HTV-1 Mission Press Kit

September 9, 2009　Rev.A

Japan Aerospace Exploration Agency

Revision History

No.	Date	Page revised	Reason for the revision
NC	2009.9.2	−	
A	2009.9.9	P.2-2, P.2-3, P.2-9 to P.2-16	・ Launch time was rescheduled ・ HTV's flight timeline was changed
		P.2-23 to P.2-25	・ Small changes in descriptions of SMILES and HREP

Contents

This page is intentionally left blank

1. H-II Transfer Vehicle Overview

1.1 Summary

The H-II Transfer Vehicle (HTV), designed and built in Japan, is JAXA's unmanned cargo transfer spacecraft that delivers supplies to the International Space Station (ISS).

The HTV delivers up to 6,000 kg of cargo, both pressurized and unpressurized, to the ISS. While the HTV is berthed to the ISS, ISS crew can enter HTV's pressurized logistics carrier (see section 1.2.1) to transfer onboard supplies to the ISS. The ISS crew will also unload the unpressurized cargo using the station's robotic arm and Kibo's robotic arm. After the supplies are unloaded, the HTV will then be loaded with trash and other discarded items. Finally, the HTV will undock and depart from the ISS, and reenter the atmosphere.

The HTV maiden flight vehicle is scheduled to launch from the Tanegashima Space Center (TNSC) aboard the H-IIB launch vehicle in September 2009.

1.1.1 Objectives and Significance

The HTV has the following three primary objectives:

1. To fulfill Japan's role in the International Space Station (ISS) program

2. To demonstrate Japan's space engineering technologies

3. To accumulate Japan's own technologies and know-how on human spacecraft systems

The HTV is a masterpiece of Japan's space development, built on an integrated technology of Japan's own launch vehicle, satellite communication systems, and manned spaceflight systems.

1.1.2 Features

Currently, Russia's Progress spacecraft, the European Space Agency's (ESA's) Automated Transfer Vehicle (ATV), and NASA's space shuttle are delivering supplies to the ISS. The HTV features an extensive cargo transportation capability that can deliver both pressurized and unpressurized cargo at once. The HTV has the following features:

Cargo transfer capability

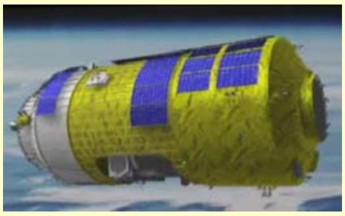
- The hatch of the HTV (a doorway to the ISS) is wide enough to transfer large pressurized experiment racks into the ISS
- HTV Unpressurized Logistics Carrier (ULC) enables accommodation of unpressurized payloads, including external experiments and orbital replacement units (ORUs) that are to be operated outside of the ISS

Unique rendezvous flight techniques

- HTV will fly to the ISS using Japan's unique rendezvous flight techniques (New rendezvous/berthing technology that uses the station's robotic arm and has never been performed)

Table 1.1.2-1 shows a comparison of resupply ships to the ISS (HTV, ATV, Progress, and the space shuttle).

Table 1.1.2-1 Comparison of Supply Vehicles to the ISS

Supply Vehicle	Weight	Up-mass Cargo Capacity	Launch Vehicle
HTV (Japan) 	16,000 kg	6,000 kg	H-IIB Launch Vehicle
ATV (ESA) 	20,500 kg	7,500 kg	Ariane V rocket (ES-ATV)
Progress (Russia) 	7,200 kg	2,500 kg	Soyuz -U
Space Shuttle (US) 	120,000 kg (Orbiter and Payloads)	14,000 kg	Space Shuttle

1.2 HTV Component

The H-II Transfer Vehicle (HTV) consists of a Pressurized Logistics Carrier (PLC), an Unpressurized Logistics Carrier (ULC), an Exposed Pallet (EP), an Avionics Module, and a Propulsion Module.

Cargo and supplies are loaded inside the PLC and on the EP, which is installed in the ULC.

Proximity Communication System (PROX) that enables wireless communications between the ISS and Laser Radar Reflector (LRR) for the HTV rendezvous sensor are installed on the Japanese Experiment Module, Kibo, and are to be used when the HTV arrives within the ISS proximity range.

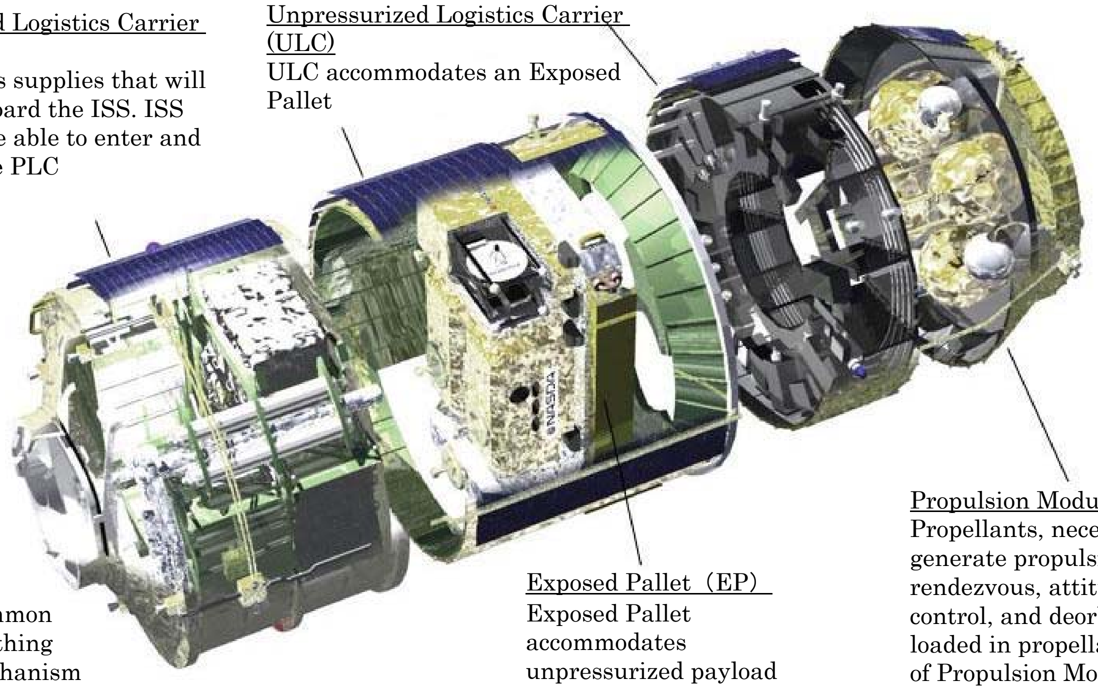


Fig. 1.2-1 HTV Configuration Diagram

Table 1.2-1 HTV Specifications

Items	Specifications	
Length	9.8 m (including the length of the main thruster)	
Diameter	4.4 m	
Mass (weight)	10,500 kg [11,500 kg*] (excluding cargo mass)	
Propellant	Fuel	MMH (Monomethylhydrazine) [Maximum loading: 918 kg*]
	Oxidizer	MON3 (Tetroxide) [Maximum loading: 1,514 kg*]
Cargo Capacity (For supplies)	6,000 kg [4,500 kg*]	
	<u>Pressurized carrier</u>: 4,500 kg [3,600 kg*] (Pressurized cargo, including, food, clothing, and potable water for crew, experiment racks, experiment equipments, which are used inside the ISS.)	
	<u>Unpressurized carrier</u>: 1,500 kg [900 kg*] (Unpressurized cargo, including exposed experiment equipment, consumables used outside the ISS)	
Cargo Capacity (For waste)	6,000 kg (Max.)	
Target Orbit to ISS	Altitude: 350 km to 460 km Inclination: 51.6 degrees	
Maximum Duration of a Mission	Solo flight: 100 hours Stand-by (on-orbit): More than a week Berthed operations: More than 30 days	

*Loading weight for the HTV-1 Mission only. HTV-1 Mission will bring additional propellant and batteries as it will perform demonstration tests during solo flight phase. Thus, cargo and supplies to be delivered to the ISS will be reduced by this extra propellant/battery mass.

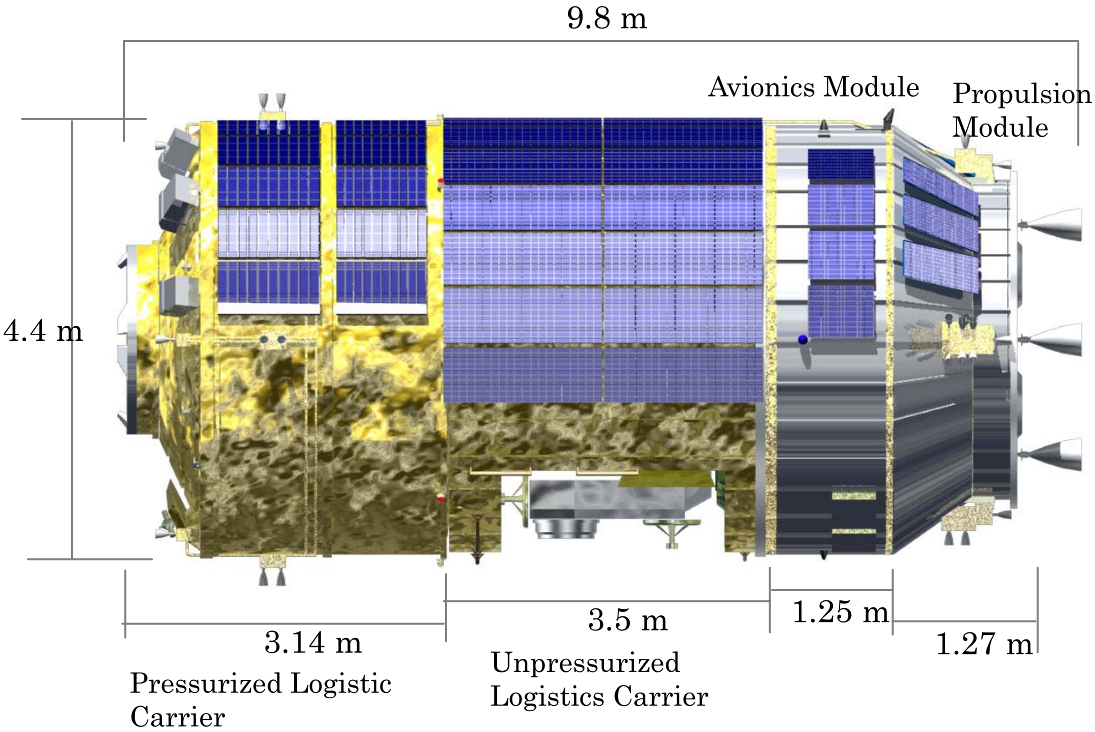


Fig. 1.2-2 HTV Dimensions

1.2.1 Pressurized Logistic Carrier (PLC)

The Pressurized Logistics Carrier (PLC) carries cargo for onboard use (experiment racks, food, and clothes). Internal air pressure of the PLC is maintained at one atmospheric pressure (1 atm). The temperature inside the HTV is controlled during its solo flight phase and berthing phase.

Once it is berthed to the ISS, internal air will be circulated between the PLC and Harmony (Node 2) through the Inter-Module Ventilation (IMV) system. The ISS crew will enter the PLC to unload the cargo transfer bags or science/system racks. After cargo unloading is complete, the HTV will then be loaded with trash and used materials. The PLC is equipped with the passive half of a Common Berthing Mechanism (CBM) for docking to the active half of the CBM on Harmony.

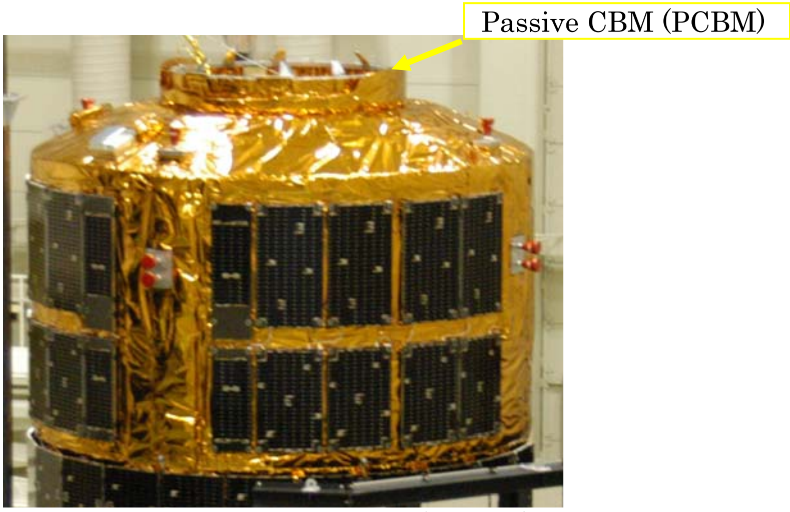


Fig. 1.2.1-1 PLC Overview (HTV-1)


Fig. 1.2.1-2 Interior View of the PLC (HTV-1)

1.2.1.1 Interior of the Pressurized Logistic Carrier (PLC)

The interior of the Pressurized Logistic Carrier (PLC) is separated into two bay areas: the first rack bay (Bay #1) located on the hatch side, and the second rack bay (Bay #2) in the rear. Each bay accommodates four racks; thus, up to eight racks may be accommodated per flight.

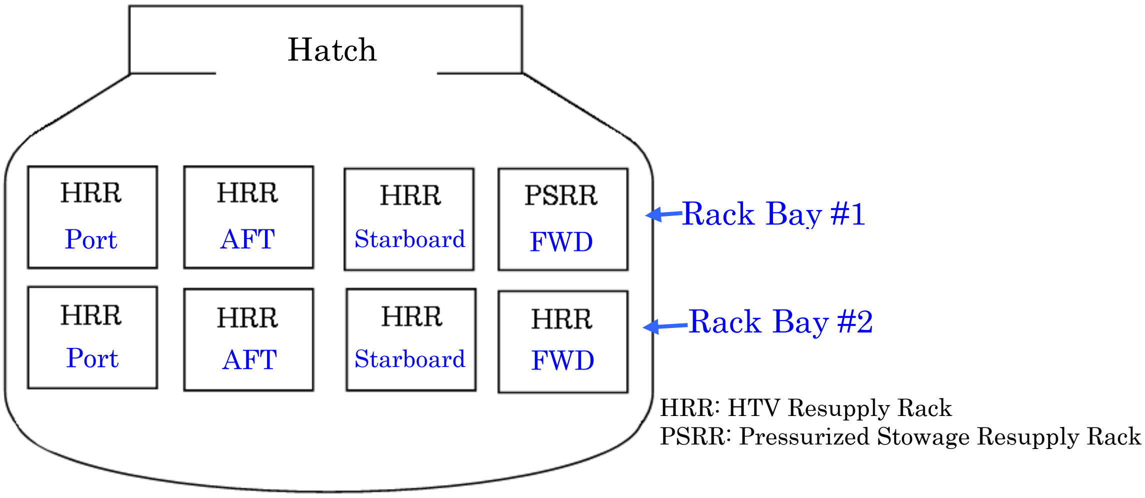


Fig. 1.2.1-3 Rack Layout inside the HTV (HTV-1)

First Rack Bay (Bay #1)	Bay #1, located on the hatch side, accommodates the International Standard Payload Rack (ISPR) or a fixed type of HTV Resupply Racks (HRRs). The ISPR is removable so that the rack can be transferred into the ISS cabin during HTV's berthing phase. The Pressurized Stowage Resupply Rack (PSRR) that will be carried on the HTV-1 Mission has an interface equal to that of the ISPR; the PSRR will be transferred to Kibo.
Second Rack Bay (Bay #2)	Bay #2, located in the rear, accommodates only a fixed type of HRRs, and those HRRs will not be transferred into the ISS cabin. After the Cargo Transfer Bags (CTB) are unloaded from the fixed type HRRs, trash and other discarded items are loaded into them.

Fig. 1.2.1-4 PSRR (left) and HRR (right)

Fig. 1.2.1-5 Cargo Layout inside the PLC

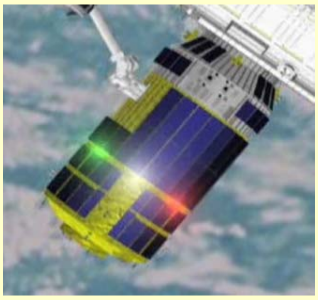
1.2.1.2 Pressurized Logistics Carrier (PLC) Subsystems

The subsystems of the Pressurized Logistics Carrier (PLC) are shown in Table 1.2.1-1.

Table 1.2.1-1 Subsystems of the PLC (1/2)

Electrical Power System	・ The PLC receives 50V DC power from the HTV Avionics Module, then, distributes the received power to the equipment inside the PLC. ・ The PLC receives 120V DC power supply from the ISS while berthed to the ISS, and distributes the received power to the Avionics Module and the equipment inside the PLC.
Thermal Control System	・ Heaters are installed in the inner wall of the PLC. The temperature inside the PLC is controlled by using this wall heater. ・ Prior to HTV's berthing to the ISS, the temperature inside the PLC will be equalized to the internal temperature of the ISS in order to prevent dew condensation in the PLC.
Environment Control System	・ The air pressure inside the PLC is monitored with pressure sensors. When the pressure value exceeds the flight criteria, a vent release valve will be used to modulate the air pressure inside. ・ While berthed to the ISS, the air between the PLC and Harmony will be circulated by fans through the Inter-Module Ventilation system (IMV). ・ Thermal sensors monitor the air temperature inside the PLC. ・ Smoke detectors are deployed inside the PLC, and when a fire is detected, the smoke detectors will set off the alarm and stop the circulation fans. The smoke detectors will be removed and stowed in the ISS before the HTV undocks from the ISS.

Table 1.2.1-1 Systems of the Pressurized Cargo Carrier (PLC) (2/2)

Crew Support System	▪ The PLC is equipped with four interior lights. The ISS crew members can turn the lights on and off manually when they enter/exit the PLC for cargo transfer and/or trash stowage. The lights will be removed from the PLC before the HTV undocks from the ISS for reuse. ▪ When the lights go off, emergency exit signs (luminous signs) will show the crew the way to the exit.
Navigation Lights 	▪ The PLC is equipped with four attitude lights (two red lights on the port side, two green lights on the starboard side) and two capture lights (one white and one yellow) on the end-cone ring. These lights are used for the ISS crew members to confirm the HTV's location and attitude while the HTV is approaching/departing from the ISS. ▪ Capture lights are flashing lights and visible to the ISS crew when the HTV approaches 1,000 meters from the ISS. Attitude lights are visible to the ISS crew when the HTV approaches 500 meters from the ISS; the ISS crew can confirm the approximate attitude of the HTV by monitoring the attitude lights.

