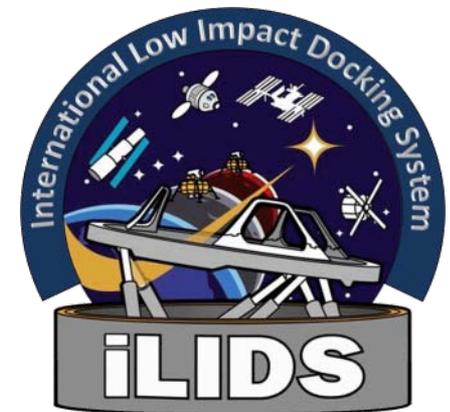




NDS Configuration and Requirements Changes since Nov 2010

Chris Lupo
June 14, 2011





- ◆ Entering CDR, NDS had four configurations
 - 301: Core: 120VDC power, integrated electronics
 - 302: Short: Reduced height, no seals; electronics boxes remotely mounted
 - 303: Low Voltage: Same as 301 except 28VDC power input
 - 304: Abated: Same as 301 except reduced functionality/reduced mass, selected missions

- ◆ After CDR:
 - -302 has been retired
 - This was a specific configuration to support the ISS Common Docking Adapter (CDA) which has been replaced with a new PMA based [APAS Docking Adapter](#)
 - -305 has been added
 - 305: Short: Reduced height with seal
 - 305: 28 VDC electronics boxes remotely mounted
 - 305 is largely based on 302 design that has been thru CDR
 - See next chart for Post-CDR Configurations

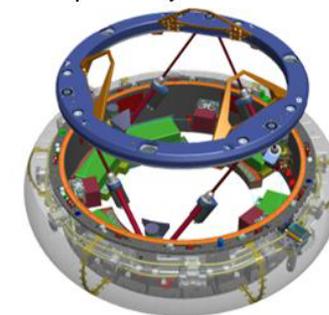
NASA Docking System (NDS) Block 0

Post-CDR Configurations SEZ29101800-3XX

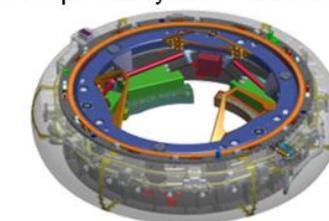


Dash Number	NDS (-301)	NDS (-303)	NDS (-304)	NDS (-305)
Status	In Development	Avail on Request	Avail on Request	Available on Request
Specification Max Weight (lb)	750	✓	711	TBD*
Host Power	120 VDC	28 VDC	✓	28 VDC
NDS Tunnel Height (in.) Flange-to-Flange	15	✓	✓	8.92
Dynamic Seal or Seal Surface	Seal	✓	✓	✓
Host Leak Check Port	NDS Tunnel	✓	✓	Host tunnel
Motorized Separation System	Yes	✓	✓	✓
Motorized Transfer Umbilicals	Power/Data	✓	✓	✓
Power & Data Umbilical Interface	Internal to NDS	✓	✓	External Panel
SCS Actuators	Yes	✓	✓	✓
SCS Magnets	Yes	✓	✓	✓
SCS Magnet Striker	Yes	✓	No	✓
Hooks	12 Active/Passive	✓	12 Active	✓
Pyrotechnic Hook Release	Yes	✓	No	✓
Ready-To-Hook Sensors	3	✓	✓	✓
Soft Capture Sensors	3	✓	✓	✓
Undocking Complete Sensors	2	✓	✓	✓
Electrical Boxes Mounting	Integral to NDS	✓	✓	Mounted to Host
Box Electrical Cable Length/Routing	Integral to NDS	✓	✓	Host extension cables, TBD length
Hermetic Pass Thru for NDS control	Integral to NDS	✓	✓	In Host Structure
NDS S/W Interface to Host	EIA422 or MIL-STD-1553	✓	✓	✓
NDS control and heater control thru single host serial port	One serial port per channel (A&B)	✓	✓	✓
MMOD Shield	Integral to NDS	✓	✓	Host Provided
Passage Way Closeout	Integral to NDS	✓	✓	✓
Life	231 days	✓	✓	✓
Active Docking Cycles	4	✓	✓	✓
Passive Docking Cycles	50	✓	None	✓

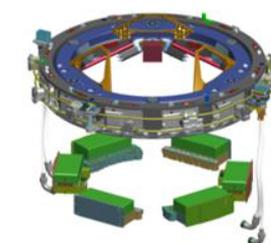
Ready to Dock (Active Mode)
Soft Capture System Extended



Ready to Dock/Launch
(-301 Passive Mode)
Soft Capture System Retracted



Ready to Dock/Launch
(-305 Passive Mode)
Electrical Boxes mounted in host



Configs Baselined 06/14/11
[Confirm latest in DDMS](#)
[Docking System Config Baseline](#)

