Baseline (Reference CR/D 000180/2-1,dated 9/24/07 also includes CAR 000180,dated 10/01/07) | 10/17/07 |
| Revision | A | | Revision A (Reference CR/D CEV-00109, dated 05/13/2008) | 9/26/08 |
| Revision | B | | Revision B (Rewrite based on change from Orion specific docking system to NASA Docking System (NDS) compliant with emerging International Docking System Standard (IDSS). Requirements validated via NDS Baseline Review comments and dispositions incorporated herein. See Appendix C-4 for a complete listing of changes. | 10/15/10 |
| Revision | C | | Revision C (Removal of Export Administration Regulations (EAR) Notice) | 11/15/10 |
| Revision | D | | ITAR statement added. See Appendix C-5 for a complete listing of changes. | 1/26/11 |
| Revision | E | | See Appendix C-5 for a complete listing of changes. | 3/15/11 |
| Revision | F | | Post-CDR updates. See Appendix C-5 for a complete listing of requirement changes. | 8/15/11 |

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# 1 INTRODUCTION

## 1.1 Purpose and Scope

The NASA Docking System (NDS) is NASA's implementation for the emerging International Docking System Standard (IDSS) using low impact docking technology. The NASA Docking System Project (NDSP) is the International Space Station (ISS) Program's project to produce the NDS, Common Docking Adapter (CDA) and Docking Hub. The NDS design evolved from the Low Impact Docking System (LIDS). The acronym international Low Impact Docking System (iLIDS) is also used to describe this system as well as the Government Furnished Equipment (GFE) project designing the NDS for the NDSP. NDS and iLIDS may be used interchangeability. This document will use the acronym iLIDS. Some of the heritage documentation and implementations (e.g., software command names, requirement identification (ID), figures, etc.) used on NDS will continue to use the LIDS acronym.

This specification defines the technical requirements for the iLIDS GFE delivered to the NDSP by the iLIDS project. This document contains requirements for two iLIDS configurations, SEZ29101800-301 and SEZ29101800-302. Requirements with the statement, "iLIDS shall", are for all configurations. Examples of requirements that are unique to a single configuration may be identified as "iLIDS (-301) shall" or "iLIDS (-302) shall". Furthermore, to allow a requirement to encompass all configurations with an exception, the requirement may be designated as "iLIDS (excluding -302) shall".

Verification requirements for the iLIDS project are identified in the Verification Matrix (VM) provided in the iLIDS Verification and Validation Document, JSC-63966.

The following definitions differentiate between requirements and other statements:

| | |
|---|---|
| Shall: | This is the only verb used for the binding requirements. |
| Should/May: | These verbs are used for stating non-mandatory goals. |
| Will: | This verb is used for stating facts or declaration of purpose. |

A "Definition of Terms" table is provided in Appendix B to define those terms with specific tailored uses in this document.

## 1.2 Responsibility and Change Authority

This document is prepared and maintained in accordance with EA-WI-023, Project Management of GFE Flight Projects. The responsibility for the development of this document lies with the Systems Architecture and Integration Office (EA3). The NDS Project Office will serve as the change authority.

# 2 APPLICABLE AND REFERENCE DOCUMENTS

## 2.1 Applicable Documents

The following documents, of the exact issue and revision shown, form a part of this specification, to the extent specified herein.

**Table 2.1-1 - Applicable Documents**

| Document Number | Revision/ Release Date | Document Title |
|---|---|---|
| ANSI/TIA/EIA-422B | Rev. B<br>16 Sep. 2005 | Electrical Characteristics of Balanced Voltage Digital Interface Circuits |
| ANSI/TIA/EIA-568-B.2 | Rev. B<br>Apr. 2001 | Balanced Twisted-Pair Telecommunications Cabling and Components Standards |
| IDSS IDD | Rev. A<br>13 May 2011 | International Docking System Standard (IDSS) Interface Definition Document (IDD) |
| JPR 8080.5 | Rev. A<br>w/Change 1<br>1 May 2009 | JSC Design and Procedural Standards |
| JPR 8730.2 | Baseline<br>Mar. 2008 | JSC Fastener Integrity Testing Program |
| JSC 28918 | Baseline<br>Feb. 2005 | Extravehicular Activity (EVA) Design Requirements and Considerations |
| JSC 62809 | Rev. D<br>22 Apr. 2010 | Human Rated Spacecraft Pyrotechnic Specification |
| JSC 64598 | Baseline<br>Mar. 2011 | iLIDS Ionizing Radiation Control Plan |
| JSC 64599 | Draft<br>Dec. 2010 | iLIDS Electric Power Quality Description Document |
| JSC 64924-A | Rev. A<br>10 Aug. 2011 | iLIDS Electrical, Electronic and Electromechanical (EEE) Parts Management and Implementation Plan |
| JSC 65795 | Rev. D<br>15 Mar. 2011 | NASA Docking System (NDS) Interface Definition Document (IDD) |
| JSC 65842 | Draft<br>Mar. 2011 | iLIDS Electromagnetic, Environmental, Effects (E3) Description Document |
| JSC 65970 | Rev A.<br>17 Jun. 2011 | iLIDS Thermal and Induced Environments Specification |
| MIL-STD-1553B | Rev. B, Change Notice 2<br>2 Sep. 1986 | Department of Defense Interface Standard for Digital Time Division Command/Response Multiplex Data Bus |
| NASA-STD-4003 | Baseline<br>8 Sep. 2003 | Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment |

| Document Number | Revision/ Release Date | Document Title |
|---|---|---|
| NASA-STD-5005 | Rev. C<br>13 Mar. 2009 | Standard for the Design and Fabrication of Ground Support Equipment |
| NASA-STD-5017 | Baseline<br>13 Jun. 2006 | Design and Development Requirements for Mechanisms |
| NASA-STD-5019 | Baseline<br>7 Jan. 2008 | Fracture Control Requirements for Spaceflight Hardware |
| NASA-STD-6016 | Baseline<br>11 Jul. 2008 | Standard Material and Processes Requirements for Spacecraft |
| NASA/TP-2002-210780 | Baseline<br>May 2002 | The New NASA Orbital Debris Engineering Model ORDEM2000 |
| PRC-9002 | Rev. I<br>Jun. 2010 | Process Specification for Part Marking |
| SN-C-0005 | Rev. D<br>w/Change 13<br>13 Feb. 2008 | Contamination Control Requirements |
| SSP 30234 | Rev. F, DCN 2<br>Dec. 2008 | Failure Modes and Effects Analysis and Critical Items List Requirements for Space Station |
| SSP 30309 | Rev. F<br>23 Oct. 2009 | Safety Analysis and Risk Assessment Requirements Document |
| SSP 30425 | Rev B<br>8 Feb. 1994 | Space Station Program Natural Environment Definition for Design |
| SSP 30559 | Rev. D<br>27 Jul. 2007 | Structural Design and Verification Requirements |
| SSP 41172 | Rev. AA<br>8 Apr. 2010 | Qualification and Acceptance Environmental Test Requirements |
| SSP 50005 | Rev. E<br>6 Jun. 2006 | International Space Station Flight Crew Integration Standard (NASA-STD-3000/T) |
| SSP 50021 | Baseline with DCN 004<br>22 Jul. 2009 | Safety Requirements Document |
| SSP 50038 | Rev. B<br>17 Nov. 1995 | Computer-Based Control System Safety Requirements |
| SSP 50254 | Rev. N<br>20 Mar. 2011 | International Space Station Program Operations Nomenclature |
| SSQ 21655 | Rev. G<br>15 Feb. 2005 | Cable, Electrical, MIL-STD-1553 Databus, Space Quality, General Specification |
| Webster's | | Webster's New World Dictionary of American English |

## 2.2 Reference Documents

The following documents are reference documents utilized in the development of this specification.

**Table 2.2-1 - Reference Documents**

| Document Number | Revision/ Release Date | Document Title |
|---|---|---|
| EA-WI-023 | Rev. E, DCN-2<br>Sep. 2010 | Project Management of Government Furnished Equipment (GFE) Flight Projects |
| JSC-27301 | Rev. F<br>Aug. 2009 | Materials Control Plan for JSC Flight Hardware |
| JSC-28533 | Rev. F<br>Jan. 2010 | International Space Station Catalogue of Intravehicular Activity (IVA) Government Furnished Equipment (GFE) Flight Crew Equipment (FCE) |
| NPR 8705.2 | Rev. B w/Change 1<br>7 Dec. 2009 | Human Rating Requirements and Guidelines |
| NSTS 07700 Vol. X, Book 2 | Rev. M, w/Change No. 256<br>15 Jul. 2011 | Space Shuttle Flight and Control System Specification Volume X, Book 2 |
| SSP 30233 | Rev. H<br>21 Aug. 2007 | Space Station Requirements for Materials and Processes |
| SSP 30426 | Rev. D<br>21 Jan. 1994 | Space Station External Contamination Control Requirements |
| SSP 41000 | Rev. BU<br>30 Mar. 2011 | System Specification for the International Space Station |
| SSP 41004 | Rev. H<br>25 Oct. 2005 | Common Berthing Mechanism to Pressurized Elements Interface Control Document Part 1 |

## 2.3 Order of Precedence

In the event of a conflict between the text of this specification and an applicable document cited herein, the text of this specification takes precedence except for JSC-65795, International Low Impact Docking System (iLIDS) Interface Definition Document (IDD). This document uses the following three methods to invoke requirements from applicable documents:

- The requirement is written directly from the applicable document
- The entire document is invoked as applicable
- An entire document is invoked as applicable with cited exceptions

# 3 REQUIREMENTS

## 3.1 International Low Impact Docking System General Requirements

### 3.1.1 iLIDS GFE Description

The iLIDS mating system supports low approach velocity docking and provides a modular and reconfigurable standard interface, supporting crewed and autonomous vehicles during mating and assembly operations.

The iLIDS is an androgynous peripheral docking system. It facilitates low approach velocity docking via a reconfigurable, active, closed-loop, force-feedback controlled mating system using modern technologies. The iLIDS supports both crewed and autonomous vehicles during mating and assembly operations. In addition, it is modular and reconfigurable for a variety of missions. Future iLIDS configurations will be certified to allow docking at positive, zero, and negative approach velocities, as well as berthing.

The iLIDS system establishes the initial contact of two vehicles through a Soft Capture System (SCS), which uses the low impact docking technology. This system consists of guide petals, magnets, magnetic striker plates, electromechanical actuators in a Stewart Platform configuration, and load sensing rings. During docking soft capture, the guide petals are the first to make contact, transferring contact/load inputs into the load sensing load cells. The load cells provide information to drive the electromechanical actuators to correct lateral and angular misalignment between the two opposing interfaces. Soft capture completes when electromagnetic attachment of the magnets to the striker plates on the opposing capture ring occurs.

The hard capture subsystem uses powered hooks to engage with another iLIDS in passive mode, providing a structural connection ready for pressurization between the mated vehicles that allows for cargo and crew transfer. The Hard Capture System (HCS) consists of a tunnel, 12 active/passive hook pairs, seals, and mechanized separation/umbilicals. The docking is complete when mechanized resource transfer umbilicals are extended and engaged with the spring-load separation system energized for undocking.

The iLIDS is a docking system that can be commanded via iLIDS electronics interface from the host vehicle in either an active mode or a passive mode. Active mode is when the iLIDS commands the soft capture and all sequences of docking. Passive mode is when the iLIDS yields control and allows the iLIDS, in active mode, to mate to it. See the iLIDS figure below.

In support of the NDSP, two iLIDS configurations are used: the iLIDS-301 and the iLIDS-302.

The iLIDS-301 is a standalone assembly with all required hardware (e.g., Micrometeoroid and Orbital Debris (MMOD, electrical boxes, etc.) contained in the assembly. The iLIDS-301 can dock to another iLIDS-301 or to iLIDS-302.

The iLIDS-302 has most of the same functionality as the iLIDS-301. The main difference is the electrical boxes are integrated in the host vehicle rather than the docking system assembly. Hence, the tunnel structure is shorter (i.e. compact). In addition, the iLIDS-302 relies on the host vehicle for MMOD shielding. Further, the iLIDS-302 does not contain a seal on the mating surface which would support longer duration missions such as for the ISS CDA. Therefore the iLIDS-302 can only dock to iLIDS-301. However, the iLIDS-302 will not be initially certified to perform powered soft capture.

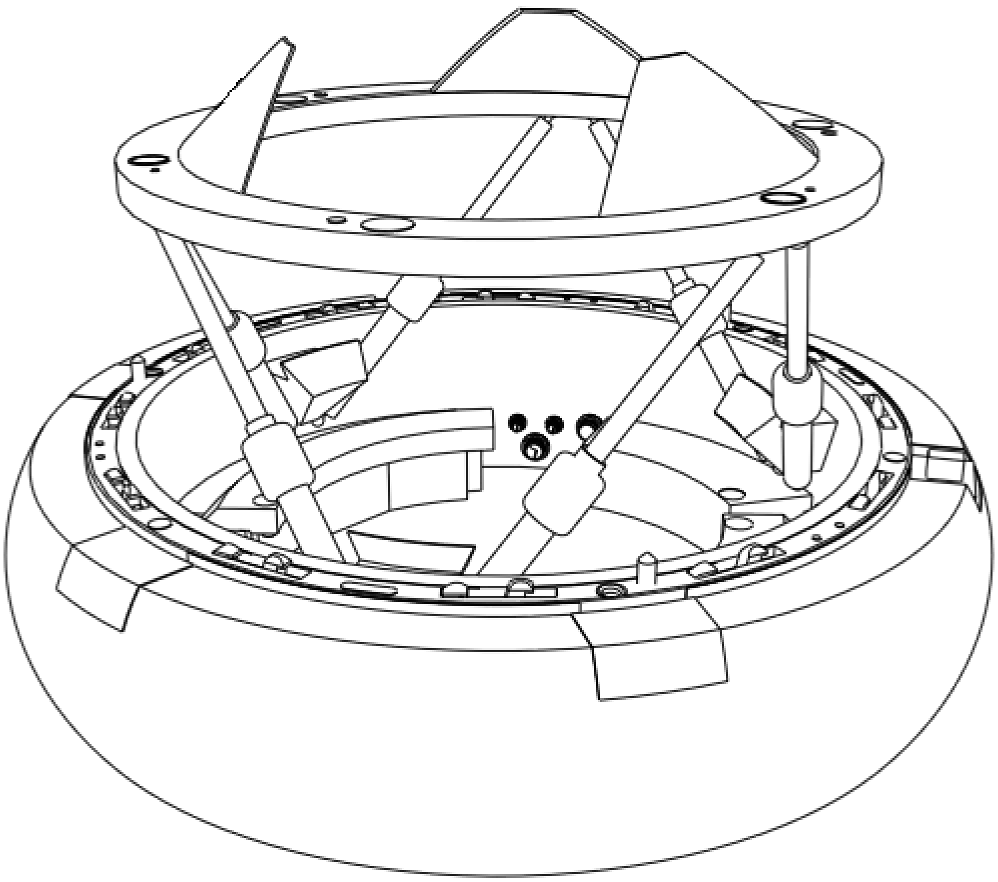


**Figure 3.1-1 - iLIDS-301**

### 3.1.2 iLIDS Interface Requirements

From a high-level system perspective, an iLIDS unit will have the following interfaces:

- iLIDS-to-Host Vehicle.
- iLIDS (chaser vehicle)-to-iLIDS (mating vehicle).
- iLIDS-to-Ground Support Equipment (GSE). The iLIDS System Interface Diagram below shows the functions crossing each interface.

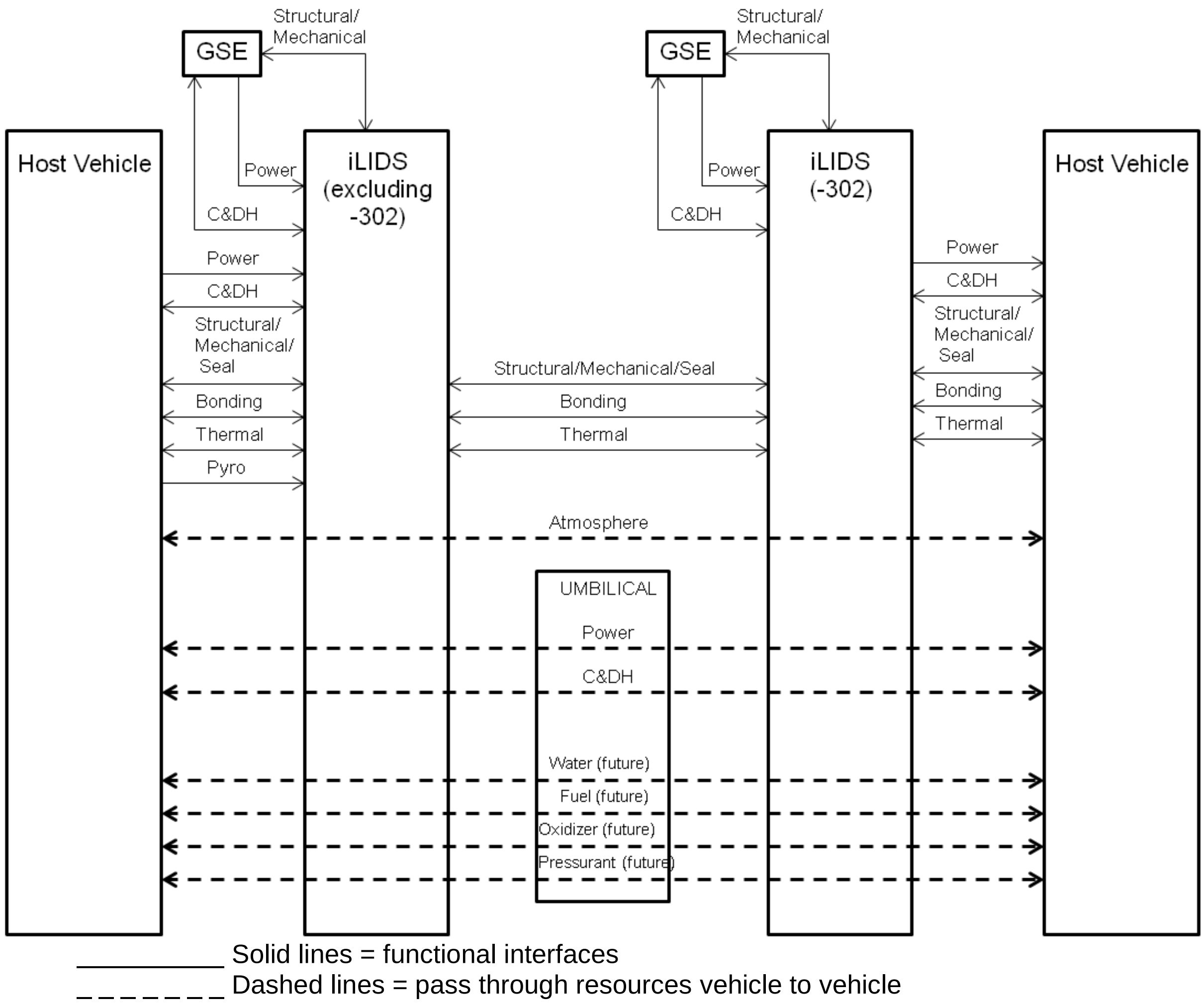



**Figure 3.1-2 - iLIDS System Interface Diagram**

**[R.LIDS.1001] Berthing**

The iLIDS shall support berthing per To Be Specified (TBS)-217.

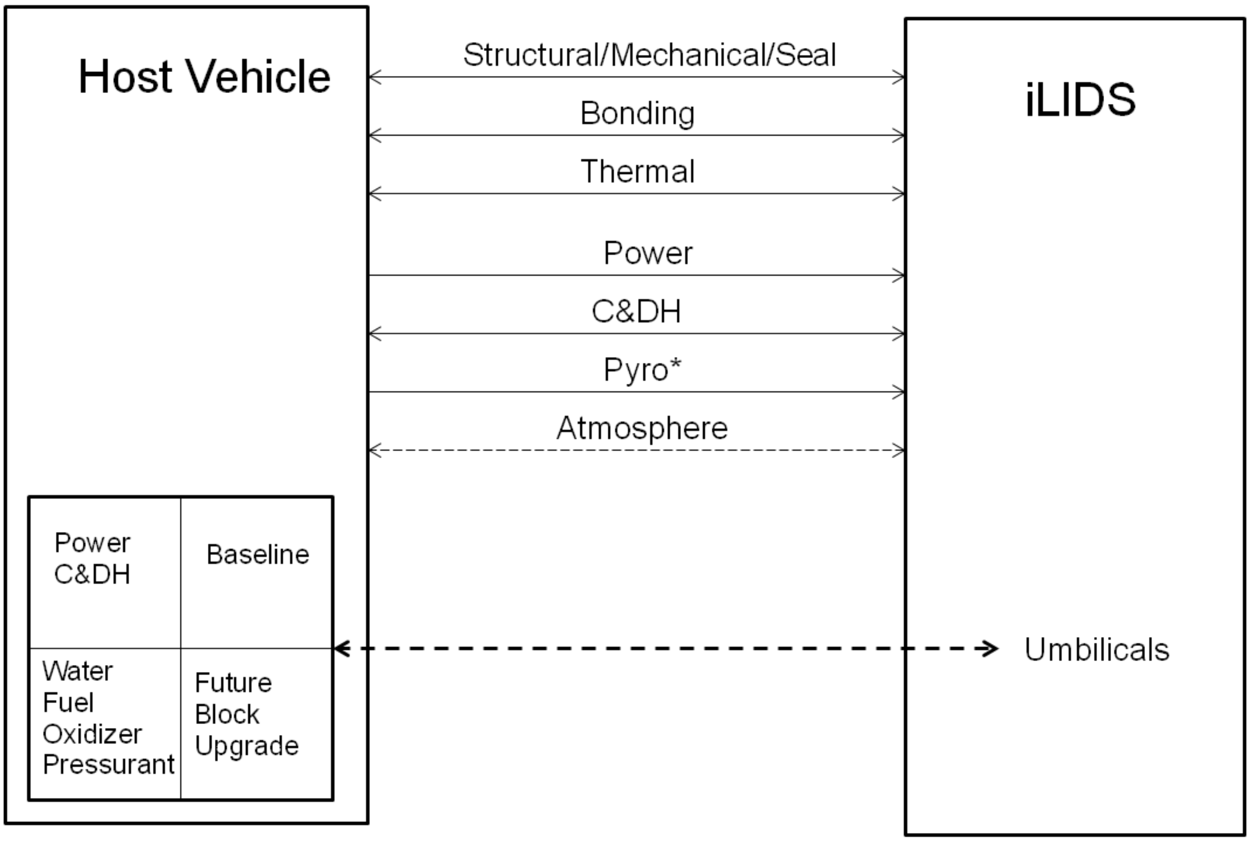
> *Rationale: The iLIDS provides for vehicle-level docking. The iLIDS design shall not preclude berthing. Refer to Berthing Requirements Document TBS-217 for specific berthing requirements.*

### 3.1.2.1 iLIDS-to-Host Vehicle Interface

The iLIDS incorporates the following interface functions to the Host Vehicle:

- iLIDS supports structural/mechanical attachment to the Host Vehicle.
- iLIDS receives power from the Host Vehicle.
- iLIDS supports vehicle-to-vehicle transfer of atmosphere, power, data, and communications. Future configurations will include water, fuel, oxidizer, and pressurant.
- iLIDS supports electrical bonding to the Host Vehicle.

- iLIDS supplies data to the Host Vehicle.
- iLIDS receives commands from the Host Vehicle.
- iLIDS (excluding -302) receives pyrotechnic controller signals from the Host Vehicle.




Note: * denotes Pyro is not an interface on iLIDS-302
__________ Solid lines = functional interfaces
_ _ _ _ _ _ _ Dashed lines = pass through resources vehicle to vehicle

**Figure 3.1-3 - iLIDS-to-Host Vehicle Interface Diagram**

**[R.LIDS.0001] iLIDS Structural Attachment on Host Vehicle**

The iLIDS shall provide structural mating and sealing to the host vehicle per JSC-65795, NDS IDD, figure NDS-to-Host Vehicle Mounting Interface.