1.2.2 Unpressurized Logistic Carrier (ULC)

The Unpressurized Logistic Carrier (ULC) accommodates an Exposed Pallet (EP) while the HTV flies to the ISS. The EP is a pallet used to carry external experiments and/or orbital replacement units (ORUs) to be used outside of the ISS.

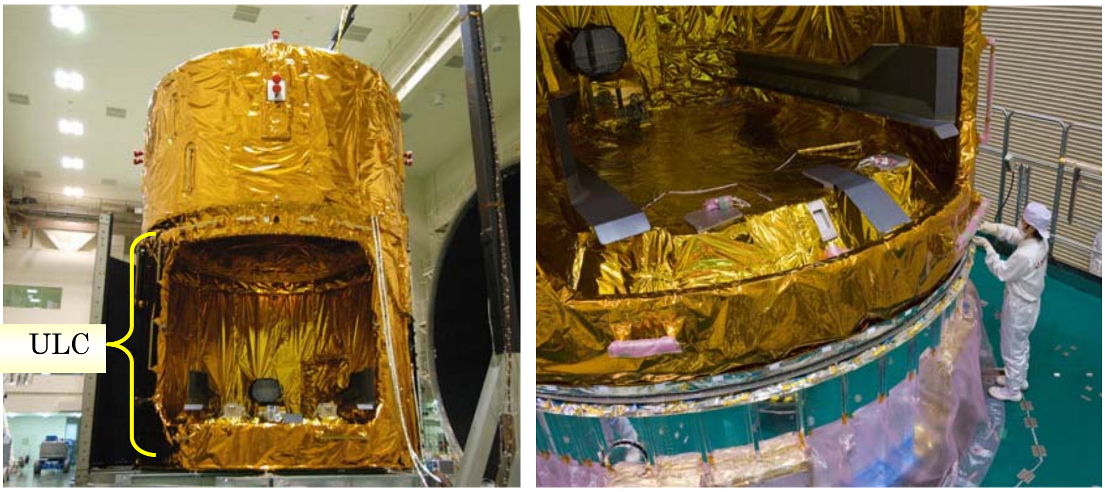


Fig. 1.2.2-1 ULC (HTV-1)

Figure 1.2.2-2 EP Being Loaded (HTV-1)

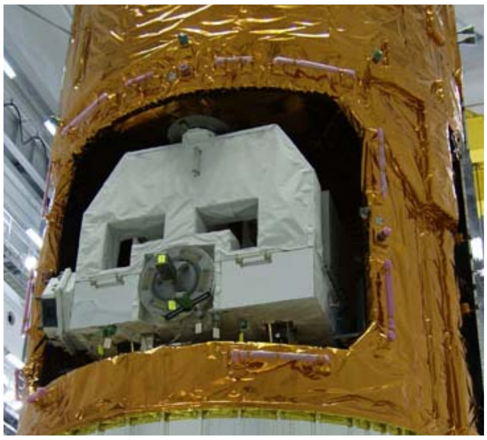


Figure 1.2.2-3 EP Installed into the ULC (HTV-1)

After the HTV is berthed to the ISS, the Exposed Pallet (EP) will be removed from the Unpressurized Logistics Carrier (ULC) by the station's robotic arm, the Space Station Remote Manipulator System (SSRMS). The EP will then be handed over to Kibo's robotic arm, the JEM Remote Manipulator System (JEMRMS), and temporarily attached to the ISS (the Mobile Base System (MBS) or Kibo's Exposed Facility (EF)) for unloading of the carried payloads. Once the payloads are unloaded, the EP will be re-stowed in the ULC by the SSRMS.

1.2.2.1 Mechanisms of Unpressurized Logistic Carrier

● Tie-down Separation Mechanism (TSM)

The Unpressurized Logistic Carrier (ULC) is equipped with four Tie-down Separation Mechanisms (TSMs). The TSMs are used to fasten the Exposed Pallet (EP) in the ULC during launch/solo flight to the ISS. After the HTV is berthed to the ISS, the TSMs enable removal or reattachment of the EP to the ULC by the SSRMS.

● Hold-down Mechanism (HDM)

The Hold-down Mechanism (HDM) is a mechanism that receives, holds, and pulls in the EP when the EP is re-stowed in the ULC by the SSRMS.

● Harness Separation Mechanism (HSM)

The Harness Separation Mechanism (HSM) is located near the aperture of the ULC. The HSM is used to separate heater power and data cables between the ULC and the EP.

● Guide Rails/Wheels

The guide rails and wheels are devises to minimize resistive load when the EP is reinstalled into the ULC. The mechanisms also support proper alignment for re-stowing of the EP. The guide rail is located on the ULC side, and the wheel (roller) is attached on the EP side.

Three guide rails are located near the aperture of the ULC, one each on the port side, the starboard side, and the nadir side. Nine wheels are located on the port side and the starboard side, and one on the nadir side of the EP.

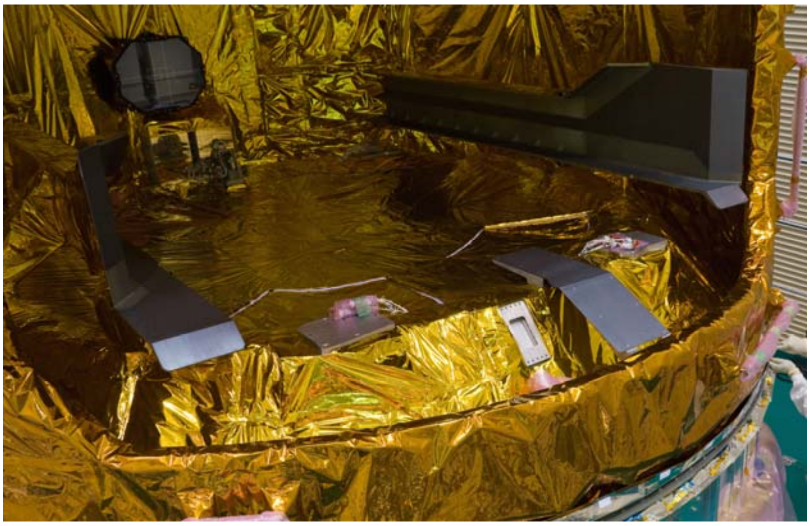


Fig. 1.2.2-4 Enlarged View of the ULC

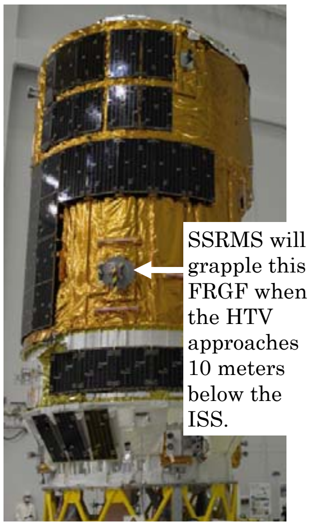


Fig. 1.2.2-5 FRGF of the ULC (HTV-1)

1.2.3 Exposed Pallet (EP)

The Exposed Pallet (EP) is used to carry external experiments and orbital replacement units (ORUs) that will be operated outside of the ISS. After the external payloads are unloaded and transferred to the ISS, the EP will be loaded with used payloads and will be re-stowed in the ULC. The EP accommodates up to 1,500 kg of cargo.

Fig. 1.2.3-1 Exposed Pallet (EP)

Fig. 1.2.3-2 EP Installed in the ULC

There are two different types of EPs:

● EP for Kibo's Exposed Facility (EF) payload

This type accommodates external experiments that will be operated on Kibo's Exposed Facility (EF), which are called "Exposed Facility (EF) payloads." Two or three EF payloads can be carried per flight. This pallet will be attached to the EF while unloading the delivered EF payloads on orbit.

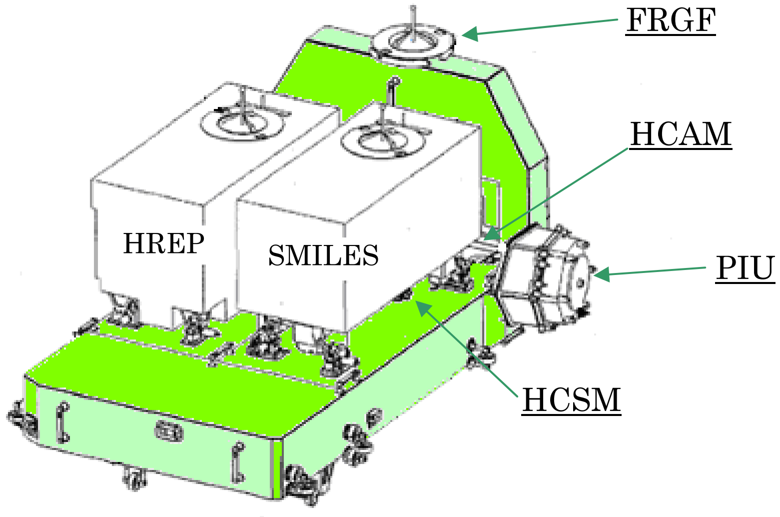


Fig. 1.2.3-3 Exposed Pallet for EF Payload
(Note: Configuration for the HTV-1 Mission)

● EP for ISS-Common ORUs

This type accommodates the ISS-Common Orbital Replacement Units (ORUs), such as battery ORUs. This pallet will be attached to the Payload/ORU Accommodation (POA) of the station's Mobile Base System (MBS). Up to six battery ORUs can be delivered to the ISS per flight.

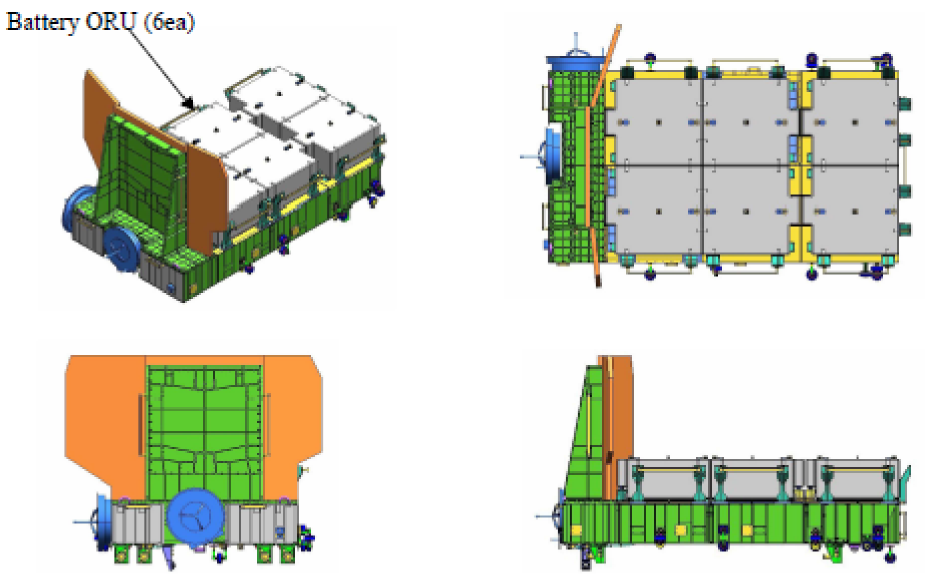


Fig. 1.2.3-4 Exposed Pallet for ISS-Common ORUs

1.2.3.1 Mechanism of Exposed Pallet (EP)

The Exposed Pallet (EP) is equipped with cargo attachment mechanisms (HCAMs), connector separation mechanisms (HCSMs), and two types of grapple fixtures. These mechanisms will enable safe and fully protected external cargo transportation activities.

● HTV Cargo Attachment Mechanism (HCAM)

The HTV Cargo Attachment Mechanism (HCAM) is used to fasten an EF payload while the HTV flies to the ISS. It fastens each of the four corners of an EF payload or ORU.

● HTV Connector Separation Mechanism (HCSM)

The HTV Connector Separation Mechanism (HCSM) is used to separate heater power cables* between the Exposed Pallet (EP) and an EF payload or ORU.

This mechanism enables the heater power cables to be separated properly and safely when the payloads are removed from the EP by Kibo's robotic arm (JEMRMS). The HCSM is not designed to reconnect heater power cables between the EP and an EF payload or ORU.

* Heater cables are used to provide heater power to EF payloads or ORUs until transferred to the ISS side.

● Grapple Fixture (FRGF/PVGF)

The Grapple Fixture is a mechanism that the station's robotic arm (SSRMS) or JEMRMS grapples and holds. The Exposed Pallet (EP) is equipped with two types of ISS-common grapple fixtures: the Flight Releasable Grapple Fixture (FRGF) and the Power and Video Grapple Fixture (PVGF). The PVGF supports data communications between the EP and the ISS through the SSRMS or POA. Heater power is also provided from the ISS to EF payloads or ORUs through the PVGF.

1.2.3.2 Electrical Interface

The Exposed Pallet (EP) receives 50V DC from the HTV Avionics Module through the HTV Unpressurized Logistics Carrier (ULC).

The EP receives 120V DC power supply from the ISS while the HTV is berthed to the ISS. No power will be provided to the EP after the EP is emptied and unberthed from Kibo's Exposed Facility (EF).

1.2.4 Avionics Module

The Avionics Module consists of guidance navigation & control, communications, data handling, and electrical power subsystems. These subsystems support HTV's autonomous and/or remotely controlled rendezvous flight.

The Avionics Module distributes power generated by solar array panels* or battery power to each component of the HTV.

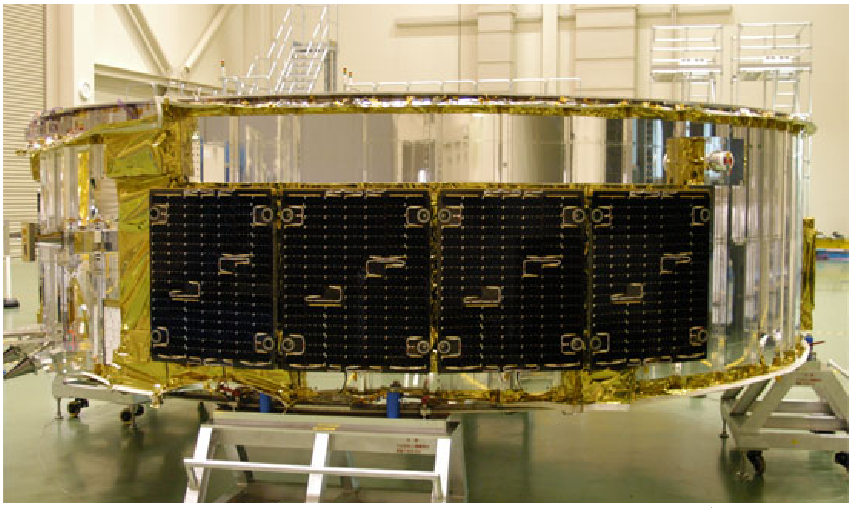


Fig. 1.2.4-1 Avionics Module (Side View)

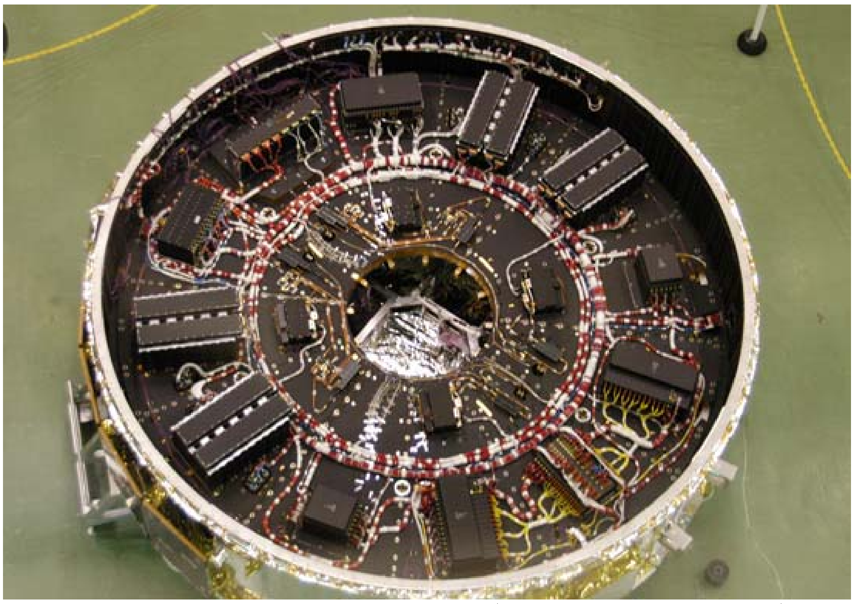


Fig. 1.2.4-2 Avionics Module (Viewed from Above)

The Avionics Module receives commands sent from the ground or the ISS through NASA's Tracking and Data Relay Satellite (TDRS), and then, relays the commands to each component. It also sends HTV's telemetry data to the ground or the ISS.

1.2.4.1 Subsystem of the Avionics Module

Table 1.2.4-1 shows subsystems of the Avionics Module.

Table 1.2.4-1 Subsystems of the Avionics Module (1/2)

Guidance & Navigation Control Subsystem	・ Once the HTV is inserted into the predetermined orbit, this subsystem obtains the navigation information using the position/attitude sensors. This subsystem supports HTV's solo flight (autonomous and remotely controlled flight). ・ This subsystem consists of a GPS antenna, rendezvous sensors, an Earth sensor, a navigation control computer, and an abort control unit.
Communications Subsystem	・ This subsystem consists of the Inter-Orbit Link System (IOS) that enables communications through NASA's TDRS and the Proximity Link System (PLS) that enables direct wireless communications with the ISS within the ISS proximity range. S-band communications will be used.
Data Handling Subsystem	・ This subsystem receives commands from the ground and the ISS, and sends HTV telemetry to the ground and the ISS. ・ This subsystem supports thermal controls of the Avionics Module and Propulsion Module, environment control of the PLC, anomaly detection/caution and warning for HTV's equipment, and data handling/control of the other subsystems.
Electrical power Subsystem	・ This subsystem consists of two Main Bus Units (MBUs), eleven primary non-rechargeable batteries called "Primary Battery (P-BAT)", two Battery Discharge Control Units (BDCUs), one secondary rechargeable battery called "Secondary Battery (S-BAT)", and a Power Control Unit (PCU). ・ When the HTV is flying in the eclipse area, the power charged in the S-BAT and or the P-BAT power will be provided to each system component. When the power supply from the ISS is out during the berthing phase, the power from the P-BAT will be provided to each system component of the HTV. ・ Power generated by the solar panel is regulated by the PCU. The PUC distributes power to the MBU, and also charges the S-BAT. ・ This subsystem receives power from the ISS while the HTV is berthed to the ISS. The DC/DC converter regulates power from the ISS and distributes the converted power to each component of the HTV.