- ◆ 301: Core: 120VDC power, integrated electronics
- ◆ 302: RETIRED – Originally intended for ISS use
- ◆ 303: Low Voltage: Same as 301 except 28VDC power input
- ◆ 304: Abated: Same as 301 except reduced functionality/reduced mass, selected missions
- ◆ 305: Short: Reduced height; 28 VDC electronics boxes remotely mounted

*305 mass Includes electrical boxes but does not include host provided h/w



- ◆ NDS TIM in November 2010
 - PTRS Rev C, IDD Rev C, and User's Guide Rev A
- ◆ NDS CDR was completed in May 2011
 - PTRS Rev E and IDD Rev D were released for this review and are available on the public website:
<http://dockingstandard.jsc.nasa.gov/index.html>
 - Both documents contain appendices detailing the changes in these releases
 - Note: PTRS Rev D primarily was a bookkeeping/administrative revision focused on traceability between the IDD, PTRS, and Verification Document
- ◆ Updates are in work
 - IDD Rev E and PTRS Rev F are planned for release 8/15/11 to incorporate changes based on CDR RIDs/Comments and NDSP approved changes
 - This presentation will summarize Configuration and Requirements Changes
 - Refer to “PTRS Changes.xlsx” for details on planned PTRS Rev Changes
 - Refer to “RID Comment.xlsx” for all changes approved by the CDR Board
 - The following charts summarize the planned changes
 - Incorporation of -305 in PTRS and IDD planned for December 2011
 - User's Guide Rev B planned for release (9/15/11)
 - User's guide changes are all children of approved IDD or PTRS changes



PTRS Changes.xlsx



CDR-RID-Comment

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Host Interface Configuration Change Summary



Change ID	Description of Change	Review	Update
Tech-27	Update host bolted/seal interface dimensions and tolerances	DSIP	8/15/11
Tech-37	Standard 1553 Host Interface vs. ISS specific	DSIP	8/15/11
Tech-96	4 vs. 24 NSI's and add applicable pyro spec req	DSIP	8/15/11
Tech-97	Provide flexibility in remote box mounting and clarify extension cable interface	DSIP	8/15/11
Action CDR - 8	Assess the docking dynamic performance requirements for different vehicle classes	CDR	8/15/11
CDR-9	Clarify that EEPROM must be reloaded every 10 yrs	CDR	8/15/11
CDR-18	Clarify that crew PPE (gloves) will be required if host chooses to open the hatches without allowing time for NDS to reach touch temperature limits	CDR	8/15/11
CDR (38-43)	Clarify heater interfaces (commands plus health and status) including warm up time for heater controller	CDR	8/15/11
CDR-44	Clarify IDD that last command will be "latched" until host sends new command	CDR	8/15/11



Host Interface Configuration Change Summary



Change ID	Description of Change	Review	Update
CDR-148	Add commands to "Charge Separator" and "Stow Separator" to Manual State Sequencing Commands and Engineering Commands and to the appropriate states/sub-states of Dock/Undock	CDR	8/15/11
CDR-149	Add commands to "Extend Umbilical Connector / Receptor" and "Stow Umbilical Connector / Receptor" for the two connectors / receptors to the list of Manual State Sequencing Commands and Engineering Commands and to the appropriate states/sub-states of Dock and Undock.	CDR	8/15/11
CDR-220	Add R.LIDS.0006 Terminate docking command to effective up to hook activation, see Action CDR-2	CDR	8/15/11
CDR-266	Add recommended wobble angle limits and ability for host to set the wobble angle	CDR	8/15/11
Misc	Update FDIR Logic Table	CDR/SRP	8/15/11
Misc	Updated IDD thermal interface information	LCCP	Rev D
Misc	Updated IDD connector pin-out definition	LCCP	Rev D

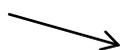


NDS IDD Section 7 Host Integration Requirements



Change ID	Description of Change	Review	Update
CDR-348	Update host response time to switch over from NDS system A to system B	CDR	8/15/11
Tech-100	Added R.LIDS.6060 to Section 7 NDS IDD The vehicle supplying umbilical power shall remove power from the umbilical connectors prior to mating or de-mating the connectors to prevent damage to the connector.	DSIP	8/15/11

- ◆ Section 7 of the NDS IDD defines requirements levied on the host for integration of the NDS
- ◆ The majority of these requirements are based on integrated hazard controls.
- ◆ See attached for details of changes occurring in Rev D and proposed for Rev E release 8/15/11
 - All changes to section 7 are a result of reviews from either the Safety Review Panel, CDR, or DSIP



Section 7 Changes



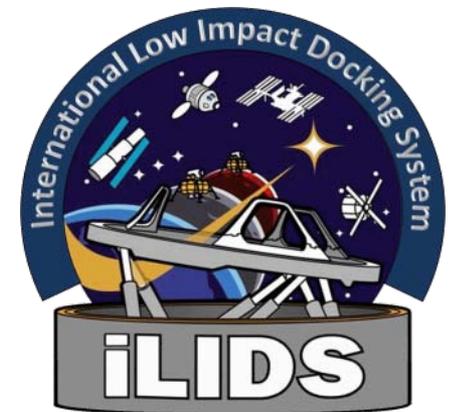
NDS to NDS Interface Configuration Change Summary