*Rationale: The mating vehicle includes CDA. The host vehicle will provide accommodation to allow iLIDS to attach to the host vehicle. The iLIDS-to-host vehicle is secured/attached by fasteners. See Figure: iLIDS-to-Host Vehicle Mounting Interface for a schematic of the mounting interface. The iLIDS will provide the fasteners for this interface. The iLIDS mechanism will be provided as Government Furnished Equipment. Refer to JSC-65795, International Low Impact Docking System (iLIDS) Interface Definition Document (IDD) for the details of this interface. The interface defined is based on the common interface used for Apollo/Soyuz, Shuttle/Mir, and Shuttle/ISS docking systems.*

### [R.LIDS.0003] Host Electrical Power Interface - 120 Vdc

The iLIDS (-301, -302) shall operate with host vehicle power of 120 Vdc in accordance with JSC-64599, iLIDS Electric Power Quality Description Document.

*Rationale: An electrical power interface is needed to allow the host vehicle to power the iLIDS. This is the power for iLIDS consumption, which is not to be confused with the host vehicle pass-through power to the mating vehicle. Future configurations will allow for other host vehicle power (e.g., 28 Vdc).*

### [R.LIDS.0004] Reception of Commands for Docking

The iLIDS shall receive commands from the host vehicle for all sequences as specified in JSC-65795, NDS IDD, Appendix C, NDS Commands List.

*Rationale: The host vehicle can send an individual sequence or chain of sequences. JSC-65795 will specify the ordering of sequence; however, it is up to the host vehicle's discretion to send the commands.*

### [R.LIDS.0006] Docking Termination

The iLIDS shall terminate docking upon receipt of a command from the host vehicle prior to hook activation.

*Rationale: For safety purposes, automated functions such as docking should be designed with an override capability that allows the host vehicle to stop, safe, or assume manual control of the automated function after it was initiated. The point at which the override occurs will differ depending on the function. Some activities may only be taken to a safe state and no manual control is available. The intent is to cover the time span beginning with SCS mechanism release contact and extending through rigidization docking completion. This ability is required for the Vehicle crew, ISS crew, or other Space System operators to control automated functions onboard the Vehicle. It covers the case where the vehicle is unable to achieve capture, wants to back out, reset, and make a second docking attempt. It also covers the case where the crew simply becomes uncomfortable with the safety of proceeding onward with the docking operation, and wishes to halt it and back away.*

### [R.LIDS.0008] Pause Docking Commands

The iLIDS shall accept a command from the host vehicle to pause the docking sequence at predetermined safe points in the sequence.

*Rationale: There are failure scenarios where the docking sequence should not be terminated, but rather paused to allow troubleshooting.*

### [R.LIDS.0009] Pause Undocking Commands

The iLIDS shall accept a command from the host vehicle to pause the undocking sequence at predetermined safe points in the sequence.

*Rationale: There are failure scenarios where the undocking sequence should not be terminated, but rather paused to allow troubleshooting.*

**[R.LIDS.0010] Validation of Commands**

The iLIDS shall validate commands from the host vehicle.

*Rationale: The iLIDS will execute commands generated internally or from other systems in order to perform the specified function or operation. This process includes checking if the command has valid data values and if those can be executed, based on the current state or mode. Updates to the corresponding health and status parameters provide the results of the command execution.*

**[R.LIDS.0011] Command Notification**

The iLIDS shall provide a notification for validity of commands to the host vehicle.

*Rationale: Command notification includes a response for both valid and invalid commands. Command originators need a response or acknowledgement to understand the status of a command. Vehicle command validation failures, particularly crew initiated commands, warrant near real-time indication of validation failure to the crew, ground, and/or command initiator.*

**[R.LIDS.0012] Command Processing Latency**

The iLIDS shall have a command processing latency no greater than 35 ms, where the performance measurement is taken from the time the command crosses the host vehicle to iLIDS interface to the time the command is acknowledged across the iLIDS to host interface, by the iLIDS avionics.

*Rationale: An upper bound on command processing latency must be established to drive and manage overall avionics and software system design and end-to-end avionics and software performance. This value is driven by and is the part of the time allocation, allocated to iLIDS, from the max total time (200 ms from JSC-65795, NDS IDD) required for a switch from system A to B to take place in the case of a fault requiring primary control being transferred from system A to B. This value is necessary for the host vehicle to control total execution latency and assures that the commands will be received, interpreted and acknowledged in the required period. See also R.LIDS.1116 and R.LIDS.1137.*

**[R.LIDS.1116] H&S Data Processing Latency**

The iLIDS shall have a Health and Status (H&S) data processing latency no greater than 45 ms, where the performance measurement is taken from the time Health and Status (H&S) data is sampled to the time conditioned H&S data crosses the iLIDS to host vehicle interface.

*Rationale: An upper bound on H&S data processing latency must be established to drive and manage overall avionics and software system design and end-to-end avionics and software performance. This value is driven by and is the part of the time allocation, allocated to iLIDS, from the max total time (200 ms from NDS IDD) required for a switch from system A to B to take place in the case of a fault requiring primary control being transferred from system A to B. If a fault requiring a switch to the redundant string is identified, there is a minimum amount of time to detect, report to the vehicle, and the vehicle to issue a command to switch* *between controllers in order to maintain safe control of the linear actuators, depending on the mode and state of iLIDS. This switch time is most critical during dock mode capture and attenuation states. See also R.LIDS.0012 and R.LIDS.1137.*

**[R.LIDS.1137] Fault Response Performance**

The iLIDS shall be capable of detecting any internal fault, notifying the host vehicle of the fault via the H&S data, and executing a fault response command from the host vehicle within 200 ms, including 120 ms of communication and processing time within the host vehicle.

*Rationale: The iLIDS must be capable of detecting and responding to faults quickly during docking attempts to ensure adequate dynamic performance in the event that system B is needed to complete a docking attempt or in the event a docking attempt abort is needed. iLIDS dynamics simulations will use this 200 ms time as the idle time between system A and system B operations and between system B operations and the beginning of a docking attempt abort. The requirement is based on the two associative requirements (R.LIDS.0012 and R.LIDS.1116). The iLIDS will send signals in 35 ms and receive in 45 ms.*

**[R.LIDS.0014] iLIDS Health and Status During iLIDS Operations**

The iLIDS shall generate and provide health and status information to the host vehicle during iLIDS operations as specified in JSC-65795, NDS IDD, Appendix D - NDS MSID.

*Rationale: This includes generic health and status data as well as data from safety and mission critical functions. This requirement meets the intent of SSP 50021, Safety Requirements Document, Section 3.3.6.1.5.2 and SSP 41000, System Specification for the International Space Station, section 3.3.6.4.*

**[R.LIDS.0017] Communications with the Host Vehicle (EIA-422-B)**

The iLIDS shall communicate with the host vehicle per the electrical characteristics specified in ANSI/TIA/EIA-422-B.

*Rationale: This standard provides reliable serial communications. The iLIDS has requirements to be able to communicate in either EIA-422-B or MIL-STD-1553B but not both to a single host vehicle. The host vehicle supplied interfacing connector to iLIDS can only be wired for one of the two communication protocol types.*

**[R.LIDS.0019] Execution of Commands**

The iLIDS shall execute valid commands received from the host vehicle.

*Rationale: The iLIDS will execute commands generated from the host vehicle in order to perform the specified function or operation.*

**[R.LIDS.0020] Status of Execution of Commands**

The iLIDS shall provide execution status of commands to the host vehicle.

*Rationale: Command initiators should know the status of host vehicle commands to the iLIDS for monitoring and awareness of the iLIDS state.*

**[R.LIDS.0024] Transfer of Data and Communications**

The iLIDS to Vehicle umbilical interfaces shall be capable of transferring hard-line MIL-STD-1553 and 10/100 Base T Ethernet data and communications between the mated vehicles.

*Rationale: Hard line communication allows command and data handling between the mated vehicles. The formats provided are based on current ISS capability.*

**[R.LIDS.0024.1] Ethernet Cable Specification**

The iLIDS umbilical cabling for 100 BASE-TX network segments shall be constructed using shielded twisted pair Category 5e components in accordance with ANSI/TIA/EIA 568B.2, Annex N, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components of maximum physical cable length not to exceed 4 feet.

*Rationale: Ethernet cable for flight hardware is to be constructed using approved standards.*

**[R.LIDS.0024.2] MIL-STD-1553 Cable Specification**

The iLIDS umbilical cabling for MIL-STD-1553 communication shall be constructed in accordance with SSQ 21655, Cable, Electrical, MIL-STD-1553 Databus, Space Quality, General Specification, with a maximum physical cable length not to exceed 4 feet.

*Rationale: MIL-STD-1553 cable for flight hardware is to be constructed using approved standards.*

**[R.LIDS.0026] Bonding**

The iLIDS to host vehicle interface shall meet Class R bonding requirements in accordance with NASA-STD-4003, Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment.

*Rationale: The mating vehicle includes the CDA. Adherence to approved standards.*

**[R.LIDS.0091] Automatic Safing with Manual Override for Temperature Control**

iLIDS heaters shall allow for individual zones to be commanded on and off by the host vehicle in order for the host vehicle to provide manual override for temperature control.

*Rationale: This requirement supports the host vehicle capability to comply with JPR 8080.5 standard G-16*

### [R.LIDS.0041] Leak Rates for iLIDS Feed-Throughs When Mated (Excluding -302)

The iLIDS (excluding -302) feed-throughs internal to iLIDS shall have a maximum of 0.0007 lbm dry air/day (0.0003 kg air/day) leakage at vestibule pressurization of 14.7 psia (101 kPa) and an external vacuum pressure when mated.

*Rationale: The leakage value is based on 14 Class 77H hermetic feed-throughs (4X size 25 connectors, 10X size 13 connectors). See also R.LIDS.1113 and R.LIDS.1114.*

### [R.LIDS.1113] Leak Rate for iLIDS-to-iLIDS Interface

The iLIDS-to-iLIDS interface shall have a maximum of 0.0025 lbm dry air/day (0.0011 kg air/day) leakage at vestibule pressurization of 14.7 psia (101 kPa) and an external vacuum pressure when mated.

*Rationale: The leakage value assumes 12 HCS hooks fully engaged and derives from a nominal ISS trajectory and exposure to 1E21 atoms/cm2 atomic oxygen and 214 equivalent sun hours (To Be Resolved (TBR)-212) ultraviolet radiation (for a duration of up to 21 days). The atomic oxygen exposure includes both pre-treatment of the seals and on-orbit exposure at 4.4 x 10E19 oxygen atoms/cm2 per day. See also R.LIDS.0041 and R.LIDS.1114.*

### [R.LIDS.1114] Leak Rate for iLIDS-to-Vehicle Interface

The iLIDS-to-vehicle interface shall have a maximum of 0.0008 lbm dry air/day (0.0004 kg air/day) leakage at vestibule pressurization of 14.7 psia (101 kPa) and an external vacuum pressure when mated.

*Rationale: The leakage value is based on room temperature static leakage testing with allowances for expected thermal excursions. See also R.LIDS.0041 and R.LIDS.1113.*

### [R.LIDS.1129] Communications with the Host Vehicle (MIL-STD-1553B)

The iLIDS shall communicate with the host vehicle per the electrical characteristics specified in MIL-STD-1553B.

*Rationale: This standard provides reliable serial communications. The iLIDS has requirements to be able to communicate in either EIA-422-B or MIL-STD-1553B but not both to a single host vehicle. The host vehicle supplied interfacing connector to iLIDS can only be wired for one of the two communication protocol types.*

### [R.LIDS.1130] Message Formats with the Host Vehicle (MIL-STD-1553B)

The iLIDS shall use message formats specified in JSC-65795, NDS IDD for the MIL-STD-1553 communication interface.

*Rationale: This document provides the data format and timing required to communicate over t he MIL-STD-1553 data bus.*

**[R.LIDS.1131] Distinguishing Communications with the Host Vehicle (EIA-422-B vs. MIL-STD-1553B)**

The iLIDS shall determine the host vehicle communication protocol (EIA-422-B or MIL-STD-1553B) by checking for shorted pins on the host vehicle connector.

*Rationale: The iLIDS has requirements to be able to communicate in either EIA-422-B or MIL-STD-1553B but not both to a single host vehicle. The host vehicle supplied interfacing connector to iLIDS can only be wired for one of the two communication protocol types. The iLIDS must determine the host vehicle communication type in order to communicate with the vehicle.*

**[R.LIDS.1132] Duplex Communications with the Host Vehicle (EIA-422-B)**

The iLIDS shall communicate with the host vehicle in full duplex, using differential signaling with two unidirectional, nonreversible point to point terminated transmission lines.

*Rationale: This is the iLIDS specific implementation of EIA-422-B.*

**[R.LIDS.1133] Data Exchange with the Host Vehicle (EIA-422-B)**

The iLIDS shall exchange data with the host vehicle in an asynchronous serial communications format utilizing a Universal Asynchronous Receiver/Transmitter (UART) controller, Non-Return to Zero (NRZ) with one start bit, 8 data bits (Least Significant Bit (LSB) first) and one stop bit.

*Rationale: This is the iLIDS specific implementation of EIA-422-B.*

**[R.LIDS.1134] Message Exchange with the Host Vehicle (EIA-422-B)**

The iLIDS shall exchange messages with the host vehicle of a fixed packet length, with a bit rate of 921.6 kilobaud, and a status update rate of 50 Hz.

*Rationale: This is the iLIDS specific implementation of EIA-422-B.*

**[R.LIDS.5022] FRAM-Type Connector Pinouts**

The iLIDS Flight Releasable Attachment Mechanism (FRAM)-Type Connectors shall utilize the pinouts as defined in JSC-65795, NDS IDD, table FRAM-Type Connector Pinouts.

*Rationale: Each connector is a SSQ22680 FRAM-type connector that contains both power and data in the same connector shell. Separate power and data cable bundles are routed to the connector then combined in the connector backshell. Maximum possible separation is maintained inside the connector.*

**[R.LIDS.5034] Heater Power and Control**

The iLIDS shall provide redundant heater control for two channels.

*Rationale: Only one channel is actively controlling a heater zone at a time while the other channel is powered and processing data (e.g., checking Resistance Temperature Detectors (RTDs), sending H&S, etc.) ready to actively control the* *heater zone if the other channel fails. Refer to JSC-64599, Electric Power Quality Description Document for heater power timelines.*

3.1.2.2 iLIDS-to-iLIDS Interface

The iLIDS integrated on the Vehicle incorporates the following interfaces when mated to another iLIDS:

- Support structural/mechanical attachment.
- Supports vehicle-to-vehicle transfer of atmosphere, power, data, and communications. Future configurations will include water, fuel, oxidizer, and pressurant.
- Support soft-capture through electromagnets. The iLIDS-to-iLIDS system interface is illustrated in the iLIDS System Interface Diagram.

**[R.LIDS.1142] IDSS IDD Compatibility**

The iLIDS shall be compatible with the IDSS IDD Rev A.

*Rationale: The IDSS IDD establishes standards for compatibility across all docking system designs such that they are capable of interfacing and safely docking with one another. The iLIDS design is based on docking interface features and loads specified in the NDS IDD that are also compatible with those specified in the IDSS IDD.*

**[R.LIDS.0029] Structural/Mechanical Attachment**

The iLIDS shall provide an interface with 24 attachment points per JSC-65795, NDS IDD, figure HCS Hook Configurations and figure HCS Docking Interface where 12 active hooks on one system are nominally closed to engage 12 passive hooks on the mating system.

*Rationale: The mating vehicle includes the CDA. The 24 points allows for nominal 12 hook pressurized/mated load carrying capability or enhanced 24 hook load capability. Alternatively, the passive hooks allow for a mated vehicle with active hooks to provide redundancy for hard mate in the event of a failure to hook.*

**[R.LIDS.0030] Transfer of Power**

The iLIDS umbilical interfaces shall provide five 8 American Wire Gauge (AWG) conductors for electrical power transfer per umbilical with a maximum physical cable length of 4 feet.

*Rationale: The intent of this requirement is to allow for power transference between two mated systems. This is not the power for the iLIDS consumption. The five lines give the host options to transfer redundant feeds of two different voltages. ISS will be capable of transferring both 120 Vdc and 28 Vdc. However, ISS is not expected to transfer both at the same time.*

**[R.LIDS.0034] Automatic Umbilical Demating**

The iLIDS-to-iLIDS umbilical interface shall automatically demate during undocking operations.

*Rationale: The mating vehicle includes the CDA. The umbilicals for power, data, etc. are intended to demate without crew intervention during the undocking sequence. This facilitates emergency undocking scenarios.*

**[R.LIDS.0037] Soft Capture**

The iLIDS SCS-to-iLIDS SCS shall meet Class S bonding requirements in accordance with NASA-STD-4003, Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment.

*Rationale: The SCS adheres to approved standards to provide a controlled resistance path to mitigate hazards caused by potential differences in electrical potential between mating vehicles during contact.*

**[R.LIDS.0038] Hard Capture**

The iLIDS HCS-to-iLIDS HCS shall meet Class R bonding requirements in accordance with NASA-STD-4003, Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment.

*Rationale: (1) to prevent possible circulating currents in interconnected electrical power systems; (2) to mitigate ground-conducted noise that could significantly degrade signal noise margins of intravehicular communications systems; and (3) to ensure a common voltage reference for intervehicular avionics systems connections. This does not apply to umbilicals.*

**[R.LIDS.1004] Hook Compliance**

The iLIDS shall implement compliance on the passive hook of the mating active-passive hook pair.

*Rationale: To successfully structurally mate with another docking system, it is necessary to specify where the compliance is located in the active/passive hook pairing.*

**[R.LIDS.1005] HCS Guide Pins**

The iLIDS shall provide guide pins for tangential constraint and alignment of the systems during hard mate per JSC-65795, NDS IDD, figure HCS Guide Pin Detail and figure HCS Docking Interface.

*Rationale: Guide pin/receptacles provide fine alignment during soft capture system retraction and restrict rotation and shear of the systems while mated. See also R.LIDS.0029 for the figure depicting guide pin location.*

**[R.LIDS.1005.1] HCS Guide Pin Receptacles**

The iLIDS shall provide guide pin receptacles for tangential constraint and alignment of the systems during hard mate per JSC-65795, NDS IDD, figure HCS Guide Pin Hole Detail and figure HCS Docking Interface.

*Rationale: Guide pin/receptacles provide fine alignment during SCS retraction and restrict rotation and shear of the systems while mated. See also R.LIDS.0029 for the figure depicting guide pin receptacle location.*

**[R.LIDS.1006] Seal on Seal Mating Interface (Excluding -302)**

The iLIDS (excluding -302) HCS seal on seal mating plane shall meet the details as specified in JSC-65795, NDS IDD, figure NDS (excluding -302) HCS Mating Plane Seal and Electrical Bonding Details.

*Rationale: The docking system must include a seal interface to support pressurization after structural mate. The seals meet the emerging IDSS and support either seal on seal or seal on metal operation. The corresponding figure in JSC-65795, NDS IDD, provides interface definition for the HCS Mating Plane.*

**[R.LIDS.1007] Seal on Metal Mating Interface (-302)**

The iLIDS (-302) HCS seal on metal mating plane shall meet the details as specified in JSC-65795, NDS IDD, figure NDS (-302) HCS Mating Plane Seal and Electrical Bonding Details.

*Rationale: Although the iLIDS is designed for seal on seal mated operations, the iLIDS for ISS will have a metallic sealing surface which will be more durable for the longer life of the ISS hardware. The corresponding figure in JSC-65795, NDS IDD, provides interface definition for the HCS Mating Plane.*

**[R.LIDS.1037] Umbilical Connector Mate Indication**

The iLIDS shall provide loop back circuits for the host to verify connector mating on power and data umbilical connectors.

*Rationale: This allows confirmation prior to power and data transfer that mating is successful.*

**[R.LIDS.1094] iLIDS Automatic/Manual Sequencing**

The iLIDS shall provide the capability to operate sequences either automatically or manually via software control.

*Rationale: Such operation allows the user to initiate sequences automatically or to manually step through the sequences. The iLIDS default is automatic sequencing.*

**[R.LIDS.1095] iLIDS Active Dock Mode**

The iLIDS shall provide an Active Dock mode of operations.

*Rationale: The Active Docking mode includes the entire docking sequence and all related flags as well as health and status data.*

**[R.LIDS.1096] iLIDS Active Undock Mode**

The iLIDS shall provide an Active Undock mode of operations.

*Rationale: The Active Undocking mode includes the entire undocking sequence and all related flags as well as health and status data.*

**[R.LIDS.1097] iLIDS Passive Dock Mode**

The iLIDS shall provide a Passive Dock mode of operations.

*Rationale: During the Passive Dock mode, the iLIDS will provide all H&S data as well as flags for soft capture. In addition, all outputs will be inhibited during operation (e.g., motors, magnets, etc.).*

**[R.LIDS.1098] iLIDS Passive Undock Mode**

The iLIDS shall provide a Passive Undock mode of operations which inhibits all outputs, while providing H&S data and flags.

*Rationale: During the Passive Undock mode, the iLIDS will provide all H&S data as well as flags for undocking completion. In addition, all outputs will be inhibited during operation (e.g., motors, magnets, etc.).*

**[R.LIDS.1099] iLIDS Safe Mode**

The iLIDS shall provide a Safe mode of operations which inhibits all outputs, while providing H&S data.

*Rationale: During the Safe mode, the iLIDS will provide all H&S data. In addition, all outputs will be inhibited during operation (e.g., motors, magnets, etc.).*

**[R.LIDS.1100] iLIDS Check-out Mode**

The iLIDS shall provide a Check-out mode of operations to exercise the iLIDS mechanism through a pre-determined sequence.

*Rationale: The Check-out mode detects damage and errors in iLIDS by exercising the iLIDS mechanisms through a pre-determined sequence.*

**[R.LIDS.1101] iLIDS Engineering Mode**

The iLIDS shall provide an Engineering mode of operations to support troubleshooting without the constraints of other modes.

*Rationale: The Engineering mode supports troubleshooting without the constraints of all other modes. For example, the Engineering mode will allow the user to command a single motor on/off. It is critical to adhere to proper procedures during this mode.*

**[R.LIDS.1112] Umbilical Auto-Mate**

The iLIDS shall automatically mate umbilical connectors within 15 minutes of achieving hard mate.

*Rationale: Umbilical connector mate is critical function for resource transfer. It is necessary to perform this action without Extravehicular Activity/Intravehicular Activity (EVA/IVA).*

**[R.LIDS.1124] iLIDS Active Hook Profile**

The iLIDS shall provide active hooks as defined in JSC-65795, NDS IDD, figure HCS Active Hook Detail.

*Rationale: The iLIDS, when mated, has 24 attachment points where 12 active hooks on one system engage 12 passive hooks on the mating system to carry nominal loads. The hook profile allows mating with the emerging IDSS. Refer to corresponding requirement ID in JSC-65795, NDS IDD.*

**[R.LIDS.1125] iLIDS Passive Hook Profile**

The iLIDS shall provide passive hooks as defined in JSC-65795, NDS IDD, figure HCS Passive Hook Detail (excluding -304).

*Rationale: The iLIDS, when mated, has 24 attachment points where 12 active hooks on one system engage 12 passive hooks on the mating system to carry nominal loads. The hook profile allows mating with the emerging IDSS. Refer to corresponding requirement ID in JSC-65795, NDS IDD.*

#### 3.1.2.4 iLIDS-to-EVA Interface

The iLIDS-to-EVA interface only includes translation around the exterior of the iLIDS while docked. If EVA occurs while undocked, the docking surfaces (i.e. "face") of the iLIDS tunnel is an EVA Keep-out Zone (KOZ) in addition to the interior of the tunnel. Refer to JSC-65795, NDS IDD for EVA KOZ.

**[R.LIDS.0046] EVA Sharp Edges**

Any iLIDS hardware accessible to the EVA crew within 24" of an adjacent EVA worksite, excluding the defined iLIDS EVA Keep-out-zone, shall meet the edge, corner, and protrusion requirements in Table 3-1 and Table 3-2 of JSC-28918, EVA Design Requirements and Considerations.