Table 1.2.4-1 Subsystems of the Avionics Module (2/2)

Solar Array Panel 	・ Fifty-seven solar panels are installed on the external wall of the HTV. – PLC: 20 panels – ULC: 23 panels – Avionics Module: 8 panels – Propulsion Module: 6 panels

1.2.5 Propulsion Module

The Propulsion Module has four propellant tanks with a capacity of 2 tons (Maximum 2.4 tons) of propellant per flight. Monomethylhydrazine (MMH) is used as fuel, and nitrogen tetroxide (MON3) is used as an oxidizer.

The propellant will be supplied to HTV's four main thrusters (two units x two strings) and 28 attitude control thrusters (14 units x two strings) from the propellant tanks. Propulsion for orbital maneuvers (phase adjustment and rendezvous maneuvers) will be controlled by command signals sent from the Avionics Module.

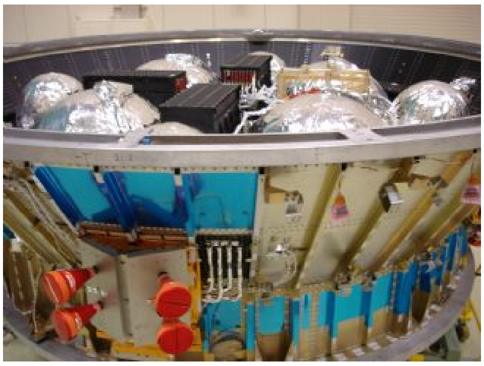


Fig. 1.2.5-1 Propulsion Module

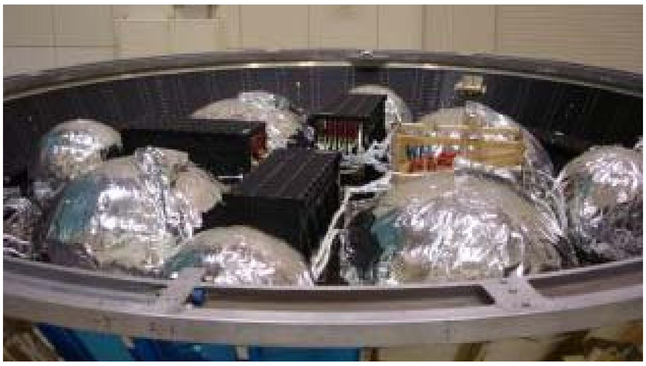


Fig. 1.2.5-2 Enlarged Photo: Propellant Tanks

There are four large propellant tanks and four small tanks. The small tanks contain helium gas used for pressurization of the propellant tanks.

Fig. 1.2.5-3 Propulsion Module (Side View)

Fig. 1.2.5-4 Propulsion Module (Main Thrusters)

Table 1.2.5-1 Thrusters of the HTV

	Specification	
	Main Thruster	Attitude Control Thruster
Numbers of Units	2 units x 2 strings Total 4 units	14 units x 2 strings (redundant structure) Total 28 units *
Thrust per Unit	490N	110N

* Of the 28 units, 12 units are installed on the outer wall of the PLC.

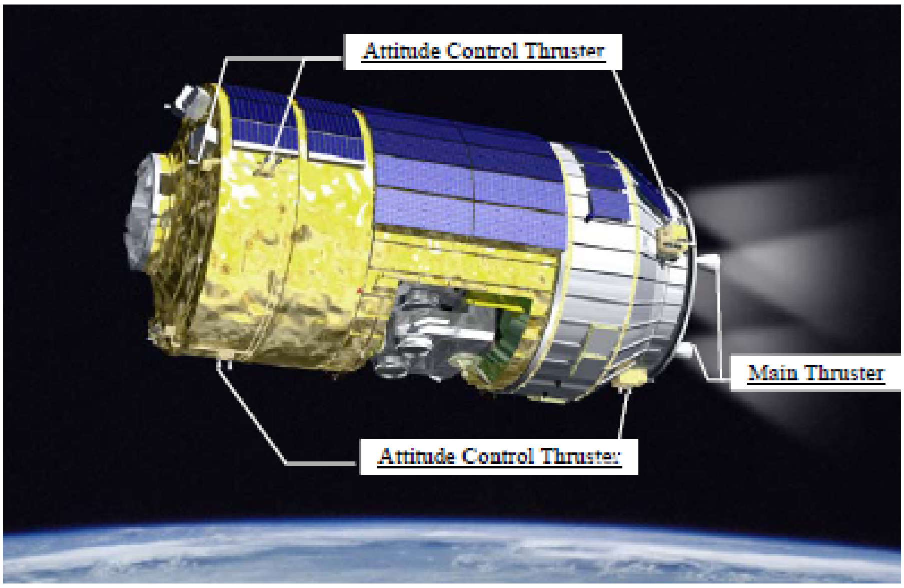


Fig. 1.2.5-5 Approximate Locations of Main Thrusters and Attitude Control Thrusters

1.2.6 Proximity Communication System (PROX)

The HTV Proximity Communication System (PROX) is a wireless communications system that enables direct communications between the HTV and ISS when the HTV is in the proximity communications range. The PROX is installed on board the Japanese Experiment Module, Kibo.

The PROX consists of PROX antennas, PROX-GPS antennas, PROX communication equipment, PROX GPS equipment, data handling equipment, and a Hardware Command Panel (HCP).

The PROX equipment, such as transmitters, receivers, data handling processors, and GPS receivers are installed in the Inter-orbit Communication System (ICS) rack onboard Kibo's Pressurized Module (PM).

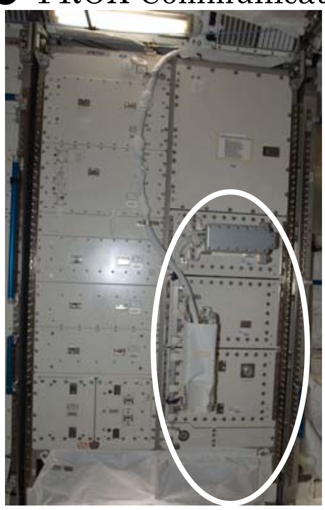
The HCP will be deployed on the station's robotic arm workstation in the Destiny laboratory module. The ISS crew can control the HTV during HTV's final approach to and departure from the ISS using the HCP for immediate critical operations in addition to using their command/monitor laptops (PCSs).

The PROX antennas are located on the side of the PM outer wall. The PROX-GPS antennas are located on the top of Kibo's Experiment Logistics Module-Pressurized Section (ELM-PS).

● PROX-GPS Antenna

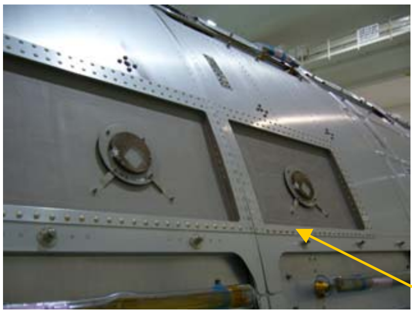
GPS antennas are used to provide information on orbital location and range rate of the ISS to the HTV.

● PROX Communications Equipment

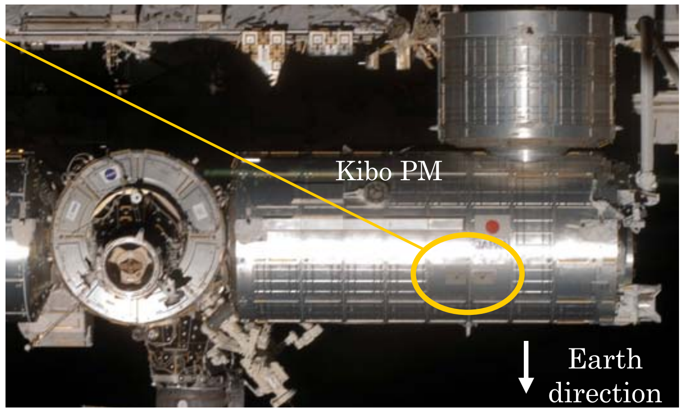


PROX communication systems are installed on the right side of the ICS/PROX rack in Kibo's PM.

● PROX Antenna



The PROX antennas are used for HTV's direct wireless communications with the ISS during Proximity Operations. It receives telemetry data from the HTV. It is also used to relay the commands sent from the ground or ISS to the HTV.



● Hardware Command Panel（HCP）

- HOLD
  Hold the approach
- RETREAT
  Retreat to 30 m or 100 m below the ISS
- ABORT
- FREE DRIFT
  Disable the HTV thrusters for the SSRMS to grapple the HTV

The ISS crew can control the HTV during its final approach to the ISS using the Hardware Command Panel (HCP) for immediate critical operations, in addition to using their command/monitor laptops (PCSs).

The key functions of the HCP are "ABORT", "RETREAT", "HOLD", and "FREE DRIFT".

The HCP will be deployed temporarily on the robotics workstation in the Destiny laboratory module during HTV's Proximity Operations. After Tranquility (Node 3) arrives at the ISS, the HCP will be deployed in the "Cupola" of Tranquility.

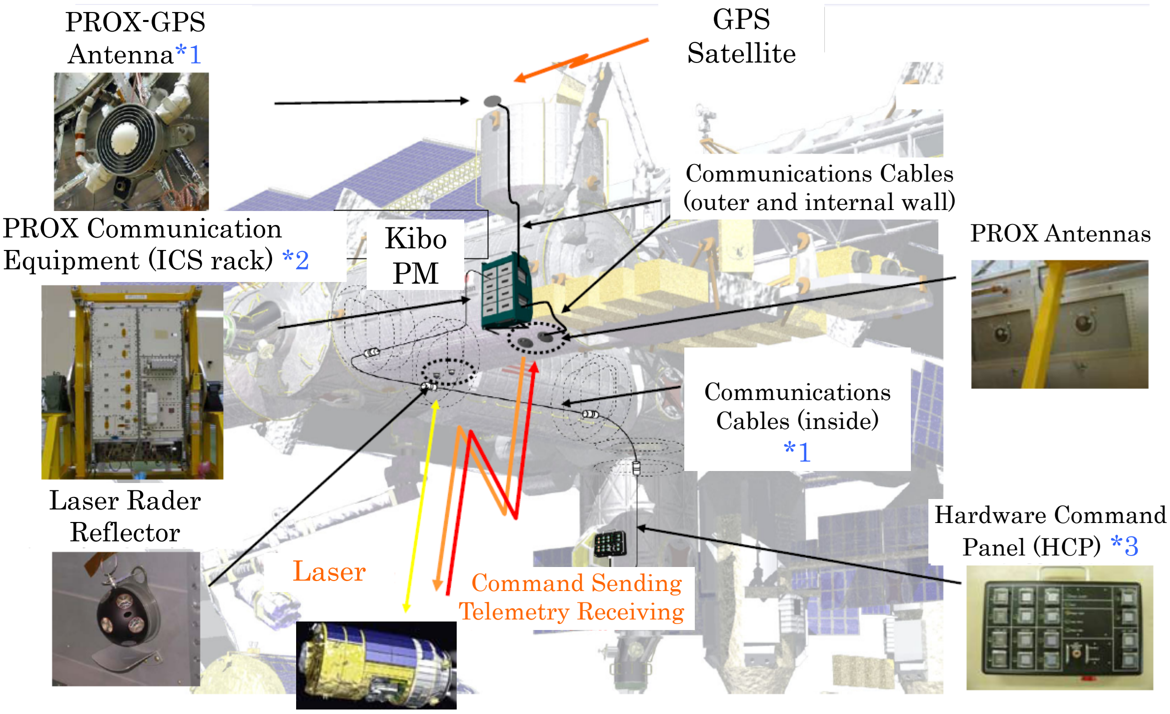
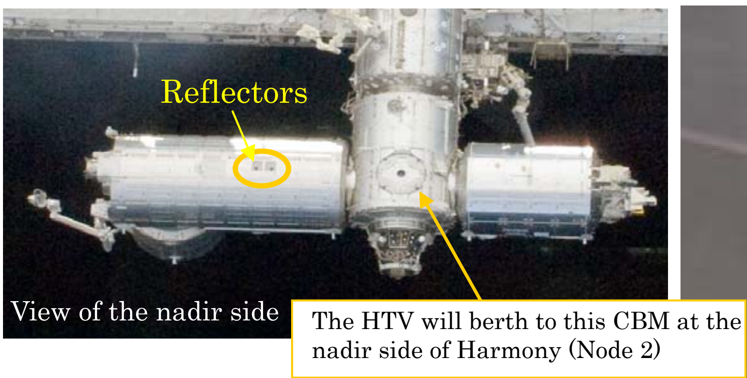


Fig. 1.2.6-1 Locations of the PROX system

*1 Delivered and installed on the STS-123 Mission in March 2008
*2 Delivered and installed on the STS-126 Mission in November 2008
*3 The HCP will be deployed in the “Cupola” of Tranquility (Node 3) after Tranquility arrives at the ISS.

1.2.7 Laser Rader Reflector (LRR)



The Laser Rader Reflectors (LRRs) are located on the nadir side of Kibo’s Pressurized Module (PM). The reflectors will reflect the lasers beamed from the HTV’s Rendezvous Sensor (RVS) when the HTV approaches from the nadir side (R-bar) of the ISS.

1.3 HTV Operations

HTV operations overview as shown in Figure 1.3-1.

1. Launch
2. Rendezvous flight to the ISS
3. Berthing to the ISS
4. Docked Operations
5. Unberthing/Departure from the ISS
6. Reentry

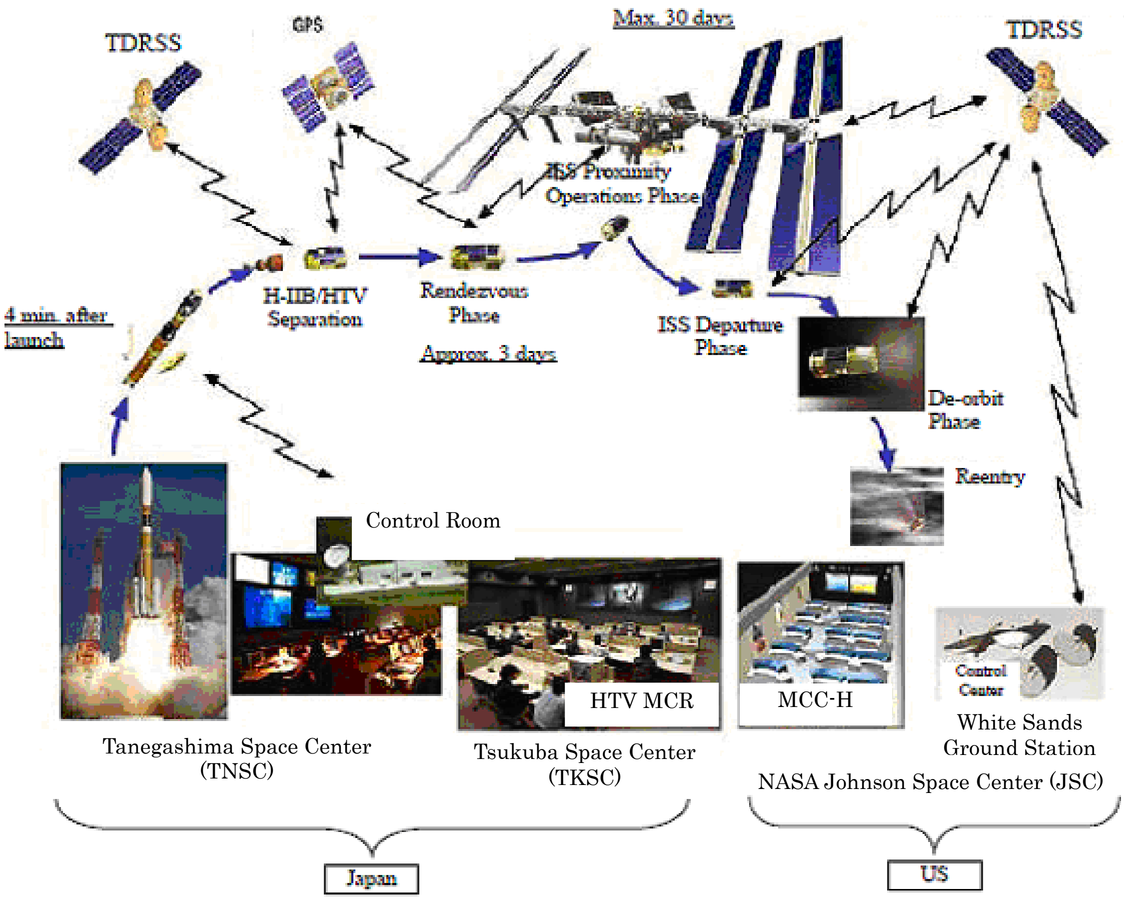


Fig. 1.3-1 HTV Operations

1.3.1 Launch Processing

The HTV component modules will be delivered to the Second Spacecraft and Fairing Assembly Building (SFA2) at the Tanegashima Space Center (TNSC). There, HTV's launch preparations will be performed.

First, the HTV components will be inspected closely for post-delivery checkout. After the checkout is completed, cargo will be loaded into the HTV Pressurized Logistics Carrier (PLC) and on the Exposed Pallet (EP).

Fig. 1.3.1-1 Cargo Transfer Bags (CTBs) being installed in the HTV Resupply Racks (HRRs) and an HRR being loaded into the PLC (Launch Processing on the HTV-1 Mission)

External payloads or ORUs will be loaded on the EP, and then, the EP will be installed in the Unpressurized Logistics Carrier (ULC).

