SUV/Module ECLSS

Cargo, Habitat, Crew

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Requirements and Capabilities

"Everything that we're doing in this vehicle is transferable to a future crewed vehicle. We actually think we're enhancing it and accelerating that crew capability."

-Mark Sirangelo, March 17th, 2015

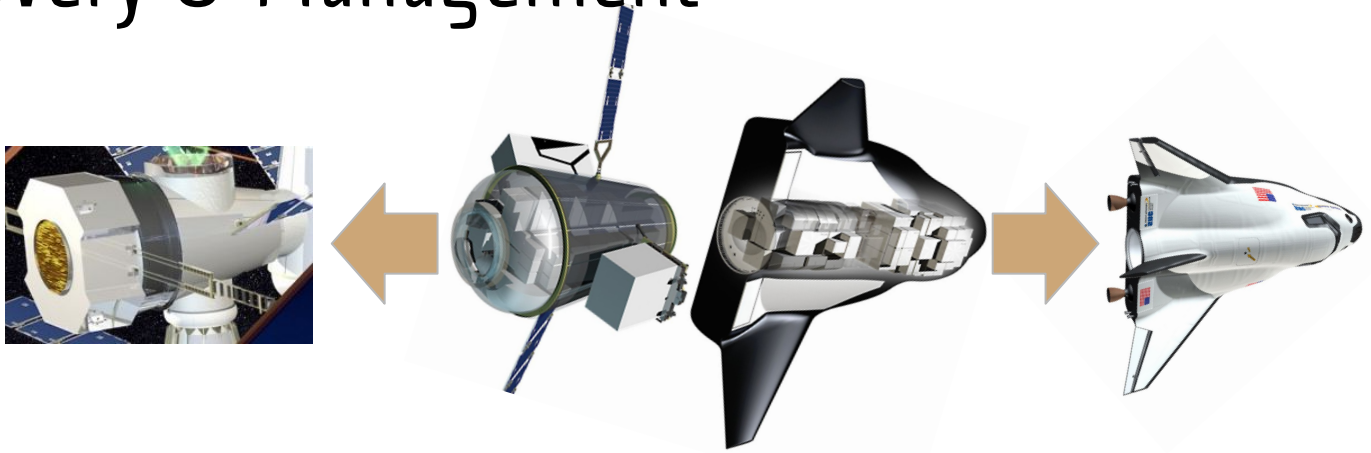
"ORBITEC's impressive performance as our partner on the Dream Chaser program for ECLSS demonstrates their strong capability to deliver human spaceflight qualified hardware."

-Mark Sirangelo, June 19th, 2014

General ECLSS Key Performance Indicators

- Cost to development and sustain
- Crew time required to train, operate, maintain, or repair
- MTBF
- MTBR
- Mass
- Volume
- Power
- Noise
- Capacity

Water Recovery & Management

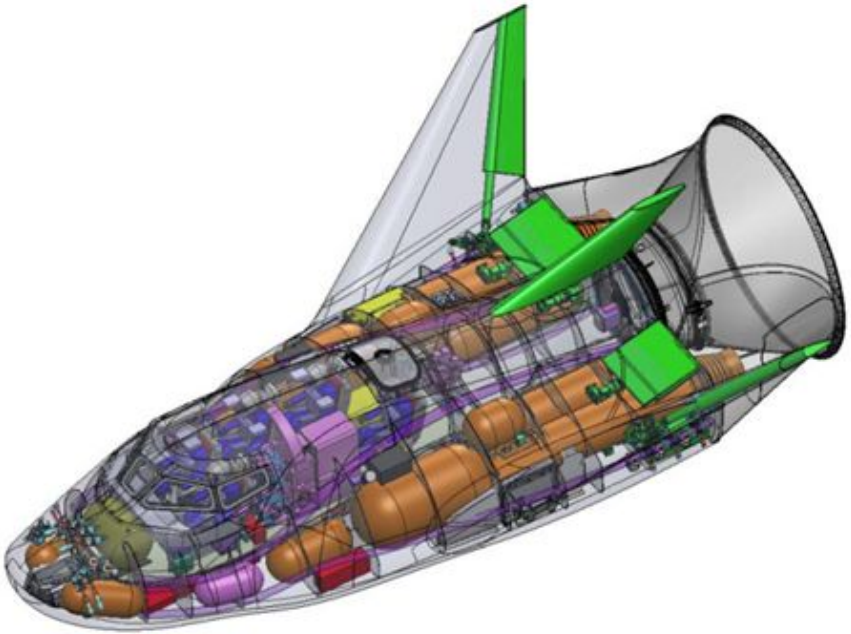


	NEXTStep-2	CRS2		
	Habitat Module	Cargo Module	Cargo SUV	Crew SUV
H2O Storage-Potable*	Required	Not required but benefits ISS	Not required but benefits ISS	Required
H2O from Dehumidification*	Required	Not required	Scar structure for the future	Required
H2O Storage-Waste/Urine/Brine	Required	Not required but benefits ISS	Not required but benefits ISS	Required
Urine Capture	Required	Not required	Scar structure for the future	Required

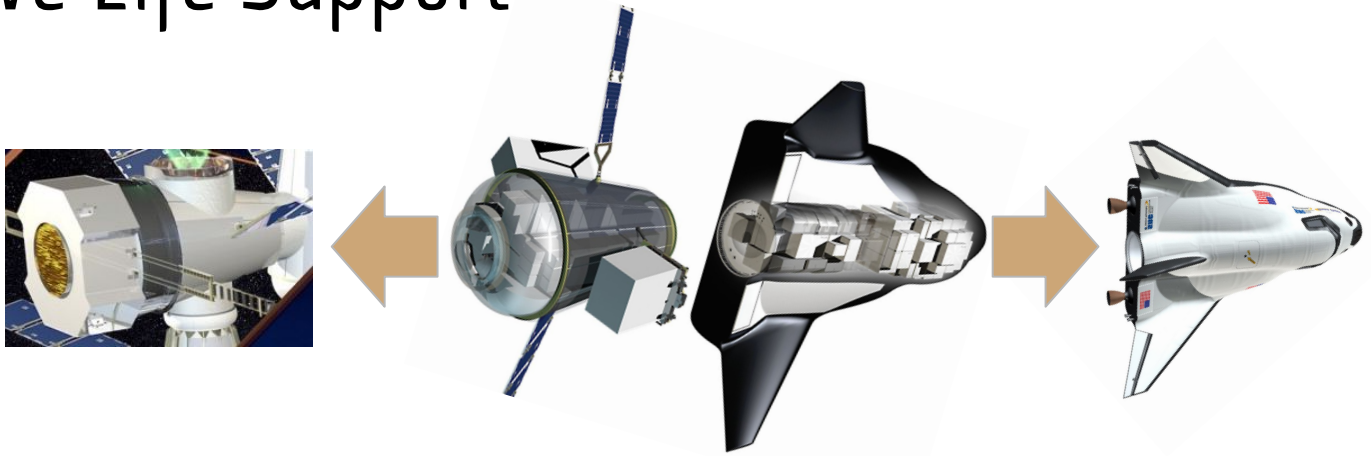
*Orbitec's silver biocide is incompatible with current USOS Iodine biocide, but NASA is actively investing in the transition of USOS to silver