Change ID	Description of Change	Review	Update
Tech-52	2 undocking complete sensors vs. 3	LCCP	8/15/11
Tech-94	Deleted X-Connector Keep-Out Zone	DSIP	IDD Rev D
Tech-98	Revise coordinate system definition (Create structural and capture performance systems)	DSIP	8/15/11
Tech-99	Add allowable RTH & Undocking Sensor force	LCCP	8/15/11
CDR-8, 21, & 22	Change to double height 7/16 hex on Guide petal captive fasteners, modify locking feature to support multiple ISS removal cycles, and be compatible with ISS tool set	CDR	8/15/11
CDR-17	Updated Soft Capture Resistance Force to 6 lb	CDR	8/15/11
CDR-200/202	Clarify allowable 100F delta between Soft Capture System	CDR	8/15/11
CDR-232	Add Berthing to planned block upgrade	CDR	8/15/11
CDR-236	Add Dry Film Lubrication req's for guide pin	CDR	8/15/11
CDR-384	Update dimensions, tolerances, and parameters per IDSS IDD Rev A	CDR	8/15/11

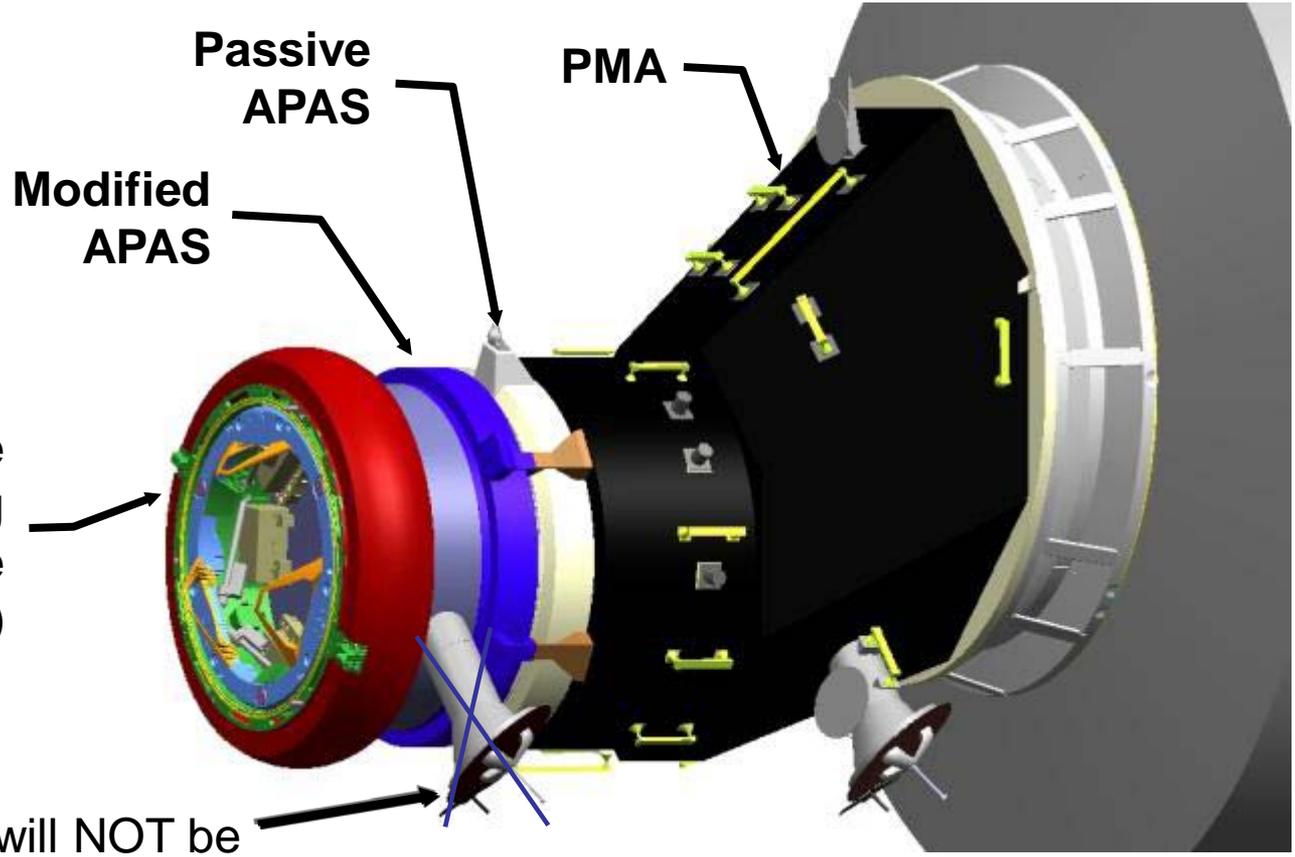


Backup





NDS APAS Docking Adapter (NADA)