*Rationale: These edge, corner, and protrusion requirements were originally developed to prevent the cutting of the EMU glove. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.11.*

**[R.LIDS.0047] EVA Thin Materials**

The iLIDS materials less than 0.08-in. (2.032-mm) thick that are used in a location accessible to EVA, edge radii shall be greater than 0.003-in. (0.0762-mm), and exposed edges shall be uniformly spaced, not to exceed 0.5-in. (1.27-cm) gaps, flush at the exposed surface plane and shielded from direct EVA interaction.

*Rationale: These edge and corner requirements were originally developed to prevent the cutting of the Extravehicular Mobility Unit (EMU) glove. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.11.2 and modified to represent the correct conversion factor.*

**[R.LIDS.0050] Burrs**

iLIDS exposed surfaces accessible to EVA crew shall be smooth and free of burrs.

*Rationale: Burrs are potential sharp edges and, therefore, can possibly cause an EVA suit catastrophic leakage. This is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.15.*

**[R.LIDS.0051] Screws and Bolts**

iLIDS hardware accessible to the EVA crew shall include protective features on screws or bolts in established worksites (planned and contingency) and translation routes to prevent snagging, and to protect against sharp edges and impact.

*Rationale: Snagging of the EVA suit or umbilicals could cause a tear, resulting in suit catastrophic leakages. Additionally, sharp-edge cuts and impact punctures could cause suit catastrophic leakages. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.13.*

**[R.LIDS.0052] Hardware Protrusion**

The iLIDS hardware shall be free of hardware protruding into the translation corridor as shown in Figure 4-6 of JSC-28918, EVA Design Requirements and Considerations, except for translation aids.

*Rationale: Protrusions into the translation path are potential snag points (suit and umbilical tear hazard) and EVA suit impact hazards (puncture hazard). The 109-cm (43-in.) diameter translation path is based upon the EMU, which is a Space Transportation System (STS)/ISS legacy and derives from JSC-28918, EVA Design Requirements and Considerations, Paragraph 4.20.1.1. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.17.*

**[R.LIDS.0054] Entrapment Hazard - Snagging**

Any iLIDS hardware that is EVA-accessible shall preclude snagging an EVA crewmember, umbilical, or a limb/tether, such that an EVA crewmember cannot be freed from entrapment.

*Rationale: Inability to free an entrapped EVA crewmember is a catastrophic hazard. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.19.1.*

**[R.LIDS.0055] Pinch Points**

The iLIDS shall ensure that hardware located within translation paths and established worksites (planned and contingency) that is EVA-accessible does not have pinch hazards.

*Rationale: This applies to, but is not limited to, hardware that pivots, retracts, flexes, or has a configuration such that a gap of greater than 0.5 in. (12.7 mm), but less than 1.4 in. (3.556 cm) (glove pinching), exists between the equipment and adjacent structure. Any item that has a potential to pinch any appendage, including legs or other body parts, will also be designed out or protected against, either by using a KOZ for areas outside a translation path or worksite or by using a physical barrier. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.18.*

**[R.LIDS.0056] Entrapment Hazard - Trapping**

iLIDS hardware that is EVA-accessible shall preclude trapping an EVA crewmember, umbilical, or a limb/tether, such that the EVA crew could not be freed.

*Rationale: Inability to free an entrapped EVA crewmember is a catastrophic hazard. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.19.1.*

**[R.LIDS.0057] Exposed Circular Holes**

Exposed circular holes on iLIDS accessible to EVA crew shall be less than 0.5 in. (1.27 cm) in diameter or greater than 1.4 in. (3.556 cm) in diameter to prevent entrapment of an EVA suit-gloved finger.

*Rationale: Entrapment of the EVA crewmember or damage to the EVA suit, and possible suit leakage, while freeing the entrapped appendage is considered a catastrophic hazard. Holes that are irregularly shaped will be evaluated individually as a part of the safety process. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.16.*

**[R.LIDS.0058] EVA Induced Loads**

iLIDS hardware within the EVA translation corridor, as shown in Figure 4-6 of JSC-28918, or adjacent EVA worksite, as defined in Figure 4-15 of JSC-28918, shall meet the requirements for Inadvertent Kick Loads, as defined in JSC-28918, EVA Design Requirements and Considerations, Table 4.7, EVA-Induced Loads.

*Rationale: EVA can induce significant loads into surrounding hardware and structure. These loads were compiled over several years of EVA with legacy EMU hardware. Meeting this requirement means that the hardware, when exposed to EVA crew-induced loads, shall not: a) create a hazardous condition; b) suffer loss of structural integrity; or c) suffer a loss of functionality. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 4.9.*

**[R.LIDS.0060] Glove Palm External Touch-Temperature Compliance**

The iLIDS hardware that interfaces with the EVA glove palm shall be in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 4.4.4.

*Rationale: The iLIDS will provide input into the integrated thermal analysis. These limits do not apply to the backside of the glove and the EMU Thermal Micrometeoroid Garment (TMG) orthofabric that have different standards set out in Section 4.4.5, see R.LIDS.1121.*

**[R.LIDS.1121] EMU TMG Orthofabric and Glove Back External Touch-Temperature Compliance**

The iLIDS hardware that interfaces with the EMU TMG orthofabric, which includes the backside of the EMU glove, shall be in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 4.4.5.

*Rationale: The iLIDS will provide input into the integrated thermal analysis. These limits do not apply to the palm of the glove that has different standards set out in Section 4.4.4. See R.LIDS.0060.*

**[R.LIDS.0061] DC Magnetic Field**

The iLIDS shall preclude emitting Direct Current (DC) magnetic fields in excess of 250 Gauss during EVA translation across the iLIDS.

*Rationale: This requirement will preclude interference with the EVA suit electronics/electrical systems and EVA tool electrical assemblies. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.5.3.*

**[R.LIDS.1119] iLIDS Hazardous Energy Provision**

iLIDS shall design or use components that retain hazardous energy, either with design features that prevent releasing the stored energy in any manner that could pose a hazard to the EVA crewmember or with provisions to allow safing of the potential energy, including provisions to confirm that the safing was successful.

*Rationale: This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.7.*

## 3.2 Characteristics

### 3.2.1 Functional Performance

#### 3.2.1.1 Docking

**[R.LIDS.0063] Docking Envelope (Excluding -302)**

The iLIDS (excluding -302) shall be capable of docking when the vehicle misalignments and relative motions are within the parameters as specified by JSC-65795, NDS IDD, table NDS Initial Contact Conditions "Design To" Limits.

*Rationale: Table NDS Initial Contact Conditions "Design To" Limits includes high-level information on capture envelope data.*

**[R.LIDS.0064] Initial Contact Signal**

The iLIDS, when in Active mode, shall provide a signal indication of initial contact.

*Rationale: This indication is required by the host vehicle to perform attitude and translational system moding during capture operations.*

**[R.LIDS.0065] Soft Capture (Excluding -302)**

The iLIDS (excluding -302) shall perform soft capture during docking operations.

*Rationale: Soft capture is the initial physical connection prior to final structural mating.*

**[R.LIDS.0066] Soft-Capture Signal Indication**

The iLIDS shall provide a signal indication of soft capture during docking operations.

*Rationale: This indication allows the host vehicle to initiate proper moding.*

**[R.LIDS.0069] Attenuation (Excluding -302)**

The iLIDS (excluding -302) shall attenuate relative motion between the two mating vehicles, subject to the mass properties, load constraints, and contact conditions specified in JSC-65970, iLIDS Thermal and Induced Environments (iLIDS TIES), during docking operations.

*Rationale: JSC-65970, iLIDS Thermal and Induced Environments (iLIDS TIES), includes load attenuations and mass properties, among other properties.*

**[R.LIDS.0071] Hard-Capture Signal Indication**

The iLIDS shall provide a signal indication of hard capture during docking operations.

*Rationale: Hard capture signal indication indicates structural mating.*

**[R.LIDS.0073] Docking Time During Free Drift**

The iLIDS shall require no more than 20 minutes of free drift once docking has been initiated.

*Rationale: When the host vehicle is in free drift, the time needs to be limited to 20 minutes to preclude vehicle problems, such as solar arrays pointing away from the sun. Free drift starts upon initial contact of the load cell and ends with latches engaging.*

**[R.LIDS.5007] iLIDS Mating Interface Allowable Thermal Differential**

The iLIDS shall achieve hard capture within the boundaries of the acceptable temperature regions as defined in JSC-65795, NDS IDD, figure NDS Mating Interface Allowable Thermal Differential for Hard Capture.

*Rationale: Hard capture includes engaging hooks and seal interface. The allowable temperature differential between the sealing interfaces during docking hard capture is restricted. If the temperatures are not within the defined boundaries, a thermal hold prior to hard latching is required until the temperature requirements are satisfied.*

**[R.LIDS.5008] iLIDS Capture Ring in Passive Mode**

The iLIDS, when in Passive mode, shall have the soft capture ring configured in accordance with JSC-65795, NDS IDD, figure NDS Capture Ring in Passive Mode.

*Rationale: The iLIDS performs soft capture using electromagnets and magnetic striker plates. The Passive mode iLIDS will also be scarred for future implementation of an SCS mechanical latch striker interface, which would allow an iLIDS-compatible docking system, using passive SCS mechanical latch striker, to capture. Soft capture is not structural mating, but the first level of attachment in the docking sequence.*

**[R.LIDS.5009] iLIDS Capture Ring in Active Mode**

The iLIDS, when in Active mode, shall have the soft capture ring configured in accordance with JSC-65795, NDS IDD, figure NDS Capture Ring in Active Mode.

*Rationale: The iLIDS performs soft capture using electromagnets and magnetic striker plates. The Passive mode iLIDS will also be scarred for future implementation of an SCS mechanical latch striker interface, which would allow an iLIDS-compatible docking system, using passive SCS mechanical latch striker, to capture. Soft capture is not structural mating, but the first level of attachment in the docking sequence.*

### [R.LIDS.5010] SCS Guide Petal System

The iLIDS guide petals shall be configured as detailed in JSC-65795, NDS IDD, figure SCS Guide Petal System.

*Rationale: There are three guide petals that mount to the soft capture ring and face inward. The petals are equally spaced around the circumference of the soft capture docking ring.*

### [R.LIDS.5011] SCS Guide Petal System Detail

The iLIDS guide petals shall meet the features as detailed in JSC-65795, NDS IDD, figure SCS Guide Petal System Detail.

*Rationale: There are three guide petals that mount to the soft capture ring and face inward. The petals are equally spaced around the circumference of the soft capture docking ring.*

### [R.LIDS.5012] SCS Ring Dimensions

The iLIDS SCS dimensions shall be in accordance with JSC-65795, NDS IDD, figure SCS Guide Petal System Profile.

*Rationale: The iLIDS is NASA's implementation for the emerging IDSS using low impact docking technology. The figure also identifies mechanical latch striker mounting holes, which provide scarring for future implementation of a mechanical latch striker interface.*

### [R.LIDS.5013] SCS Magnet and Striker

The SCS shall employ three magnets and three striker plates distributed across the soft capture ring, as defined in JSC-65795, NDS IDD, figure SCS Magnetic Capture System.

*Rationale: The iLIDS performs soft capture using electromagnets and magnetic striker plates.*

### [R.LIDS.5014] Pre-Capture SCS Compressive Force Resistance

The iLIDS soft capture interface shall have no more than 6 lb compressive force resistance during capture.

*Rationale: The low impact technology SCS requires minimal compressive force resistance across the interface prior to capture. To maximize the benefit of low impact technology, a maximum of 12 lb compressive force resistance is allowed across the interface. This means each side is allowed to have a maximum of 6 lb resistance. This resistance might include magnet strikers compliance mechanisms, the SCS capture sensors, and any other sources of compressive force resistance.*

### [R.LIDS.5061] Maximum Temperature Differential for SCS Mating Interfaces

The iLIDS-SCS to iLIDS-SCS shall have a maximum allowable temperature differential of 100 °F (56 °C) for soft capture.

*Rationale: This restriction is based on thermal expansion limits for the engagement of the mating guide petals in the mating iLIDS.*

### 3.2.1.2 Undocking

**[R.LIDS.0075] Undocking Time**

The iLIDS shall be capable of undocking within 10 minutes when iLIDS undocking sequence is initiated.

*Rationale: The requirement implies that all nominal systems are required to be operational within this time, including GN&C parameters. The undocking sequence begins with the hatch secured and the crew's initiation of the iLIDS undocking sequence.*

**[R.LIDS.0076] Indication of Physical Separation**

The iLIDS shall provide a signal indication of physical separation during undocking operations.

*Rationale: This indication is required by the host vehicle to perform attitude and translational system moding during undocking operations.*

**[R.LIDS.0079] Adjustability of iLIDS Performance Parameters**

The iLIDS shall accept software reconfiguration, via commands, of soft capture system controller performance parameters to accommodate capture/attenuation of various mass vehicles within the load set defined in JSC-65970, iLIDS Thermal and Induced Environments (iLIDS TIES).

*Rationale: This requirement will allow iLIDS reconfiguration (through software parameters or mode settings). For example, iLIDS can be reconfigured to make the Six Degrees of Freedom (6-DOF) platform load reaction stiffer for a particular mission or docking scenario.*

**[R.LIDS.1042] Pyrotechnic Initiation (Excluding -302)**

The iLIDS (excluding -302) shall use NASA Standard Initiators (NSIs) for pyrotechnic devices.

*Rationale: Pyrotechnic provides additional fault tolerance for undocking hazards. iLIDS pyrotechnics are safety-critical because their inadvertent operation results in a catastrophic hazard. Use of proven NSI design ensures safe and reliable pyrotechnic design and operation. This requirement is in accordance with SSP 50021, Safety Requirements Document, Section 3.3.6.5.1.1. The -302 is intended for use on ISS and has been decided to not include pyros so that the port cannot be fouled by firing pyros and disabling hooks for future docking.*

**[R.LIDS.1069] Separation System - Demate**

The iLIDS shall provide a separation system capable of providing demate work (energy) between 28.9 ft-lb (4.0 kgf-m) and 31.1 ft-lb (4.3 kgf-m) after umbilical and seal demating.

*Rationale: Docking systems historically have provided a means to accelerate the vehicle away when the structural mate mechanism is released. The system must be capable of demating connectors and overcoming seal stiction in addition to providing the demating energy. Refer to corresponding requirement ID in JSC-65795, NDS IDD.*

**[R.LIDS.1115] Pyrotechnic Release (Excluding -302)**

The iLIDS (excluding -302) shall provide pyrotechnics in both the active and passive hooks at the hard mate interface capable of releasing a single gang of 6 hooks within 150 ms, allowing the host vehicle to separate from the mated vehicle.

*Rationale: If the iLIDS active hooks fail to unlatch, the host vehicle may fire the pyrotechnic(s) to release the gang(s) of hooks containing the failed hooks allowing the host to separate from the mated vehicle. The iLIDS active and passive hooks are distributed across 4 gangs of 6 hooks each (2 active hook gangs and 2 passive hook gangs) for a total of 24 hooks (12 active and 12 passive).*

**[R.LIDS.5021] Umbilical Separation - Passive**

The iLIDS umbilicals shall be designed to be separated passively by the energized separation system in the event of a failure to retract.

*Rationale: The iLIDS umbilical connector interfaces transfer resources between the docked vehicles. On undocking, these connectors are nominally driven to the unmated state prior to unlatching the hooks. This requirement ensures the umbilical mechanism design accounts for the off-nominal case of passive umbilical separation. Passive separation requires only axial loads to disengage the umbilical connector.*

### 3.2.2 Physical

**[R.LIDS.0082] iLIDS Pass-Through Diameter, Petals Removed**

With SCS guide petals removed, the iLIDS shall provide an unobstructed minimum diameter passage for pressurized transfer of crew and cargo with no permanent protrusions, drag-through cables, or obstruction, excluding the inter-module ventilation air duct as specified in JSC-65795, NDS IDD, figure NDS Docking Interface.

*Rationale: Pressurized transfer of cargo and unsuited crew, etc. is the primary purpose of docking the Vehicle. SSP 50005, Section 8.8.3.1 requires a minimum pass-through diameter of 32 in. be available for translation paths.*

**[R.LIDS.0082.1] iLIDS Pass-Through Diameter, With Petals**

With SCS guide petals installed, the iLIDS shall provide the unobstructed minimum diameter passage for pressurized transfer of crew and cargo with no permanent protrusions, drag-through cables, or obstruction, excluding the inter-module ventilation air duct as specified in JSC-65795, NDS IDD, figure NDS Docking Interface.

*Rationale: With the petals installed it is still a requirement to provide a clear passage for unsuited crew, cargo, etc. Value is based on study by ISS for cargo transfer.*

3.2.2.1 Mass

**[R.LIDS.0080] iLIDS (-301) Mass**

The iLIDS (-301) mass shall not exceed 750 lbm (340.91 kg).

*Rationale: This is the mass with Mass Growth Allowance (MGA).*

**[R.LIDS.1056] iLIDS (-302) Mass**

The iLIDS (-302) mass shall not exceed 704 lbm (320.0 kg).

*Rationale: This allocation is based on the -301 with adjustments per the -302 configuration differences. The -302 mass does not include host-supplied components (e.g., MMOD shield, Thermal Protection System [TPS], etc.). The mass of these host-provided integration components is dependent on the host implementation. The -302 mass does include cabling and electrical box mass for the NDS-provided, host-mounted boxes.*

3.2.2.2 Dimensions/Volume

Dimensions and volume are defined in JSC-65795, NDS IDD. iLIDS will meet all IDD definitions as defined by [R.LIDS.1085].

**[R.LIDS.5003] iLIDS Volume and Keep Out Zones**

The iLIDS envelope shall be in accordance with JSC-65795, NDS IDD, figure NDS Cross Section.

*Rationale: The figure defines the static and dynamic envelopes that the iLIDS must adhere to for host vehicle integrations and operations. The figure also establishes an EVA KOZ that is used for the exclusion of EVA requirements.*

### 3.2.3 Environmental

**[R.LIDS.0027] iLIDS Thermal and Induced Environments**

The iLIDS shall meet all of its functional and performance requirements during and after exposure to the loads defined in JSC-65970, iLIDS Thermal and Induced Environments (iLIDS TIES).

*Rationale: The iLIDS will meet the loads defined in JSC-65970, iLIDS TIES. JSC-65970 contains loads for launch, in-flight, docking/berthing, structural limits, and postcapture, thermal, among others. JSC-65970 will specify which loads are functional during and/or after vs. survival only.*

**[R.LIDS.0104] Environmental Qualification and Acceptance Testing**

The iLIDS shall comply with SSP 41172, Qualification and Acceptance Environmental Test Requirements, for environmental certification testing.

*Rationale: The SSP 41172 standard contains both qualification and acceptance testing requirements for natural and induced environments as well as minimum design screening requirements that are beyond the expected environments. As with other design and construction standards, SSP 41172 will drive the design because the design must take into account that it will need to encompass a larger range of environments or minimum screening environments, whichever is greater, as part of the equipment's certification program. Vehicle spacecraft equipment is required to meet specific requirements through qualification testing to Maximum Predicted Environments (MPE) with sufficient margin, durations, and workmanship standards. Qualification testing demonstrates the design, manufacturing process, and acceptance program produce hardware/software that meet specification requirements with adequate tolerance.*

#### 3.2.3.1 Thermal

**[R.LIDS.1051] Active Thermal System Control**

The iLIDS shall provide heater control for the docking system, which has controllable set points from the host.

*Rationale: Requiring the docking system to control its own heaters simplifies the electrical interface to the host. Control set points allow for different hosts to set minimum temperature to correspond to host dew point requirements. The docking system will define operational and survivability constraints. Based on these constraints, the docking system will implement blankets and/or heaters as required. This requirement also fulfills JPR 8080.5 G-16.*

**[R.LIDS.1141] Heater Operation - Blind Mode**

The iLIDS shall perform default heater operation when communications to the iLIDS heater controller is not available.

*Rationale: The blind mode heater operation is to maintain the iLIDS within the thermal survivability range when being stored or displaced. The iLIDS heater controller will have default values preprogrammed into the controller. If the controller* *starts up with no communications, it will use the internal default values for set points. If the controller is operating normally and then loses communications, the last heater set points received will be used until another communications message is received or the heater controller is power-cycled.*

#### 3.2.3.1.1 iLIDS-to-iLIDS Thermal Docking Interface

**[R.LIDS.5050] iLIDS-to-iLIDS Thermal Contact Conductance**

The iLIDS thermal contact conductance across the iLIDS-to-iLIDS docking interface shall be 15 Btu/hr-ft^2-°F (85 W/m2-K) to 50 Btu/hr-ft^2-°F (284 W/m2-K) for the metal-to-metal contact area.

*Rationale: The iLIDS utilizes heaters to condition/maintain temperatures above the minimum limits for each operating mode.*

#### 3.2.3.1.2 iLIDS-to-Vehicle Thermal Docking Interface

**[R.LIDS.5057] iLIDS-to-Host Vehicle Thermal Contact Conductance**

The thermal contact conductance across the iLIDS-to-host vehicle interface shall be 15 Btu/hr-ft^2-°F to 50 Btu/hr-ft^2-°F for the metal-to-metal contact area

*Rationale: The iLIDS utilizes heaters to condition/maintain temperatures above the minimum limits for each operating mode.*

3.2.3.2 Pressure

**[R.LIDS.0101] Differential Pressure Limits**

The iLIDS shall function during and after exposure to the pressure differential of 15.95 psi (1100 hPa).

*Rationale: The iLIDS must survive specified pressurized environments to ensure operations during design reference missions throughout its life. This is also in accordance with JPR 8080.5, Standard MS-1, "Equipment containers or enclosures for use within pressurized compartments of spacecraft shall be designed to withstand rapid decompression of the spacecraft without yielding, fracturing, or sustaining damage."*

**[R.LIDS.0103] iLIDS Depress Rate**

The iLIDS shall survive a 0.76 psi/sec (5.24 kPa/sec) depressurization rate over the range of 15.2 psia (104.8 kPa) to 5.5E-12 psia (2.7E-10 Torr) without loss of functionality as specified herein.

*Rationale: The iLIDS must survive all specified natural and induced pressure to ensure operations during design reference missions throughout its life. This is also in accordance with JPR 8080.5, Standard MS-1. The 0.76 psi/sec is the same value in SSP 41004, Common Berthing Mechanism to Pressurized Elements Interface Control Document (ICD).*

**[R.LIDS.1118] iLIDS Repress Rate**

The iLIDS shall survive a 0.30 psi/sec (2.07 kPa/sec) repressurization rate over the range of 5.5E-12 psia (2.7E-10 Torr) to 15.2 psia (104.8 kPa) without loss of functionality as specified herein.

*Rationale: The iLIDS must survive all specified natural and induced pressure to ensure operations during design reference missions throughout its life. This is also in accordance with JPR 8080.5, Standard MS-1. The 0.30 psi/sec is the same value in SSP 41004, Common Berthing Mechanism to Pressurized Elements Interface Control Document (ICD).*

#### 3.2.3.3 Vibration

The iLIDS acceleration requirements are decomposed in [R.LIDS.0027] by meeting all functional and performance requirements during and after exposure to the loads defined in JSC-65970, iLIDS Thermal and Induced Environments (iLIDS TIES).

#### 3.2.3.4 Acceleration

The iLIDS acceleration requirements are decomposed in [R.LIDS.0027] by meeting all functional and performance requirements during and after exposure to the loads defined in JSC-65970, iLIDS Thermal and Induced Environments (iLIDS TIES).

#### 3.2.3.5 Shock

The iLIDS acceleration requirements are decomposed in [R.LIDS.0027] by meeting all functional and performance requirements during and after exposure to the loads defined in JSC-65970, iLIDS Thermal and Induced Environments (iLIDS TIES).

#### 3.2.3.6 Electromagnetic Interference/Electromagnetic Compatibility

**[R.LIDS.0100] Electromagnetic Interference/Electromagnetic Compatibility**

The iLIDS shall be designed to meet requirements in JSC-65842, iLIDS Electromagnetic Environmental Effects (E3) Description Document.

*Rationale: This requirement adheres to approved standards.*

#### 3.2.3.7 Humidity

**[R.LIDS.1077] Humidity Limits**

The iLIDS shall meet specified performance following exposure 0 to 98 percent relative humidity during ground stowage and processing operations.