Liquid and Gas Tanks Outside Pressure Vessel

Fluid and gas tanks may be located outside pressure vessel to save space



Regenerative Life Support



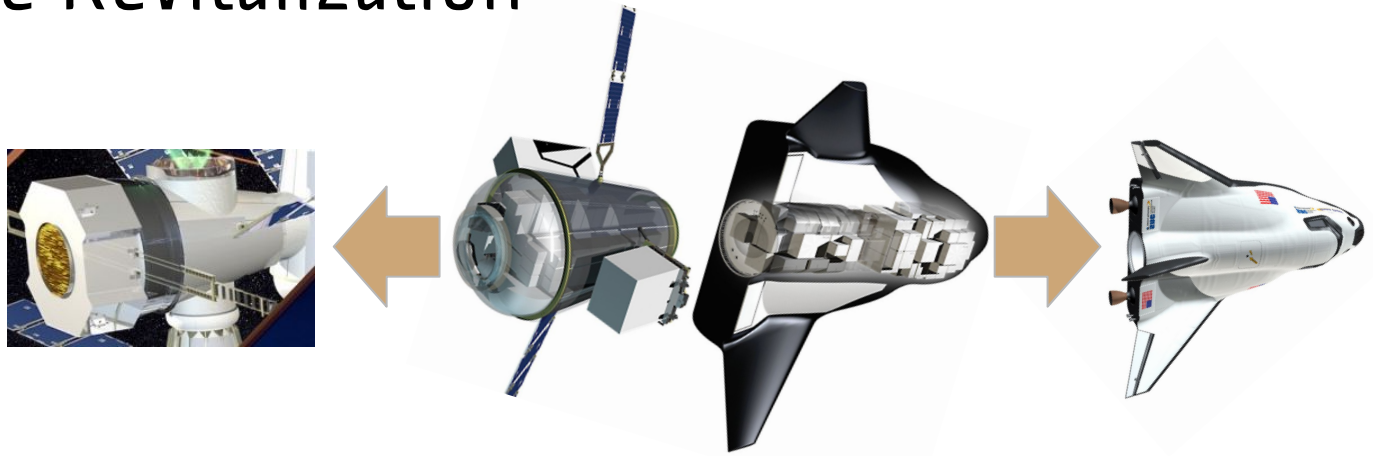
	NEXTStep-2	CRS2		
	Habitat Module	Cargo Module	Cargo SUV	Crew SUV
H2 + O2: H2O (Electrolysis) ORBITEC	Required	Not required	Not required	Not required
H2 & CO2 Storage	Required	Not required	Not required	Not required
H2O from CO2+H2 (Sabatier)	Required	Not required	Not required	Not required
H2O Purification* ORBITEC	Required	Not required	Not required	Not required
H2O + Brine from Urine ORBITEC	Required	Not required	Not required	Not required

*Orbitec's silver biocide is incompatible with current USOS Iodine biocide, but NASA is actively investing in the transition of USOS to silver

Atmosphere Control and Supply

	NEXTStep-2	CRS2		
	Habitat Module	Cargo Module	Cargo SUV	Crew SUV
O2 Storage/Supply	Required	Not required but benefits ISS	Not required but benefits ISS	Required
N2 Storage/Supply	Required	Not required but benefits ISS	Not required but benefits ISS	Required
O2 Repressurization: 3000 PSI EMU	Required	Not required	Not required	Not required
Positive Pressure Relief	Required	Required	Required	Required
Negative Pressure Relief	Not required	Not required	Required	Required

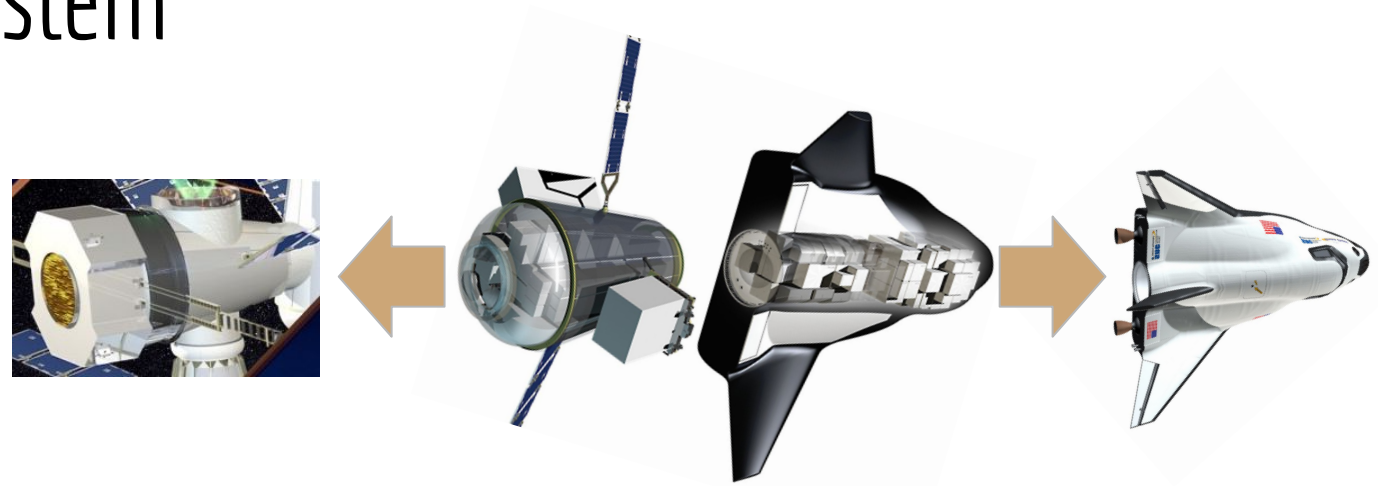
Atmosphere Revitalization



	NEXTStep-2	CRS2		
	Habitat Module	Cargo Module	Cargo SUV	Crew SUV
Inter Module Ventilation	Required	Required	Required	Required for docked ops
Intra Module Ventilation	Required	Required	Required	Required
Maintain Temperature	Required	Required	Required	Required
CO2 Capture	Required	Not required	Scar structure for the future	Required
Monitor Environment*	TC Required	Not required	Scar structure for the future	Required
Trace Contaminant Removal	Required	Not required	Scar structure for the future	Required