Fig. 1.3.1-2 Exposed Pallet being installed in the ULC

After the cargo loading is complete, the PLC and ULC will be mated. Following the PLC/ULC mating, all component modules, including the Avionics Module and Propulsion Module, will be mated.


Fig. 1.3.1-3 PLC and ULC being mated


Fig. 1.3.1-4 HTV Maiden Flight Vehicle

Once the HTV components are assembled, integrated system checkouts will be performed. Propellant loading will be conducted approximately one month prior to the launch date.

An inter-organizational Flight Readiness Review (FRR) by NASA and JAXA will be held approximately three weeks prior to the target launch date, and readiness of the HTV will be reviewed and assessed.

Approximately 20 days prior to the launch, the HTV will be installed in the H-IIB rocket fairing and moved to the Vehicle Assembly Building (VAB) to be mounted on the H-IIB launch vehicle.

A final cargo loading of the HTV Pressurized Logistics Module (PLC) will be performed at the VAB approximately one week prior to the launch. This final cargo loading is called "Late Access" and it will be the last opportunity to access the HTV before launch.

During Late Access, the ground crew will load some last-minute items into the HTV PLC through the access door (1.3 m x 1.3 m) on the H-IIB rocket fairing.

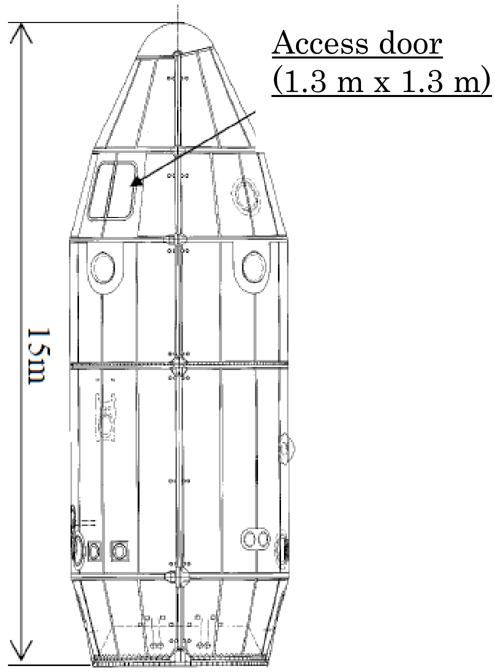


Fig. 1.3.1-5 HTV Installed in H-IIB Rocket Fairing (Image: left)
Location of Access Door for HTV Late Access (Image: right)

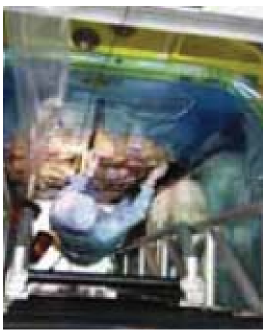


Fig. 1.3.1-6 Late Access Demonstration

Fig. 1.3.1-7 SFA2

Fig. 1.3.1-8 VAB

Fig. 1.3.1-9 VAB, Launch Pad 1 (LP1), and Launch Pad 2 (LP2) at the Yoshinobu Launch Complex of TNSC

On launch day, the H-IIB launch vehicle with the HTV installed will be rolled out to Launch Pad 2 (LP2) from the VAB.

1.3.2 Launch

The HTV will be launched from Launch Pad 2 (LP2) at the Tanegashima Space Center (TNSC) aboard the H-IIB launch vehicle. HTV's launch opportunity is once a day since the HTV's launch time has to be adjusted and scheduled for when the orbital plane of the ISS is passing over TNSC.

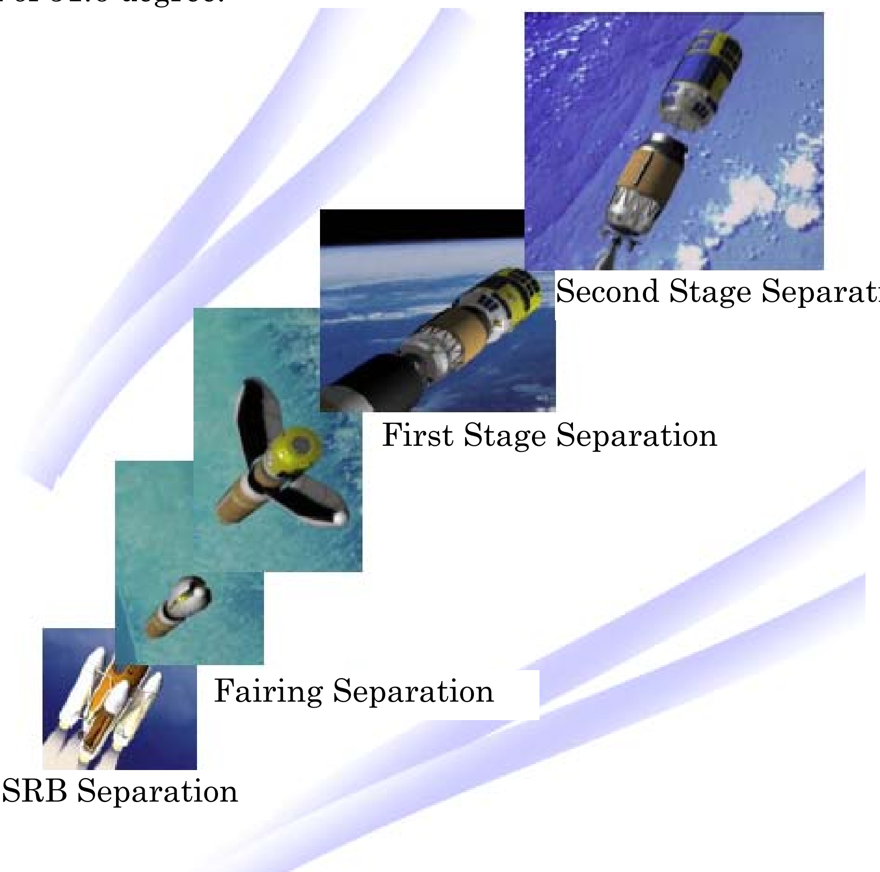

Yoshinobu Launch Complex at Tanegashima Space Center


Launch of the H-IIB Launch Vehicle (Image)

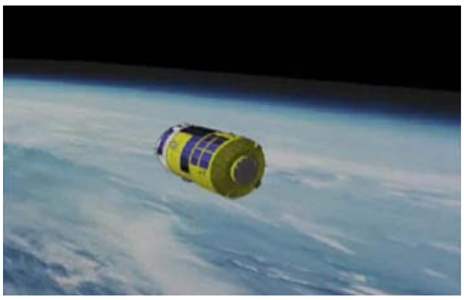

Launch control room at Tanegashima Space Center

After lift-off, four units of the Solid Rocket Booster (SRB-A), two at a time, will separate approximately 2 minutes 4 seconds and 2 minutes 7 seconds after launch. Fairing separation will occur approximately 3 minutes 40 seconds after launch.

The First Stage will separate 5 minutes 54 seconds after launch, and thereafter, the Second Stage will ignite to insert the HTV into an elliptical orbit with an altitude of 200 km (Perigee) x 300 km (Apogee) at an inclination of 51.6 degree.



Approximately 15 minutes and 11 seconds after launch, the Second Stage will separate from the HTV. The HTV will then automatically activate the HTV subsystems, maintain its attitude, and perform a self-check on HTV components. After that, the HTV will establish communications with the NASA's TDRS and initiate communications with the HTV Mission Control Room (MCR) at Tsukuba Space Center (TKSC).



1.3.3 Rendezvous

After separating from the H-IIB launch vehicle, HTV's rendezvous flight will continue over the following three days*.

*For the HTV-1 Mission, HTV's rendezvous flight will take approximately seven days because the HTV-1 Mission will perform demonstration tests during the solo rendezvous flight phase.

1. The HTV will automatically activate HTV subsystems and communication systems, establish communications with NASA's Tracking and Data Relay Satellite (TDRS), and initiate communications with the HTV Mission Control Room (MCR) at Tsukuba Space Center (TKSC).
2. The HTV will start orbital rendezvous flight towards the ISS. Status of the HTV will be monitored from the ground during the flight.
3. After the 3-day orbital rendezvous flight, the HTV will reach close proximity to the ISS.
4. The HTV will reach the proximity "Communication Zone" (23 km from the ISS) where the HTV can directly communicate with the ISS.
5. The HTV will establish communications with the Proximity Communication System (PROX).
6. While communicating with the PROX, the HTV will approach the ISS guided by GPS (Relative GPS navigation) until the HTV reaches the "Approach Initiation (AI)" point (5 km behind the ISS). At this point, the HTV will maintain this relative distance from the ISS until approval for HTV Proximity Operations is given by the ISS Mission Management Team (IMMT).

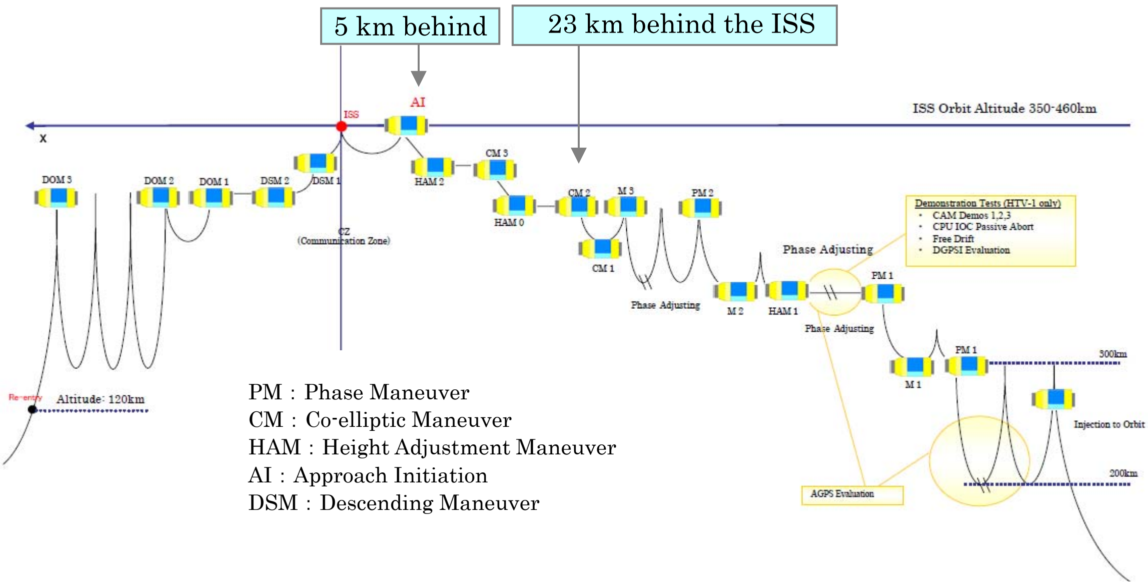


Fig. 1.3.3-1 HTV Rendezvous Profile

1.3.4 Proximity Operations

After approval for final approach is given by NASA's ISS Mission Management Team (IMMT), the HTV will move from the AI point to the final approach point guided by Relative GPS (RGPS) Navigation.

The HTV will approach the ISS from the nadir side of the ISS (from the direction of Earth). The HTV will then be grappled by the station's robotic arm (SSRMS) and berthed to the ISS. This operation phase is called "PROX Operations".

HTV's approach sequence during PROX Operations is as follows:

1 The HTV will move from the AI point to a point 500 m below the ISS guided by GPS (RGPS Navigation).
2 Using a laser sensor called Rendezvous Sensor (RVS), the HTV will approach the ISS, beaming the laser to the reflector located on the nadir side (facing Earth) of Kibo (RVS Navigation).
3 The HTV will hold its approach twice: when reaching 300 m below the ISS (hold point) and 30 m below the ISS (parking point). At the hold point, the HTV will perform 180° yaw-around to prepare for a contingency maneuver in case of emergency.
4 Finally, the HTV will reach 10 m below the ISS, a grappling position called the "Berthing Point". At the Berthing Point, the HTV will maintain this distance from the ISS.

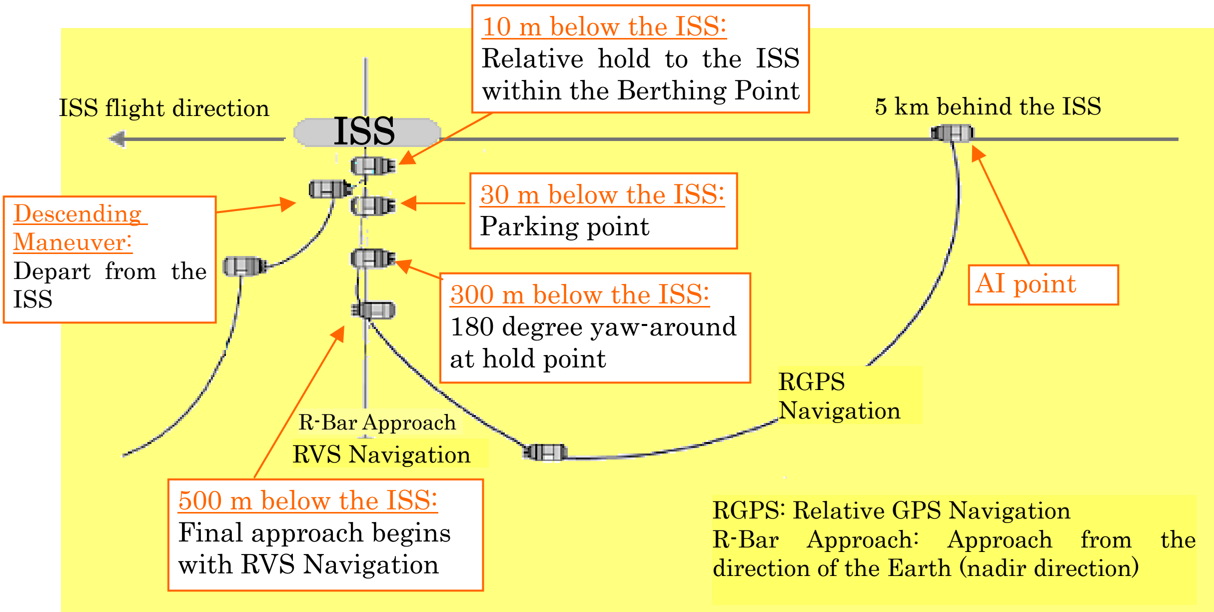


Fig. 1.3.4-1 HTV's RGPS Navigation and R-Bar Approach

HTV's approach speed during the RVS Navigation phase is 1 to 10 meters per minute. During this phase, the ISS crew can control the HTV by sending commands such as "HOLD", "RETREAT", "ABORT", or "FREE DRIFT" using the Hardware Command Panel (HCP) deployed on the robotics workstation onboard the Destiny module. If an emergency occurs and HTV's further approach can not be permitted, the ISS crew will command the HTV to depart in the forward direction of the ISS.

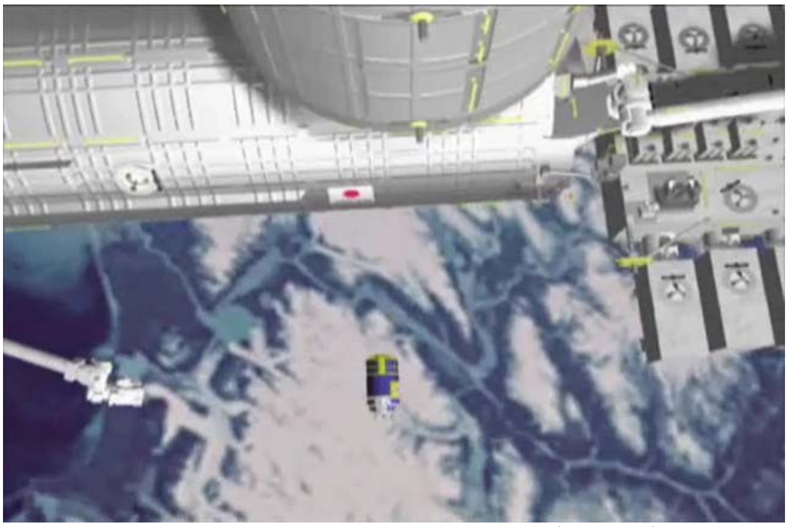


Fig. 1.3.4-2 HTV's Approach (Image)

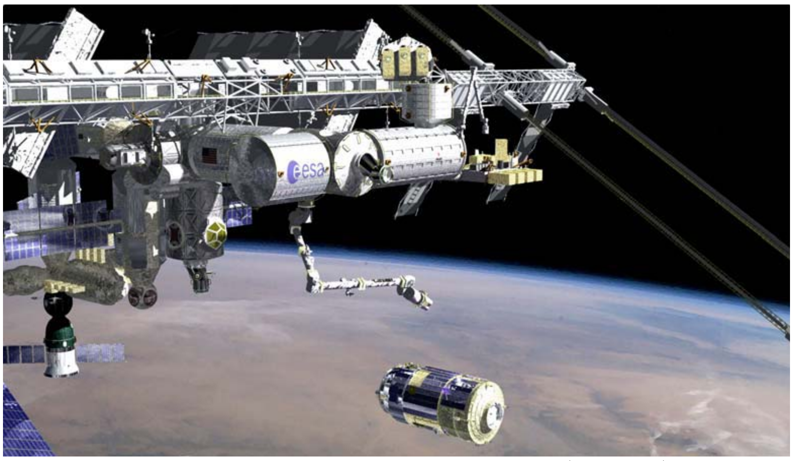


Fig. 1.3.4-3 HTV's Approach (Image)

Once the HTV Mission Control Room (MCR) at TKSC confirms that the HTV has arrived at the Berthing Point (the grappling point 10 m below the ISS), the ISS crew will disable the HTV thrusters (free drift). Then, the station's robotic arm (SSRMS) will grapple the HTV.

Fig. 1.3.4-4 SSRMS Moving the HTV to the Berthing Position

Finally, the SSRMS will berth the HTV to the CBM located at the nadir side (facing Earth) of Harmony.

Fig. 1.3.4-5 HTV being berthed to the ISS

1.3.5 Docked Operations

Once the HTV is berthed to Harmony, the HTV subsystems will be activated. Vestibule outfitting will be performed from the Harmony side by the ISS crew as ingress preparation.