*Rationale: Refer to the launch site values for humidity in NSTS 07700 Vol. X, Space Shuttle Flight and Ground System Specification Book 2, Environment Design, Weight, and Performance, and Avionics Events Table 11.10.9 and Figure 11.10-5.*

3.2.3.8 Acoustic Emissions

**[R.LIDS.1074] Acoustic Emission Limits**

The iLIDS shall limit acoustic emissions to the limits as defined in SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 5.4.

*Rationale: This is in accordance with approved standards. Acoustic limits are only applicable to a crewed vehicle condition with hatches closed. The iLIDS is not a source of acoustic noise when docked and unpowered.*

3.2.3.9 Meteoroids and Orbital Debris

**[R.LIDS.0295] iLIDS MMOD - Short Duration**

The iLIDS (excluding -302) shall provide a Probability of No Penetration (PNP) of 0.999983 or greater during 210 days docked with the ISS when exposed to the MMOD environments as defined in NASA/TP-2002-210780 for orbital debris and SSP 30425, Space Station Program Natural Environment Definition for Design for meteoroids.

*Rationale: The system will be exposed to a variety of natural and induced environments that may pose a threat to functionality and performance, and therefore must be taken into account in the design. The PNP is based on the exposed surface area of the iLIDS with 210 days of exposure while docked at the ISS. The surface area assumes standoff shielding on the iLIDS outer diameter. Penetration is defined as a through-hole in the pressure shell or detached spall from the inside surface of the pressure shell such that hazardous debris is generated within the pressurized volume. This requirement does not account for failures resulting from MMOD strikes on other components or during unmated operations. These failure probabilities will be presented as technical risks and accounted for in hazard reports. The -302 has a longer life and therefore a different PNP number.*

**[R.LIDS.1111] iLIDS (-302) MMOD**

The iLIDS (-302) shall provide a MMOD shield mounting interface as defined in JSC-65795, NDS IDD, figure NDS (-302) Host-Provided MMOD Interface.

*Rationale: The system will be exposed to a variety of natural and induced environments that may pose a threat to functionality and performance, and therefore must be taken into account in the design. This requirement is for providing the interface only; the MMOD shield and PNP will be provided by the host vehicle.*

#### 3.2.3.10 Atomic Oxygen

**[R.LIDS.1088] Atomic Oxygen**

The iLIDS shall withstand the nominal ram Atomic Oxygen (AO) fluence of 5.0 x 10E21 oxygen atoms/cm2 per year to exposed ram surfaces for missions.

*Rationale: The AO environment is applicable to iLIDS internal surfaces and equipment exposed to the external AO environment in the absence of a docked vehicle. The maximum short-term: 4.4 x 10E19 oxygen atoms/cm2 per day for 30 days or less. Values are derived from the natural environment definition given in SSP 30425, Space Station Program Natural Environment Definition for Design.*

#### 3.2.3.11 External Contamination

NASA Materials and Processes Division (ES4) material experts have reviewed the iLIDS and determined that the contamination requirements are not applicable to docking systems. Contamination requirements are intended for systems such as photovoltaic (PV) arrays, radiators, optical GN&C instruments, windows, etc.

#### 3.2.3.12 Ionizing Radiation

**[R.LIDS.0183] Ionizing Radiation**

The iLIDS shall meet specified performance requirements when exposed to the radiation dose environment in accordance with JSC-64598, iLIDS Ionizing Radiation Control Plan.

Exception: The iLIDS (-301 & -302) shall meet radiation hardness levels for Single Event Upsets (SEUs), Single Event Latch-up (SEL), Single Event Gate Rupture (SEGR), and Single Event Burn-Out (SEB) to a minimum True Linear Energy Transfer (LET) = TBS-218.

*Rationale: The iLIDS must meet ionizing radiation requirements. This document establishes the ionizing radiation design susceptibility environment for low earth orbit and lunar environments.*

#### 3.2.3.13 Lightning

**[R.LIDS.5033] Command and Data Handling Interface, Physical Layer Safe Operation Area**

The iLIDS TIA-422-B Command and Data Handling (C&DH) interface shall be protected against lightning transients to the limits as defined in JSC-65795, NDS IDD, figure Safe Operation Area for TIA-422-B C&DH Serial Port.

*Rationale: The host vehicle protects the iLIDS from primary lightning effects (i.e., lightning direct current path) and limits secondary effects on the TIA-422-B C&DH interface to levels compliant with the Safe Operation Area curves documented in JSC-65795, NDS IDD. The curves were computed for the iLIDS TIA-422-B Transient Voltage Suppressor (TVS) using ARP5412, Double Exponential Current Waveform 1. Open circuit voltage and short circuit current refer to the circuit parameters at the iLIDS host connector.*

#### 3.2.3.14 Solar Ultraviolet Radiation

**[R.LIDS.1138] Solar Ultraviolet Radiation (Excluding -302)**

The iLIDS (excluding -302) shall meet all of its functional and performance requirements during and after exposure to the solar ultraviolet radiation (UV) environment as defined in SSP 30425, Space Station Program Natural Environment Definition for Design, Section 7.2 with the limit to not to exceed 214 Equivalent Sun Hours (ESH) (TBR-212) ultraviolet radiation (for a duration of up to 21 days).

*Rationale: The iLIDS must operate in the solar ultraviolet radiation environment. The limits are based on restrictions for the iLIDS seal exposure to ESH and UV.*

**[R.LIDS.1139] Solar Ultraviolet Radiation (-302)**

The iLIDS (-302) shall meet all of its functional and performance requirements during and after exposure to the solar ultraviolet radiation environment as defined in SSP 30425, Space Station Program Natural Environment Definition for Design, Section 7.2.

*Rationale: The iLIDS must operate in the solar ultraviolet radiation environment.*

#### 3.2.3.15 Vacuum

**[R.LIDS.1140] Vacuum Environment**

The iLIDS shall be fully functional while exposed to the ambient pressure of 1.0E-11 Pascal.

*Rationale: Value is derived from the natural environment definition given in SSP 30425, Space Station Program Natural Environment Definition for Design. This is the vacuum environment for geosynchronous environment.*

### 3.2.4 Reliability

**[R.LIDS.0113] Failure Modes and Effects Analysis/Critical Item List**

A Failure Modes and Effects Analysis (FMEA) shall be performed on each level of the iLIDS assembly for each required environmental condition and for each operational and abort mode per SSP 30234, Instructions for Preparation of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL) for Space Station.

*Rationale: This requirement adheres to approved standards*

#### 3.2.4.1 Failure Tolerance

**[R.LIDS.0106] Catastrophic Hazard Fault Tolerance**

The iLIDS shall be designed such that no combination of two failures, or two operator errors, or one of each can result in a disabling or fatal personnel injury, or loss of the ISS, unless controlled by Design For Minimum Risk (DFMR). Compliance with this requirement may be accomplished at the iLIDS level or through a combination of hazard controls at the integrated Visiting Vehicle (VV) and/or ISS levels.

*Rationale: Compliance with ISS program safety requirements. Verification of this requirement may be satisfied via a combination of hazard controls at the iLIDS level and at the integrated-system level (including both the VV and ISS). In areas where the iLIDS cannot meet this requirement alone, the required integrated hazard controls will be documented as an interface requirement in the appropriate ICD/IDD, and the hazard reports will reference those requirements as appropriate. Personnel considered include all flight and ground crews.*

**[R.LIDS.0107] Critical Hazard Fault Tolerance**

The iLIDS shall be designed such that no single failure or single operator error can result in a non-disabling personnel injury, severe occupational illness; loss of a major ISS element on-orbit life sustaining function or emergency system, unless controlled by DFMR. Compliance with this requirement may be accomplished at the iLIDS level or through a combination of hazard controls at the integrated VV and/or ISS levels.

*Rationale: Compliance with ISS program safety requirements. Verification of this requirement may be satisfied via a combination of hazard controls at the iLIDS level and at the integrated-system level (including both the VV and ISS). In areas where the iLIDS cannot meet this requirement alone, the required integrated hazard controls will be documented as an interface requirement in the appropriate ICD/IDD, and the hazard reports will reference those requirements as appropriate. Personnel considered include all flight and ground crews.*

**[R.LIDS.1107] Failure Tolerance**

The iLIDS failure tolerances shall meet or exceed the allocations in the Failure Tolerance Allocation table for the identified functions.

**Table 3.2-1 - Failure Tolerance Allocation**

| End Item Function | Failure Tolerance Allocation (A) (B) (C) (E) (F) (G) | |
|---|---|---|
| | iLIDS (-301) | iLIDS (-302) |
| Unlatch hard capture hooks | 2 | 1 |
| Achieve soft capture during docking | 1 | 1 |
| Achieve hard capture during docking | 1 | 1 |
| Hold cabin pressure while docked | 1 (D, G) | 1 (D,G) |
| Charge separator springs | 1 | 1 |
| Pass power and data between docked vehicles | 1 | 1 |
| Provide heater power | 1 | 1 |
| Provide temperature sensing | 1 | 1 |
| Provide MMOD protection | 0 | 0 |

Notes:
(A) Maintenance may not be considered as a redundant path to meet these requirements.
(B) Redundancy used to achieve failure tolerance may be similar or dissimilar.
(C) Failure tolerance defined by requirements in R.LIDS.0106 and R.LIDS.0107.
(D) Degraded performance allowed after one hook failure.
(E) When the iLIDS functions are implemented using structure, the structure shall be exempted from failure tolerance requirements.
(F) When the iLIDS functions are implemented via mechanisms, the mechanisms will be designed for minimum risk and considered to be single failure tolerant equivalent.
(G) One fault tolerance on iLIDS is implemented via dual seals.

*Rationale: Fault tolerance improves safety and likelihood of mission success for missions involving iLIDS. The levels of fault tolerance established are reflective of the design that resulted from mass and risk trades performed in the development of iLIDS for the Constellation program, as subsequently further tailored for the ISS program.*

3.2.4.2 Failure Propagation

**[R.LIDS.0108] Failure Propagation**

A single failure of the iLIDS shall preclude propagation of additional failures external to the failed end item.

*Rationale: This is a NASA standard reliability requirement.*

3.2.4.3 Failure Detection, Isolation, and Recovery

**[R.LIDS.0109] Failure Detection, Isolation, and Recovery**

The iLIDS shall provide Fault Detection, Isolation, and Recovery (FDIR).

*Rationale: NPR 8705.2, Human-Rating Requirements for Space Systems, mandates FDIR for faults of human-rated systems that affect critical functions. FDIR is required for crew safety and mission success because it enables the recovery of such critical functions. In addition, fault detection enables crew abort or flight* *termination (in case of nonrecoverable failures). Fault isolation further enables common-mode failure identification, in-flight maintenance, and fleet supportability.*

3.2.5 Maintainability

Reserved

3.2.6 Transportability

3.2.6.1 Ground Transportability

The iLIDS ground transportability loads are decomposed in [R.LIDS.0027] by meeting all functional and performance requirements during and after exposure to the loads defined in JSC-65970, iLIDS Thermal and Induced Environments (iLIDS TIES).

3.2.7 JPR 8080.5 - JSC Design and Procedural Standards

**[R.LIDS.1109] JPR 8080.5 - JSC Design and Procedural Standards**

The iLIDS shall meet JPR 8080.5, JSC Design and Procedural Standards requirements marked applicable, as specified in Appendix C.

*Rationale: Adherence to NASA standards. JPR 8080.5, JSC Design and Procedural Standards provides design and procedural requirements for any human spaceflight program, project, spacecraft, system, or end item.*

## 3.3 Design and Construction

**[R.LIDS.1108.1] Fastener - Threaded Ends**

The iLIDS threaded ends of IVA and EVA screws and bolts extending more than 0.12 in. shall be capped to protect against sharp threads.

*Rationale: This is to protect the crew from injury due to sharp edges in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 6.3.3.6.*

**[R.LIDS.1108.2] Fastener - Maintenance Force**

iLIDS on-orbit maintainable IVA fasteners shall require no greater than 20 lbf for engagement or disengagement with ratchet-type tools.

*Rationale: The value accommodates the strength limitations of the 5th percentile male population, as stated by SSP 41000, System Specification for the International Space Station, Section 3.3.7.3.2, which is derived from SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 4.9.3.B.*

**[R.LIDS.1108.3] Fastener - Maintenance Torque**

iLIDS on-orbit maintainable IVA fasteners shall require no greater than 11 ft-lb torque for engagement or disengagement with driver type tools.

*Rationale: The value accommodates the strength limitations of the 5th percentile male population as stated by SSP 41000, System Specification for the International Space Station, Section 3.3.7.3.2, which is derived from SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 4.9.3.B.*

**[R.LIDS.1108.4] IVA Toolbox Compatibility**

iLIDS mounting fasteners used on guide petals and electrical boxes shall be selected to be compatible with IVA tool box assembly part number SEG33113668-301.

*Rationale: This requirement adheres to approved standards to support on-orbit maintenance. The standard tool list is comprised of tools to be used for Orbital Replacement Unit (ORU) removal and replacement. The IVA tool box is in accordance with JSC 28533, ISS Catalogue of IVA GFE FCE.*

**[R.LIDS.1117] Fastener Integrity**

iLIDS fasteners shall be in accordance with JPR 8730.2, JSC Fastener Integrity Testing Program.

*Rationale: The iLIDS contains numerous safety-critical fasteners whose properties are crucial to the safe operation of the iLIDS. Counterfeit or substandard fasteners could cause a structural failure of the iLIDS and result in a catastrophic hazard.*

### 3.3.1 Materials, Processes and Parts

#### 3.3.1.1 Materials and Processes

**[R.LIDS.0116] Flight Hardware**

Materials and processes for flight hardware shall meet the requirements of NASA-STD-6016, Standard Material & Process Requirements for Spacecraft as implemented by JSC-27301, Materials Control Plan for JSC Flight Hardware.

*Rationale: The NASA standard covers generic Materials and Process requirements. The iLIDS will utilize JSC-27301, Materials Control Plan for JSC Flight Hardware as a specific implementation to meet NASA-STD-6016. JSC-27301 also covers workmanship standards for mechanical and electrical hardware and implements SSP 30233, Space Station Requirements for Materials and Processes.*

#### 3.3.1.2 Electrical, Electronic and Electromechanical Parts

**[R.LIDS.0120] Electrical, Electronic, and Electromechanical Parts Selection**

The iLIDS shall comply with the design requirements contained in JSC-64924, iLIDS Electrical, Electronic, and Electromechanical (EEE) Parts Management and Implementation Plan.

*Rationale: This plan defines the requirements, processes and policies for an EEE Parts Control Program for the Project.*

**[R.LIDS.5036] iLIDS-to-Host Vehicle Electrical Interface (Excluding -302)**

The iLIDS (excluding -302) shall provide electrical connections to the host vehicle as defined in JSC-65795, NDS IDD, figure NDS (excluding -302) Tunnel Connections-to-Host Vehicle Electrical Interface.

*Rationale: The vehicle interface has a separate connector for power and data, unlike the iLIDS umbilical interface, which combines power and data.*

**[R.LIDS.5037] Host Interface Connector Pinouts**

The iLIDS shall comply with the Host Interface Connector Pinouts as defined in JSC-65795, NDS IDD, Appendix F.

*Rationale: The vehicle interface has a separate connector for power and data, unlike the iLIDS umbilical interface, which combines power and data.*

**[R.LIDS.5038] iLIDS Box Connections-to-Host Vehicle Electrical Interface (Excluding -302)**

The iLIDS (excluding -302) shall provide electrical connections to the host vehicle as defined in JSC-65795, NDS IDD, figure NDS (excluding -302) Box Connections-to-Host Vehicle Electrical Interface.

*Rationale: The IDD figure defines the required host interfaces for both power and data to the iLIDS electrical boxes.*

### 3.3.2 Structural Design

**[R.LIDS.0124] Structural Design and Verification Requirements**

The iLIDS shall be designed and verified to meet the requirements of SSP 30559 Structural Design and Verification Requirements.

Exception: SSP 30559, Section 3.1.9.3 (Dewars) and 3.1.9.7 (Burst Discs) are not applicable.

*Rationale: This requirement adheres to approved standards. For launch and unmated cases, the shuttle factors of safety will be used.*

**[R.LIDS.0127] Fracture Control Design**

The iLIDS shall implement the fracture control requirements specified in NASA-STD-5019, Fracture Control Requirements for Spaceflight Hardware.

*Rationale: Fracture control implementation is mandatory to ensure safety of the manned space systems. Implementation of fracture control is necessary to prevent premature failure due to flaws. The procedure for meeting these requirements is found in JSC-25863B, Fracture Control Plan for JSC Flight Hardware. In the case of conflict, the technical requirements of NASA-STD-5019 take precedence over the technical requirements cited in applicable documents or referenced guidance documents.*

**[R.LIDS.0128] Mechanisms**

The iLIDS shall comply with Section 1 through Section 4 of NASA-STD-5017, Design and Development Requirements for Mechanisms.

*Rationale: This requirement adheres to approved standards.*

### 3.3.3 Nameplates and Product Marking

**[R.LIDS.0136] General Identification Marking Requirements**

The iLIDS shall use nameplates and product marking in accordance with PRC-9002, Process Specification for Part Marking.

*Rationale: This is in accordance with approved standards.*

**[R.LIDS.0137] Nomenclature Plan**

iLIDS nameplates and product marking shall use operational nomenclature related to on−orbit operations, which shall conform to SSP 50254, Operations Nomenclature.

*Rationale: The iLIDS shall adhere to standards currently in use for ISS hardware markings. Labeling applicable only to ground−based (nonoperational) functions may use other common technical terms. This is in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 9.5.3.1.2 (D).*

**[R.LIDS.0286] Mounting/Alignment Labels/Codes**

The iLIDS shall be labeled or coded to identify proper mounting alignment.

*Rationale: Labels provide contextual information to help assure that ground crewmembers do not attempt to install an iLIDS incorrectly; such an attempt could damage the iLIDS or the interfaces to the vehicle. Each iLIDS is verified for flight in its designed orientation and configuration.*

### 3.3.4 Workmanship

**[R.LIDS.0294] Surface Cleanliness**

iLIDS surfaces shall at a minimum be Visibly Clean (VC) Sensitive in accordance with SN-C-0005, Contamination Control Requirements for the Space Shuttle Program upon delivery for integration.

*Rationale: The iLIDS may require a more stringent level of cleanliness if the installation has proximity or exposure to more sensitive surfaces. Areas that are inaccessible in the final assembly and that may act as contamination sources while on-orbit shall be cleaned to the VC Sensitive level of JSC SN-C-0005, Contamination Control Requirements for the Space Shuttle Program before close–out, as specified in SSP 30426, Space Station External Contamination Control Requirements, Section 3.2.1.1.*

**[R.LIDS.0298] iLIDS-to-Vehicle Interface Seal Cleanliness**

The iLIDS-to-vehicle interface, seal gland, and seals shall at a minimum be Visibly Clean (VC) Highly Sensitive in accordance with SN-C-0005, Space Shuttle Contamination Control Requirements upon delivery for integration.

*Rationale: The ISS levies a minimum VC Sensitive level for Space Station components and user hardware per SSP 30426, Space Station External Contamination Control Requirements. iLIDS-to-vehicle interface requires a higher VC Highly Sensitive level. This requirement is in accordance with SN-C-0005, Space Shuttle Contamination Control Requirements, Table A.2.*

**[R.LIDS.1093] iLIDS-to-iLIDS Interface Seal Cleanliness**

The iLIDS-to-iLIDS interface, seal gland, and seals shall at a minimum be Visibly Clean (VC) Highly Sensitive in accordance with SN-C-0005, Space Shuttle Contamination Control Requirements upon delivery for integration.

*Rationale: The ISS levies a minimum VC Sensitive level for Space Station components and user hardware per SSP 30426, Space Station External Contamination Control Requirements. iLIDS-to-vehicle interface requires a higher VC Highly Sensitive level. This requirement is in accordance with SN-C-0005, Space Shuttle Contamination Control Requirements, Table A.2.*

### 3.3.5 Human Engineering

**[R.LIDS.0158] Anthropometry**

The iLIDS internal hardware shall provide fit, access, reach, view, and operation of human-system interfaces in crew functional areas for unsuited crewmembers for the 5th percentile Japanese female to the 95th percentile American male anthropometric size measurement.

*Rationale: This requirement is in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 3.3.*

**[R.LIDS.0159] Range of Motion**

Aspects of the iLIDS with which unsuited IVA crewmembers physically interact during planned tasks shall be within the ranges of motion provided in SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Figure 3.3.2.3.1-1.

*Rationale: This requirement is in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 3.3.*

3.3.5.3 Strength

**[R.LIDS.1084] Strength**

iLIDS internal hardware, which will have a crew interface under normal operations, shall accommodate the strength limitations of the 5th percentile American female in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 4.9.

*Rationale: This is in accordance with approved standards.*

3.3.5.4 Natural and Induced Environment

**[R.LIDS.0162] IVA Crew-Induced Loads**

The iLIDS internal structure shall meet requirements specified herein when exposed to IVA-crew induced loading as specified in SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 8.8.3.3.b.

*Rationale: System components and hardware with which the crew interacts during nominal operations on-orbit must be able to withstand incidental contact by crewmembers without creating a hazard.*

3.3.5.5 IVA Crew Safety

**[R.LIDS.0185] Corners and Edges**

iLIDS corners and edges to which the IVA crew is expected to be exposed during normal operations shall be rounded, as specified in SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T) to protect the crew from injury due to sharp edges and corners.

*Rationale: This requirement is in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Sections 6.3.3.1, 6.3.3.2, 6.3.3.3, and 6.3.3.11. The host vehicle is responsible for the -302 passage cover. Since implementation is unknown, all items located within the internal passageways of the -302 will be considered exposed and need to meet the sharp edge requirement.*

**[R.LIDS.0186] Loose Equipment**

Any iLIDS loose equipment, except for equipment with functional sharp edges, shall have corners and edges rounded, as specified in SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T) to protect the crew from injury due to sharp edges and corners.

*Rationale: This requirement is in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Sections 6.3.3.1, 6.3.3.2, 6.3.3.3, and 6.3.3.11.*

**[R.LIDS.0187] Burrs**

Any iLIDS exposed surfaces accessible to IVA crew shall be smooth and free of burrs.

*Rationale: Removal of burrs can help to prevent personnel injury and damage to protective equipment from sharp edges during normal operations.*

**[R.LIDS.0188] Pinch Points**

The iLIDS shall prevent pinch points from injuring the IVA crew.

*Rationale: Pinch points can cause injury to the crew, but may exist for the nominal function of equipment (i.e., equipment panels). This may be avoided by locating pinch points out of the reach of the crew or providing guards to eliminate the potential to cause injury.*

**[R.LIDS.0189] IVA Touch Temperature**

iLIDS surfaces, which are subject to IVA crewmember contact, shall meet the touch temperature requirements as specified in SSP 50021, Safety Requirements Document, Section. 3.3.6.12.1, Internal Volume Touch Temperature.

Exception: IVA touch temperature limits may not be met for some time after the two vehicles have completed docking until the warm-up period is complete. The warm-up period will be characterized in JSC 65795, NDS IDD.

*Rationale: iLIDS internal surface temperatures must be maintained within the touch temperature limits to prevent crewmember injury from continuous and momentary contact.*

**[R.LIDS.0190] Labeling**

The iLIDS shall provide labels for crew interfaces, in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T).

*Rationale: This is to allow for identification of relevant features.*

**[R.LIDS.0192] Language**

The iLIDS shall use text written in the American English language, as specified by Webster's New World Dictionary of American English.

*Rationale: The intent of this requirement is to ensure as much commonality and consistency as possible in written text (i.e., language and spelling) across vehicle subsystems and across ISS systems. This will facilitate learning and minimize interface-induced crew error.*

**[R.LIDS.1104] Crew Protection for Electrical Shock**

The iLIDS shall provide protection for the crew from electrical hazards in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 6.4.3.

*Rationale: The crew must be protected from potentially catastrophic electrical shock from the iLIDS electrical systems. This requirement is in accordance with SSP 50021, Safety Requirements Document, Section 3.3.6.8.2.*

**[R.LIDS.1105] IVA Exposed Circular Holes**

Any exposed round or slotted holes on the iLIDS accessible to IVA crew that are uncovered shall be less than 0.4 in. or greater than 1.0 in. in diameter for equipment located inside iLIDS.