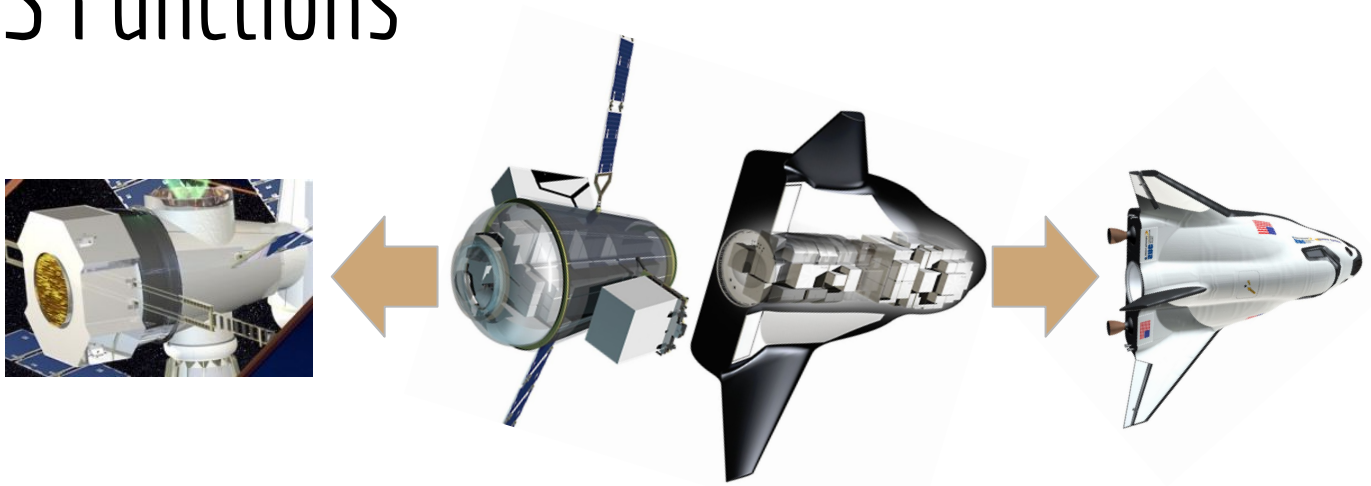
*Monitoring two-chambered docked craft may require sample line to ISS MCA; this may preclude PMA docking w/o onboard MCA. JPL's "Spacecraft Atmosphere Monitor" SDR was 4/8/2016

Vacuum System



	NEXTStep-2	CRS2		
	Habitat Module	Cargo Module	Cargo SUV	Crew SUV
Cabin Pressure Regulation	Required	Required	Required	Required
CO2 Vent	Not required	Not required	Not required	Not required
H2 Vent	Not required	Not required	Not required	Not required
CH4 Vent	Required	Scar for the Future	Not required	Not required
H2O/Urine/Brine Vent	Not required	Not required	Not required	Not required

Other ECLSS Functions



	NEXTStep-2	CRS2		
	Habitat Module	Cargo Module	Cargo SUV	Crew SUV
Air Particulate/Microbial Filtering	Required	Not required but benefits ISS	Not required but benefits ISS	Required
Metabolic Waste Capture/Storage*	Required	Not required	Not required but benefits NASA	Required
Fire Detection & Suppressior	Required	Required	Required	Required
Portable Breathing Apparatu	Required	Not required	Not required but benefits ISS	Required

*United Technologies Corporation Universal Waste Management System (UWMS) SN01 slated for ISS testing in 2018. SN02 is slated for MPCV EM-2

HEPA Particulate and Microbial Filters

- Ground stock contain abundant HEPA filter spares that will never be used
- ISS now transitions to Polydimethysiloxane-scrubbing Carbon “CHEPA”s
- NEXTStep might use legacy CABFHs, HEPAs, or CHEPA filters
- CRS2 SUV might use ISS filters & then transfer them to ISS before undock
    - MPLM IMV fans were transferred at end of shuttle missions to ISS

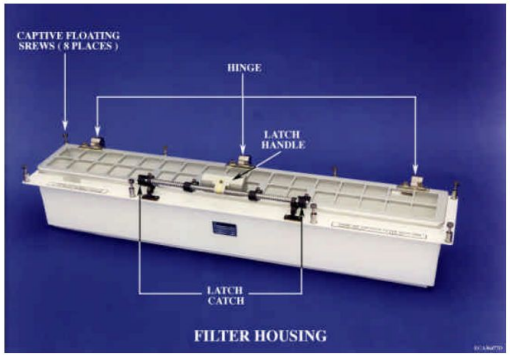


Figure 3.1 Cabin Air Bacteria Filter Housing

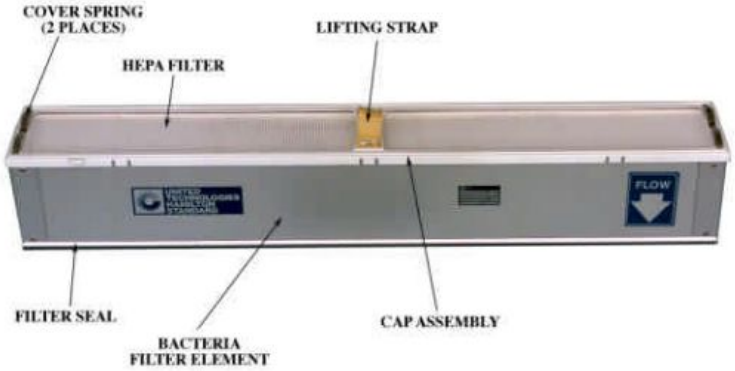


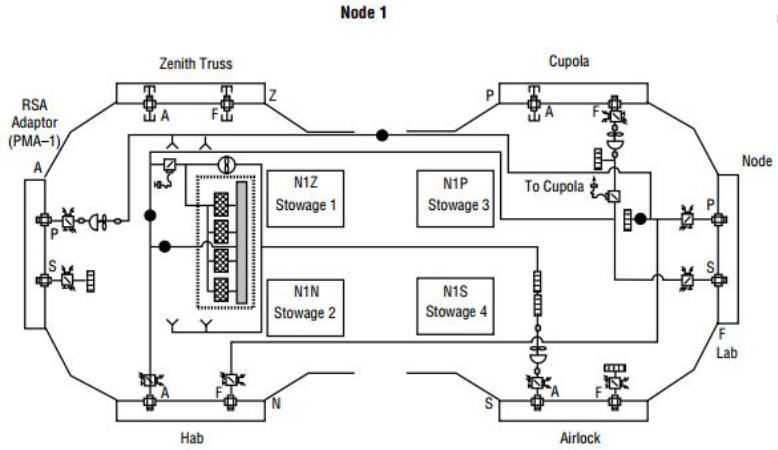
Figure 6 Final assembly of new Charcoal Filters at KSC