Grapple Fixture will NOT be Included for this concept



- ◆ Configuration Baseline Description
 - The host bolt circle diameter and number of bolts shall match the APDA interface. The hole pattern must match APAS but the edge distance and clearance hole size may be adjusted if necessary for NASA load cases. The bolts and shear pins shall be metric. The shear features may be different than the APAS.
 - Update IDD to modify flange thickness for NDS tunnel, seal groove dimensions, shear pin location, and miscellaneous tolerances to match tunnel drawing SDZ29101974.
 - In addition update IDD based on mated interface analysis as follows. Host flange minimum = .75 in. Update insert drill depth to be consistent with minimum host flange thickness. Loosen tolerance on alignment slot for drill template.
- ◆ Approval: DSIP 6/1/11
- ◆ Incorporation: Pending NDS IDD Rev E

Return to [Host Interface Change Summary](#)



- ◆ Configuration Baseline Description
 - The iLIDS to Host Vehicle shall communicate using either TIA-422-B or MIL-STD-1553. The iLIDS connector interface to the host shall provide pins for both 422 and 1553 but the host can only use one of the communication standards.
 - The iLIDS will use a standard 1553 implementation (instead of the the ISS specific protocol) for 1553 communication. The 1553 packet will be based on the 422 packet. Update 1553 specifications in document as well.
 - The host will provide 1 comm channel per System (A and B) to control the system and the heaters. Refer to Tech-47 for Heater operation.
 - CDR RID 38, 39, 40, 41, 42, 43 address 1553 and heater interfaces.
- ◆ Approval: DSIP 6/1/11
 - Discussed in NDSP Docking Systems Integration Panel (DSIP) 3/2/11
 - Action Electrical 21 Assigned to assess impact
 - CDR RID 38, 39, 40, 41, 42, 43 Approved to update IDD to generic interface
- ◆ Incorporation: Pending NDS IDD Rev E

Return to [Host Interface Change Summary](#)



- ◆ Configuration Baseline Description
 - The NDS shall provide indication of undocking complete with sensors in the 2 guide pins receptacles that trip when the guide pins exit the receptacle.
 - Previous baseline had an additional sensor in the guide pin
 - Review with NDSP technical lead and S&MA lead to removal of this sensor
 - Concerned that sensor in pin could lead to jamming
 - Determined additional sensor did not provide any required information
- ◆ Approval: LCCP 3/23/11
- ◆ Incorporation: Pending NDS IDD Rev E

Return to [NDS Interface Change Summary](#)



- ◆ Configuration Baseline Description
 - The NDS shall accommodate APAS hard mate where the APAS based system is in active mode and the NDS is in passive mode. ~~The NDS shall place umbilicals such that they do not interfere with APAS x-connectors. And the NDS shall include accommodations in the MMOD shield to avoid interference with APAS x-connectors.~~ The NDS sensors, GSE interfaces, and separation system shall be placed to avoid interference with APAS hard mate. The Rationale: See direction memo OA-10-019 to support compatibility with APAS hard mate.
 - It is not necessary to provide keep out zones for the APAS x-connectors. It is assumed any APAS based system docking to the NDS will use NDS compatible umbilicals for power and data transfer.
- ◆ Approval: DSIP 1/15/11
- ◆ Incorporation: Capture in NDS IDD Rev D

Return to [NDS Interface Change Summary](#)



- ◆ Configuration Baseline Description
 - For CDR and NDS IDD Rev D, NDS assumed 24 NSI's for pyro hook release with the NSI's positioned on the hooks.
 - Hence cables were routed from the host interface feed thru connectors in the tunnel to the NSI's on the hooks.
 - However, this architecture was changed after CDR to ETL with 4 NSI's.
 - Hence cables are only routed to the 4 NSI's and then ETL is routed to the 24 hooks via a series of manifolds
 - This allows the host to fire the hooks in groups of 6 (i.e. gang 1 & 2 for active and passive).
 - In addition, the NDS IDD section 7 will be updated to allocate applicable JSC 62809 Pyrotechnic Specification sections to the host.
- ◆ Approval: LCCP 5/11/11, DSIP 6/1/11
 - Pre-coordination at multiple splinters and hooks management meetings where NDSP technical lead was in attendance
- ◆ Incorporation: Pending NDS IDD Rev E

Return to [Host Interface Change Summary](#)



- ◆ Configuration Baseline Description
 - For the short tunnel active config (-305), the electrical boxes are remote mounted. The NDS IDD documents has a table documenting maximum cable lengths for the extension cables required to remote mount the boxes.
 - A desire has been communicated to give increased flexibility to host vehicle for packaging. The NDS IDD will be updated with definition of performance parameters for extension cables and box-to-box cables to allow hosts to design alternate cable combinations (i.e. longer box to box and shorter extension or vice versa). This could be done with a matrix of options or equations defining cable performance.
 - Clarify connector interface for extension cables.
- ◆ Approval: DSIP 6/1/11
- ◆ Incorporation: Pending NDS IDD Rev E

Return to [Host Interface Change Summary](#)