*Rationale: Holes should be sized either small enough to prevent crewmember finger entry or large enough such that crewmember fingers cannot be stuck or injured. This requirement is in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 6.3.3.4.*

### 3.3.6 Safety

**[R.LIDS.0197] Hazard Analysis and Safety Risk Assessment**

A safety hazard analysis and safety risk assessment shall be performed for the iLIDS, as specified in SSP 30309, Safety Analysis and Risk Assessment Requirements Document.

*Rationale: The foremost consideration for resolving hazards, identified by the hazard analysis process, is to eliminate hazards by removing hazard sources and hazardous operations. The methods for controlling critical and catastrophic hazards are failure tolerance and DFMR.*

**[R.LIDS.1092] Control System Safety Requirements**

The iLIDS shall be designed in accordance with SSP 50038, Computer-Based Control System Safety Requirements.

*Rationale: Compliance with ISS program safety requirements. Verification of this requirement may be satisfied via a combination of hazard controls at the iLIDS level and at the integrated-system level (including both the VV and ISS). In areas where the iLIDS cannot meet this requirement alone, the required integrated hazard controls will be documented as an interface requirement in the appropriate ICD/IDD, and the hazard reports will reference those requirements as appropriate. Personnel considered include all flight and ground crews.*

**[R.LIDS.1102] Design For Minimum Risk**

iLIDS hazards related to DFMR areas of design shall be controlled by the safety-related properties and characteristics of the design. The failure tolerance criteria are only to be applied to these designs as necessary to ensure that credible failures that may affect the design do not invalidate the safety-related properties of the design.

*Rationale: This requirement is in accordance with SSP 41000, System Specification for the International Space Station, Section 3.3.6.1.2. DFMR are areas where hazards are controlled by specification requirements that specify safety-related properties and characteristics of the design that have been baselined by the ISS program requirements rather than failure tolerance criteria. The failure tolerance criteria of R.LIDS.0106 will only be applied to these designs as necessary to ensure that credible failures that may affect the design do not invalidate the safety-related properties of the design. For example, a pressure vessel shall be certified safe based upon its inherent properties to withstand pressure loading that have been verified by analysis and qualification and acceptance testing; however, failure tolerance must be imposed upon external systems that might affect the vessel, such as a tank heater, to ensure that failures of the heater do not cause the pressure to exceed the Maximum Design Pressure (MDP) of the pressure vessel. Examples are mechanisms, structures, glass, pressure vessels, pressurized lines and fittings, functional pyrotechnic devices, material compatibility, flammability, etc.*

**[R.LIDS.1103] Pyrotechnic Operated Devices (Excluding -302)**

The iLIDS (excluding -302) shall provide pyrotechnic devices designed and tested to the requirements of JSC 62809, Human Rated Spacecraft Pyrotechnic Specification.

Exception: Exception is taken to JSC 62809 Sections 3.1, 3.2.2, 3.6.18, 3.6.19, 3.6.20, 3.6.24.1, 3.6.24.2, 3.6.24.3, 3.6.26.1, 4.1.3, 4.4.9, 4.5.1.6, 4.5.2.4, 4.5.2.5, 7.3.3, 7.3.4, 8.1, 8.2, 8.2.4, 8.3 to 8.3.6, 8.4.7, 8.5.1, and 8.5.2. Sections noted are not verifiable by the iLIDS project.

*Rationale: iLIDS pyrotechnic devices must meet pyrotechnic requirements to ensure safe pyrotechnic design and operation. This requirement is in accordance with SSP 50021, Safety Requirements Document, Section 3.3.6.5.1.3.*

**[R.LIDS.1106] Verifiable Seal Leakage Paths**

The iLIDS project shall provide for redundancy and verifiability requirements for leak paths through the pressurized module to the external environment in accordance with the criteria listed in the Seal Redundancy and Verifiability Requirements table.

**Table 3.3-1 - Seal Redundancy and Verifiability**

| Seal | Redundancy and verifiability requirements [2,3,4,5] | |
|---|---|---|
| | D<= 6.0 in. | D> 6.0 in. |
| Feed-through connections[1] | A | B |
| Host vehicle Interface | A | B |
| Docking | A | B |

Notes:

(1) Includes valves, gages, transducers, etc.
(2) D = Major diameter of the seal
(3) A = Interface shall have two seals. The interface shall be verifiable prior to launch.
(4) B = Interface shall have two seals. Each seal shall be verifiable prior to launch.
(5) The interface may be verified in flight after docking via vestibule pressurization and leak check prior to hatch opening.

*Rationale: This requirement is derived from SSP 50021, Safety Requirements Document, section 3.2.2.7, but removes the requirement for on-orbit individual seal leakage verification for seals with a diameter greater than 6 in.; the requirement was tailored to be consistent with current docking and berthing operations on the ISS.*

### 3.3.7 Operational Lifetime

**[R.LIDS.0201] On-Orbit Design Life - Long Duration (-302)**

The iLIDS (-302) shall be designed to meet a minimum of 15 years of low earth orbit design life without maintenance.

*Rationale: The current manifest shows a 10-year ISS life after CDA delivery. In order to avoid recertification in the event of ISS life extension, iLIDS (-302) will certify to 15 years. This equates to a Mean Time To Failure (MTTF) of 15 years.*

**[R.LIDS.0202] iLIDS On-Orbit Design Life without Maintenance - Short Duration (Excluding -302)**

The iLIDS (excluding -302) shall be designed to meet a minimum of 231 days of low earth orbit design life with no maintenance.

*Rationale: The 231 days are as follows:*

*a. Unmated operations on-orbit: 21 days*

- *Ultraviolet exposure not to exceed 214 equivalent sun hours (TBR-212)*

*b. Mated mission duration: 210 days*

**[R.LIDS.0203] Shelf Life**

The iLIDS shall be designed to meet a minimum 5-year shelf life.

*Rationale: The intent of this requirement is to specify a minimum life prior to required maintenance. The shelf life is derived from the longest time between manufacture and delivery of the iLIDS. This will be verified by the Limited Life Item List (LLIL).*

**[R.LIDS.0206] iLIDS Passive Mode Docking/Undocking Cycles**

The iLIDS shall be capable of a minimum of 70 passive mode docking/undocking operations.

*Rationale: This includes 20 ground operations and 50 flight cycles. Fifty cycles is calculated by a 15-year life with 3 missions per year and a margin of 5. The cycles are defined as a full docking/undocking sequence. The 70 Passive mode docking/undocking cycle operations does not account for component-level cycles (i.e., flex-drive, actuators, etc.).*

**[R.LIDS.0207] Launch**

The iLIDS shall be designed to meet a minimum of one launch.

*Rationale: The iLIDS must survive the minimum cycles for launch in order to meet operational life. Launch includes one Earth launch.*

**[R.LIDS.1060] iLIDS Active Mode Docking/Undocking Cycles (Excluding -302)**

The iLIDS (excluding -302) shall be capable of a minimum of 24 active mode docking/undocking operations.

*Rationale: This includes 20 ground operation cycles and 4 flight cycles. The cycles are defined as a full docking/undocking sequence. The 24 active mode docking/undocking cycle operations does not account for component-level cycles (i.e., flex-drive, actuators, etc.).*

#### 3.3.8 Electrical Parts and System Design, Construction, and Verification

**[R.LIDS.1120] iLIDS Electrical Boxes**

iLIDS electrical boxes shall include captive fasteners.

*Rationale: This is to allow the electrical boxes to be compatible with potential IVA replacement. However, IVA replacement must be considered on a case-by-case basis depending on integration with the host vehicle.*

**[R.LIDS.1126] Host Electrical Power Interface - Modularity**

The iLIDS shall allow for reconfiguration to alternate host vehicle power values.

*Rationale: An electrical power interface is needed to allow the host vehicle to power the iLIDS. This is the power for iLIDS consumption, which is not to be confused with the host vehicle pass-through power to the mating vehicle. Host vehicles may operate with different nominal power configurations (e.g., 28 Vdc, 120 Vdc, etc.). This requirement allows for a modular power system to accommodate multiple hosts. The host vehicle power must be specified at the time of the delivered docking system buildup; the system cannot accept multiple power configurations at the same time.*

## 3.4 Logistics

### 3.4.1 Maintenance

#### 3.4.1.1 On-Orbit Maintenance

No on orbit maintenance is planned; however, refer to R.LIDS.1108.1 through R.LIDS.1108.4 and R.LIDS.1120 for requirements on captive fasteners to support potential on-orbit replacement of electrical boxes.

#### 3.4.1.2 Ground Maintenance

**[R.LIDS.0229] Tool Clearance**

The iLIDS shall provide tool clearances for tool installation and actuation for all tool interfaces during ground maintenance.

*Rationale: No further rationale is required.*

# 4 GROUND SUPPORT EQUIPMENT REQUIREMENTS

## 4.1 Ground Support Equipment Interface Definition

The iLIDS incorporates the following interfaces to GSE:

- Power
- C&DH
- Structural/Mechanical - The iLIDS-to-GSE interface is illustrated in the iLIDS-to-GSE Interface Diagram figure.

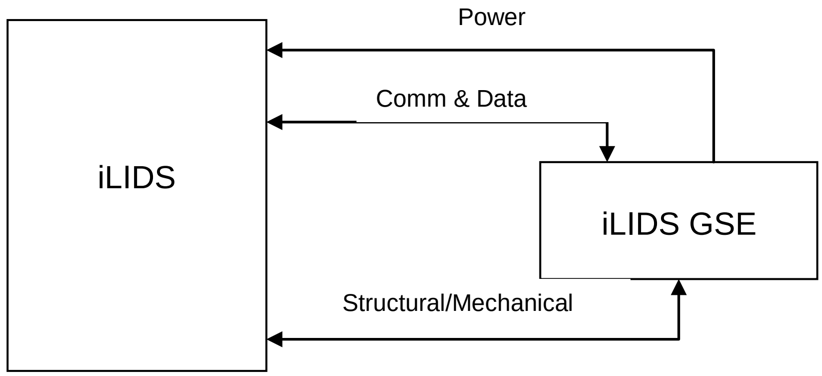



**Figure 4.1-1 - iLIDS to GSE Interface Diagram**

**[R.LIDS.0043] GSE Command and Data Handling Interface**

The iLIDS shall provide a unique C&DH interface for GSE separate from the host vehicle interface to allow ground check-out and testing.

*Rationale: A separate interface is needed to allow check-out of the system after installation on the host vehicle. This allows for docking system evaluation without requiring the host vehicle's computer system.*

**[R.LIDS.0044] Structural Interface**

The iLIDS shall provide a structural interface for GSE.

*Rationale: An interface between the iLIDS and GSE is needed during ground testing.*

## 4.2 GSE Requirements

### 4.2.1 General

**[R.LIDS.1083] General**

All iLIDS GSE shall conform to NASA-STD-5005, Ground Support Equipment.

*Rationale: These NASA standards for GSE and GSE hardware must be maintained and controlled as Class I. The standards ensure that uniform engineering practices, methods, and essential criteria are employed in the design of GSE used within NASA.*

### 4.2.2 Ground Support and Transportation

### 4.2.3 Ground Crew Interfaces

**[R.LIDS.0256] Labeling**

The iLIDS, including iLIDS GSE, shall provide labels for ground crew interface controls and indicators.

*Rationale: This is in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 9.5.3.1.*

**[R.LIDS.0259] Hazards Labeling**

The iLIDS GSE shall provide labels to identify hazards to ground crew or to equipment.

*Rationale: Hazard labeling shall be verified by inspection. The inspection shall identify the list of equipment that is susceptible to damage or constitutes a hazard to the ground crew. This list will include the type of hazard [Electrostatic Discharge (ESD), chemical, pressurized fluid, etc.]. The verification shall be considered successful when the inspection shows that all items on the list have been labeled with hazard information.*

# 5 PREPARATION FOR DELIVERY

## 5.1 Preservation

### 5.1.1 General Preservation Requirements

Preservation methods shall include the application of protective measures and materials to maintain the item within the appropriate cleanliness levels and to prevent damage or degradation in reliability or performance of the item when exposed to the natural and induced ground based and transportation and ground handling environments.

The requirement for preservation method and level of protection shall be in accordance with MIL-STD-2073-1 and MIL-STD-2073-2.

## 5.2 Packing

### 5.2.1 General Packing Requirements

Packing should include military standard and special design containers used for the transportation and storage of the item.

Packing should be used in conjunction with the appropriate preservation methods, handling procedures, and methods of transport to prevent damage or degradation in reliability or performance of the item when exposed to the natural and induced ground based and transportation and ground handling environment.

Packing should be in accordance with MIL-STD-2073-2, 5.6 and SSP 50005, 11.12.3.

### 5.2.2 Detailed Packing Requirements

The specific details relating to unique preservation, handling, and packaging selection should be reflected in the Sustaining Engineering Plan for mission essential items, Oversized Flight Element Transportation Plans, and corporate internal procedures.

## 5.3 Marking and Labeling

### 5.3.1 General Marking and Labeling Requirements

#### 5.3.1.1 Unit Packages, Intermediate Packages, and Exterior Shipping

Marking and labeling for shipment and storage for unit packages, intermediate packages, and exterior shipping containers shall be in accordance with MIL-STD-129 and NPR 6000.1.

#### 5.3.1.2 Hazardous Materials

The marking of containers and other packaging for shipment and storage of hardware containing or having hazardous material characteristics shall be in accordance with Code of Federal Regulations (CFR) Title 49.

#### 5.3.1.3 Detailed Marking and Labeling Requirements

Specific and detailed marking and labeling requirements should be reflected in the Sustaining Engineering Plan, Oversized Flight Element Transportation Plans, engineering drawings, manufacturing planning papers, and corporate internal procedures.

# 6 CUSTOMER IMPOSED VERIFICATION REQUIREMENTS

# 7 NOTES / ERRATA

**Ultraviolet Radiation**: The studies for ultraviolet (UV) exposure to seals and assumed mission scenario are still being conducted. The definition for UV exposure will aid in defining the scaling factor for ESH per hour on orbit. The scaling factor for ESH determines the period of time that the seal can face the sun without causing degradation of the seal. UV exposure level is highly dependent on orientation of vehicle (alpha/beta) with respect to the sun (e.g., solar facing; local vertical, local horizontal (LVLH); edge-to-the-sun). Worst case scenario of UV exposure is constrained by iLIDS seals and the ESH time. See iLIDS requirements R.LIDS.0202, R.LIDS.1113, and R.LIDS.1138 for TBR-212 placeholder. Estimated closure of open item is September 2011.

**Berthing**: The development of the berthing requirements document is still in-work. iLIDS Berthing requirement R.LIDS.1001 has been added as a placeholder for the future Block 1 Upgrade and includes TBS-217 for the berthing requirements document number. Estimated closure of open item is September 2011.

**Ionizing Radiation**: The 120V iLIDS configurations (-301 and -302) will take exception to the radiation hardness levels defined in JSC 64598, iLIDS Ionizing Radiation Control Plan. EV will be tasked to determine a value for True LET to be applied to these configurations. See requirement R.LIDS.0183 for TBS-218 placeholder.

## APPENDIX A ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| 6-DOF | Six Degrees of Freedom |
| ANSI | American National Standards Institute |
| AO | Atomic Oxygen |
| AWG | American Wire Gauge |
| baud | Symbol Rate |
| Btu | British Thermal Unit(s) |
| C&DH | Command and Data Handling |
| CDA | Common Docking Adapter |
| CDR | Critical Design Review |
| CFR | Code of Federal Regulations |
| CIL | Critical Items List |
| cm | Centimeter(s) |
| $cm^2$ | Square Centimeters |
| °C | Degrees Celsius |
| °F | Degrees Fahrenheit |
| DC | Direct Current |
| DCN | Document Change Notice |
| DFMR | Design for Minimum Risk |
| DRM | Design Reference Mission |
| E3 | Electromagnetic Environmental Effects |
| EA3 | Systems Architecture and Integration Office |
| EAR | Export Administration Regulations |
| EEE | Electrical, Electronic, and Electromechanical |
| EMU | Extravehicular Mobility Unit |
| ES4 | NASA Materials and Processes Division |
| ESD | Electrostatic Discharge |
| ESH | Equivalent Sun Hours |
| EVA | Extravehicular Activity |
| FDIR | Fault Detection, Isolation, and Recovery |
| FMEA | Failure Modes and Effect Analysis |
| FRAM | Flight Releasable Attachment Mechanism |
| ft-lb | Foot Pound |
| GFE | Government Furnished Equipment |

| | |
|---|---|
| GN&C | Guidance, Navigation, and Control |
| GSE | Ground Support Equipment |
| H&S | Health and Status |
| HCS | Hard Capture System |
| hPa | Hectopascal(s) |
| Hz | Hertz |
| ICD | Interface Control Document |
| ID | Identification |
| IDD | Interface Definition Document |
| IDSS | International Docking System Standard |
| iLIDS | International Low Impact Docking System |
| in. | Inch(es) |
| ISS | International Space Station |
| IVA | Intravehicular Activity |
| JPR | JSC Program Requirements |
| JSC | Johnson Space Center |
| kilobaud | 1000 baud |
| kg | Kilogram(s) |
| kgf-m | Kilograms Force per meter |
| KOZ | Keep Out Zone |
| kPa | Kilopascal(s) |
| kPa/sec | Kilopascals per Second |
| lb | Pound(s) |
| lbf | Pound-Force |
| lbm | Pound-Mass |
| LET | Linear Energy Transfer |
| LIDS | Low Impact Docking System |
| LLIL | Limited Life Item List |
| LSAM | Lunar Surface Access Module |
| LSB | Least Significant Bit |
| LVLH | Local Vertical Local Horizontal |
| MDP | Maximum Design Pressure |
| MGA | Mass Growth Allowance |
| MIL | Military |
| mm | Millimeter(s) |

| | |
|---|---|
| MMOD | Micrometeoroid and Orbital Debris |
| MPE | Maximum Predicted Environment |
| ms | Millisecond(s) |
| MSID | Measurement Stimulation Identification |
| MTTF | Mean Time to Failure |
| NASA | National Aeronautics and Space Administration |
| NDS | NASA Docking System |
| NDSP | NASA Docking System Project |
| NDT | Non-Destructive Testing |
| NPR | NASA Processes and Requirements |
| NRZ | Non-Return to Zero |
| NSI | NASA Standard Initiator |
| NT | NASA Quality and Flight Equipment Division |
| OA | ISS Program Office |
| ORU | Orbital Replacement Unit |
| PNP | Probability of No Penetration |
| psia | Pounds per Square Inch Absolute |
| psi | Pounds per Square Inch |
| psi/sec | Pounds per Square Inch per Second |
| PV | Photovoltaic |
| Pyro | Pyrotechnic |
| RMS | Remote Manipulator System |
| RTD | Resistance Temperature Detector |
| S&MA | Safety and Mission Assurance |
| SCS | Soft Capture System |
| SEB | Single Event Burn-Out |
| sec | Second |
| SEGR | Single Event Gate Rupture |
| SEL | Single Event Latch-up |
| SEU | Single Event Upset |
| STD | Standard |
| STS | Space Transportation System |
| TBD | To Be Determined |
| TBR | To Be Resolved |
| TBS | To Be Specified |

| | |
|---|---|
| TIES | Thermal and Induced Environments |
| TMG | Thermal Micrometeoroid Garment |
| TPS | Thermal Protection System |
| TVS | Transient Voltage Suppressor |
| TX | Transmit |
| UART | Universal Asynchronous Receiver/Transmitter |
| UV | Ultraviolet |
| V | Volt |
| VC | Visibly Clean |
| Vdc | Volts Direct Current |
| VM | Verification Matrix |
| VV | Visiting Vehicle |
| W | Watt |
| W-hr | Watt-hours |
| $W/m^2$-K | Thermal transmittance, transfer of heat (in watts) through one square meter of a structure divided by the difference in temperature across the structure. |
| X | Times |

## APPENDIX B DEFINITION OF TERMS

| Term | Definition |
|---|---|
| Active iLIDS | An iLIDS (International Low Impact Docking System) that has electro-mechanical actuation controlled features such as linear actuators, motor driven hooks and electro-magnets. An "Active iLIDS" can only interface with a "Passive iLIDS" (see definition of Passive iLIDS below in this table). |
| Active Mode | A functional mode of iLIDS. An active iLIDS performs all capture and structural attachment to the passive iLIDS. See definition of Passive Mode. |
| Alignment | Alignment is the function that allows iLIDS to compensate and correct to the proper orientation necessary for successful soft capture. |
| Androgynous | Hardware that does not have distinct male or female characteristics, all hardware are identical in form and function. |
| Backout | A dynamic process in which a maneuvering vehicle halts its approach to the target and separates along a controlled path (within the approach/departure corridor) to a planned, safe station keeping range. A backout is normally followed by a resumed approach or breakout maneuver. |
| Berth | Mating method that allows connection of two vehicles with the assistance of a robotic arm or a Remote Manipulator System (RMS)-type device. |
| Breakout | A dynamic process in which a maneuvering vehicle alters its intercept approach to a target and separates with the intention of not immediately resuming the approach that day. A second rendezvous is necessary to reestablish intercept conditions. In emergency scenarios, the maneuvering vehicle may perform an emergency deorbit burn as part of the breakout sequence. |
| Bulkhead | A bulkhead is a partition inside a ship, aircraft, or large vehicle. |
| Bulkhead Connectors | The bulkhead connectors are those that pass through a pressurized bulkhead. |
| Capture | The use of a docking mechanism to bring an approaching vehicle from a free flight state to a physically connected state (but not fully constrained) with the mating vehicle. Capture enables placement of the system in a controlled orientation in preparation for hard mate. When captured, the system may be easily released and is typically unable to withstand its full mechanical loading environment. |

| **Term** | **Definition** |
|---|---|
| Catastrophic Hazard | A catastrophic hazard is a condition that may cause loss of life or a permanently disabling injury. It also includes a condition that may cause loss of vehicle, prior to completing its primary mission. For example, a hazard that could cause loss of Orion prior to rendezvous with the Lunar Surface Access Module (LSAM) is considered catastrophic. A hazard that may cause loss of Orion after crew evacuation, during a water landing, would not be considered catastrophic. |
| CheckSum | CheckSum is a value transmitted with a data stream, derived from the other elements in the data stream, and used to check for transmission errors in the data. If the transmitted checksum differs from the one derived by the receiving computer, a transmission error has probably occurred and the transmission is repeated. |
| Command | A command is an instruction to a computer to carry out an operation. |
| Command/Response Packet | This is a message or part of a message packaged as a fixed-size segment of data for transmission through a computer network. |
| Control Box | The control box is an enclosure that houses a computer system. |
| Control Pendant | This is a handheld control box. |
| Critical Hazard | A critical hazard is a condition that may cause a severe injury or occupational illness, loss of mission, or major property damage to facilities, systems, or flight hardware, but does not meet the criteria of a catastrophic hazard. |
| Demate | Demating is a function that can be performed by one of either two methods: undocking or unberthing. Demated also signifies structural separation once undocking/unberthing operations are complete. |
| Design Reference Mission (DRM) | Typical mission scenario encompassing tasks that are most likely to drive the architecture system design requirements. The DRMs are analyzed for all mission aspects from failure tolerance to hardware layout, software functionality, and design suitability. |
| Dock | Docking is the mating of two independently operating spacecraft or other systems in space, using independent control of the two vehicles' flight paths and attitudes during contact and capture. Docking begins at the time of initial contact of the vehicles' docking mechanisms and concludes when full rigidization of the interface is achieved. |
| Extravehicular Activity (EVA) | EVA operations are performed by suited crew outside the pressurized environment of a flight vehicle or habitat (during space flight or on a destination surface). |