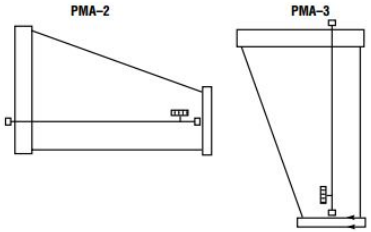
Interfaces

IMV Interface at Docking & Berthing ports

Node 2 IMV Modified 2015 for PMA3 relocation to Zenith

Node 1 Nadir has already supported MPLM and PMM IMV





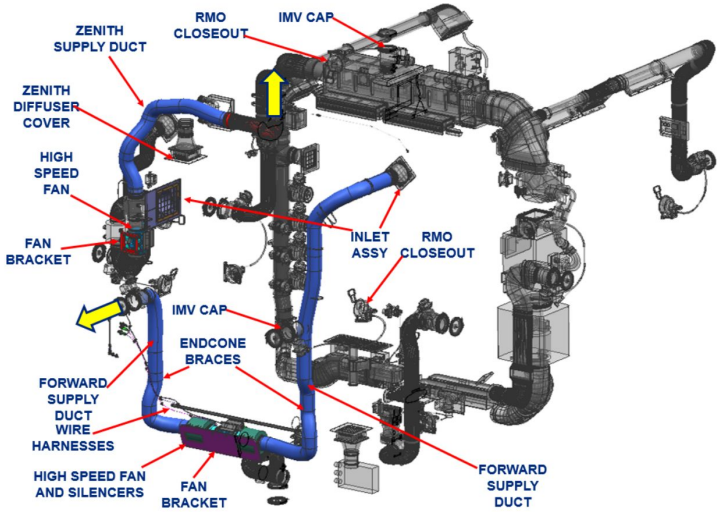
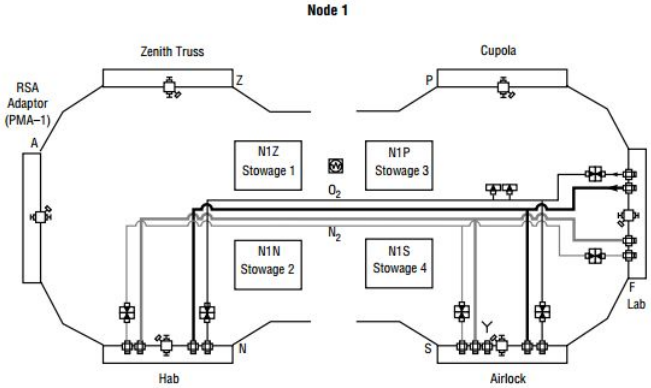


Figure 3 Node 2 Inter-Module Ventilation Hardware Modifications

IMV Interface: CBM and IDSS(PMA)

ISS N2/O2 Plumbing



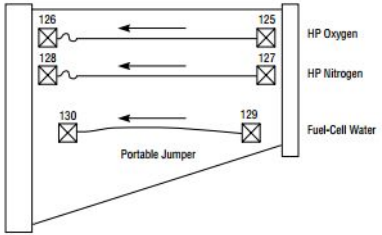
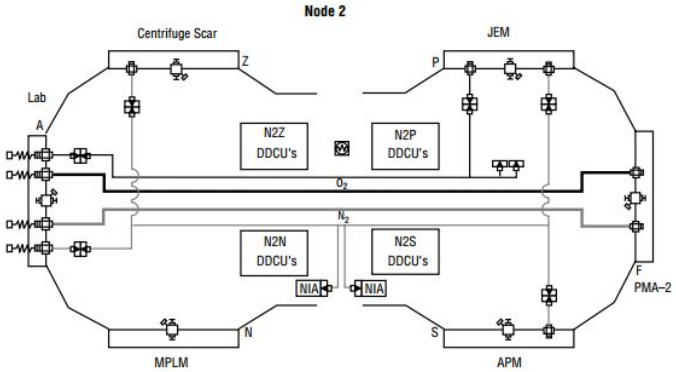
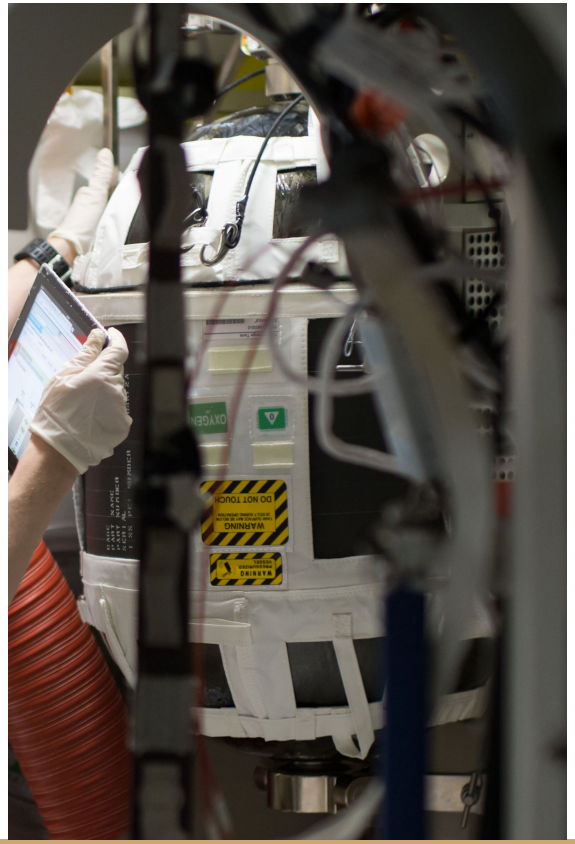
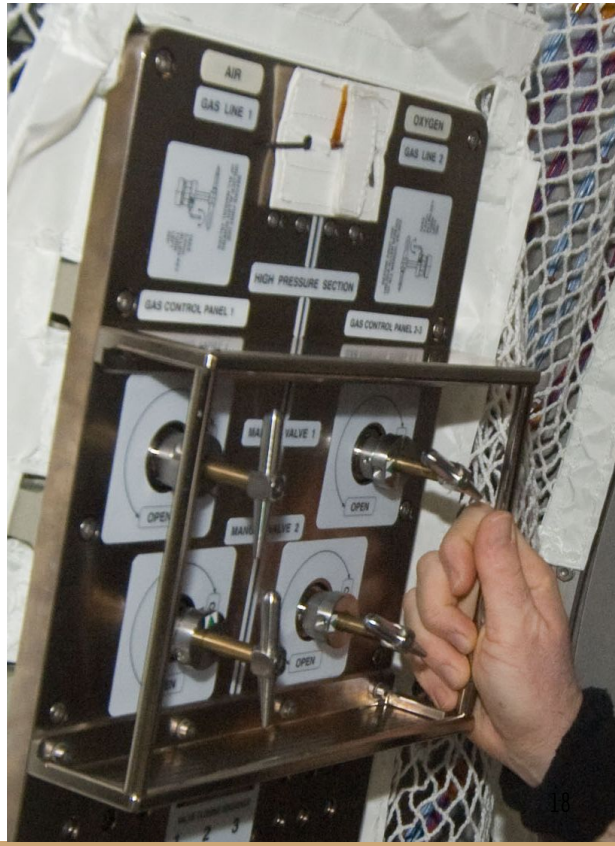


FIGURE 24.—ECLS interconnections through PMA–2 and PMA–3.