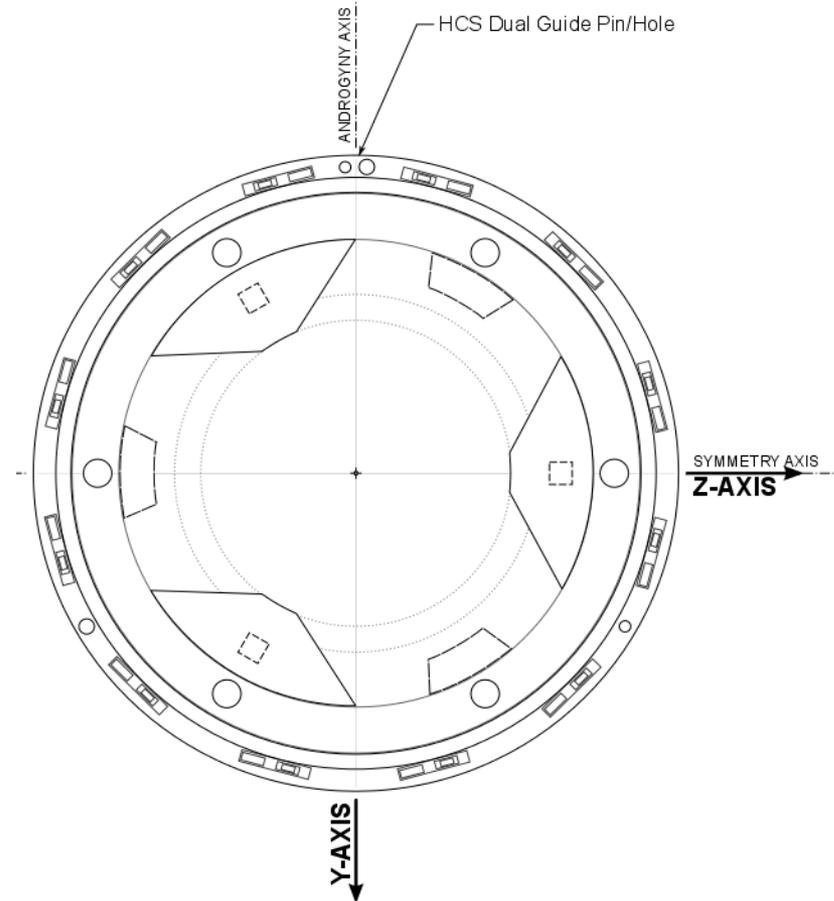
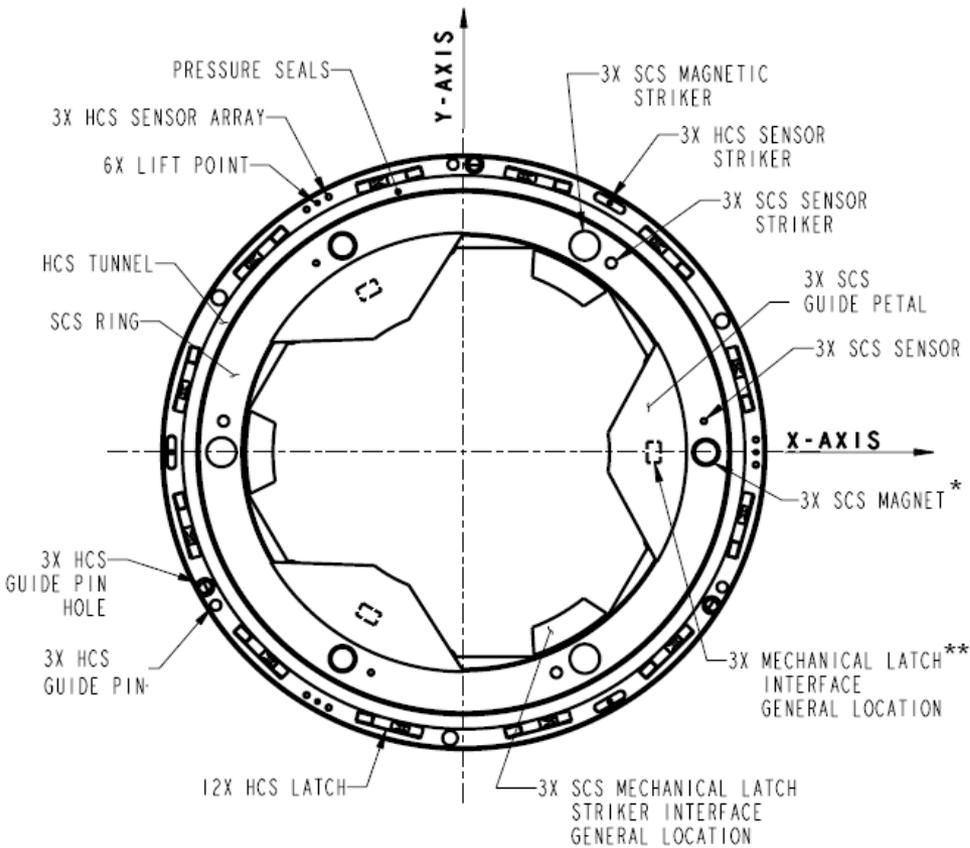