| Term | Definition |
|---|---|
| Failure Detection, Isolation, and Recovery (FDIR) | Determining the occurrence of a fault/failure, determining what caused the fault/failure, and providing corrective action. |
| Failure Modes and Effects Analysis (FMEA) | FMEA is the study of a system and the working relationships of its elements to determine ways in which failure can occur (failure modes), and the effects of each potential failure on the system element in which it occurs on other systems. |
| Fault | An anomalous condition of a system, which includes hardware and software. |
| Fault Detection | Determine and notify fault occurrence. |
| Fault Tolerance | Built-in capability of a system to perform as intended in the presence of specified hardware or software faults. EVA, emergency systems, or emergency operations may not be used as a leg of fault tolerance. |
| Ground Support Equipment (GSE) | All equipment (implements, tools, test equipment devices, simulations, etc.) required on the ground to support appropriate ground testing or training. |
| Hard Capture | A hard capture is when two docking vehicles are structurally connected, sealing is complete, vestibule is ready for equalization and hatch is ready to open. This is also the state when a vehicle or payload is rigidly attached to the capture mechanism and relative motion is fully constrained. |
| Health and Status (H&S) | This is information on subsystem performance and flight performance, including configuration data, vehicle state data, subsystem status, failures, hazards, and measured parameters outside of normal limits. |
| Induced Environment | Any form of matter or energy released, radiated or modified by one component or System that could impact or influence another component or System. Includes radiated and reflected thermal energy; vibrations, aerodynamic, and shock loads; electromagnetic energy, Paschen discharge, arcing, glow discharge, spacecraft charging, and V x B voltages; debris; particulate and molecular contamination, waste water dumps; and reflections, glows, and other optical contamination. |
| Intravehicular Activity (IVA) maintenance | An IVA is corrective or preventive maintenance performed by the crew within the pressurized spacecraft during a mission. |
| iLIDS | See Definition in Sec. 3.1, and Sec. 3.1.1 of the document |
| LIDS | Low Impact Docking System acronym from heritage design still |

| Term | Definition |
|---|---|
| | used in legacy data utilized in iLIDS project (e.g., Command labels, requirements ID's, etc.) |
| Maintainable | The ability of a system to be retained in or restored to a specified condition when maintenance is performed in a stated time interval, under stated conditions, and using stated procedures and resources. Maintenance, preventative and corrective, may include identification, safing access, removal, replacement, restoration, and verification of functionality. |
| Mating | Mating is the mechanical connection of two vehicles, in space (via docking or berthing) or on the Earth, Moon, or Mars (via docking, berthing, or some other method). When the mating is successfully accomplished, the two vehicles are hard-mated and mated operations commence. |
| Mating Vehicle | In rendezvous and proximity operations, the mating vehicle performs minimal, if any maneuvers. |
| MMOD Shield | MMOD Shield is made up of thin Aluminum, Nextel and Kevlar materials. The MMOD shield protects iLIDS from MMOD strikes. |
| Orbital Replacement Unit (ORU) | A piece of equipment that can be removed and replaced with a working spare by a user or operator during the mission. |
| Passive iLIDS | An iLIDS that has no electro-mechanical actuation controlled features. A “Passive iLIDS” can only interface with an “Active iLIDS.” (see definition of an Active iLIDS above in the Table) |
| Passive Mode | A functional mode of iLIDS. A passive iLIDS allows the Active iLIDS to perform all capture and structural attachment to the passive iLIDS. See definition of Active Mode. |
| Seal Gland | A machined groove into which a seal is installed. |
| Soft Capture | A soft capture is a iLIDS function where the electromagnets are used to attach mating mechanisms. This is not structural mating, but the first level of attachment. |

| Term | Definition |
|---|---|
| Special Processes | Processes where the resulting output cannot be verified by subsequent monitoring or measurement. (e.g., deficiencies become apparent only after the product is in use or the service has been delivered). Special processes include, but are not limited to, soldering, coating/painting, cleaning, non-destructive examinations, plating, welding, brazing.<br><br>**A defense industry consensus list of special processes**<br>NDT: Liquid Penetrant, Magnetic Particle, Ultrasonics, X-ray<br>Heat Treating: For multiple Alloy Families: Stress Relieving, Annealing, Carburizing, Nitriding, Carbonitiriding, Ferritic Nitrocarburizing, Ion Nitriding, Vacuum Heat Treating, Vacuum Oil Quenching, Hardening, Induction Hardening, Furnace Brazing, Dip Brazing, Induction Brazing, Vacuum Furnace Brazing, Flame Hardening, Cryogenic Treatments, Hot Forming/Hot sizing, Die Quenching, Hipping, Hardness and Metallography to support the heat treating function<br><br>Welding: Torch/Induction Manual Brazing, Flash Welding, Electron Beam Welding, Fusion Welding, Laser Welding, Resistance Welding, Friction/Inertia Welding, Diffusion Welding, Percussion Stud Welding.<br><br>Coatings: Thermal Spray, Vapor Deposition, Cementation, Stripping, Coating Evaluations, Plating of Coated Parts, Heat Treating of Coatings<br><br>Chemical Processing: Plating, Anodizing, Conversion/Phosphate Coatings, Paint and Dry Film Lubricants, Etch<br><br>Materials Testing Laboratories: Chemical, Mechanical, Metallography & Microhardness, Hardness, Corrosion, Mechanical Test Specimen Preparation, Differential Thermal Analysis, X-Ray Diffraction, Coating Evaluations, Fastener Testing |
| TBD | Acronym for To Be Determined. Inserting TBD indicates values or information have yet to be added, but will be determined prior to document baseline. |
| TBR | Acronym for To Be Resolved. Inserting TBR indicates that the information provided is tentative and is subject to change, if approved by project and program. |
| TBS | Acronym for To Be Specified. Inserting TBS indicates that the information provided is information that has yet to be added. |
| TIA/EIA-422 | ANSI/TIA/EIA-422-B specifies the electrical signaling characteristics of the data link. |

| Term | Definition |
|---|---|
| Umbilical Systems | This system provides a link or system of links to something essential. |
| Undocking | Demating of spacecraft or other elements in space using independent control of the two vehicles' flight paths and attitudes during release.  Undocking is done without the assistance of a robotic arm or a Remote Manipulator System (RMS)-type device. |

# APPENDIX C MISCELLANEOUS INFORMATION

## Table C-1 - Compliance Document Applicability

JPR 8080.5 standards carry multiple requirements within each standard. For standards that have “Partially Applicable” applied, the standard is decomposed into individual shall statements and a preceding number is applied to each shall statement within the standard starting with (1). The numbering allows exception of individual sections of the JPR 8080.5 standard as well as partial applicability.

| Standard | Section | Section Title | Applicability | Comments/Rationale | Requirements |
|---|---|---|---|---|---|
| JPR 8080.5 | E-1 | Mating Provisions for Electrical Connectors | Applicable | | |
| JPR 8080.5 | E-2 | Protection of Severed Electrical Circuits | Not Applicable | iLIDS conductors are not cut using guillotine devices. | |
| JPR 8080.5 | E-3 | Electrical and Electronic Devices Protection from Reverse Polarity and/or Other Improper Electrical Inputs | Applicable | | |
| JPR 8080.5 | E-4 | Electrical Connectors - Moisture Protection | Applicable | | |
| JPR 8080.5 | E-5 | Electrical Connectors - Pin Assignment | Applicable | | |
| JPR 8080.5 | E-6 | Corona Suppression | Applicable | Corona is applicable with the custom power supply design inside of the 120V iLIDS that has peak voltages of 300+V. | |
| JPR 8080.5 | E-7 | Electrical Components - Restrictions on Use | Applicable | | |
| JPR 8080.5 | E-8 | Electrical / Electronic Supplies and Loads - Verification Tests | Applicable | | |
| JPR 8080.5 | E-9 | Electrical Circuits - Deenergizing Requirement | Not Applicable | Vehicle level requirement. | |
| JPR 8080.5 | E-10 | Cleaning of Electrical and Electronic Equipment | Applicable | | |
| JPR 8080.5 | E-11 | Protective Covers or Caps for Electrical Receptacles and Plugs | Applicable | | |
| JPR 8080.5 | E-12 | Electrical Connectors - Disconnection for Trouble-Shooting and Bench | Applicable | | |

| Standard | Section | Section Title | Applicability | Comments/Rationale | Requirements |
|---|---|---|---|---|---|
| | | Testing | | | |
| JPR 8080.5 | E-13 | Bioinstrumentation Systems - Crew Electrical Shock Protection | Not Applicable | iLIDS is not a Bioinstrumentation System. | |
| JPR 8080.5 | E-14 | Electrical Wire Harnesses -Acceptance Testing | Partially Applicable | E-14(3) is not applicable - No shipping cables. | |
| JPR 8080.5 | E-15 | Electrical Power Distribution - Overload Protection & Fault Propagation | Applicable | | |
| JPR 8080.5 | E-16 | Testing Protective Devices for Electrical and Electronic Circuits | Applicable | | |
| JPR 8080.5 | E-17 | Electrical and Electronic Piece Parts - Hermetic Construction | Not Applicable | Other functional requirements specified in the iLIDS PTRS will provide necessary protection from damage, the parts need not be hermetically sealed. | |
| JPR 8080.5 | E-18 | Circuitry for Automatic Shutdown of Launch Vehicle Engine(s) | Not Applicable | Reclassified as G-54. | |
| JPR 8080.5 | E-19 | Equipment Design - Power Transients | Applicable | | |
| JPR 8080.5 | E-20 | Electrostatic Discharge Protection of Electronic Equipment | Applicable | | |
| JPR 8080.5 | E-21 | Electrical Connectors | Not Applicable | Cancelled | |
| JPR 8080.5 | E-22 | Ionizing Radiation Effects on Electronics | Partially Applicable | E-22(2),(4)&(5) are not applicable - iLIDS will not use suggested test levels and methods for MTBF and no similarity to be used. | |
| JPR 8080.5 | E-23 | Transistors - Selection of Types | Not Applicable | Cancelled | |
| JPR 8080.5 | E-24 | Electrical Wire and Cable Acceptance Tests | Applicable | | |
| JPR 8080.5 | E-25 | Protecting Electrical Wires, Cables, Bundles, and Harnesses | Applicable | | |
| JPR 8080.5 | F-1 | Restriction Requirements - Pressurized Components | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | F-2 | Water Separators in a Zero-Gravity Environment | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-3 | Service Points - Positive Protection From | Not Applicable | iLIDS has no fluid transfer requirements. | |

| Standard | Section | Section Title | Applicability | Comments/Rationale | Requirements |
|---|---|---|---|---|---|
| | | Interchangeability of Fluid Service Lines | | | |
| JPR 8080.5 | F-4 | Ground Service Points - Fluid Systems | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-5 | Fluid Lines - Separation Provisions | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-6 | Temperature and Pressure Monitoring Requirements for Potentially Hazardous Reactive Fluids | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-7 | Capping of Servicing and Test Ports not Required to Function in Flight | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-8 | Fluid System Components Whose Function is Dependent on Direction of Flow - Protection Against Incorrect Installation | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-9 | Spacecraft Venting - Induced Perturbing Forces | Not Applicable | iLIDS is not a spacecraft. | |
| JPR 8080.5 | F-10 | Nozzle and Vents - Protection Prior to Launch | Not Applicable | iLIDS has no relative hardware | |
| JPR 8080.5 | F-11 | Fluid Supplies - Verification Test Provisions | Not Applicable | iLIDS block1 has no fluid transfer requirements. This will be unverifiable. | |
| JPR 8080.5 | F-12 | Protection of Pressurized Systems from Damage Due to Pressurant Depletion -Support Equipment | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-13 | Habitable Module Pressure - Venting Restriction | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-14 | Crew Cabin Module Ventilating Fans - Protection From Debris | Not Applicable | Cancelled | |
| JPR 8080.5 | F-15 | Separation of Hypergolic Reactants | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-16 | Fluid Line Routing Installation | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-17 | Cleanliness of Flowing Fluids and Associated | Not Applicable | iLIDS has no fluid transfer requirements. | |

| Standard | Section | Section Title | Applicability | Comments/Rationale | Requirements |
|---|---|---|---|---|---|
| | | Systems | | | |
| JPR 8080.5 | F-18 | Pressure Relief Valves - Standardization of Functional Testing | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-19 | Cleanliness Protection for Fluid Systems | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-20 | Fluid Systems - Cleanliness | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-21 | Purge Gases - Dew Point Requirements | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-22 | Pressure Garments - Protection Against Failure Propagation | Not Applicable | Relative hardware doesn't exist on iLIDS. | |
| JPR 8080.5 | F-23 | Qualification Fluid | Not Applicable | Reclassified as G-53. | |
| JPR 8080.5 | F-24 | Fluid Systems - Design for Flushing and Draining | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-25 | Toxicity - Fluids Contained in Systems in the Crew Compartment | Applicable | | |
| JPR 8080.5 | F-26 | Atmosphere Pressure and Composition Control | Not Applicable | iLIDS is not a Spacecraft or habitable module. | |
| JPR 8080.5 | F-27 | Liquid or Gas Containers - Verification of Contents | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-28 | Use of Halogen Method for Coolant System Leak Detection | Not Applicable | Cancelled | |
| JPR 8080.5 | F-29 | Filter Protection of Sensitive Fluid Components | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | F-30 | Pressure Relief for Pressure Vessels/Systems | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | G-1 | Equipment Accessibility for Maintenance | Partially Applicable | G-1(4)&(5) are not applicable - iLIDS is not habitable. | |
| JPR 8080.5 | G-2 | Separation of Redundant Systems | Applicable | | |
| JPR 8080.5 | G-3 | Electrical and Fluid Systems Checkout Provisions | Partially Applicable | Applicable to only electrical systems, iLIDS (at this time) does not transfer any fluids. | |
| JPR 8080.5 | G-4 | Protection from Debris - Electrical & Mechanical Systems | Partially Applicable | G-4(4) is not applicable - no fluids in iLIDS. | R.LIDS.0295 |

| Standard | Section | Section Title | Applicability | Comments/Rationale | Requirements |
|---|---|---|---|---|---|
| JPR 8080.5 | G-5 | Prevention of Debris - Electrical & Mechanical Systems. | Applicable | | |
| JPR 8080.5 | G-6 | Redundancy Requirements | Not Applicable | Cancelled | |
| JPR 8080.5 | G-7 | Time Displays | Not Applicable | Cancelled | |
| JPR 8080.5 | G-8 | Design for Redundancy Verification | Applicable | | |
| JPR 8080.5 | G-9 | Shatterable Material - Exclusion | Not Applicable | Shatterable materials are not consistent with the iLIDS design and functions. It is not foreseeable that iLIDS would include a shatterable material. | |
| JPR 8080.5 | G-10 | Parts identification | Partially Applicable | G-10 (3) is not applicable - beyond the capability of the iLIDS project | |
| JPR 8080.5 | G-11 | Procurement Document Identification for Human Spaceflight Items | Applicable | | |
| JPR 8080.5 | G-12 | Application of Previous Qualification Test Data | Not Applicable | iLIDS has no previous qualification data. | |
| JPR 8080.5 | G-13 | Shipping and Handling Protection for Spaceflight Hardware | Not Applicable | Cancelled | |
| JPR 8080.5 | G-14 | Classification of Flight and Non-Flight Equipment | Partially Applicable | G-14(2) is not applicable - Nonflight equipment | |
| JPR 8080.5 | G-15 | Resolution of Flight Equipment Failures/Anomalies Prior to Launch | Applicable | | |
| JPR 8080.5 | G-16 | Operational Limits on Temperature-Controlled Equipment | Applicable | | R.LIDS.0091 |
| JPR 8080.5 | G-17 | Separate Stock for Spaceflight Parts and Materials | Applicable | | R.LIDS.0136 |
| JPR 8080.5 | G-18 | Safety Precautions - Test and Operating Procedures | Applicable | | |
| JPR 8080.5 | G-19 | Special Processes-Identification of Drawings | Applicable | | |
| JPR 8080.5 | G-20 | Spacecraft Equipment - Protection from Liquids During Ground Operations | Not Applicable | No plan to locate iLIDS where it is subject to liquid leaks | |
| JPR 8080.5 | G-21 | Spacecraft Equipment - Moisture Protection | Applicable | | R.LIDS.1077 |

| Standard | Section | Section Title | Applicability | Comments/Rationale | Requirements |
|---|---|---|---|---|---|
| JPR 8080.5 | G-22 | Parts Identification | Applicable | | R.LIDS.0136, R.LIDS.0137 |
| JPR 8080.5 | G-23 | Pressure Garment Wiring - Ignition of Materials by Electrical Current | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | G-24 | Protecting Flight Equipment From Support Equipment | Applicable | | |
| JPR 8080.5 | G-25 | Thermal Design and Analysis | Applicable | | |
| JPR 8080.5 | G-26 | Internally Generated Radiation | Not Applicable | No laser sources on iLIDS. | |
| JPR 8080.5 | G-27 | Fire control | Partially Applicable | G-27(2) & (3) not applicable - iLIDS does not provide fire detection or suppression capability. | |
| JPR 8080.5 | G-28 | Sealing - Solid Propellant Rocket Motors | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | G-29 | Reentry Propulsion Subsystem In-Flight Test | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | G-30 | Switch Protection Devices | Not Applicable | Cancelled | |
| JPR 8080.5 | G-31 | Detachable Crew-Operated Actuating Tools | Not Applicable | No on-orbit maintenance | |
| JPR 8080.5 | G-32 | Measurement Systems That Display Flight information to the Crew - Indication of Failure | Not Applicable | Cancelled | |
| JPR 8080.5 | G-33 | Surface Temperatures | Not Applicable | Cancelled | |
| JPR 8080.5 | G-34 | Extravehicular Activity Electronic Connectors | Not Applicable | Cancelled | |
| JPR 8080.5 | G-35 | Enclosure Panels External to the Habitable Modules | Not Applicable | Cancelled | |
| JPR 8080.5 | G-36 | Thermal Blankets - Extravehicular Activity | Not Applicable | Cancelled | |
| JPR 8080.5 | G-37 | Verification of External Visibility | Not Applicable | iLIDS is not a crewed spacecraft. | |
| JPR 8080.5 | G-38 | Pressurization Or Repressurization-Preventing Ingress of Undesirable Elements | Not Applicable | iLIDS is not a crewed spacecraft. | |
| JPR 8080.5 | G-39 | Lightning Protection Design | Not Applicable | iLIDS is not a spacecraft. | |
| JPR 8080.5 | G-40 | Radioactive Luminescent Devices | Not Applicable | No radioactive materials on iLIDS. | |

| Standard | Section | Section Title | Applicability | Comments/Rationale | Requirements |
|---|---|---|---|---|---|
| JPR 8080.5 | G-41 | Acoustic Noise Criteria | Not Applicable | Cancelled | |
| JPR 8080.5 | G-42 | Solar Wind Environment | Not Applicable | Cancelled | |
| JPR 8080.5 | G-43 | Centralized Subsystem Controls | Not Applicable | Cancelled | |
| JPR 8080.5 | G-44 | Attitude Control Authority | Not Applicable | Vehicle requirement. | |
| JPR 8080.5 | G-45 | Solid Propellant Rocket Motors | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | G-46 | Separation Sensing System - Structural Deformation | Applicable | | |
| JPR 8080.5 | G-47 | Gyroscopes - Verification of Operational Status | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | G-48 | Onboard Experiments - Required Preinstallation Checklist | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | G-49 | Temperature and Pressure Monitoring Requirements of Hydrogen Peroxide System | Not Applicable | Cancelled | |
| JPR 8080.5 | G-50 | Direct Procurement of Parts | Applicable | | |
| JPR 8080.5 | G-51 | Flight Hardware - Restriction on Use for Training | Not Applicable | Non-functional requirement. | |
| JPR 8080.5 | G-52 | Reuse of Flight Equipment | Not Applicable | iLIDS is not intended to be reused. | |
| JPR 8080.5 | G-53 | Reverification | Applicable | | |
| JPR 8080.5 | G-54 | Automatic Shutdown of Launch Vehicle Engines(S) | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | MP-1 | Materials And Processes Control | Applicable | | R.LIDS.0116 |
| JPR 8080.5 | MP-2 | Flammability of Wiring Material | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-3 | Toxicity of Materials Used in Crew Compartments - Wire Insulation, Ties, Identification Marks, and Protective Covering | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-4 | Metals and Metal Couples - Restriction on Use | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-5 | Solutions Which Contain | Not Applicable | Cancelled | |

| Standard | Section | Section Title | Applicability | Comments/Rationale | Requirements |
|---|---|---|---|---|---|
| | | Ethylene Glycol - Requirements for Silver Chelating Agent | | | |
| JPR 8080.5 | MP-6 | Toxicity - Requirements for Nonmetallic Materials Proposed for Use within Crew Compartment | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-7 | Material Detrimental to Electrical Connectors | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-8 | Leak Detectors - Wetting Agents | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-9 | Mercury Limitations in Breathable Atmospheres | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | MP-10 | Liquid Locking Compounds - Restrictions and Controls | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-11 | Pressure Vessel Documentation | Not Applicable | iLIDS is not a pressure vessel. | |
| JPR 8080.5 | MP-12 | Multilayer Blanket Bake-Out | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-13 | Pressure Vessel / Special Pressurized Equipment Design and Certification | Not Applicable | iLIDS contain no relevant hardware. | |
| JPR 8080.5 | MP-14 | Silicate Ester Coolant System Design | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-15 | Mercury - Restriction on Use | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-16 | Restriction on Coatings for Areas Subject to Abrasion | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-17 | Radiographic Inspection of Brazed and Welded Tubing Joints | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-18 | Etching Fluorocarbon Insulated Electrical Wire | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-19 | Spacecraft Material - Restriction on Use of Polyvinyl Chloride | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-20 | Titanium or its Alloys - Prohibited Use with Oxygen | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-21 | Beryllium - Restricted Use within Crew | Not Applicable | Cancelled | |

| Standard | Section | Section Title | Applicability | Comments/Rationale | Requirements |
|---|---|---|---|---|---|
| | | Compartment(s) | | | |
| JPR 8080.5 | MP-22 | Brazed Joints - Identification Marks | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-23 | Pressure Vessels - Materials Compatibility and Vessel Qualification Test | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-24 | Cadmium - Restriction on Use | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-25 | Pressure Vessels - Non-destructive Evaluation Plan | Not Applicable | Cancelled | |
| JPR 8080.5 | MP-26 | Repair of Sandwich - Type Structures | Not Applicable | Cancelled | |
| JPR 8080.5 | MS-1 | Equipment containers - Design for Rapid Spacecraft Decompression | Applicable | | R.LIDS.0027, R.LIDS.0101, R.LIDS.0103 |
| JPR 8080.5 | MS-2 | Alignment, Adjustment, and Rigging of Mechanical Systems | Applicable | | |
| JPR 8080.5 | MS-3 | Wire bindles - Protective Coating | Not Applicable | Reclassified as E-25 | |
| JPR 8080.5 | MS-4 | Crew Hatches | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | MS-5 | Threaded Fasteners | Applicable | | |
| JPR 8080.5 | MS-6 | Exposed Sharp Surfaces or Protrusions | Not Applicable | Cancelled | |
| JPR 8080.5 | MS-7 | Windows and Glass Structure | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | MS-8 | Penetration of Inhabited Spacecraft Compartments | Not Applicable | No relative hardware on iLIDS. | |
| JPR 8080.5 | MS-9 | Positive Indication of Status for Mechanisms | Applicable | | |
| JPR 8080.5 | MS-10 | Functional Doors That Operate in Flight | Not Applicable | Cancelled | |
| JPR 8080.5 | MS-11 | Meteoroid and Orbital Debris Protection Levels for Structures | Not Applicable | iLIDS will not be performing MMOD impact updates to risk assessments based on unknown mission profiles. iLIDS requirement [R.LIDS.0295] carries a specific PNP value relayed to host vehicle and mission profile. | |
| JPR 8080.5 | MS-12 | Spacecraft Recovery Hoist Loops | Not Applicable | No relative hardware on iLIDS. | |

| Standard | Section | Section Title | Applicability | Comments/Rationale | Requirements |
|---|---|---|---|---|---|
| JPR 8080.5 | MS-13 | Lifting and Hoisting Ground Support Equipment Identification | Not Applicable | Cancelled | |
| JPR 8080.5 | MS-14 | Structural Analysis | Applicable | | R.LIDS.0027 |
| JPR 8080.5 | MS-15 | Fluid Systems - Method of Joining Metallics | Not Applicable | iLIDS has no fluid transfer requirements. | |
| JPR 8080.5 | MS-16 | Pressure Vessels - Negative Pressure Damage | Not Applicable | iLIDS is not a pressure vessel. | |
| JPR 8080.5 | P-1 | Pyrotechnic Devices - Arming and Disarming | Not Applicable | iLIDS design does not have the capability to arm or disarm pyros. | |
| JPR 8080.5 | P-2 | Pyrotechnic Devices Preflight Verification Tests | Applicable | | |
| JPR 8080.5 | P-3 | Electrical Circuit Wire Splicing | Not Applicable | | |
| JPR 8080.5 | P-4 | Pyrotechnic Devices - Packaging Material | Not Applicable | | |
| JPR 8080.5 | P-5 | Pyrotechnic Devices - Identification Requirements | Applicable | | |
| JPR 8080.5 | P-6 | Protection of Electrical Circuitry for the NASA Standard Initiator | Applicable | | |
| JPR 8080.5 | P-7 | Pyrotechnic Devices Color Coding Requirements | Not Applicable | | |