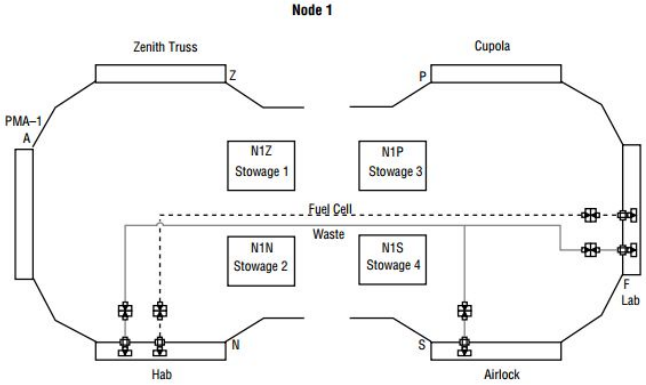


N2/O2 Interface: Plumbed, Portable, or Direct





ISS H2O Plumbing



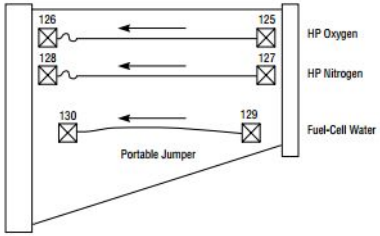
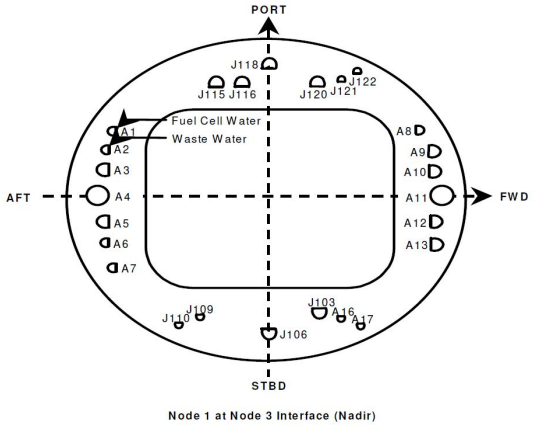
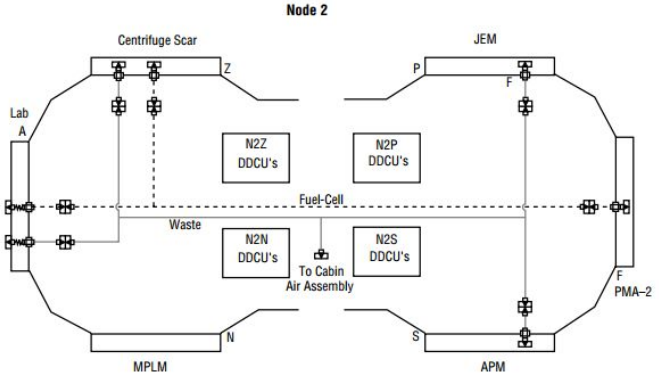


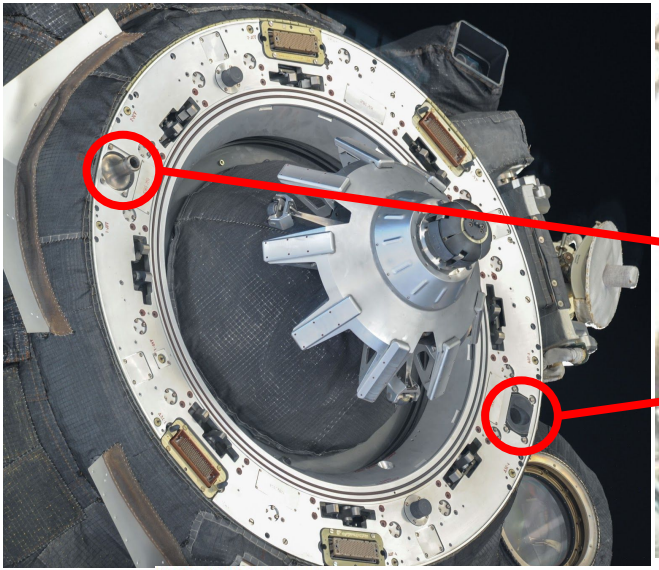
FIGURE 24.—ECLS interconnections through PMA–2 and PMA–3.

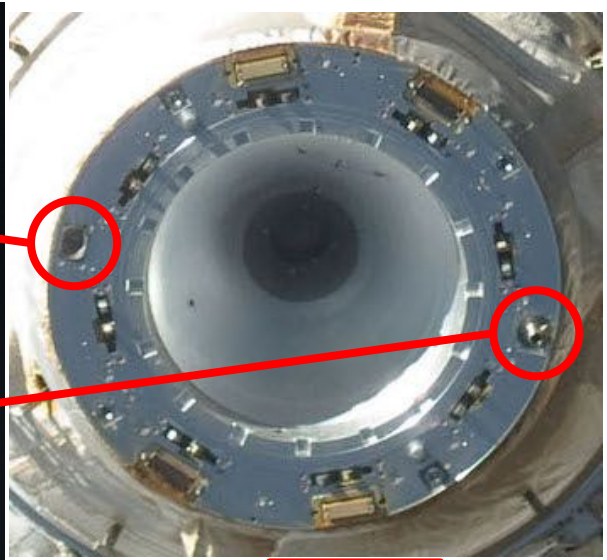




(Waste)Water: Int/Ext Plumbed, Portable, or Direct

Docked Fluid Transfer: RDS Present & IDSS Future





IDSS IDD Revision D
April 30, 2015

3.4 RESOURCE TRANSFER UMBILICALS

The IDSS umbilical connectors transfer resources between two docked vehicles. Currently, connectors are only defined to transfer power, data, and a ground safety wire. Future revisions of this IDD may add other resources such as water source and water return capability, fuel, tank pressurization, and oxidizer transfer capability. All umbilical connectors shall be mechanized such that they are recessed below the docking mating

3.4.2 WATER TRANSFER

Reserved

3.4.3 FUEL TRANSFER

Reserved

3.4.4 PRESSURANT TRANSFER

Reserved

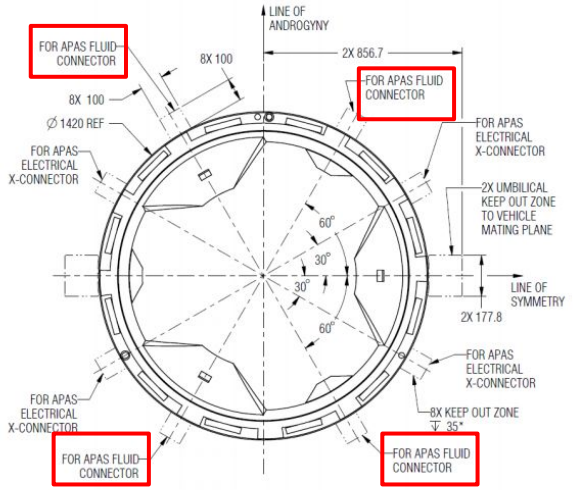
3.4.5 OXIDIZER TRANSFER

Reserved

3.5 DOCKING NAVIGATION AIDS

The IDSS includes three different types of target systems t
in Figure 3.5-1, IDSS Target Systems: the Perimeter Reflec