- ◆ Configuration Baseline Description
 - IDSS IDD Rev A does not specify a coordinate system. NDS IDD coordinate system does not meet classical approach for structures or GN&C. Update NDS IDD to have two coordinate systems with the classical approach.
 - See following charts for recommended coordinate system change
- ◆ Approval: DSIP 6/1/11
- ◆ Incorporation: Pending NDS IDD Rev E and tunnel drawing revision

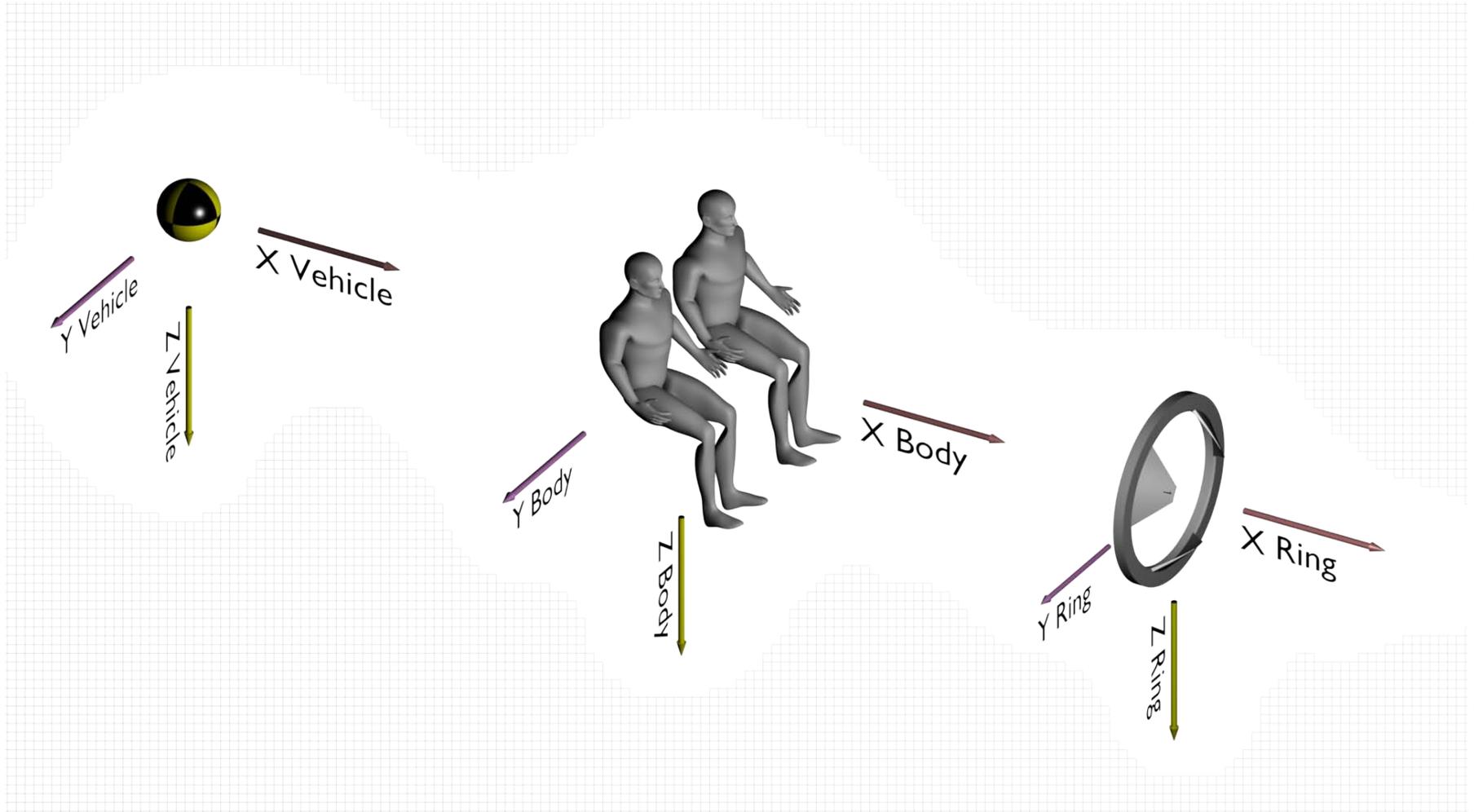
Return to [NDS Interface Change Summary](#)