**Table C-2 - To Be Resolved/Determined/Specified (TBR/D/S) Items**

| TBR/D/S ID | Identity | Title |
|---|---|---|
| TBR-212 | R.LIDS.0202<br>R.LIDS.1113<br>R.LIDS.1138 | On-orbit life for sun hours |
| TBS-217 | R.LIDS.1001 | Berthing Concept of Operations |
| TBS-218 | R.LIDS.0183 | Ionizing Radiation |

**Table C-3 - iLIDS Configuration Applicability**

The following table defines requirements that are unique to specific iLIDS configurations (i.e. -301, -302, etc.). All other requirements are applicable to all configurations.

| Applicability | iLIDS (-301) | iLIDS (-302) |
|---|---|---|
| R.LIDS.0001 | | |
| R.LIDS.0003 | | |
| R.LIDS.0004 | | |
| R.LIDS.0006 | | |
| R.LIDS.0008 | | |
| R.LIDS.0009 | | |
| R.LIDS.0010 | | |
| R.LIDS.0011 | | |
| R.LIDS.0012 | | |
| R.LIDS.0014 | | |
| R.LIDS.0017 | | |
| R.LIDS.0019 | | |
| R.LIDS.0020 | | |
| R.LIDS.0024 | | |
| R.LIDS.0024.1 | | |
| R.LIDS.0024.2 | | |
| R.LIDS.0026 | | |
| R.LIDS.0027 | | |
| R.LIDS.0029 | | |
| R.LIDS.0030 | | |
| R.LIDS.0034 | | |
| R.LIDS.0037 | | |
| R.LIDS.0038 | | |
| R.LIDS.0041 | X | |
| R.LIDS.0043 | | |
| R.LIDS.0044 | | |
| R.LIDS.0046 | | |
| R.LIDS.0047 | | |
| R.LIDS.0050 | | |
| R.LIDS.0051 | | |
| R.LIDS.0052 | | |
| R.LIDS.0054 | | |
| R.LIDS.0055 | | |
| R.LIDS.0056 | | |
| R.LIDS.0057 | | |
| R.LIDS.0058 | | |
| R.LIDS.0060 | | |
| R.LIDS.0061 | | |

| Applicability | iLIDS (-301) | iLIDS (-302) |
| --- | --- | --- |
| R.LIDS.0063 | X | |
| R.LIDS.0064 | | |
| R.LIDS.0065 | X | |
| R.LIDS.0066 | | |
| R.LIDS.0069 | X | |
| R.LIDS.0071 | | |
| R.LIDS.0073 | | |
| R.LIDS.0075 | | |
| R.LIDS.0076 | | |
| R.LIDS.0079 | | |
| R.LIDS.0080 | X | |
| R.LIDS.0082 | | |
| R.LIDS.0082.1 | | |
| R.LIDS.0091 | | |
| R.LIDS.0100 | | |
| R.LIDS.0101 | | |
| R.LIDS.0103 | | |
| R.LIDS.0104 | | |
| R.LIDS.0106 | | |
| R.LIDS.0107 | | |
| R.LIDS.0108 | | |
| R.LIDS.0109 | | |
| R.LIDS.0113 | | |
| R.LIDS.0116 | | |
| R.LIDS.0120 | | |
| R.LIDS.0124 | | |
| R.LIDS.0127 | | |
| R.LIDS.0128 | | |
| R.LIDS.0136 | | |
| R.LIDS.0137 | | |
| R.LIDS.0158 | | |
| R.LIDS.0159 | | |
| R.LIDS.0162 | | |
| R.LIDS.0183 | | |
| R.LIDS.0185 | | |
| R.LIDS.0186 | | |
| R.LIDS.0187 | | |
| R.LIDS.0188 | | |
| R.LIDS.0189 | | |
| R.LIDS.0190 | | |
| R.LIDS.0192 | | |
| R.LIDS.0197 | | |
| R.LIDS.0201 | | X |
| R.LIDS.0202 | X | |
| R.LIDS.0203 | | |

| Applicability | iLIDS (-301) | iLIDS (-302) |
|---|---|---|
| R.LIDS.0206 | | |
| R.LIDS.0207 | | |
| R.LIDS.0229 | | |
| R.LIDS.0256 | | |
| R.LIDS.0259 | | |
| R.LIDS.0286 | | |
| R.LIDS.0294 | | |
| R.LIDS.0295 | X | |
| R.LIDS.0298 | | |
| R.LIDS.1001 | | |
| R.LIDS.1004 | | |
| R.LIDS.1005 | | |
| R.LIDS.1005.1 | | |
| R.LIDS.1006 | X | |
| R.LIDS.1007 | | X |
| R.LIDS.1037 | | |
| R.LIDS.1042 | X | |
| R.LIDS.1051 | | |
| R.LIDS.1056 | | X |
| R.LIDS.1060 | X | |
| R.LIDS.1069 | | |
| R.LIDS.1074 | | |
| R.LIDS.1077 | | |
| R.LIDS.1083 | | |
| R.LIDS.1084 | | |
| R.LIDS.1088 | | |
| R.LIDS.1092 | | |
| R.LIDS.1093 | | |
| R.LIDS.1094 | | |
| R.LIDS.1095 | | |
| R.LIDS.1096 | | |
| R.LIDS.1097 | | |
| R.LIDS.1098 | | |
| R.LIDS.1099 | | |
| R.LIDS.1100 | | |
| R.LIDS.1101 | | |
| R.LIDS.1102 | | |
| R.LIDS.1103 | X | |
| R.LIDS.1104 | | |
| R.LIDS.1105 | | |
| R.LIDS.1106 | | |
| R.LIDS.1107 | | |
| R.LIDS.1108.1 | | |
| R.LIDS.1108.2 | | |
| R.LIDS.1108.3 | | |

| Applicability | iLIDS (-301) | iLIDS (-302) |
|---|---|---|
| R.LIDS.1108.4 | | |
| R.LIDS.1109 | | |
| R.LIDS.1111 | | X |
| R.LIDS.1112 | | |
| R.LIDS.1113 | | |
| R.LIDS.1114 | | |
| R.LIDS.1115 | X | |
| R.LIDS.1116 | | |
| R.LIDS.1117 | | |
| R.LIDS.1118 | | |
| R.LIDS.1119 | | |
| R.LIDS.1120 | | |
| R.LIDS.1121 | | |
| R.LIDS.1124 | | |
| R.LIDS.1125 | | |
| R.LIDS.1126 | | |
| R.LIDS.1129 | | |
| R.LIDS.1130 | | |
| R.LIDS.1131 | | |
| R.LIDS.1132 | | |
| R.LIDS.1133 | | |
| R.LIDS.1134 | | |
| R.LIDS.1137 | | |
| R.LIDS.1138 | X | |
| R.LIDS.1139 | | X |
| R.LIDS.1140 | | |
| R.LIDS.1141 | | |
| R.LIDS.1142 | | |
| R.LIDS.5003 | | |
| R.LIDS.5007 | | |
| R.LIDS.5008 | | |
| R.LIDS.5009 | | |
| R.LIDS.5010 | | |
| R.LIDS.5011 | | |
| R.LIDS.5012 | | |
| R.LIDS.5013 | | |
| R.LIDS.5014 | | |
| R.LIDS.5021 | | |
| R.LIDS.5022 | | |
| R.LIDS.5033 | | |
| R.LIDS.5034 | | |
| R.LIDS.5036 | X | |
| R.LIDS.5037 | | |
| R.LIDS.5038 | X | |
| R.LIDS.5050 | | |

| Applicability | iLIDS (-301) | iLIDS (-302) |
| --- | --- | --- |
| R.LIDS.5057 | | |
| R.LIDS.5061 | | |

## Table C-4 - iLIDS PTRS/IDD Associative Requirements

| Identity | Title |
|---|---|
| R.LIDS.0001 | iLIDS Structural Attachment on Host Vehicle |
| R.LIDS.0003 | Host Electrical Power Interface - 120 Vdc |
| R.LIDS.0004 | Reception of Commands for Docking |
| R.LIDS.0014 | iLIDS Health and Status During iLIDS Operations |
| R.LIDS.0024 | Transfer of Data and Communications |
| R.LIDS.0024.1 | Ethernet Cable Specification |
| R.LIDS.0024.2 | MIL-STD-1553 Cable Specification |
| R.LIDS.0027 | iLIDS Thermal and Induced Environments |
| R.LIDS.0029 | Structural/Mechanical Attachment |
| R.LIDS.0030 | Transfer of Power |
| R.LIDS.0041 | Leak Rates for iLIDS Feed-Throughs When Mated (Excluding -302) |
| R.LIDS.0063 | Docking Envelope (Excluding -302) |
| R.LIDS.0080 | iLIDS (-301) Mass |
| R.LIDS.0082 | iLIDS Pass-Through Diameter, Petals Removed |
| R.LIDS.0082.1 | iLIDS Pass-Through Diameter, With Petals |
| R.LIDS.0124 | Structural Design and Verification Requirements |
| R.LIDS.1005 | HCS Guide Pins |
| R.LIDS.1005.1 | HCS Guide Pin Receptacles |
| R.LIDS.1006 | Seal on Seal Mating Interface (Excluding -302) |
| R.LIDS.1007 | Seal on Metal Mating Interface (-302) |
| R.LIDS.1051 | Active Thermal System Control |
| R.LIDS.1056 | iLIDS (-302) Mass |
| R.LIDS.1069 | Separation System - Demate |
| R.LIDS.1103 | Pyrotechnic Operated Devices (Excluding -302) |
| R.LIDS.1111 | iLIDS (-302) MMOD |
| R.LIDS.1113 | Leak Rate for iLIDS-to-iLIDS Interface |
| R.LIDS.1114 | Leak Rate for iLIDS-to-Vehicle Interface |
| R.LIDS.1115 | Pyrotechnic Release (Excluding -302) |
| R.LIDS.1124 | iLIDS Active Hook Profile |
| R.LIDS.1125 | iLIDS Passive Hook Profile |
| R.LIDS.1141 | Heater Operation - Blind Mode |
| R.LIDS.1142 | IDSS IDD Compatibility |
| R.LIDS.5003 | iLIDS Volume and Keep Out Zones |
| R.LIDS.5007 | iLIDS Mating Interface Allowable Thermal Differential |
| R.LIDS.5008 | iLIDS Capture Ring in Passive Mode |
| R.LIDS.5009 | iLIDS Capture Ring in Active Mode |
| R.LIDS.5010 | SCS Guide Petal System |

| Identity | Title |
|---|---|
| R.LIDS.5011 | SCS Guide Petal System Detail |
| R.LIDS.5012 | SCS Ring Dimensions |
| R.LIDS.5013 | SCS Magnet and Striker |
| R.LIDS.5014 | Pre-Capture SCS Compressive Force Resistance |
| R.LIDS.5021 | Umbilical Separation - Passive |
| R.LIDS.5022 | FRAM-Type Connector Pinouts |
| R.LIDS.5033 | Command and Data Handling Interface, Physical Layer Safe Operation Area |
| R.LIDS.5034 | Heater Power and Control |
| R.LIDS.5036 | iLIDS-to-Host Vehicle Electrical Interface (Excluding -302) |
| R.LIDS.5037 | Host Interface Connector Pinouts |
| R.LIDS.5038 | iLIDS Box Connections-to-Host Vehicle Electrical Interface (Excluding -302) |
| R.LIDS.5050 | iLIDS-to-iLIDS Thermal Contact Conductance |
| R.LIDS.5057 | iLIDS-to-Host Vehicle Thermal Contact Conductance |
| R.LIDS.5061 | Maximum Temperature Differential for SCS Mating Interfaces |

## Table C-5 - iLIDS Requirements Revision From/To Comparison

The "From/To" table contains red colored text for omissions, blue for new or replaced text, and black for no changes. Strike-through text means the requirement is deleted. The table reflects only items that have been modified between revisions. The column definitions are as follows:

*1* Status

- Accepted: Previously accepted in earlier revision
- To Be Deleted: Deleted from revision
- Candidate: New requirement from revision

*2* Change

- IDD Reference Change: Requirement text/rationale changed to reference the IDD in lieu of a specific value.
- Major: Context change of requirement for reference or new inputs.
- Major – Deleted: Accepted requirements from Rev E that have been deleted in Rev F.
- Minor: Editorial changes made that do not impact the context of the requirement. Changes include the addition or deletion of rationale text to further convey meaning.
- Minor – Status Change: Requirements status changed from *Candidate* in Rev E to *Accepted* in Rev F with no other changes impacting the context of the requirement.
- New: New (Candidate) requirement added to current revision.

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.0003 | ACCEPTED | Host Electrical Power Interface - 120 Vdc | The iLIDS (-301, -302) shall operate with host vehicle power of 120 Vdc in accordance with JSC-64599, iLIDS Electric Power Quality Description Document. | An electrical power interface is needed to allow the host vehicle to power the iLIDS. This is the power for iLIDS consumption, which is not to be confused with the host vehicle pass-through power to the mating vehicle. Future configurations will allow for other host vehicle power (e.g., 28 Vdc). | Minor |

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.0006 | CANDIDATE | Docking Termination | The iLIDS shall terminate docking upon receipt of a command from the host vehicle prior to hook activation. | For safety purposes, automated functions such as docking should be designed with an override capability that allows the host vehicle to stop, safe, or assume manual control of the automated function after it was initiated. The point at which the override occurs will differ depending on the function. Some activities may only be taken to a safe state and no manual control is available. The intent is to cover the time span beginning with SCS mechanism release contact and extending through rigidization docking completion. This ability is required for the Vehicle crew, ISS crew, or other Space System operators to control automated functions onboard the Vehicle. It covers the case where the vehicle is unable to achieve capture, wants to back out, reset, and make a second docking attempt. It also covers the case where the crew simply becomes uncomfortable with the safety of proceeding onward with the docking operation, and wishes to halt it and back away. | New |
| R.LIDS.0008 | ACCEPTED | Pause Docking Commands | The iLIDS shall accept a command from the host vehicle to pause the docking sequence ~~during any part of~~at predetermined safe points in the ~~operation~~sequence. | There are failure scenarios where the docking sequence should not be terminated, but rather paused to allow troubleshooting. | Major |
| R.LIDS.0009 | ACCEPTED | Pause Undocking Commands | The iLIDS shall accept a command from the host vehicle to pause the undocking sequence ~~during any part of~~at predetermined safe points in the ~~operation~~sequence. | There are failure scenarios where the undocking sequence should not be terminated, but rather paused to allow troubleshooting. | Major |
| R.LIDS.0024.1 | ACCEPTED | Ethernet Cable Specification | The iLIDS umbilical cabling for 100 BASE-TX network segments shall be constructed using shielded twisted pair Category 5e components in accordance with ANSI/TIA/EIA ~~568C~~568B.2, Annex N, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components of maximum physical cable length not to exceed 4 feet. | Ethernet cables for flight hardware is to be constructed using approved standards. | Minor |
| R.LIDS.0041 | ACCEPTED | Leak Rates for iLIDS Feed-Throughs When Mated (~~excluding~~Excluding -302) | The iLIDS (excluding -302) feed-throughs internal to iLIDS shall have a maximum of 0.0007 lbm dry air/day (0.0003 kg air/day) leakage at vestibule pressurization of 14.7 psia (101 kPa) and an external vacuum pressure when mated. | The leakage value is based on 14 Class 77H hermetic feed-throughs (~~8X~~4X size 25 connectors, ~~6X~~10X size 13 connectors). See also R.LIDS.1113 and R.LIDS.1114. | Minor |

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.0046 | ACCEPTED | EVA Sharp Edges | Any iLIDS hardware accessible to the EVA crew within 24" of an adjacent EVA worksite, excluding the defined iLIDS EVA Keep-out-zone, shall meet the edge, corner, and protrusion requirements in Table 3.-1, Figure 3-1, and Table 3-2 of JSC-28918, EVA Design Requirements and Considerations. | These edge, corner, and protrusion requirements were originally developed to prevent the cutting of the EMU glove. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.11. | Minor |
| R.LIDS.0047 | ACCEPTED | EVA Thin Material Edge RadiiMaterials | The iLIDS materials less than 0.08-in. (2.032-mm) thick that are used in a location accessible to EVA, edge radii shall be greater than 0.003-in. (0.0762-mm).(0.0762-mm), and exposed edges shall be uniformly spaced, not to exceed 0.5-in. (1.27-cm) gaps, flush at the exposed surface plane and shielded from direct EVA interaction. | These edge and corner requirements were originally developed to prevent the cutting of the Extravehicular Mobility Unit (EMU) glove. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.11.2 and modified to represent the correct conversion factor. | Major |
| R.LIDS.0048 | ACCEPTED To Be Deleted | EVA Thin Material Spacing | iLIDS materials less than 0.08-in. (2.032-mm) thick that are used in a location accessible to EVA, shall have edges uniformly spaced, not to exceed 0.5-in. (1.27-cm) gaps, flush at the exposed surface plane and shielded from direct EVA interaction. | These edge and corner requirements were originally developed to prevent cutting of the EMU glove. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.11.2. | Major - Deleted |
| R.LIDS.0055 | ACCEPTED | Pinch Points | The iLIDS shall ensure that hardware located within translation paths and established worksites (planned and contingency) that is EVA-accessible does not have pinch hazards. | This applies to, but is not limited to, hardware that pivots, retracts, flexes, or has a configuration such that a gap of greater than 0.5 in. (12.7 mm), but less than 1.4 in. (3.556 cm) (glove pinching), exists between the equipment and adjacent structure. Any item that has a potential to pinch any appendage, including legs or other body parts, will also be designed out or protected against, either by using a keep out zone (KOZ) for areas outside a translation path or worksite or by using a physical barrier. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 3.18. | Minor |
| R.LIDS.0063 | ACCEPTED | Docking Envelope (excludingExcluding -302) | The iLIDS (excluding -302) shall be capable of docking when the vehicle misalignments and relative motions are within the parameters as specified by JSC-65795, NDS IDD, table NDS Initial Contact Conditions "Design To" Limits. | Table NDS Initial Contact Conditions "Design To" Limits includes high-level information on capture envelope data. | Minor |
| R.LIDS.0065 | ACCEPTED | Soft Capture (excludingExcluding -302) | The iLIDS (excluding -302) shall perform soft capture during docking operations. | Soft capture is the initial physical connection prior to final structural mating. | Minor |
| R.LIDS.0069 | ACCEPTED | Attenuation (excludingExcluding -302) | The iLIDS (excluding -302) shall attenuate relative motion between the two mating vehicles, subject to the mass properties, load constraints, and contact conditions specified in JSC-65970, iLIDS Thermal and Induced Environments (iLIDS TIES), during docking operations. | JSC-65970, iLIDS Thermal and Induced Environments (iLIDS TIES), includes load attenuations and mass properties, among other properties. | Minor |

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.0075 | ACCEPTED | Undocking Time | The iLIDS shall be capable of undocking within 10 minutes when iLIDS undocking sequence is initiated. | The requirement implies that all nominal systems are required to be operational within this time, including ~~Guidance, Navigation, and Control (GN&C)~~GN&C parameters. The undocking sequence begins with the hatch secured and the crew's initiation of the iLIDS undocking sequence. | Minor |
| R.LIDS.0082.1 | ~~CANDIDATE~~ ACCEPTED | iLIDS Pass-Through Diameter, With Petals | With SCS guide petals installed, the iLIDS shall provide the unobstructed minimum diameter passage for pressurized transfer of crew and cargo with no permanent protrusions, drag-through cables, or obstruction, excluding the inter-module ventilation air duct as specified in JSC-65795, NDS IDD, figure NDS Docking Interface. | With the petals installed it is still a requirement to provide a clear passage for unsuited crew, cargo, etc. Value is based on study by ISS for cargo transfer. | Minor - Status Change |
| R.LIDS.0100 | ACCEPTED | Electromagnetic Interference/Electromagnetic Compatibility ~~(EMI/EMC)~~ | The iLIDS shall be designed to meet requirements in JSC-65842, iLIDS Electromagnetic Environmental Effects (E3) Description Document. | This requirement adheres to approved standards. | Minor |
| R.LIDS.0116 | ACCEPTED | Flight Hardware | Materials and processes for flight hardware shall meet the requirements of NASA-STD-6016, Standard Material & Process Requirements for Spacecraft~~.~~ as implemented by JSC-27301, Materials Control Plan for JSC Flight Hardware. | The NASA standard covers generic Materials and Process requirements. The iLIDS will utilize JSC-27301, Materials Control Plan for JSC Flight Hardware as a specific implementation to meet NASA-STD-6016. JSC-27301 also covers workmanship standards for mechanical and electrical hardware and implements SSP 30233, Space Station Requirements for Materials and Processes. | Major |
| R.LIDS.0124 | ACCEPTED | Structural Design and Verification Requirements | The iLIDS shall be designed and verified to meet the requirements of SSP 30559 Structural Design and Verification Requirements.~~-~~ Exception: SSP 30559, Section 3.1.9.3 (Dewars) and 3.1.9.7 (Burst Discs) are not applicable. | This requirement adheres to approved standards. For launch and unmated cases, the shuttle factors of safety will be used. | Minor |
| R.LIDS.0136 | ACCEPTED | General Identification Marking Requirements | The iLIDS shall use nameplates and product marking in accordance with ~~MIL-STD-130, Identification~~PRC-9002, Process Specification for Part Marking~~ of U.S. Military Property~~. | This is in accordance with approved standards. | Major |
| R.LIDS.0159 | ACCEPTED | Range of Motion | Aspects of the iLIDS with which unsuited ~~Intravehicular Activity (~~IVA~~)~~ crewmembers physically interact during planned tasks shall be within the ranges of motion provided in SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Figure 3.3.2.3.1-1. | This requirement is in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 3.3. | Minor |

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.0183 | ACCEPTED | Ionizing Radiation | The iLIDS shall meet specified performance requirements when exposed to the radiation dose environment in accordance with JSC-64598, iLIDS Ionizing Radiation Control Plan. Exception: The iLIDS (-301 & -302) shall meet radiation hardness levels for Single Event Upsets (SEUs), Single Event Latch-up (SEL), Single Event Gate Rupture (SEGR), and Single Event Burn-Out (SEB) to a minimum True Linear Energy Transfer (LET) = TBS-218. | The iLIDS must meet ionizing radiation requirements. This document establishes the ionizing radiation design susceptibility environment for low earth orbit and lunar environments. | Major |
| R.LIDS.0189 | ACCEPTED | IVA Touch Temperature | iLIDS surfaces, which are subject to IVA crewmember contact, shall meet the touch temperature requirements as specified in SSP 50021, Safety Requirements Document, Section. 3.3.6.12.1, Internal Volume Touch Temperature. Exception: IVA touch temperature limits may not be met for some time after the two vehicles have completed docking until the warm-up period is complete. The warm-up period will be characterized in JSC 65795, NDS IDD. | iLIDS internal surface temperatures must be maintained within the touch temperature limits to prevent crewmember injury from continuous and momentary contact. | Major |
| R.LIDS.0202 | TBD | iLIDS On-Orbit Design Life without Maintenance - Short Duration (~~excluding~~Excluding -302) | The iLIDS (excluding -302) shall be designed to meet a minimum of 231 days of low earth orbit design life with no maintenance. | The 231 days are as follows: a. Unmated operations on-orbit: 21 days - Ultraviolet exposure not to exceed 214 equivalent sun hours (TBR-212) b. Mated mission duration: 210 days | Minor |
| R.LIDS.0206 | ACCEPTED | iLIDS Passive Mode Docking/Undocking Cycles | The iLIDS shall be capable of a minimum of 70 passive mode docking/undocking operations. | This includes 20 ground operations and 50 flight cycles. Fifty cycles is calculated by a 15-year life with 3 missions per year and a margin of 5. The cycles are defined as a full docking/undocking sequence. The 70 Passive mode docking/undocking cycle operations does not account for component-level cycles (i.e., flex-drive, actuators, etc.). ~~Guide Petal removal and installation is a function of the nominal cycling of the docking/undocking operation.~~ | Minor |