IDSS IDD Revision D
April 30, 2015



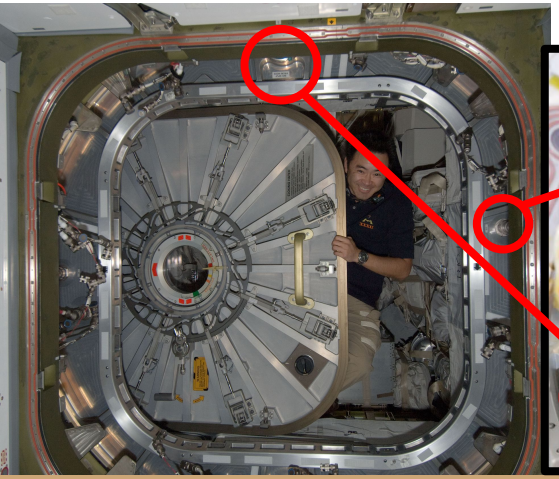
* The KOZ extends 35 mm below the HCS Mating Plane as a minimum. This depth is to accommodate the protrusion of 30mm of connectors on legacy systems.

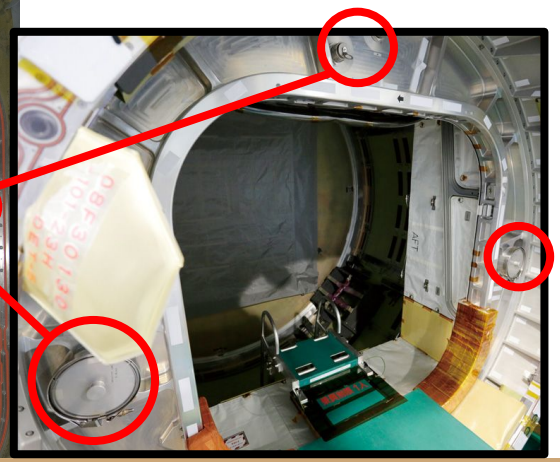
FIGURE 3.4-1 UMBILICAL CONNECTOR KEEP-OUT ZONES

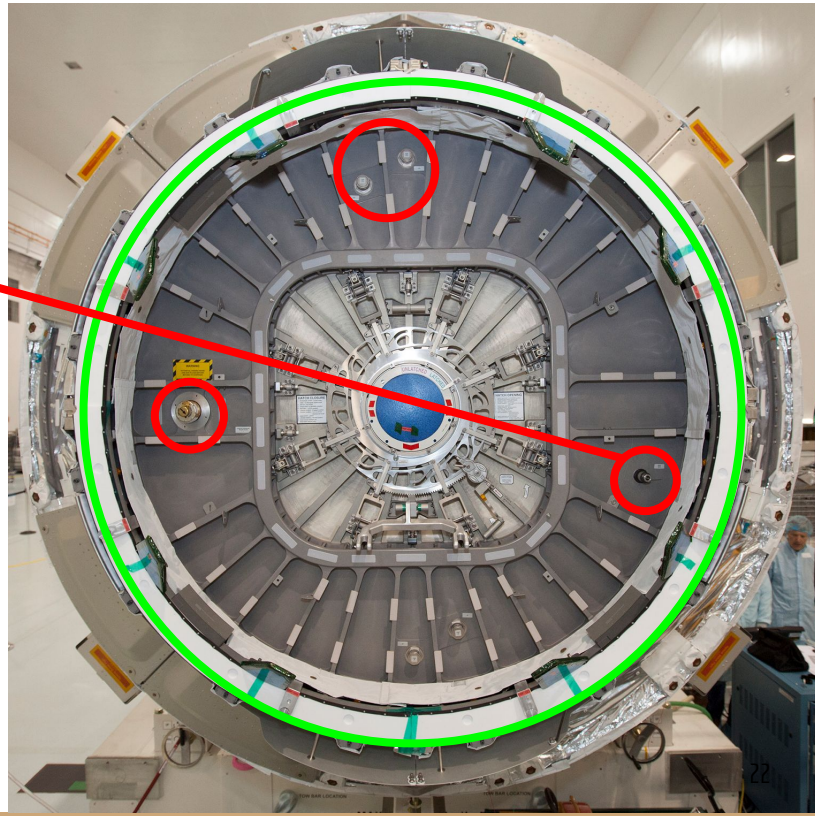
HTV and Cygnus Vestibule Bulkheads

Could cargo module have common bulkhead for CBM and IBDM version?

Will air sample port be required?





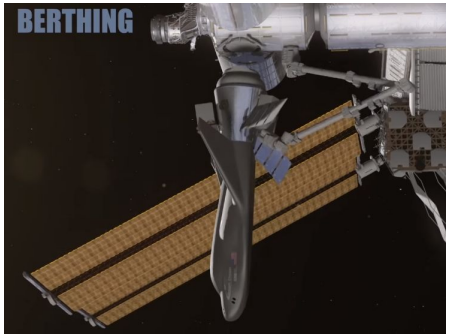


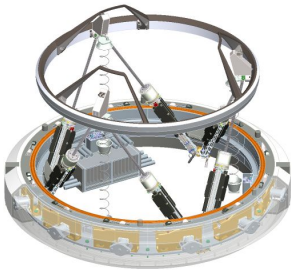
Backup

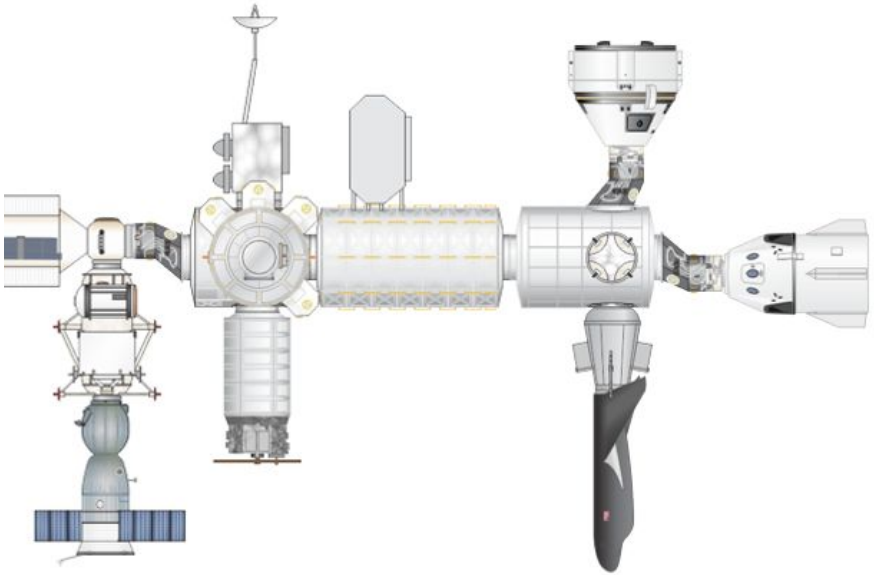
Docking (IBDM+IDA) vs Birthing(CBM)