The ISS crew will perform wire connections and cable settings at the berthing port between the HTV and the Harmony. After completing the vestibule outfitting, lights in the Pressurized Logistics Carrier (PLC) will be powered and air pressure in the PLC will be adjusted by commands from the HTV Mission Control Room (MCR). Then, both hatches of the Harmony and HTV will be opened.

After the hatches are opened, the Inter-Module Ventilation (IMV) system will be activated and air between Harmony and the HTV PLC will be circulated. ISS crew will then enter the PLC and deploy safety tools, such as an emergency procedure manual, Portable Breathing Apparatus (PBA), and Portable Fire Extinguisher (PFE).

The temperature inside the PLC will be adjusted and maintained above 15.6 degrees Celsius before berthing to the ISS in order to prevent dew condensation inside the PLC.

Fig. 1.3.5-1 Internal View of the PLC

Once those post-ingress activities are complete, cargo transfer from the PLC to the ISS will begin. The ISS crew will perform transfer operations according to transfer checklists.

When all cargo and racks are unloaded from the PLC, trash and other discarded items will then be loaded into the PLC.

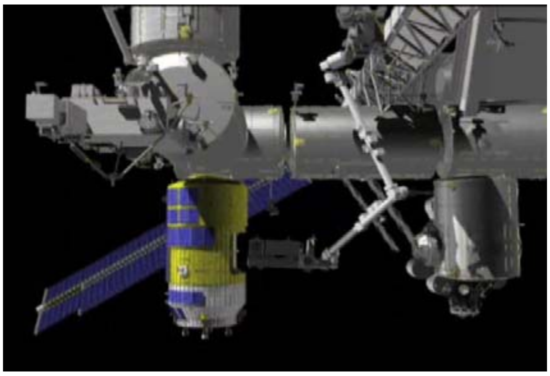
Fig. 1.3.5-2 Exposed Pallet being installed in the ULC

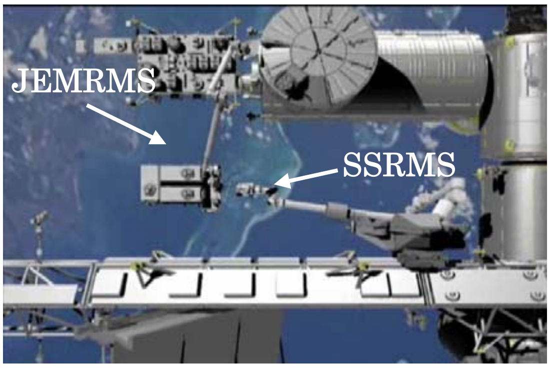
HTV's Exposed Pallet (EP) will be removed from the HTV Unpressurized Logistics Carrier (ULC) by the Space Station Remote Manipulator System (SSRMS).

The EP will be temporarily installed onto Kibo's Exposed Facility (EF) or Payload/ORU Accommodation (POA) of the Mobile Base System (MBS) for unloading the payloads on the ISS.

■ Relocation of the Exposed Pallet (EP) to the ISS
【Example: When attached to Kibo's Exposed Facility (EF)】

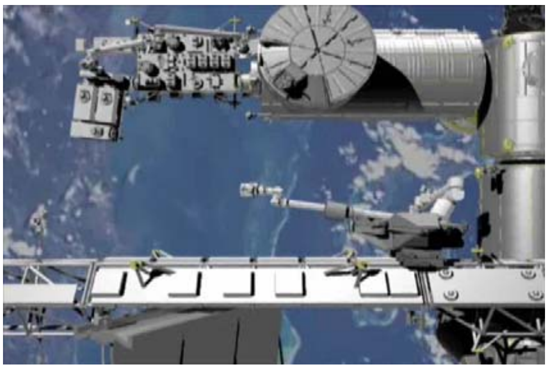
First, the station's robotic arm (SSRMS) will pull out the Exposed Pallet (EP) from the HTV Unpressurized Logistics Module (ULC).





Then, the EP will be handed over to Kibo's robotic arm (JEMRMS).

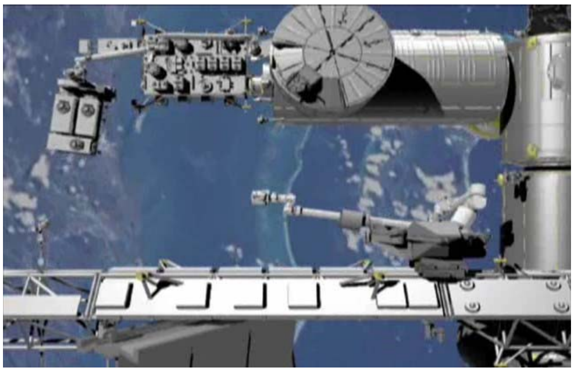
Finally, the EP will be attached to Kibo's EF by the JEMRMS.



While the EP is attached to the EF, payloads carried on the EP will be relocated to the EF by the JEMRMS.

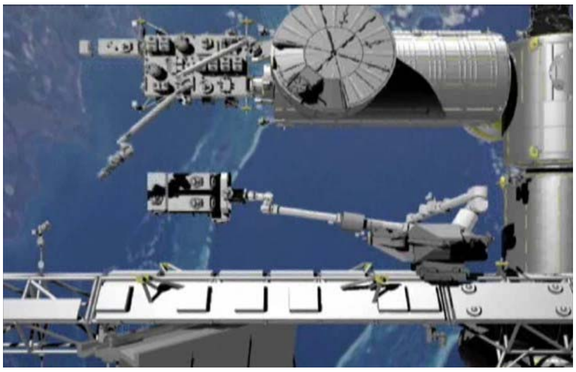
Fig. 1.3.5-3 EP Relocation

■ Reinstallation of the Exposed Pallet (EP) in the ULC
【Example: When attached to the EF】

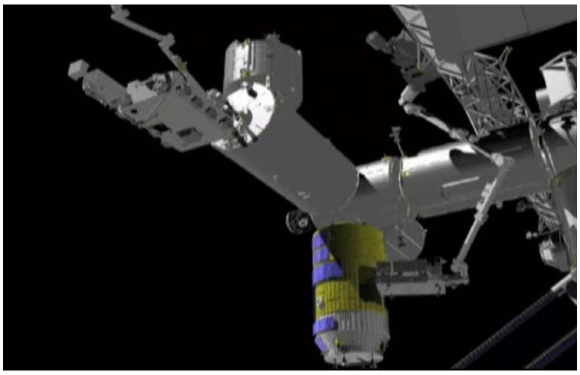


After the payloads are unloaded and relocated to Kibo's EF, the EP will be re-stowed in the ULC.

First, Kibo's robotic arm (JEMRMS) will remove the EP from the EF.



Then, the EP will be handed over to the station's robotic arm (SSRMS).



Finally, the EP will be reinstalled in the ULC by the SSRMS.

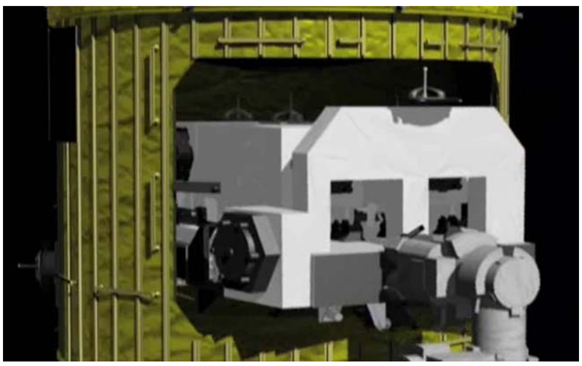
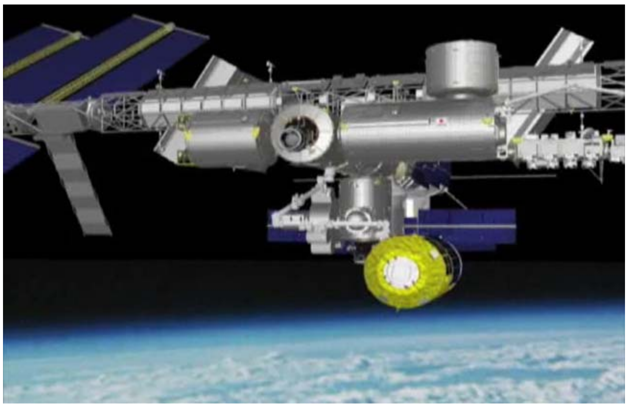


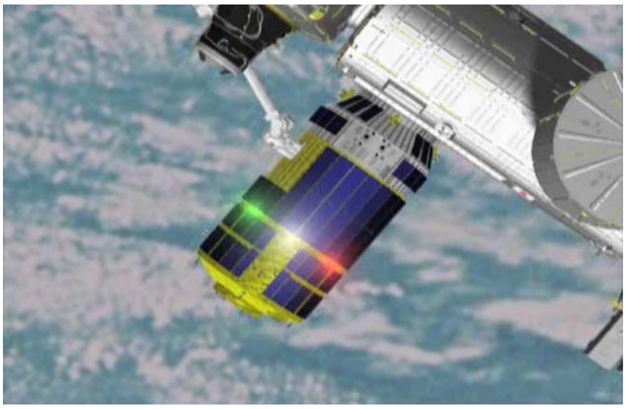
Fig. 1.3.5-4 Reinstallation of the EP into the ULC

1.3.6 Departure from the ISS and Reentry

After being loaded with trash and discarded items, the HTV will be unberthed from the ISS. The HTV will complete its operations by reentering the atmosphere. HTV's undocking and departure sequence is as follows:

1. The ISS crew will conduct preparations for unberthing the HTV.
2. The Inter-Module Ventilation (IMV) system will be deactivated.
3. The ISS crew will perform vestibule de-outfitting between the HTV and Harmony, and the hatches of the HTV and Harmony will be closed.
4. The station's robotic arm (SSRMS) will grapple the HTV.
5. The HTV will be deactivated.
6. The Common Berthing Mechanism (CBM) will be disengaged.
7. The SSRMS will move the HTV to the release point.
8. The SSRMS will release the HTV.
9. The HTV thrusters will be activated.
10. The HTV will separate and depart from the ISS.





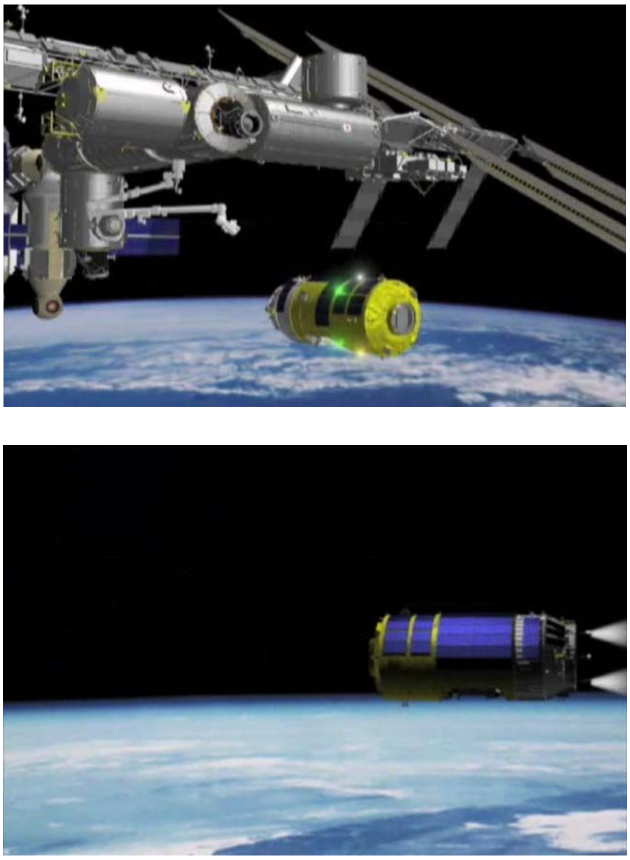


Fig. 1.3.6-1 Departure from the ISS

After the HTV departs from ISS orbit, the HTV will conduct two orbital maneuvers. These maneuvers will insert the HTV into the preparatory orbit for reentry.

In the pre-reentry orbit, timing of deorbit maneuvers will be adjusted. The HTV will enter the atmosphere with the deorbit maneuvers.

Fig. 1.3.6-2 shows a planned HTV reentry path and expected falling area of HTV debris.

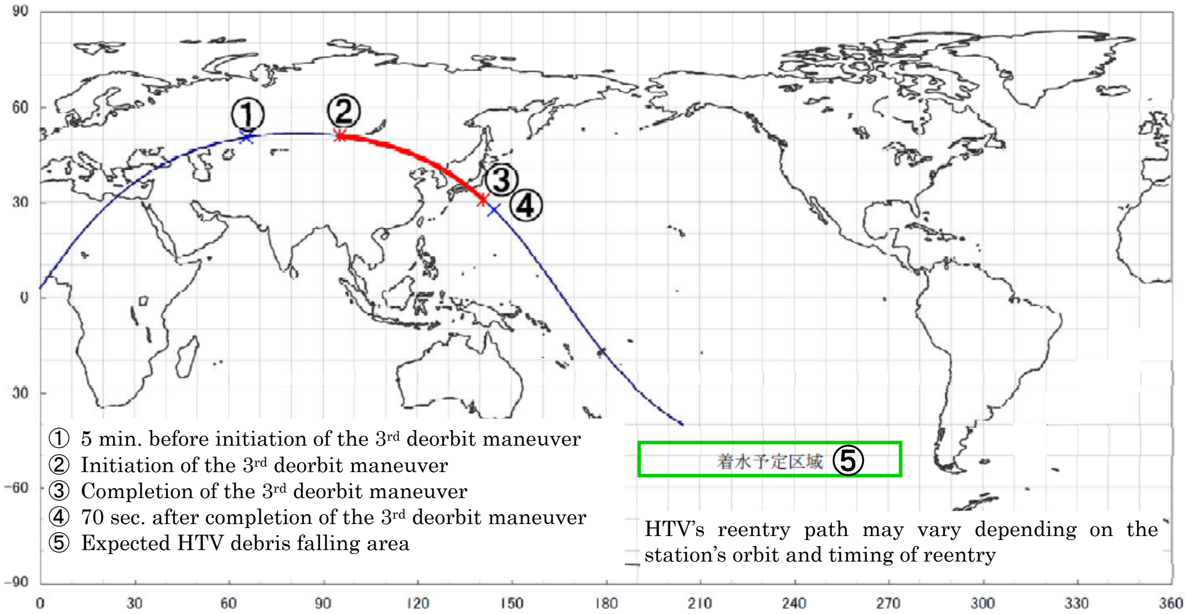
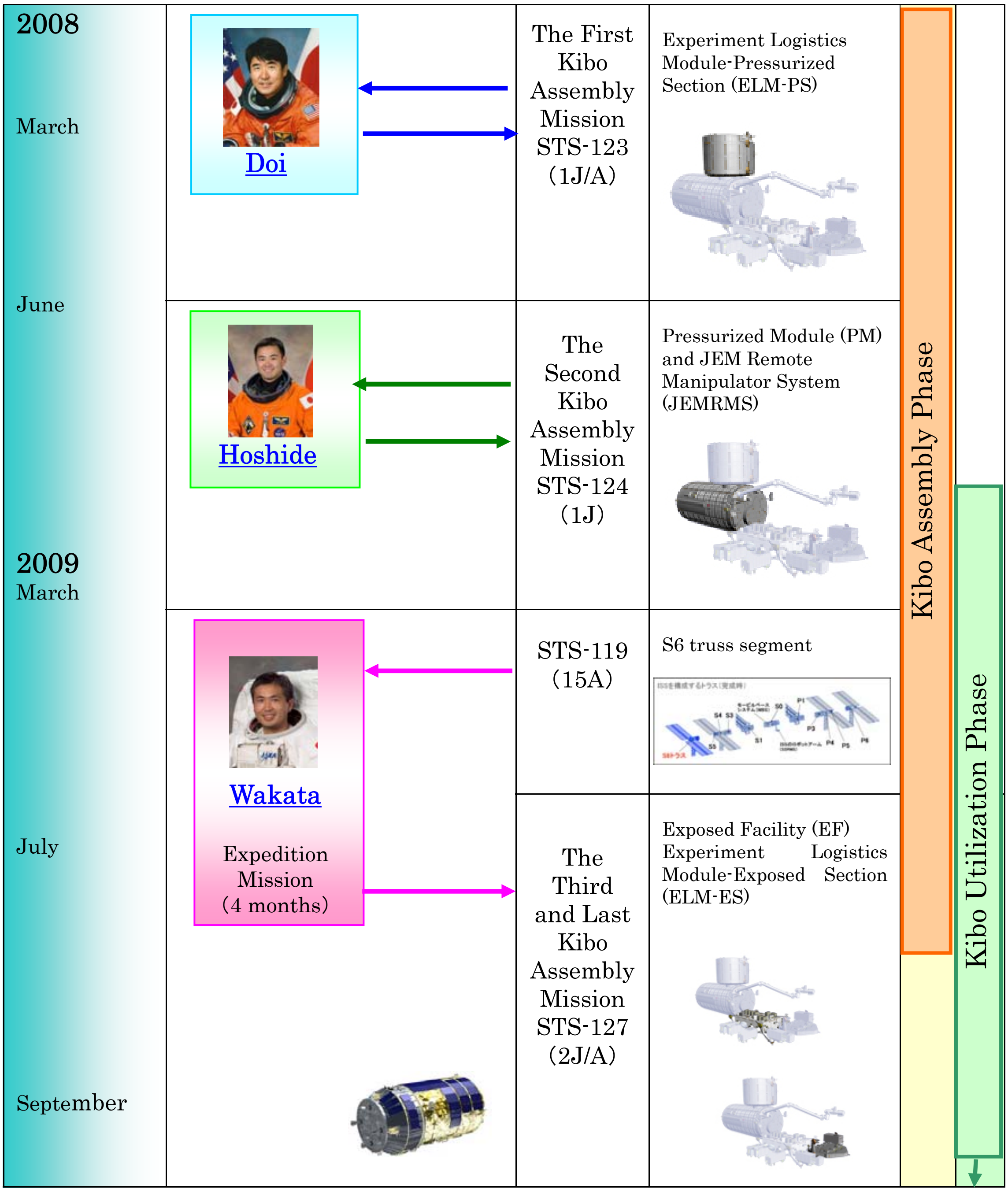
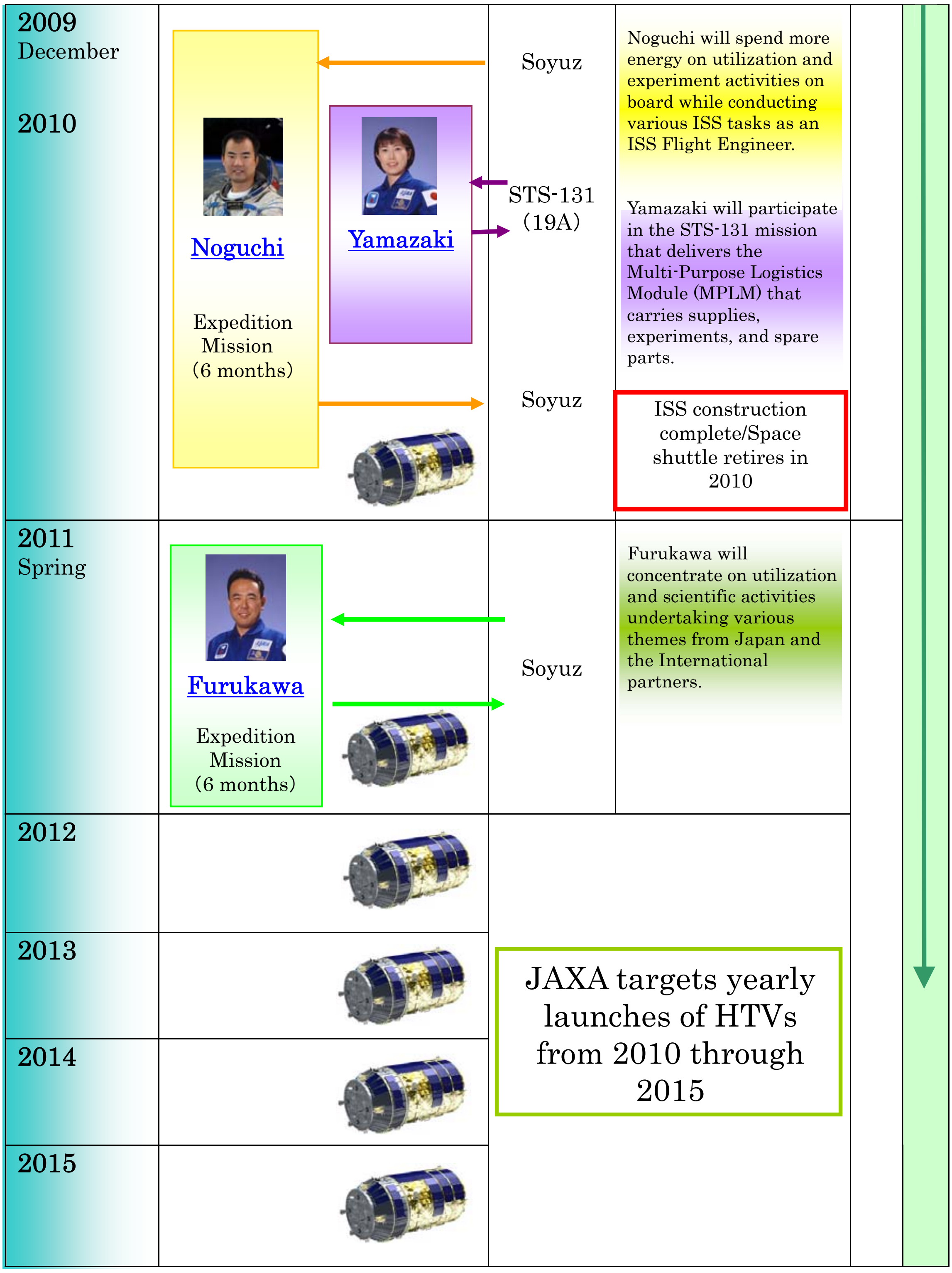