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.0295 | ACCEPTED | iLIDS MMOD - Short Duration | The iLIDS (excluding -302) shall provide a Probability of No Penetration (PNP) of 0.999983 or greater during 210 days docked with the ISS when exposed to the Micrometeoroid and Orbital Debris (MMOD)MMOD environments as defined in NASA/TP-2002-210780 for orbital debris and SSP 30425, Space Station Program Natural Environment Definition for Design for meteoroids. | The system will be exposed to a variety of natural and induced environments that may pose a threat to functionality and performance, and therefore must be taken into account in the design. The PNP is based on the exposed surface area of the iLIDS with 210 days of exposure while docked at the ISS. The surface area assumes standoff shielding on the iLIDS outer diameter. Penetration is defined as a through-hole in the pressure shell or detached spall from the inside surface of the pressure shell such that hazardous debris is generated within the pressurized volume. This requirement does not account for failures resulting from MMOD strikes on other components or during unmated operations. These failure probabilities will be presented as technical risks and accounted for in hazard reports. The -302 has a longer life and therefore a different PNP number. | Minor |
| R.LIDS.1001 | CANDIDATE | Berthing | The iLIDS shall support berthing per To Be Specified (TBS)-217. | The iLIDS provides for vehicle-level docking. The iLIDS design shall not preclude berthing. Refer to Berthing Requirements Document TBS-217 for specific berthing requirements. | New |
| R.LIDS.1005.1 | ACCEPTED | HCS Guide Pin Receptacles | The iLIDS shall provide guide pin receptacles for tangential constraint and alignment of the systems during hard mate per JSC-65795, NDS IDD, figure HCS Guide Pin Hole Detail and figure HCS Docking Interface. | Guide pin/receptacles provide fine alignment during soft capture systemSCS retraction and restrict rotation and shear of the systems while mated. See also R.LIDS.0029 for the figure depicting guide pin receptacle location. | Minor |
| R.LIDS.1006 | ACCEPTED | Seal on Seal Mating Interface (excludingExcluding -302) | The iLIDS (excluding -302) HCS seal on seal mating plane shall meet the details as specified in JSC-65795, NDS IDD, figure NDS (excluding -302) HCS Mating Plane Seal and Electrical Bonding Details. | The docking system must include a seal interface to support pressurization after structural mate. The seals meet the emerging IDSS and support either seal on seal or seal on metal operation. The corresponding figure in JSC-65795, NDS IDD, provides interface definition for the HCS Mating Plane. | Minor |
| R.LIDS.1042 | ACCEPTED | Pyrotechnic Initiation (excludingExcluding -302) | The iLIDS (excluding -302) shall use NASA Standard Initiators (NSIs) for pyrotechnic devices. | Pyrotechnic provides additional fault tolerance for undocking hazards. iLIDS pyrotechnics are safety-critical because their inadvertent operation results in a catastrophic hazard. Use of proven NSI design ensures safe and reliable pyrotechnic design and operation. This requirement is in accordance with SSP 50021, Safety Requirements Document, Section 3.3.6.5.1.1. The -302 is intended for use on ISS and has been decided to not include pyros so that the port cannot be fouled by firing pyros and disabling hooks for future docking. | Minor |
| R.LIDS.1060 | ACCEPTED | iLIDS Active Mode Docking/Undocking Cycles (excludingExcluding -302) | The iLIDS (excluding -302) shall be capable of a minimum of 24 active mode docking/undocking operations. | This includes 20 ground operation cycles and 4 flight cycles. The cycles are defined as a full docking/undocking sequence. The 24 active mode docking/undocking cycle operations does not account for component-level cycles (i.e., flex-drive, actuators, etc.). | Minor |

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.1097 | ACCEPTED | iLIDS Passive Dock Mode | The iLIDS shall provide a Passive Dock mode of operations. | During the Passive Dock mode, the iLIDS will provide all ~~health and status~~H&S data as well as flags for soft capture. In addition, all outputs will be inhibited during operation (e.g., motors, magnets, etc.). | Minor |
| R.LIDS.1098 | ACCEPTED | iLIDS Passive Undock Mode | The iLIDS shall provide a Passive Undock mode of operations which inhibits all outputs, while providing H&S data and flags. | During the Passive Undock mode, the iLIDS will provide all ~~health and status~~H&S data as well as flags for undocking completion. In addition, all outputs will be inhibited during operation (e.g., motors, magnets, etc.). | Minor |
| R.LIDS.1099 | ACCEPTED | iLIDS Safe Mode | The iLIDS shall provide a Safe mode of operations which inhibits all outputs, while providing H&S data. | During the Safe mode, the iLIDS will provide all ~~health and status~~H&S data. In addition, all outputs will be inhibited during operation (e.g., motors, magnets, etc.). | Minor |
| R.LIDS.1102 | ACCEPTED | Design For Minimum Risk | iLIDS hazards related to ~~Design For Minimum Risk (~~DFMR~~)~~ areas of design shall be controlled by the safety-related properties and characteristics of the design. The failure tolerance criteria are only to be applied to these designs as necessary to ensure that credible failures that may affect the design do not invalidate the safety-related properties of the design. | This requirement is in accordance with SSP 41000, System Specification for the International Space Station, Section 3.3.6.1.2. DFMR are areas where hazards are controlled by specification requirements that specify safety-related properties and characteristics of the design that have been baselined by the ISS program requirements rather than failure tolerance criteria. The failure tolerance criteria of R.LIDS.0106 will only be applied to these designs as necessary to ensure that credible failures that may affect the design do not invalidate the safety-related properties of the design. For example, a pressure vessel shall be certified safe based upon its inherent properties to withstand pressure loading that have been verified by analysis and qualification and acceptance testing; however, failure tolerance must be imposed upon external systems that might affect the vessel, such as a tank heater, to ensure that failures of the heater do not cause the pressure to exceed the Maximum Design Pressure (MDP) of the pressure vessel. Examples are mechanisms, structures, glass, pressure vessels, pressurized lines and fittings, functional pyrotechnic devices, material compatibility, flammability, etc. | Minor |
| R.LIDS.1103 | ACCEPTED | Pyrotechnic Operated Devices (~~excluding~~Excluding -302) | The iLIDS (excluding -302) shall provide pyrotechnic devices designed and tested to the requirements of JSC~~-~~ 62809, Human Rated Spacecraft Pyrotechnic Specification. Exception: Exception is taken to JSC 62809 Sections 3.1, 3.2.2, 3.6.18, 3.6.19, 3.6.20, 3.6.24.1, 3.6.24.2, 3.6.24.3, 3.6.26.1, 4.1.3, 4.4.9, 4.5.1.6, 4.5.2.4, 4.5.2.5, 7.3.3, 7.3.4, 8.1, 8.2, 8.2.4, 8.3 to 8.3.6, 8.4.7, 8.5.1, and 8.5.2. Sections noted are not verifiable by the iLIDS project. | iLIDS pyrotechnic devices must meet pyrotechnic requirements to ensure safe pyrotechnic design and operation. This requirement is in accordance with SSP 50021, Safety Requirements Document, Section 3.3.6.5.1.3. | Major |

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.1104 | ACCEPTED | Crew Protection for Electrical Shock | The iLIDS shall provide protection for the crew from electrical hazards in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 6.4.3. | The crew must be protected from potentially catastrophic electrical shock from the iLIDS electrical systems. This requirement is in accordance with SSP 50021, Safety Requirements Document, Section 3.3.6.8.2. | Minor |
| R.LIDS.1108 | ~~ACCEPTED~~ To Be Deleted | Fastener Selection | The iLIDS fasteners used on removable structures and components shall be selected and designed in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Sections 11.9.3 and 14.6.3.3. | This requirement adheres to approved standards. | Major - Deleted |
| R.LIDS.1108.1 | ~~CANDIDATE~~ ACCEPTED | Fastener - Threaded Ends | The iLIDS threaded ends of IVA and EVA screws and bolts extending more than 0.12 in. shall be capped to protect against sharp threads. | This is to protect the crew from injury due to sharp edges in accordance with SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 6.3.3.6. | Minor - Status Change |
| R.LIDS.1108.2 | ~~CANDIDATE~~ ACCEPTED | Fastener - Maintenance Force | iLIDS on-orbit maintainable IVA fasteners shall require no greater than 20 lbf for engagement or disengagement with ratchet-type tools. | The value accommodates the strength limitations of the 5th percentile male population, as stated by SSP 41000, System Specification for the International Space Station, Section 3.3.7.3.2, ~~Table XXXIII,~~ which is derived from SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 4.9.3.B. | Minor - Status Change |
| R.LIDS.1108.3 | ~~CANDIDATE~~ ACCEPTED | Fastener - Maintenance Torque | iLIDS on-orbit maintainable IVA fasteners shall require no greater than 11 ft-lb torque for engagement or disengagement with driver type tools. | The value accommodates the strength limitations of the 5th percentile male population as stated by SSP 41000, System Specification for the International Space Station, Section 3.3.7.3.2, ~~Table XXXIII,~~ which is derived from SSP 50005, International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), Section 4.9.3.B. | Minor - Status Change |
| R.LIDS.1108.4 | CANDIDATE | IVA Toolbox Compatibility | iLIDS mounting fasteners used on guide petals and electrical boxes shall be selected to be compatible with IVA tool box assembly part number SEG33113668-301. | This requirement adheres to approved standards to support on-orbit maintenance. The standard tool list is comprised of tools to be used for Orbital Replacement Unit (ORU) removal and replacement. The IVA tool box is in accordance with JSC 28533, ISS Catalogue of IVA GFE FCE. | New |
| R.LIDS.1109 | ACCEPTED | JPR 8080.5 - JSC Design and Procedural Standards | The iLIDS shall meet JPR 8080.5, JSC Design and Procedural Standards, requirements marked applicable, as specified ~~herein~~ in Appendix C. | Adherence to NASA standards. JPR 8080.5, JSC Design and Procedural Standards provides design and procedural requirements for any human spaceflight program, project, spacecraft, system, or end item. | Minor |
| R.LIDS.1112 | ACCEPTED | Umbilical Auto-Mate | The iLIDS shall automatically mate umbilical connectors within 15 minutes of achieving hard mate. | Umbilical connector mate is critical function for resource transfer. It is necessary to perform this action without ~~EVA/IVA.~~ Extravehicular Activity/Intravehicular Activity (EVA/IVA). | Minor |

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.1113 | TBD | Leak Rate for iLIDS-to-iLIDS Interface | The iLIDS-to-iLIDS interface shall have a maximum of 0.0025 lbm dry air/day (0.0011 kg air/day) leakage at vestibule pressurization of 14.7 psia (101 kPa) and an external vacuum pressure when mated. | The leakage value assumes 12 ~~hard capture system~~HCS hooks fully engaged and derives from a nominal ISS trajectory and exposure to 1E21 atoms/cm2 atomic oxygen and 214 equivalent sun hours (To Be Resolved (TBR~~-~~)-212) ultraviolet radiation (for a duration of up to 21 days). The atomic oxygen exposure includes both pre-treatment of the seals and on-orbit exposure at 4.4 x 10E19 oxygen atoms/cm2 per day. See also R.LIDS.0041 and R.LIDS.1114. | Minor |
| R.LIDS.1115 | ~~TBD~~ACCEPTED | Pyrotechnic Release (~~excluding~~Excluding -302) | The iLIDS (excluding -302) shall provide pyrotechnics in both the active and passive hooks at the hard mate interface capable of releasing ~~all 24~~a single gang of 6 hooks within 150 ms ~~(TBR-40) ms~~, allowing the host vehicle to separate from the mated vehicle. | If the iLIDS active hooks fail to unlatch, the host vehicle may fire the ~~pyrotechnics releasing all 24 hooks~~ pyrotechnic(s) to release the gang(s) of hooks containing the failed hooks allowing the host to separate from the mated vehicle. The iLIDS active and passive hooks are distributed across 4 gangs of 6 hooks each (2 active hook gangs and 2 passive hook gangs) for a total of 24 hooks (12 active and 12 passive). | Minor - Status Change |
| R.LIDS.1116 | ACCEPTED | H&S Data Processing Latency | The iLIDS shall have a ~~health~~Health and ~~status~~Status (H&S) data processing latency no greater than 45 ms, where the performance measurement is taken from the time Health and Status (H&S) data is sampled to the time conditioned H&S data crosses the iLIDS to host vehicle interface. | An upper bound on H&S data processing latency must be established to drive and manage overall avionics and software system design and end-to-end avionics and software performance. This value is driven by and is the part of the time allocation, allocated to iLIDS, from the max total time (200 ms from NDS IDD) required for a switch from system A to B to take place in the case of a fault requiring primary control being transferred from system A to B. If a fault requiring a switch to the redundant string is identified, there is a minimum amount of time to detect, report to the vehicle, and the vehicle to issue a command to switch between controllers in order to maintain safe control of the linear actuators, depending on the mode and state of iLIDS. This switch time is most critical during dock mode capture and attenuation states. See also R.LIDS.0012 and R.LIDS.1137. | Minor |
| R.LIDS.1117 | ACCEPTED | Fastener Integrity | iLIDS fasteners shall be in accordance with JPR 8730.2, JSC Fastener Integrity Testing Program. | The iLIDS contains numerous safety-critical fasteners whose properties are crucial to the safe operation of the iLIDS. Counterfeit or substandard fasteners could cause a structural failure of the iLIDS and result in a catastrophic hazard. | Minor |
| R.LIDS.1121 | ACCEPTED | EMU TMG Orthofabric and Glove Back External Touch-Temperature Compliance | The iLIDS hardware that interfaces with the EMU ~~Thermal/Micrometeoroid Garment (~~TMG~~)~~ orthofabric, which includes the backside of the EMU glove, shall be in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 4.4.5. | The iLIDS will provide input into the integrated thermal analysis. These limits do not apply to the palm of the glove that has different standards set out in Section 4.4.4. See R.LIDS.0060. | Minor |

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.1122 | ~~ACCEPTED~~ To Be Deleted | EMU TMG Orthofabric and Glove Back External Touch-Incidental Contact | iLIDS EVA surfaces that can be touched shall be within a range of -244 °F to 320 °F (-153 °C to 160 °C). | This is to demonstrate compliance with EMU TMG orthofabric limitations for external portions of hardware that can be inadvertently touched by brushing or bumping in EVA operations. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 4.4.5.1. | Major - Deleted |
| R.LIDS.1123 | ~~ACCEPTED~~ To Be Deleted | EMU TMG Orthofabric and Glove Back External Touch-Extended Contact | The iLIDS shall design EVA hardware surfaces requiring prolonged compression of the EMU TMG orthofabric to remain within a | In rare cases, EVA operations and/or hardware design require long-duration compression of the TMG orthofabric, thereby thermally shorting the multilayer insulation and making TMG layers vulnerable to thermal damage. This requirement is in accordance with JSC-28918, EVA Design Requirements and Considerations, Section 4.4.5.2. | Major - Deleted |
| R.LIDS.1127 | ~~ACCEPTED~~ To Be Deleted | IVA Connectors | The iLIDS connectors shall allow for IVA mate/demate operations in support of contingency maintenance operations in orbit. | The iLIDS assembly does not count for nominal maintenance in flight. However, iLIDS connectors on the electrical boxes are designed to be mated/demated by an IVA operator if a contingency Orbital Replacement Unit (ORU) replacement is required. | Major - Deleted |
| R.LIDS.1133 | ACCEPTED | Data Exchange with the Host Vehicle (EIA-422-B) | The iLIDS shall exchange data with the host vehicle in an asynchronous serial communications format utilizing a Universal Asynchronous Receiver/Transmitter (UART) controller, ~~NRZ (~~Non-Return to Zero (NRZ) with one start bit, 8 data bits (Least Significant Bit (LSB) first) and one stop bit. | This is the iLIDS specific implementation of EIA-422-B. | Minor |
| R.LIDS.1137 | ~~CANDIDATE~~ ACCEPTED | Fault Response Performance | The iLIDS shall be capable of detecting any internal fault, notifying the host vehicle of the fault via the H&S data, and executing a fault response command from the host vehicle within 200 ms, including 120 ms of communication and processing time within the host vehicle. | The iLIDS must be capable of detecting and responding to faults quickly during docking attempts to ensure adequate dynamic performance in the event that system B is needed to complete a docking attempt or in the event a docking attempt abort is needed. iLIDS dynamics simulations will use this 200 ms time as the idle time between system A and system B operations and between system B operations and the beginning of a docking attempt abort. The requirement is based on the two associative requirements (R.LIDS.0012 and R.LIDS.1116). The iLIDS will send signals in 35 ms and receive in 45 ms. | Minor - Status Change |
| R.LIDS.1138 | TBD | Solar Ultraviolet Radiation (~~excluding~~Excluding -302) | The iLIDS (excluding -302) shall meet all of its functional and performance requirements during and after ~~expose~~exposure to the solar ultraviolet radiation (UV) environment as defined in SSP 30425, Space Station Program Natural Environment Definition for Design, Section 7.2 with the limit to not to exceed 214 ~~equivalent sun hours~~Equivalent Sun Hours (ESH) (TBR-212) ultraviolet radiation (for a duration of up to 21 days). | The iLIDS must operate in the solar ultraviolet radiation environment. The limits are based on restrictions for the iLIDS seal exposure to ~~Equivalent Sun Hours (~~ESH~~)~~ and UV. | Minor |

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.1139 | ~~CANDIDATE~~ ACCEPTED | Solar Ultraviolet Radiation (-302) | The iLIDS (-302) shall meet all of its functional and performance requirements during and after ~~expose~~exposure to the solar ultraviolet radiation environment as defined in SSP 30425, Space Station Program Natural Environment Definition for Design, Section 7.2. | The iLIDS must operate in the solar ultraviolet radiation environment. | Minor - Status Change |
| R.LIDS.1140 | ~~CANDIDATE~~ ACCEPTED | Vacuum Environment | The iLIDS shall be fully functional while exposed to the ambient pressure of 1.0E-11 Pascal. | Value is derived from the natural environment definition given in SSP 30425, Space Station Program Natural Environment Definition for Design. This is the vacuum environment for geosynchronous environment. | Minor - Status Change |
| R.LIDS.1141 | ~~CANDIDATE~~ ACCEPTED | Heater Operation - Blind Mode | The iLIDS shall ~~provide~~perform default heater operation when communications to the iLIDS heater controller is not available. | The blind mode heater operation is to maintain the iLIDS within the thermal survivability range when being stored or displaced. The iLIDS heater controller will have default values preprogrammed into the controller. If the controller starts up with no communications, it will use the internal default values for set points. If the controller is operating normally and then loses communications, the last heater set points received will be used until another communications message is received or the heater controller is power-cycled. | Minor – Status Change |
| R.LIDS.1142 | CANDIDATE | IDSS IDD Compatibility | The iLIDS shall be compatible with the IDSS IDD Rev A. | The IDSS IDD establishes standards for compatibility across all docking system designs such that they are capable of interfacing and safely docking with one another. The iLIDS design is based on docking interface features and loads specified in the NDS IDD that are also compatible with those specified in the IDSS IDD. | New |
| R.LIDS.5003 | ACCEPTED | iLIDS Volume and Keep Out Zones ~~(KOZ)~~ | The iLIDS envelope shall be in accordance with JSC-65795, NDS IDD, figure NDS Cross Section. | The figure defines the static and dynamic envelopes that the iLIDS must adhere to for host vehicle integrations and operations. The figure also establishes an EVA KOZ that is used for the exclusion of EVA requirements. | Minor |
| R.LIDS.5012 | ACCEPTED | SCS Ring Dimensions | The iLIDS SCS dimensions shall be in accordance with JSC-65795, NDS IDD, figure SCS Guide Petal System Profile. | The iLIDS is NASA's implementation for the emerging ~~International Docking System Standard (~~IDSS~~)~~ using low impact docking technology. The figure also identifies mechanical latch striker mounting holes, which provide scarring for future implementation of a mechanical latch striker interface. | Minor |
| R.LIDS.5014 | ACCEPTED | Pre-Capture SCS Compressive Force Resistance | The iLIDS soft capture interface shall have no more than ~~5~~6 lb compressive force resistance during capture. | The low impact technology SCS requires minimal compressive force resistance across the interface prior to capture. ~~In order to achieve soft capture~~To maximize the benefit of low impact technology, a maximum of ~~10~~12 lb compressive force resistance is allowed across the interface. This means each side is allowed to have a maximum of ~~5~~6 lb resistance. This resistance might include magnet strikers compliance ~~mechanism~~mechanisms, the SCS capture sensors, and any other sources of compressive force resistance. | Minor |

| Identity | Status[1] | Name | Requirement | Rationale | Change[2] |
|---|---|---|---|---|---|
| R.LIDS.5030 | ~~ACCEPTED~~ To Be Deleted | iLIDS-to-Host Vehicle Electrical and Signal Interface | The iLIDS-to-vehicle functions shall be in accordance with the electrical interface between the iLIDS and the host vehicle as defined in JSC-65795, NDS IDD, figure NDS-to-Host Vehicle Electrical Interface. | The IDD figure defines all the required host interfaces for both power and communication to the iLIDS as well as power and data transfer through iLIDS. | Major - Deleted |
| R.LIDS.5034 | ACCEPTED | Heater Power and Control | The iLIDS shall provide redundant heater control for two channels. | Only one channel is ~~active~~actively controlling a heater zone at a time while the other channel is ~~in standby.~~powered and processing data (e.g., checking Resistance Temperature Detectors (RTDs), sending H&S, etc.) ready to actively control the heater zone if the other channel fails. Refer to JSC-64599, Electric Power Quality Description Document for heater power timelines. | Minor |
| R.LIDS.5036 | ACCEPTED | iLIDS-to-Host Vehicle Electrical Interface (~~excluding~~Excluding -302) | The iLIDS (excluding -302) shall provide electrical connections to the host vehicle as defined in JSC-65795, NDS IDD, figure NDS (excluding -302) Tunnel Connections-to-Host Vehicle Electrical Interface. | The vehicle interface has a separate connector for power and data, unlike the iLIDS umbilical interface, which combines power and data. | Minor |
| R.LIDS.5038 | CANDIDATE | iLIDS Box Connections-to-Host Vehicle Electrical Interface (Excluding -302) | The iLIDS (excluding -302) shall provide electrical connections to the host vehicle as defined in JSC-65795, NDS IDD, figure NDS (excluding -302) Box Connections-to-Host Vehicle Electrical Interface. | The IDD figure defines the required host interfaces for both power and data to the iLIDS electrical boxes. | New |
| R.LIDS.5061 | ~~CANDIDATE~~ ACCEPTED | Maximum Temperature Differential for SCS Mating Interfaces | The iLIDS-SCS to iLIDS-SCS shall have a maximum allowable temperature differential of 100 °F (56 °C) for soft capture. | This restriction is based on thermal expansion limits for the engagement of the mating guide petals in the mating iLIDS. | Minor - Status Change |

## Table C-6 - iLIDS JPR 8080.5 Compliance Requirements Revision From/To Comparison

The "From/To" table contains red colored text for omissions, blue for new or replaced text, and black for no changes. Strike-through text means the requirement is deleted. The table reflects only items that have been modified between revisions.

| Standard | Section | Section Title | Applicability | Comments/Rationale | Requirements |
|---|---|---|---|---|---|
| JPR 8080.5 | P-1 | Pyrotechnic Devices - Arming and Disarming | Not Applicable | iLIDS design does not have the capability to arm or disarm pyros. | |