Structural Coordinate System*

Capture Coordinate System*



*View shown is from Rev A of NDS IDD, hence some features or not up-to-date

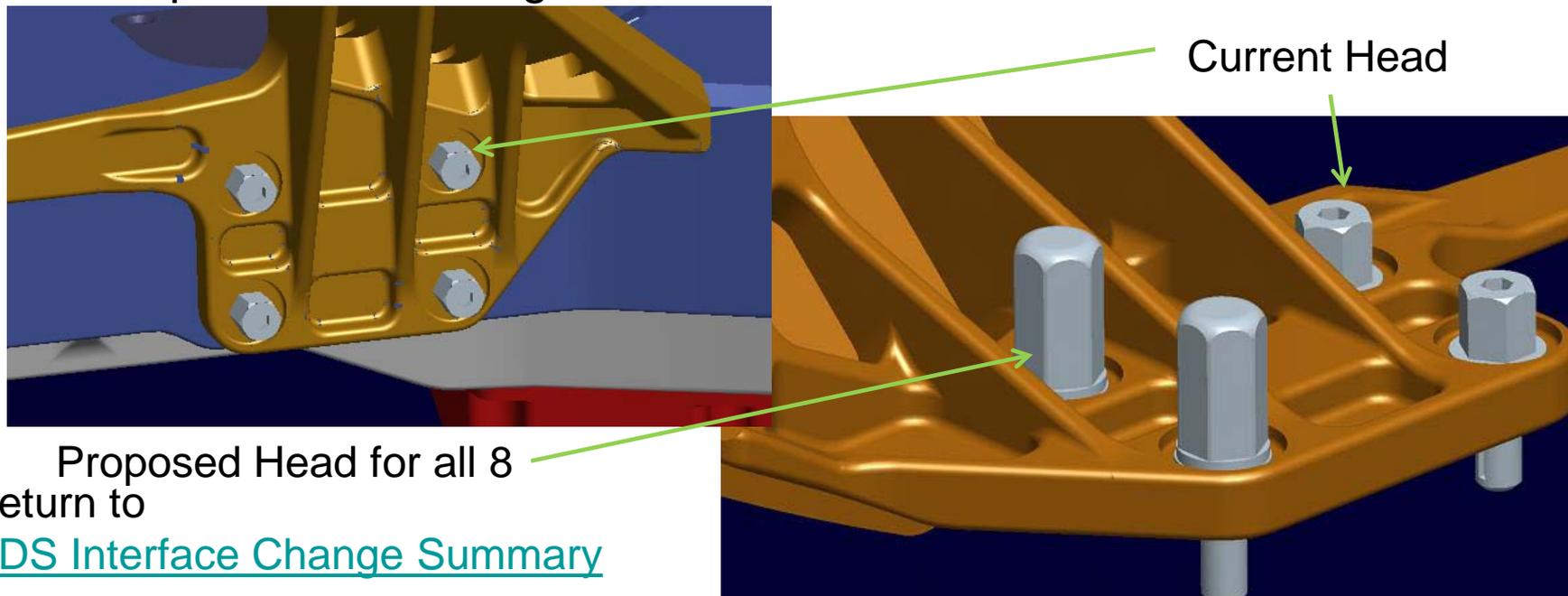


Return to [NDS Interface Change Summary](#)



- ◆ Configuration Baseline Description
 - Added R.LIDS.6060 to Section 7 NDS IDD
 - The vehicle supplying umbilical power shall remove power from the umbilical connectors prior to mating or de-mating the connectors to prevent damage to the connector
 - This is to ensure we are in compliance with JPR8080.5 Standard No. E-9 Electrical Circuits – De-energizing Requirement at the integrated level
 - Spacecraft electrical systems shall be designed so that all necessary mating and demating of connectors can be accomplished without producing electrical arcs that will damage connector pins or ignite surrounding materials or vapors.
 - Unless connectors are specifically designed and approved for mating or demating in the existing environment under the loads being carried, they shall not be mated or demated until voltages have been removed from the powered side(s) of the connector.
 - If the circuit breakers and switches normally provided in the power distribution system of the spacecraft do not provide a satisfactory means of complying with the intent of this standard in all planned flight and ground test operations, additional circuit interruption capability shall be provided as required.
- ◆ Approval: Pending DSIP review
- ◆ Incorporation: Pending NDS IDD Rev E

- ◆ RID CDR-8, 21 and 22
 - Guide Petals are IVA removable. Although there is no requirement for EVA access, the crew requested and the board approved a design change to 7/16 double height hex.
 - Modified locking feature to support multiple removal cycles for ISS
 - Ensure fasteners are compatible with IVA tool box SEG33113668-301
 - Deleted specific IVA compatibility requirements from PTRS
- ◆ Approval: CDR Board 5/9/11
- ◆ Incorporation: Pending NDS IDD Rev E



Proposed Head for all 8
Return to
[NDS Interface Change Summary](#)



- ◆ RID CDR-266
 - IDD does not specify wobble angle during capture. Update IDD to include wobble angle corresponding to required capture performance.
 - Add software setting that will allow host to minimize the wobble angle in the event there is a reduced clearance when the vehicles dock (e.g. a winged vehicle docking to ISS)
 - NOTE: Reduction of the wobble angle also results in reduced capture performance for the same initial conditions. Hence the vehicle may have to hit a tighter box to achieve the same capture performance
- ◆ Approval: CDR Board 5/9/11
- ◆ Incorporation: Pending NDS IDD Rev E