Fig. 1.3.6-2 HTV's Projected Reentry Path (Red Lines) and Expected HTV Debris Falling Area

This Page is intentionally left blank

1.4 Kibo Assembly Missions and Future HTV Missions




2009
December
2010
Noguchi
Expedition Mission (6 months)
Yamazaki
Soyuz
STS-131 (19A)
Soyuz
Noguchi will spend more energy on utilization and experiment activities on board while conducting various ISS tasks as an ISS Flight Engineer.
Yamazaki will participate in the STS-131 mission that delivers the Multi-Purpose Logistics Module (MPLM) that carries supplies, experiments, and spare parts.
ISS construction complete/Space shuttle retires in 2010
2011
Spring
Furukawa
Expedition Mission (6 months)
Soyuz
Furukawa will concentrate on utilization and scientific activities undertaking various themes from Japan and the International partners.
2012
2013
2014
2015
JAXA targets yearly launches of HTVs from 2010 through 2015

2. HTV-1 Mission

2.1 HTV-1 Mission Summary

The HTV-1 Mission, HTV's first flight to the ISS, has two major objectives: one is to deliver supplies to the ISS and the other is to verify HTV's rendezvous flight techniques and operability of the HTV onboard systems during its actual flight. For this reason, this HTV maiden flight vehicle is also called a "Technical Demonstration Vehicle". The HTV-1 Mission will perform the following technical/engineering demonstrations while transporting supplies and cargo to the ISS:

- Demonstration of HTV's rendezvous flight operations
- Verification of HTV's safety and flight control technology
- Demonstration of durability and robustness of the HTV structures on orbit
- Verification of HTV's avionics and propulsion system components (more than 800,000 parts)
- Demonstration of astronaut's ingress to the HTV pressurized section during the docked phase

Table 2.1-1 shows the HTV-1 Mission Profile.

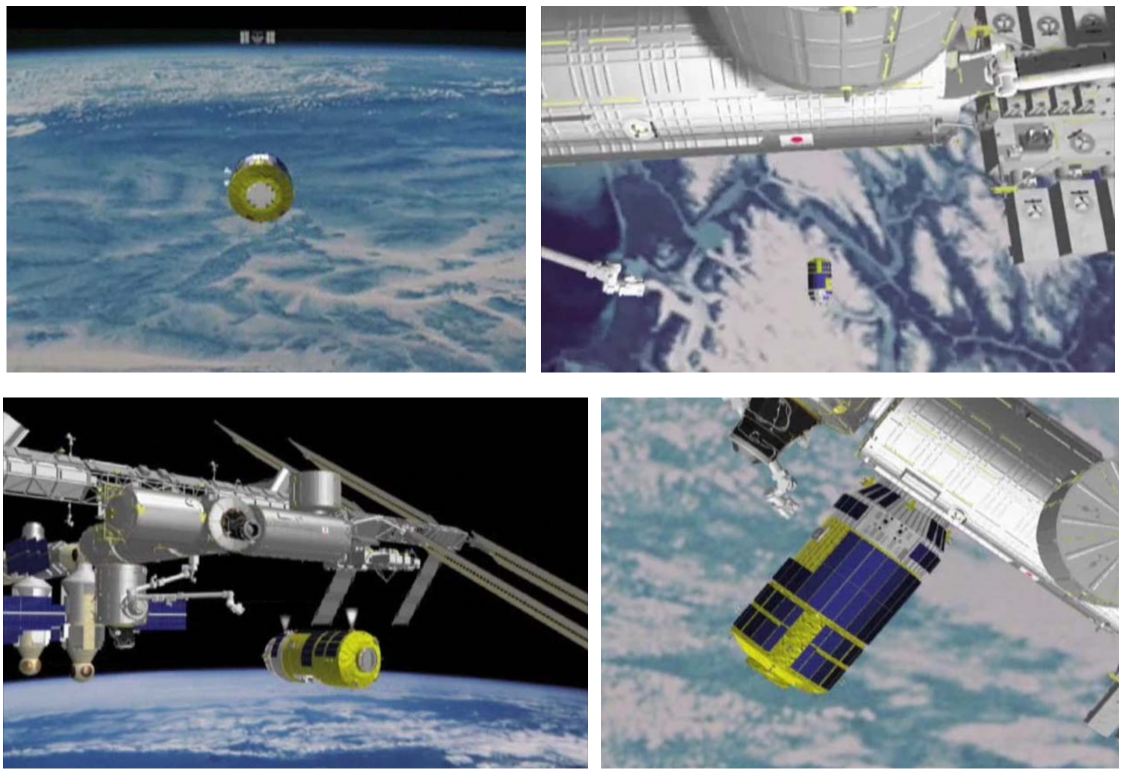


Fig. 2.1-1 HTV Flight Images

Table 2.1-1 HTV-1 Mission Profile

<table>
<tr><th colspan="3">Mission Details</th></tr>
<tr><td>HTV Flight Number</td><td colspan="2">HTV-1 (maiden flight)</td></tr>
<tr><td>Vehicle</td><td colspan="2">Technical Demonstration Vehicle</td></tr>
<tr><td>Launch Date</td><td colspan="2">September 11, 2009 2:01 a.m. (Japan Standard Time)</td></tr>
<tr><td>Launch Period</td><td colspan="2">September 12 through September 30, 2009</td></tr>
<tr><td>Launch Site</td><td colspan="2">Launch Pad 2 (LP2), Tanegashima Space Center (TNSC)</td></tr>
<tr><td>Mission Duration</td><td colspan="2">55 days (maximum duration)</td></tr>
<tr><td>Altitude</td><td colspan="2">Insertion: 200 km × 300 km (elliptical orbit)
Rendezvous: Approx. 350 km</td></tr>
<tr><td>Inclination</td><td colspan="2">51.6 degrees</td></tr>
<tr><td rowspan="2">Payload</td><td>Pressurized Logistics Carrier (PLC)</td><td>Supplies for onboard use
HTV Resupply Rack (HRR) x 7,
Pressurized Section Resupply Rack (PSRR) x 1</td></tr>
<tr><td>Unpressurized Logistics Carrier (ULC)</td><td>SMILES (Japanese experiment)
HREP (NASA's experiment)</td></tr>
</table>

You will find more information about the HTV-1 Mission at the following websites:
http://iss.jaxa.jp/en/htv/index.html
http://www.jaxa.jp/countdown/h2bf1/index_e.html

Note1: The HTV-1 Mission schedule will vary depending on the ISS's operations timeline

Note2: Berthing duration may be rescheduled and extended from HTV's nominal berthing duration (30 days) up to 45 days

2.2 HTV-1 Mission Timeline

Table 2.2-1 HTV-1 Mission Timeline Overview

Updated September 9, 2009

Flight Day	Missions
FD1	Launch/Insertion, post-insertion auto sequence (the HTV subsystem activations, attitude control, self-check, TDRS communications establishment, initiation of communication with the HTV Mission Control Room (MCR), TKSC, far field rendezvous flight maneuver
FD2	Far field rendezvous flight maneuver
FD3	Far field demonstrations Collision Avoidance Maneuver (CAM), passive abort and attitude control, correction from large attitude deviation, Free Drift
FD4 to 5	Far field rendezvous flight maneuver
FD6	IMMT review on the HTV demonstration operations data
FD7	Far field rendezvous flight maneuver
FD8	ISS proximity operations, final approach, capture by station's robotic arm, berthing to the ISS critical vestibule outfitting, activation of the HTV subsystems
FD9	Vestibule outfitting, crew ingress, cargo transfer (from HTV to ISS)
FD10 to 13	Cargo transfer from HTV to ISS
FD14	Temporary installation of the Exposed Pallet (EP) to Kibo Exposed Facility (EF)
FD15	Transfer and installation of two external experiments (SMILES and HREP) to the Exposed Facility (EF)
FD16	Removal of the EP from the EF and reinstallation of the EP onto the HTV (robotic operation)
Berthed Operations From FD17	Cargo Transfer from HTV to ISS Trash stowage (loading waste and other discarded items on the HTV PLC)
Unberthing Preparations	HTV unberthing preparation (cable de-mate, deactivation of the Inter-Module Ventilation system, hatch closure)
Unberthing Operations	HTV deactivation and release ・ Vestibule outfitting ・ HTV subsystem deactivation ・ CBM unberthing ・ HTV Guidance Navigation Control (GNC) activation, HTV propulsion system enabled ・ Release, departure
Reentry (2 days)	Deorbit maneuver, reentry

Note: The HTV-1 Mission schedule will vary depending on the space station's operations timeline

On the HTV-1 Mission, the HTV will be berthed to the ISS on FD8. Once the HTV is docked to the ISS, supply/cargo transfer between the HTV and the ISS will begin. The HTV will then be loaded with trash and used materials and will be unberthed from the ISS. Finally, the HTV will reenter the atmosphere and complete its operations.

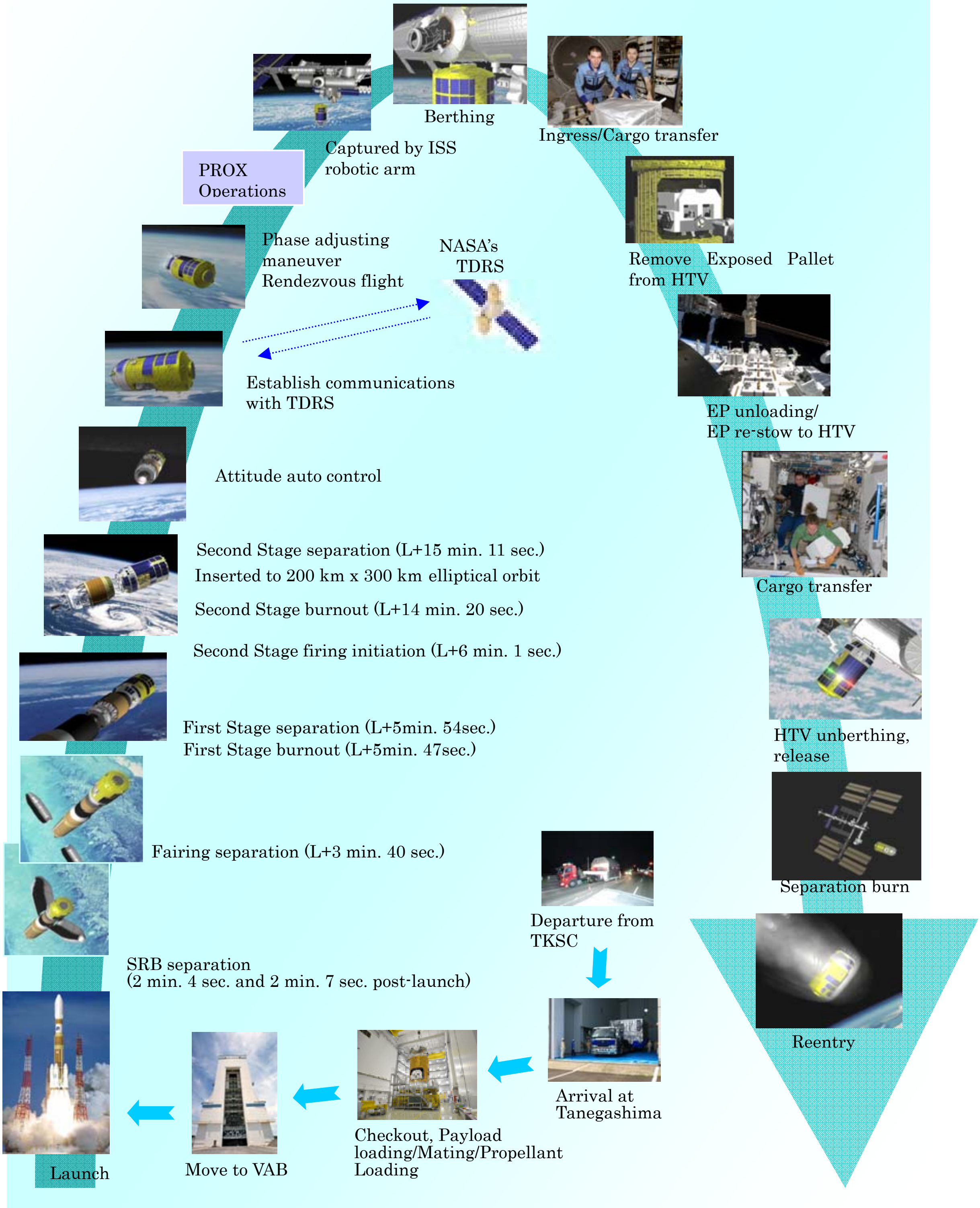


Fig. 2.2-1 HTV-1 Mission Event Sequence

The following pages show a day-by-day schedule of the HTV-1 Mission.

Definition of HTV Mission Flight Day (FD):
HTV Mission's Flight Day (FD) is based on the ISS crew timeline. Thus, there may be a slight difference in the day count between the Mission Elapsed Time (MET) and the FD.

Note1: The HTV-1 Mission schedule will vary depending on the ISS's operations timeline

Note2: Berthing duration may be rescheduled and extended from HTV's nominal berthing duration (30 days) up to 45 days

Updated September 9, 2009

FD1 (Flight Day 1 Activities)

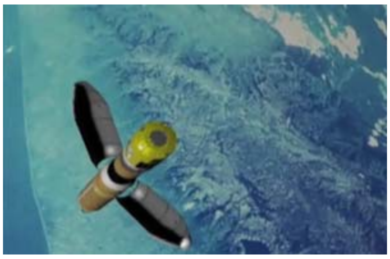
Major Objectives

- Launch/Insertion into Orbit
- Post-Insertion Auto Sequence (activation of the HTV subsystems, attitude control, self-check, acquisition of TDRS communications, initiation of communications with the HTV Mission Control Room)
- Far Field Rendezvous Flight

- Launch/Orbit Insertion

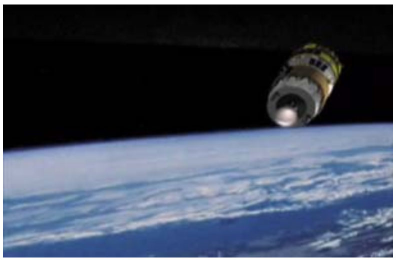
The HTV maiden flight vehicle (Technical Demonstration Vehicle) will be launched from the Tanegashima Space Center (TNSC) aboard the H-IIB launch vehicle. Launch opportunity is once a day as its launch time has to be adjusted and scheduled for when the ISS orbital plane is passing over the Tanegashima Space Center.