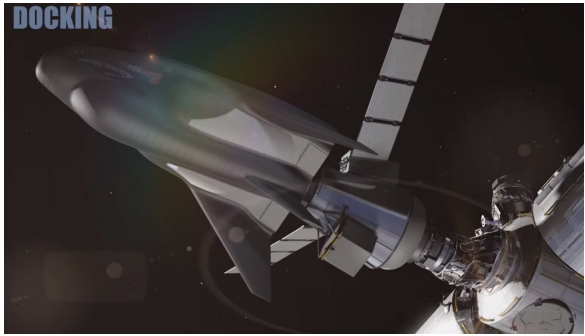
CRS2 NASA has asked cargo providers to provide an options for docking

SNC must consider special atmospheric monitoring considerations for docking

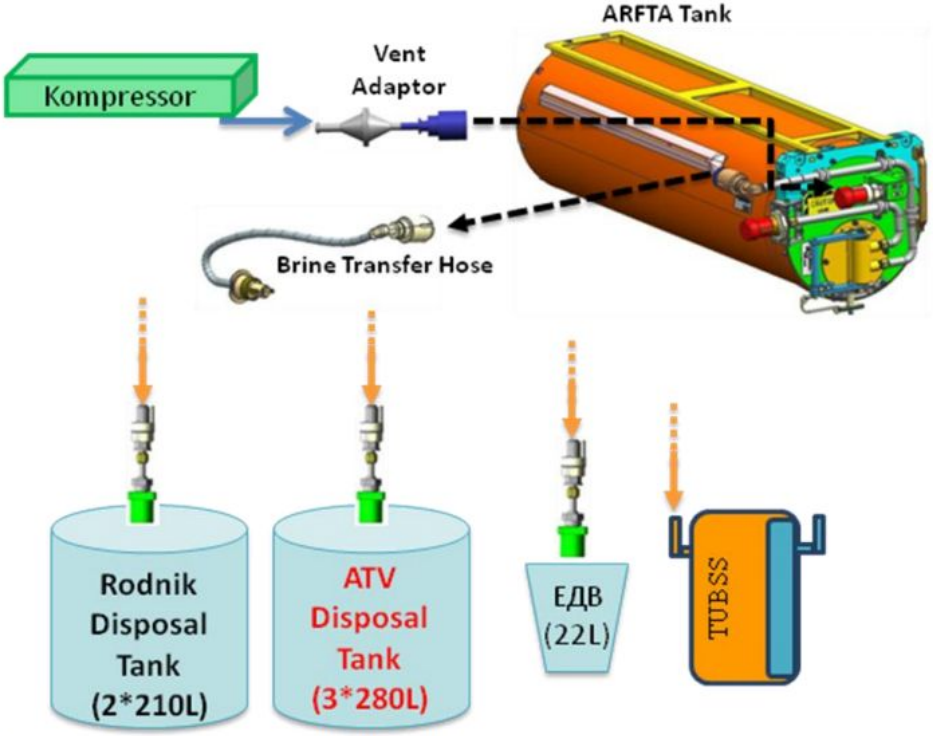






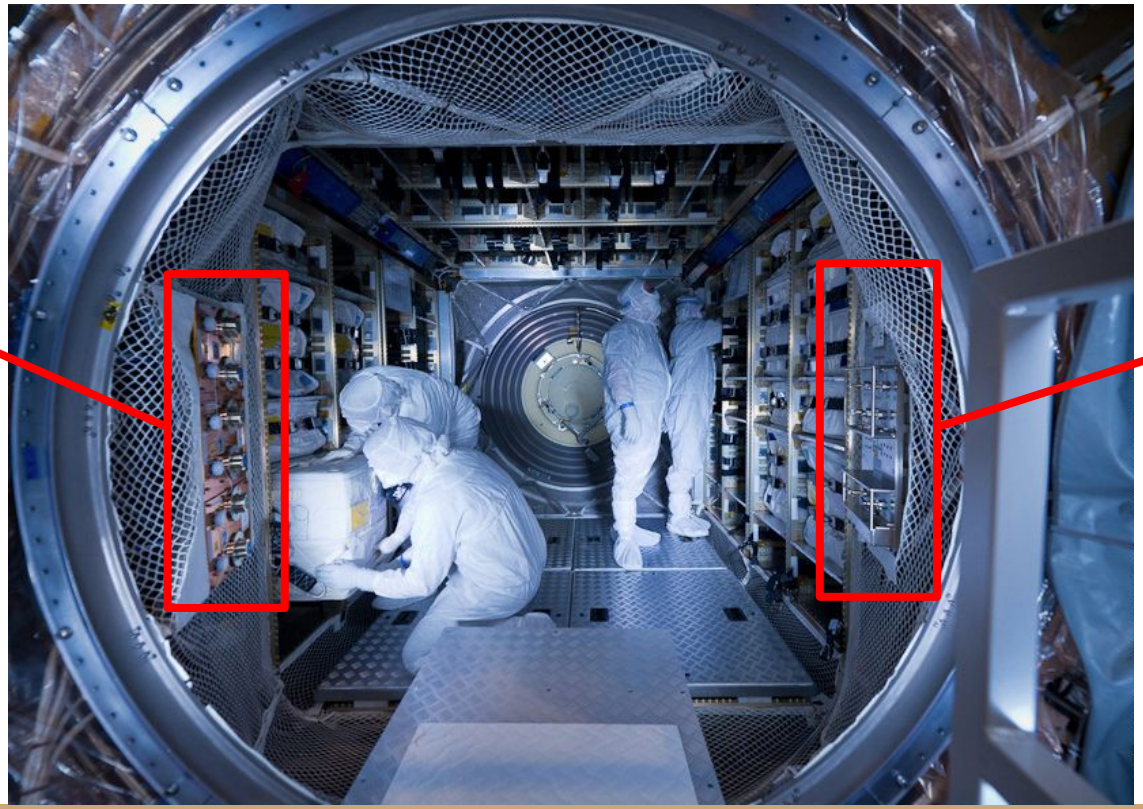


Progress, HTV deliver water and Receive Brine



ESA ATV: Water and Gas Crew Interfaces

(Waste)/Water Interface



Air & O2 Panel

Short Term Crewed Metabolic Waste Handling

SSP 50481
Revision B

OPS NOM: CUCD	ASSY P/N: 10108-10076-05
Description: Used as a contingency bag for liquid human waste	Material:
Dimensions (Launch): 6.5 in. x 4.75 in. x 0.25 in. / 16.5 cm x 12.1 cm x 0.6 cm	Dimensions (In Use/Full): 13.5 in. x 19 in. x 0.125 in. / 34.3 cm x 48.3 cm x 0.3 cm
Usable Volume: 0.009 CTBE / 525.41 cm	Unit Mass: 0.07 lbs / 0.032 kg
Unit Mass (STD/Full):	Special Requirements (Yes/No):
Assembly Required: No	Limited Life: No
Certified for use in all ISS:	Acceptability for Hazardous Waste:
Launch Stowage Method:	Progress Removal Stowage Method:
MPLM Removal Stowage Method:	Middeck Removal Stowage Method:

FIGURE D-11 CONTINGENCY URINE COLLECTION DEVICE

SSP 50481
Revision B

OPS NOM: Fecal Collection Assembly (Apollo Bag)	ASSY P/N: 10108-10045-01
Description: Used as a contingency bag for solid human waste	Material:
Dimensions (Launch): Folded fecal and storage bag combined 7.5 in. x 4 in. x 0.375 in. / 19.1 cm x 10.2 cm x 0.9 cm	Dimensions (In Use): unfolded fecal bag with flange seal 7.5 in. x 12 in. x 0.12 in. / 19.1 cm x 30.5 cm x 0.3 cm Dimensions (Full): unfolded storage bag for used fecal bag 7.5 in. x 14 in. x 0.12 in. / 19.1 cm x 35.6 cm x 0.3 cm
Usable Volume: 0.004 CTBE / 206.477 cm	Unit Mass: 0.13 lbs / 0.059 kg
Unit Mass (STD/Full):	Special Requirements (Yes/No):
Assembly Required: No	Limited Life:
Certified for use in all ISS: Yes	Acceptability for Hazardous Waste:
Launch Stowage Method:	Progress Removal Stowage Method:
MPLM Removal Stowage Method:	Middeck Removal Stowage Method:

FIGURE D-10 APOLLO BAG

IMV pressure loss w/ crewed docked dreamchaser

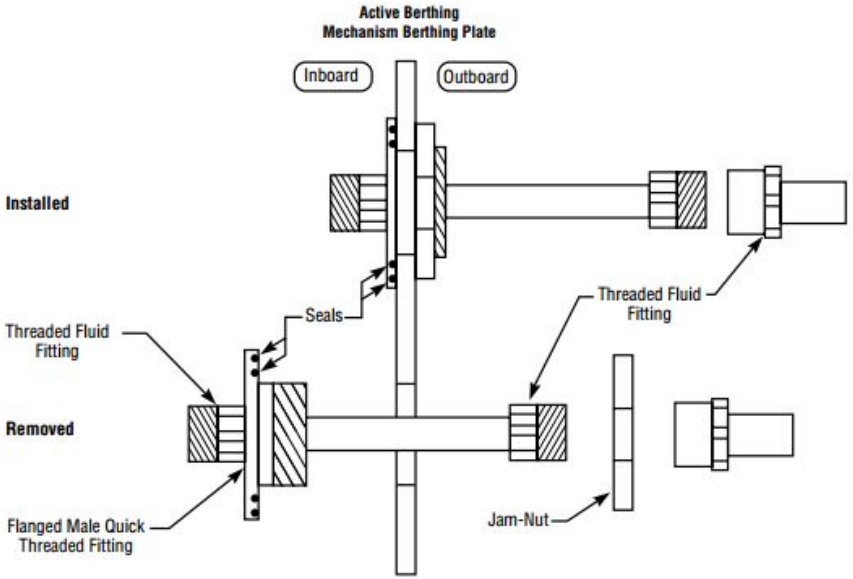
Table 1: Pressure Loss Due to Each Element in the Node 2 Forward IMV System

Component	Delta P (Pa)	Delta P (inches H2O)
Inlet screen	39.81	0.16
Reducer	2.49	0.01
Flex duct with two 90° and one 45° bend	12.44	0.05
Silencer	92.07	0.37
Silencer	92.07	0.37
Flex duct with two 90°	7.47	0.03
IMV Valve	19.91	0.08
PMA and IDA ducting	37.33	0.15
Total Delta P	301.10	1.21
With 15% design margin	**345.89**	**1.39**

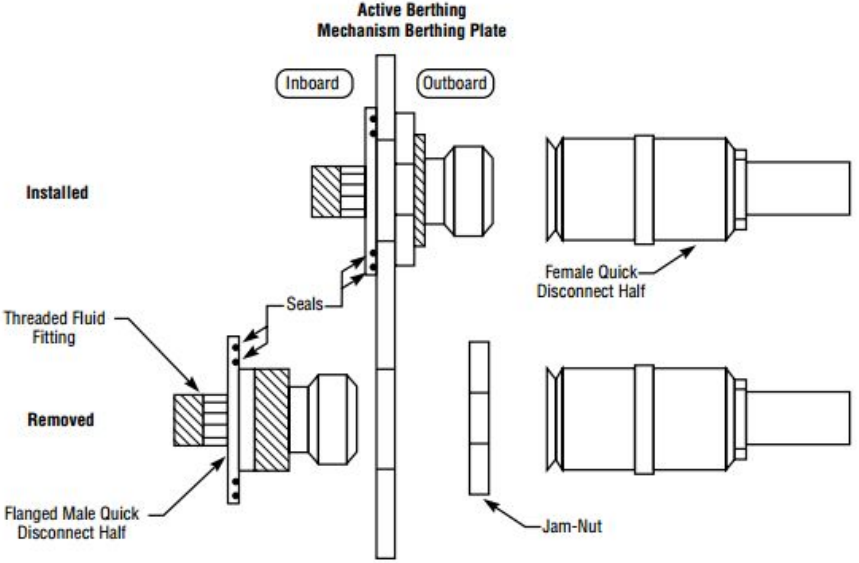
Table 2: Pressure Loss Due to Each Element in the Node 2 Zenith IMV Sys

Component	Delta P (Pa)	Delta P (inches H2O)
Inlet screen	17.42	0.07
Reducer	2.49	0.01
Coupling and Bend	2.49	0.01
Silencer	92.08	0.37
U-Bend	7.47	0.03
Silencer	92.08	0.37
90° Bend	9.95	0.04
IMV Valve	19.91	0.08
PMA and IDA ducting	37.33	0.15
Total Delta P	278.71	1.12
With 15% design margin	**321.00**	**1.29**

ISS Module Bulkhead Fluid Interface



(A): Threaded Fluid Fitting Feedthrough



(B): Self-Sealing Quick Disconnect Feedthrough

FIGURE 25.—USOS vestibule fluid connectors.

Paradigms of ISS Modularity and Maintainability

Tradeoffs of upmass, crew training, and system availability

Rack

ORU

Component

Flow Meter With Telemetry

“CWCs do not have quantity indicators, therefore, when the container is filled and subsequently used, the ground controllers rely on the crew to determine how much fluid is left in the bag. This is not a very precise or accurate measurement. This uncertainty increases the risk of overfilling the CWCs and results in the need to purposefully underfill them. Underfilling the bags is necessary to prevent damage and leakage to the CWCs but means less available space to store water.”

“There is no quantity indicator on this ЕДВ, and the quantity can only be estimated by a flush counter that must be reported manually by the crew.”

http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20110012703.pdf

https://hydrofarm.com/p/LGP0550

SpaceX IMV Drag Through Hatch Opening