Return to [Host Interface Change Summary](#)



Host Interface Configuration Change: CDR-348



- ◆ RID CDR-348
 - Current switchover time of 120 ms is too restrictive
 - NDS will perform a sensitive analysis and determine how much this value can be increased and still meet capture performance requirements
- ◆ Approval: CDR Board 5/9/11
- ◆ Incorporation: Pending NDS IDD Rev E

Return to [Host Integration Section 7 Change Summary](#)



- ◆ Description:
 - In previous reviews, the requirement, R.LIDS.0006 Terminate docking command, was deleted because it was redundant with the Pause Undocking command which allows docking to be paused at any time and hold position until docking is resumed.
 - However, during review of operational concepts, it was noted that depending on the reason for the pause, it may be some time if ever before the docking is resumed.
 - Therefore it was decided to add the Terminate Command which will return the docking system to stowed and locked state
 - Refer to Action CDR-2 reviewed during LCCP 5/25/11
- ◆ Approval: CDR Board
- ◆ Incorporation: Pending PTRS Rev F

Return to [Host Interface Change Summary](#)



SE&I RID/Comment Overview



- ◆ All TBD/TBR's planned to be resolved by 08/2011

Doc No.	Doc Title	Pre-CDR State Rev #	RIDs	Comments	Post-CDR RID/Comment Incorporation Draft/Rev Date	Post-CDR State Rev.
JSC 65795	NDS IDD	D	33	5	8/15/11	E
JSC 63686	PTRS	E	0	9	8/15/11	F

NDS IDD JSC 65795	Approve+Approve W/Mod	Withdraw	Take to Board
RID	27	2	4
Comment	5	0	0

iLIDS VD JSC 63966	Approve+Approve W/Mod	Withdraw	Take to Board
RID	9	0	1
Comment	31	3	0

- ◆ Note: PTRS was non-RIDable, received comments only



SE&I TBD/TBR Burn Down Plan



TBD #	Title	Planned Closure Date	Comments	IDD	PTRS
TBD-2	Mass Properties – NDS (-304)	8/1/2011	New post BR configuration: Not to exceed masses established for all configs but mass properties will remain TBD until ESCG is officially on contract to work these configs	X	X
TBR-40	Pyrotechnic Interface Androgynous NDS (timing)	Waiting on Boeing	3/1/11: Pyrotechnic architecture under review by Boeing. Value to remain TBR until new architecture is defined. Rev C Note: 150 milliseconds chosen based on APAS Procurement spec. Review firing of single gang. Provide timing for pyro release. Need to assess how fast we need the pyro's fired in order to avoid jamming. NSI's capable of supporting a minimum of 5 milliseconds.	X	
TBR-44	NDS-to-Host Vehicle, Host Interface Requirements	7/1/2011	Decided Warm up time was beneficial. However no analysis has been done to determine how long is required. Further, if NDS is already warm, a 30 minute warm up may be detrimental. Jerry to capture in Thermal Data Book range of RTD temperatures. Consider whether an ops rule is written based on RTD temperatures or whether the vehicle has a requirements	X	



Electrical TBD/TBR Burn Down Plan



TBD #	Title	Planned Closure Date	Comments	JSC-66103 Control Plan for Complex Electronics	JSC-64598 Ionizing Radiation Control Plan
TBD-61	Maintenance Releases	9/1/2011		X	
TBD-62	Maintenance Versioning	9/1/2011		X	
TBD-63	Visualization of Delivery Plan	9/1/2011		X	
TBD-64	Forward Plans	9/1/2011		X	
TBD-65	Calculate the MTBFI	10/31/2011			X



S/W TBD/TBR Burn Down Plan



TBD number	Description	Planned Closure Date
67	1. Update MIL-STD-1553 host interface for commanding NDS. Current interface is based on ISS protocols. With latest architecture for docking systems on ISS that do not communicate to ISS, it may be better to use a more generic set of protocols.	6/30/2011
81	Update appendix D spreadsheet with 2 undocking complete sensors. Decide if NDS IDD should be rewritten based on current MML philosophy vs. MSID/HS Packet list in IDD	5/30/2011
45	Update Appendix C - NDS Commands List TBDs	8/1/2011



Dynamics TBD/TBR Burn Down Plan



TBD number	Description	Planned Closure Date
TBD-60	Need to decide what failures and faults should be included in the analysis to verify the unique dynamics requirements. Requires detailed discussions with Travis and the FDIR team, and additional analysis of failure signatures.	8/31/2011 change to TBR to be closed 05/01/2012
TBR-41	Confirm RTD extension is adequate to cover all classes of vehicle masses through analysis using test correlated dynamics model and simulation.	10/15/2011
TBD-46	Confirm PCT requirement for host vehicles through analysis using test correlated dynamics model and simulation.	10/15/2011
TBR-54a/b	Verify passive host vehicle transition to free-drift timing requirement. Discuss requirement with vehicle experts and perform analysis to determine an appropriate timing requirement.	08/01/2011