The Solid Rocket Boosters (SRB-A) will separate 2 minutes 7 seconds after launch, and the fairing will separate 3 minutes 40 seconds after launch. Propellant of the First Stage will be spent in 5 minutes 47 seconds and First Stage separation will occur 5 minutes 54 seconds after launch. Thereafter, the Second Stage will ignite to insert the HTV into an elliptical orbit with an altitude of 200 km (apogee) x 300 km (perigee). The Second Stage will burn out after 14 minutes 20 seconds and separate from the HTV 15 minutes 11 seconds after launch.

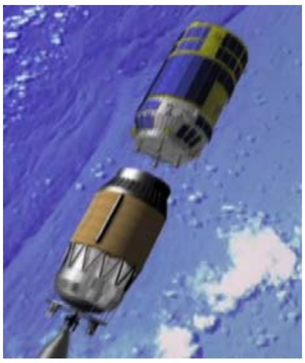


Fairing Separation

First Stage Separation



Second Stage Ignition



Second Stage Separation

- Post-Insertion Auto Sequence

Following the ascent phase, the HTV will automatically activate the HTV subsystems, stabilize its attitude, and perform self-checks on the HTV components. Then, the HTV will establish communications with TDRS and initiate communications with the HTV Mission Control Room (MCR) at Tsukuba Space Center (TKSC).

- HTV Rendezvous Flight

HTV's rendezvous flight will continue over the next 7 days.

*Please see Section 1.3.2 "Rendezvous Flight"

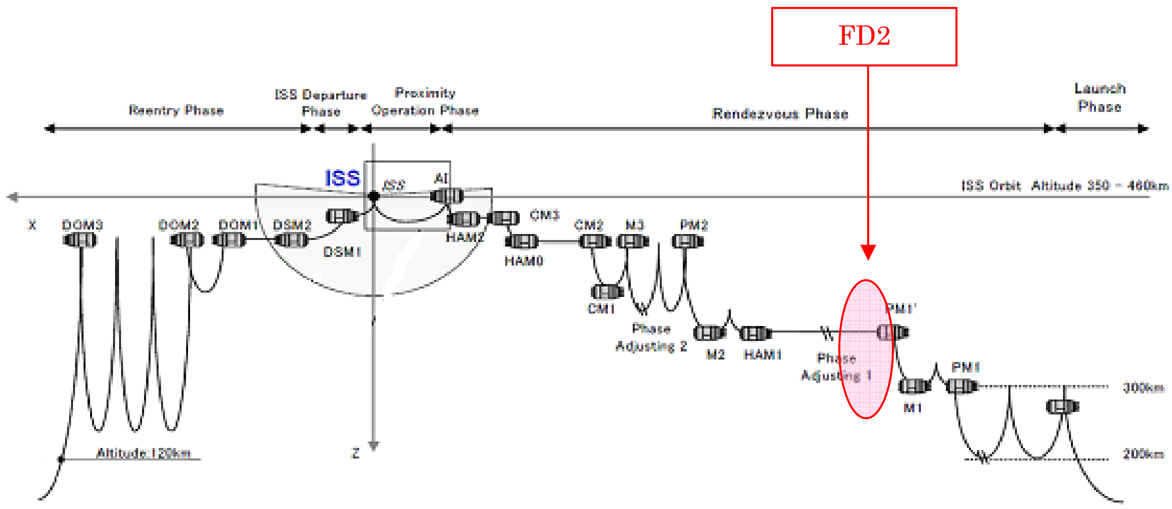
FD2 (Flight Day 2 Activities)

Major Objective

- Far Field Rendezvous Flight

- Far Field Rendezvous Fight (Continued)

  *Please see Section 1.3.2 "Rendezvous Flight"



FD3 (Flight Day 3 Activities)

Major Objectives

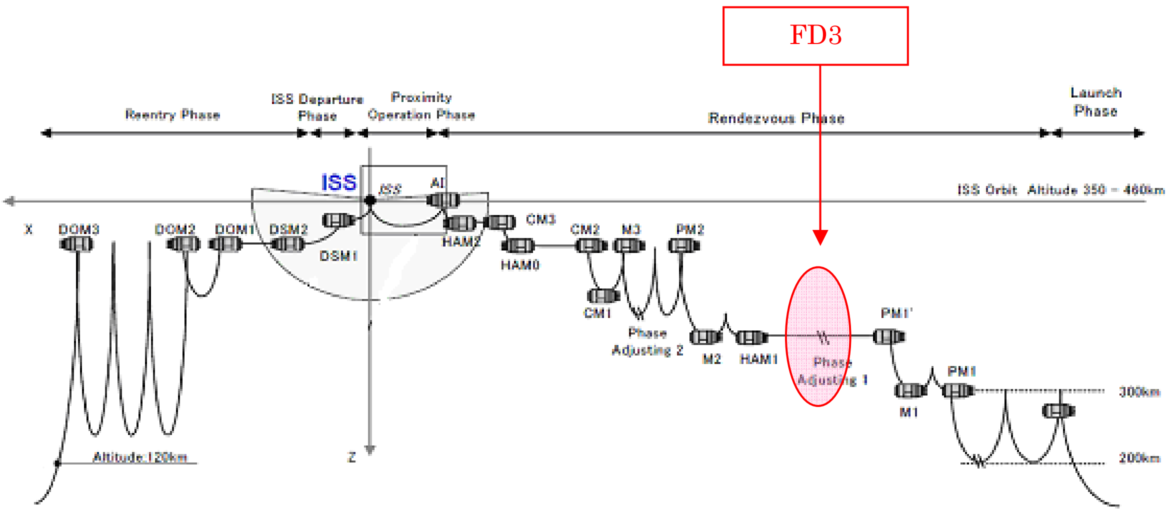
- Far Field Demonstrations
- Far Field Rendezvous Flight

- Far Field Demonstrations

The following demonstrations will be performed on FD3:

- Collision Avoidance Maneuver (CAM)
- Passive abort and attitude control by HTV's Guidance & Navigation Control system
- Checkouts of the Abort Control Unit (ACU) and CAM
- Correction of large attitude deviation
- Free Drift

The data collected during the demonstrations will be analyzed by the ground team prior to the technical assessment of the HTV by the ISS Mission Management Team (IMMT) scheduled on FD6. The IMMT will give the "Go" if the data meet the criteria for receiving the ISS resupply vehicle.



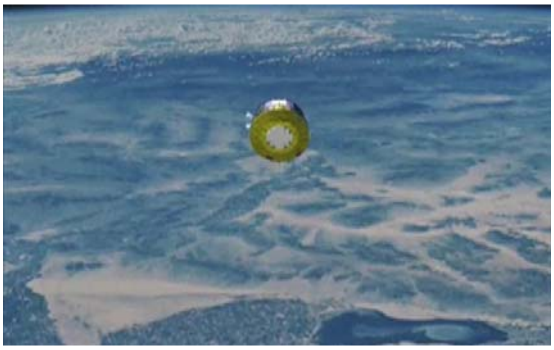
FD4 to FD7 (Flight Day 4 to 7 Activities)

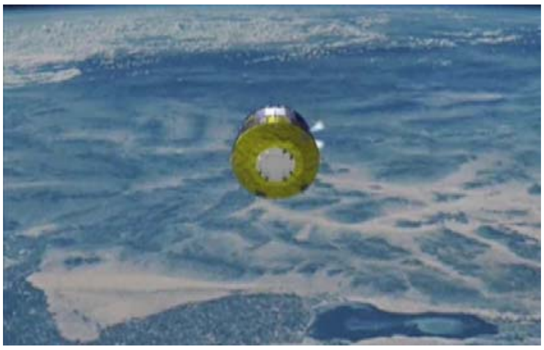
Major Objectives

- Far Field Rendezvous Flight
- IMMT Review on the Demonstration Data

- Far Field Rendezvous Fight (Continued)

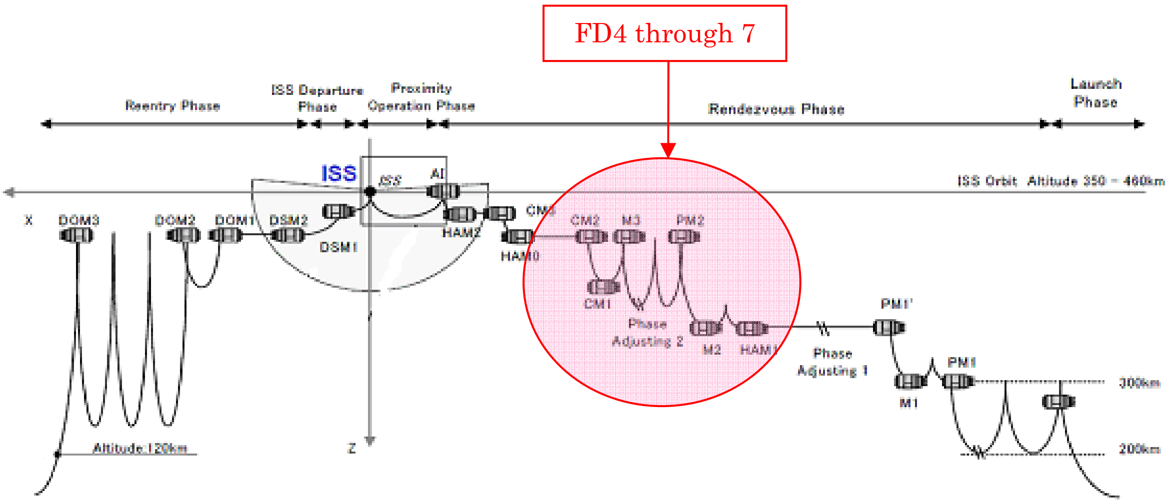
*Please see Section 1.3.2 "Rendezvous Flight"





- IMMT Review on the Demonstration Data, IMMT Approval of HTV's Final Rendezvous Operations

On FD6, the ISS Mission Management Team (IMMT) will review the data collected during the HTV demonstration tests on FD3. The IMMT will give the "Go" for ISS proximity operations, final approach, and berthing if the data meet the criteria for receiving the ISS resupply vehicle.



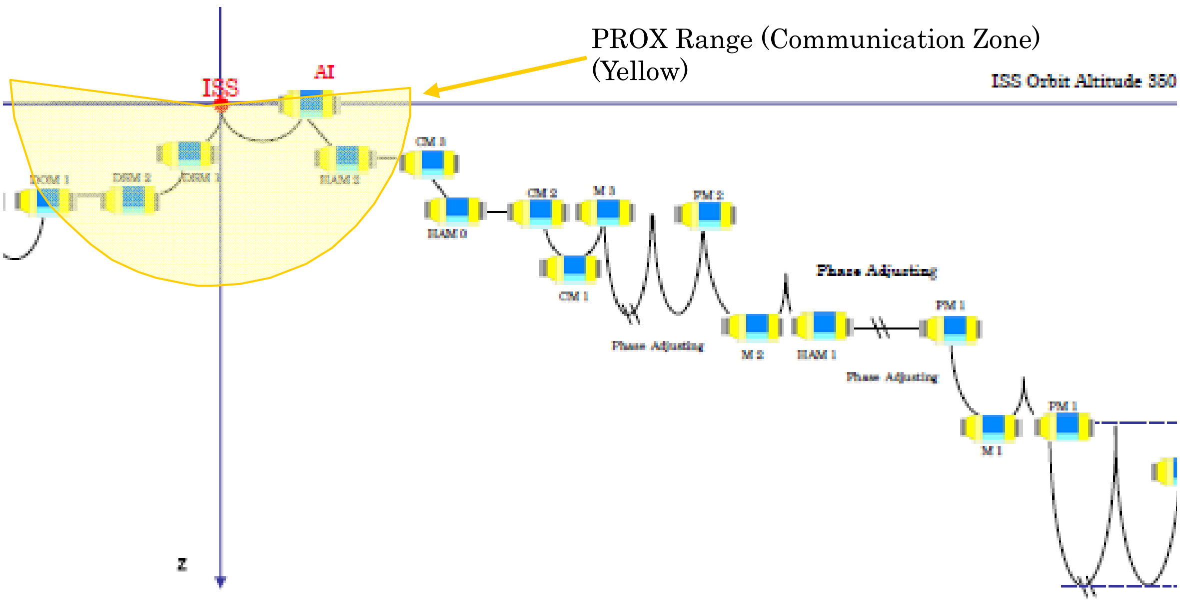
FD8 (Flight Day 8 Activities)

Major Objectives

- Proximity Operation
- Final Approach to the ISS
- Capture by the Space Station Remote Manipulator System (SSRMS)
- Berthing to the Nadir Side of the Common Berthing Mechanism (CBM) of Harmony (Node 2)
- Vestibule Outfitting

- Proximity Operation

After the HTV reaches the "proximity communication zone" (23 km from the ISS), where the HTV can directly communicate with the ISS, the HTV will establish communications with the Proximity Communication System (PROX). The HTV will continue to approach until it reaches the "Approach Initiation (AI) point", 5 km behind the ISS. At this point, the HTV will maintain this distance from the ISS and wait for IMMT's approval for final approach maneuvers.



From 90 minutes before the HTV reaches the AI point, the Mission Control Center (MCC-H) at NASA's Johnson Space Center (JSC) in Houston will begin monitoring of HTV operations. From this point, HTV integration operations by the HTV MCR and MCC-H will begin. The HTV may have to adjust and reschedule its flight timeline up to 24 hours (16 hours during the phase adjusting period and up to 8 hours at the AI point) since HTV proximity operation will have to be performed during ISS crew on-duty hours.

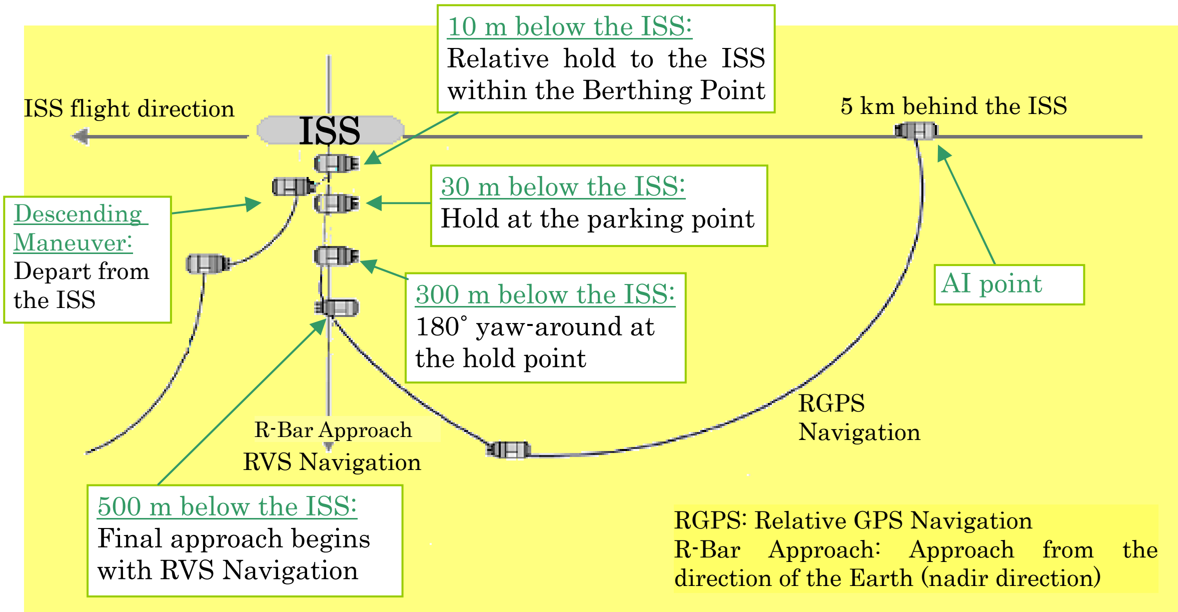
- Final Approach

After the IMMT gives approval for final rendezvous maneuvers, the HTV will initiate the final approach to the ISS (the "AI Maneuver").

The HTV will move from the AI point to a point 500 meters below the ISS (RI point) guided by the Relative GPS Navigation. Using a laser called "Rendezvous Sensor (RVS)*", the HTV will move closer to the ISS.

* Laser reflectors are installed on Kibo.

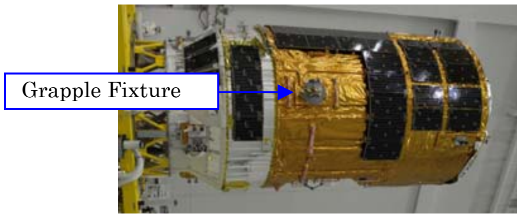
FD8 (Flight Day 8 Activities) (Continued)



The HTV will hold its approach at 300 m below the ISS (hold point) and at 30 m below the ISS (parking point). At the hold point, the HTV will turn its attitude 180 degrees (yaw-around) to prepare for its contingency maneuver. Eventually, the HTV will stop 10 m below the ISS at the "Berthing Point" and maintain its distance from the ISS.
During this phase, HTV's approach speed is 1 to 10 meters per minute. The ISS crew can send commands such as "HOLD", RETREAT", and "ABORT", to the HTV if an emergency occurs.

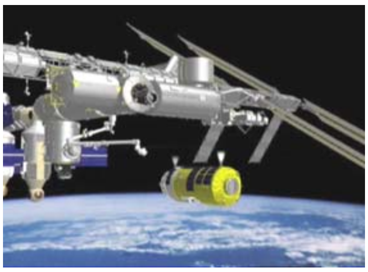
- Capture by the SSRMS

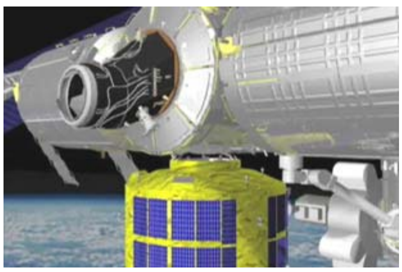
Once the HTV MCR confirms that the HTV has reached 10 m below the ISS and is maintaining this distance from the ISS, HTV MCR or the ISS crew will send commands to disable the HTV thrusters (free drift state).



- Berthing to the Nadir Side of the CBM on Harmony (Node 2)

The station's robotic arm (SSRMS) will grapple the HTV and berth the HTV to the CBM located at the nadir side (facing Earth) of Harmony.





Once the HTV is berthed to Harmony, the HTV subsystems will be activated. Vestibule outfitting from the Harmony side will be performed by the ISS crew for ingress preparation.

FD9 (Flight Day 9 Activities)

Major Objectives

- Crew Ingress
- Cargo Transfer

- Crew Ingress

The ISS crew will perform vestibule outfitting (wire connections and cable settings) in preparation for ingress. After completing vestibule outfitting, lights in the Pressurized Logistics Carrier (PLC) will be powered and air pressure in the PLC will be adjusted by commands from the HTV MCR. Then, both HTV and ISS hatches will be opened by commands from the HTV MCR.

Once the hatches are opened, the Inter-Module Ventilation (IMV) will be activated and air between Harmony and the PLC will be circulated. ISS crew will then enter the PLC and deploy safety tools, such as the emergency procedure manual, Portable Breathing Apparatus (PBA), and Portable Fire Extinguisher (PFE).

Inside of the HTV Pressurized Logistics Carrier (PLC)

View of the vestibule between Harmony and the MPLM; The MPLM being docked to the CBM, located at the nadir side of Harmony

The temperature inside the PLC will be maintained at 15.6 degrees Celsius prior to opening the HTV hatch.

- Cargo Transfer (from HTV to ISS)

ISS crew will begin cargo transfer.

FD10 to FD13 (Flight Day 10 to 13 Activities)

Major Objective

- Cargo Transfer (from HTV to ISS)

● Cargo Transfer (from HTV to ISS)

The ISS crew will perform cargo transfer operations according to transfer checklists.

Cargo Transfer Bags (CTBs) being installed in the HTV Resupply Rack (HRR)

Food, Commodities, Samples

Crew members look at transfer checklists during cargo transfer operations

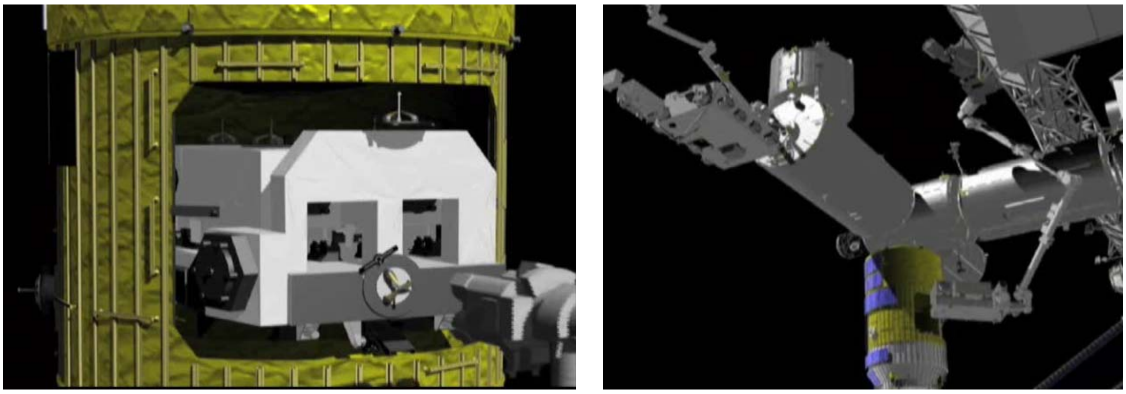
FD14 (Flight Day 14 Activities)

Major Objective

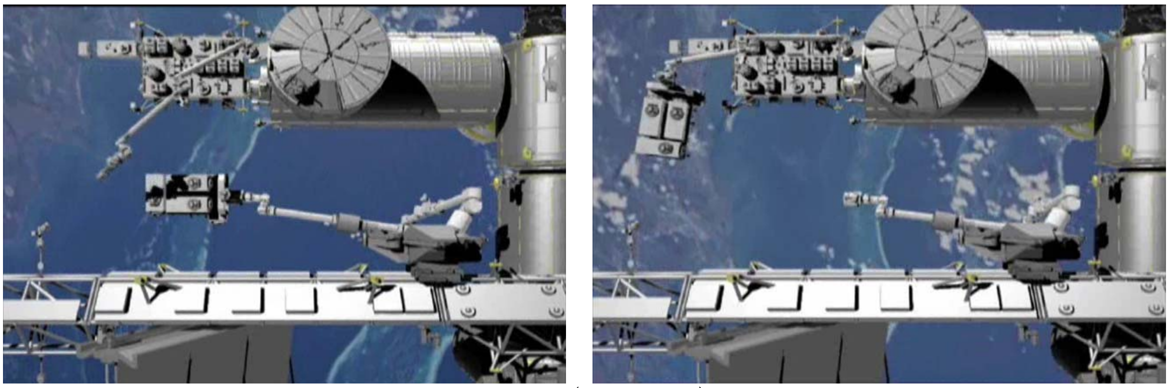
- Removal of the Exposed Pallet from the HTV Unpressurized Logistics Carrier (ULC)
- Temporary Installation of the Exposed Pallet on Kibo's Exposed Facility (EF)

- Removal of HTV's Exposed Pallet (EP) from the ULC/Temporary Installation of the EP on Kibo's Exposed Facility (EF)

The Exposed Pallet (EP) will be removed from the HTV Unpressurized Logistics Carrier (ULC) by the station's robotic arm (SSRMS). The EP will be temporarily installed on Kibo's Exposed Facility (EF) for unloading of the two external experiments carried on the EP.



SSRMS removes the EP from the ULC



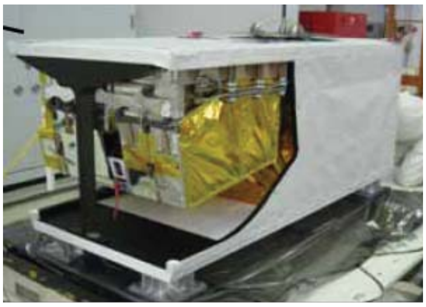
The EP is handed over to Kibo's robotic arm (JEMRMS) and temporarily installed on Kibo's Exposed Facility

FD15 (Flight Day 15 Activities)

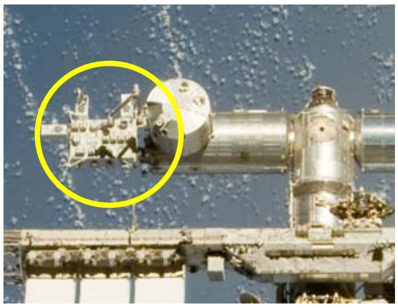
Major Objective

- Transfer of two External Experiment

- Transfer of an External Experiment (HREP)
  Using Kibo's robotic arm (JEMRMS), NASA's external experiment will be removed from the Exposed Pallet (EP) and transferred and installed on the Exposed Facility (EF).
  ※Please see Section 2.3.2 "Payload carried on the ULC" for more information on the HREP


HREP

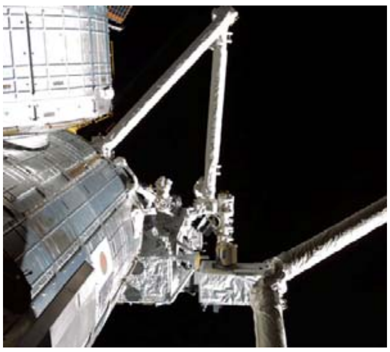

Kibo's Robotic Arm Work Station (JEMRMS Console)

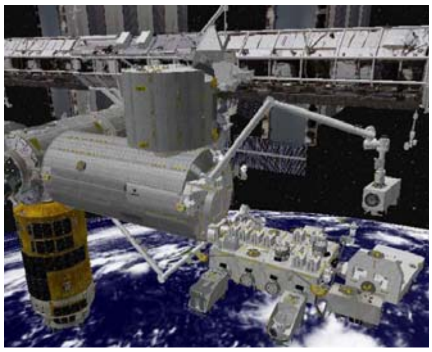

Location of Kibo's EF on the ISS (STS-127)

*HREP: Hyperspectral Imager for the Coastal Ocean (HICO) and Remote Atmospheric & Ionospheric Detection System (RAIDS) Experiment Payload

- Transfer of an External Experiment (SMILES)
  Using Kibo's robotic arm (JEMRMS), Japanese external experiment will be removed from the Exposed Pallet (EP) and transferred and installed on the Exposed Facility (EF).
  ※Please see Section 2.3.2 "Payload carried on the ULC" for more information on SMILES


SMILES


Kibo's robotic arm, JEMRMS, installing an external payload


An image of robotic installation

*SMILES: Superconducting Submilimeter-Wave Limb-Emission Sounder

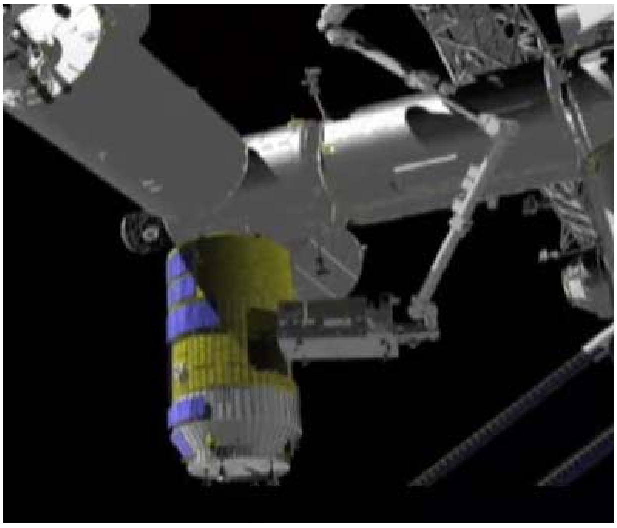
Berthed Operations (Activities on FD16 and from FD 17)

Major Objectives

- Reinstallation of the Exposed Pallet into the ULC
- Trash Stowage (from ISS to HTV)

- Reinstallation of the Exposed Pallet (EP) into the ULC

On FD16, after the EF payloads carried on the Exposed Pallet (EP) are unloaded, the EP will be re-stowed in the HTV Unpressurized Logistics Carrier (ULC).
First, Kibo's robotic arm (JEMRMS) will remove the EP from the EF.
Then the EP will be handed over to the station's robotic arm (SSRMS).
Finally, the EP will be reinstalled into the HTV ULC.



- Trash Stowage (from ISS to HTV)

From FD17, when cargo transfer from the HTV PLC to the ISS is complete, trash and other discarded items will be loaded into the PLC from the ISS.

Unberthing Preparation (Activities on the Day before Unberthing)

Major Objectives

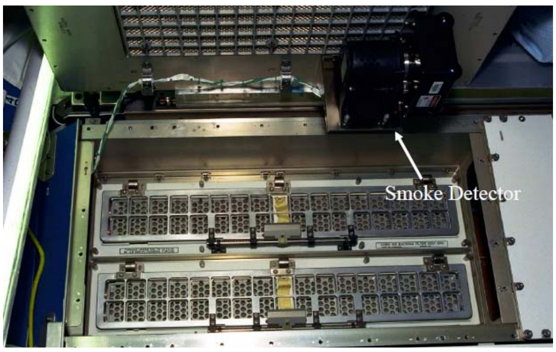
- Preparation for HTV Unberthing (Removal of lights, smoke detectors, portable fire extinguishers, and portable breathing apparatuses, installation of CPA on the CBM, cable de-mating, deactivation of IMV system)
- Vestibule De-outfitting/Hatch Closure

● Preparation for HTV Unberthing/Vestibule De-outfitting/Hatch Closure

For reuse purposes, lights and smoke detectors carried onboard the HTV will be removed and transferred to the ISS before hatch closure. Portable fire extinguishers and portable breathing apparatuses deployed inside the PLC will also be removed and transferred to the ISS. Lastly, ISS crew will de-mate the cables and wires in the vestibule and close the hatches between the HTV and Harmony. Then, the Inter-Module Ventilation (IMV) system and subsystems of the HTV will be deactivated.

Left: Portable Fire Extinguisher (PFE)

Right: Portable Breathing Apparatus (PBA)



Smoke Detectors will be installed on the ventilation system in the PLC during docked operations

Unberthing Operations (Activities on the Unberthing Day)

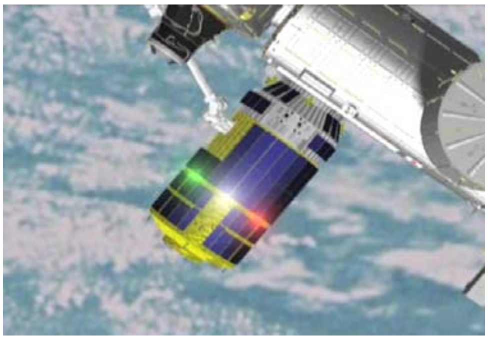
Major Objectives

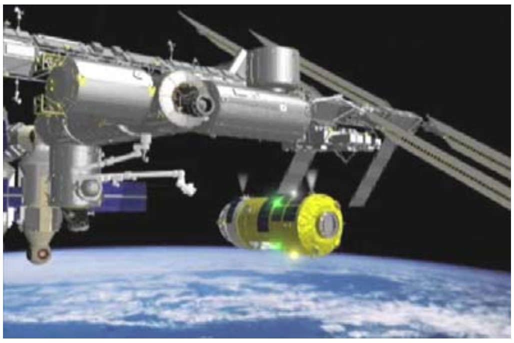
- Unberthing and Release of the HTV by the Space Station Remote Manipulator System (SSRMS)
- Separation Maneuver

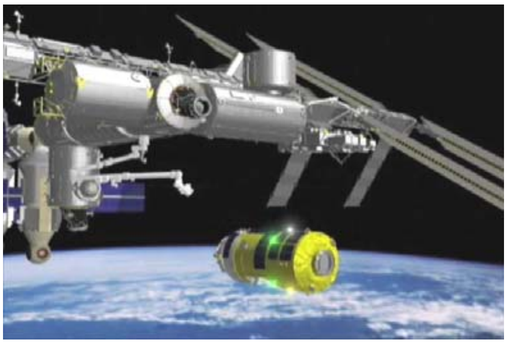
- Unberthing and Release of the HTV

The HTV will be unberthed from the ISS by the station's robotic arm (SSRMS) and released into space according to the following procedures:

1 The HTV will be grappled by the SSRMS
2 The Common Berthing Mechanism (CBM) between the HTV and Harmony will be unberthed
3 The SSRMS will move the HTV to the release position
4 HTV's Guidance Navigation Control (GNC) will be activated
5 HTV's propulsion system will be primed
6 The SSRMS will release the HTV
7 The HTV will perform departure maneuver







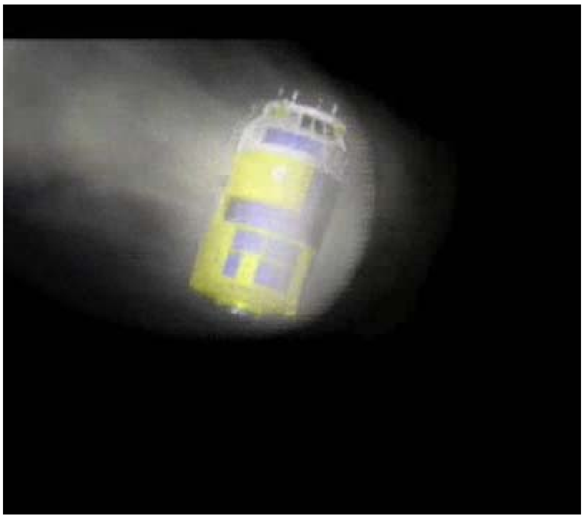
Reentry Operations (Two-day Operations after the Unberthing)

Major Objectives

- Deorbit Burn, Reentry

- Deorbit Burn, Reentry

The HTV will conduct deorbit maneuvers. Then, the HTV will reenter the atmosphere.



2.3 Payload

The HTV-1 Mission will deliver approximately 4.5 tons of cargo to the ISS.
On the HTV-1 Mission, the HTV will carry additional propellants and batteries since demonstration tests are scheduled during the mission. Therefore, the cargo carried on the HTV-1 Mission is less than the standard mass capacity of the HTV.

Fig. 2.3-1 PLC (Resupply racks with cargo transfer bags being installed inside the module)

Fig. 2.3-2 EP (External payloads being installed on the pallet)

2.3.1 Payload Carried on the PLC

The HTV Pressurized Logistics Carrier (PLC) will carry about 3.6 tons of cargo on the HTV-1 Mission.

- Seven HTV Resupply Racks (HRRs)
- One Pressurized Stowage Resupply Rack (PSRR)

Supplies will be packed in Cargo Transfer Bags (CTBs) and then installed in the HRRs and PSRR.

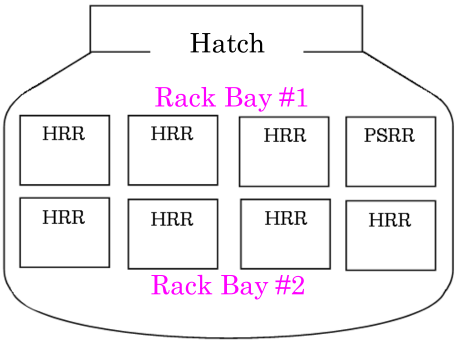


Fig. 2.3.1-1 PLC Rack Layout

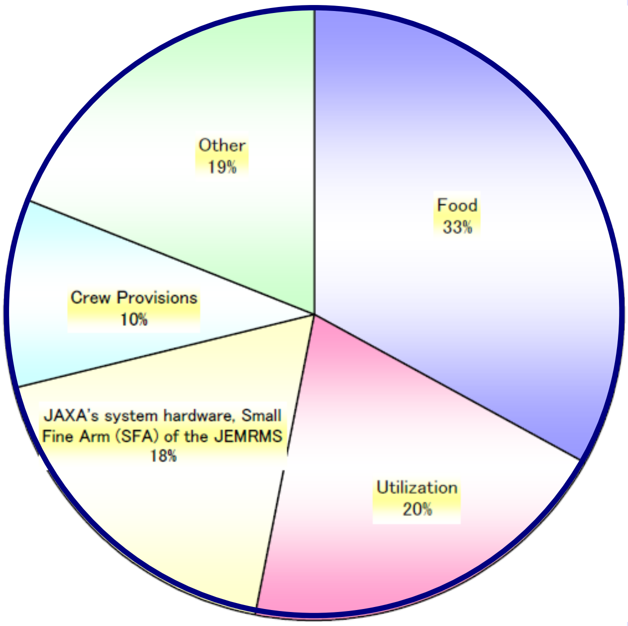


Fig. 2.3.1-2 Cargo Ratio

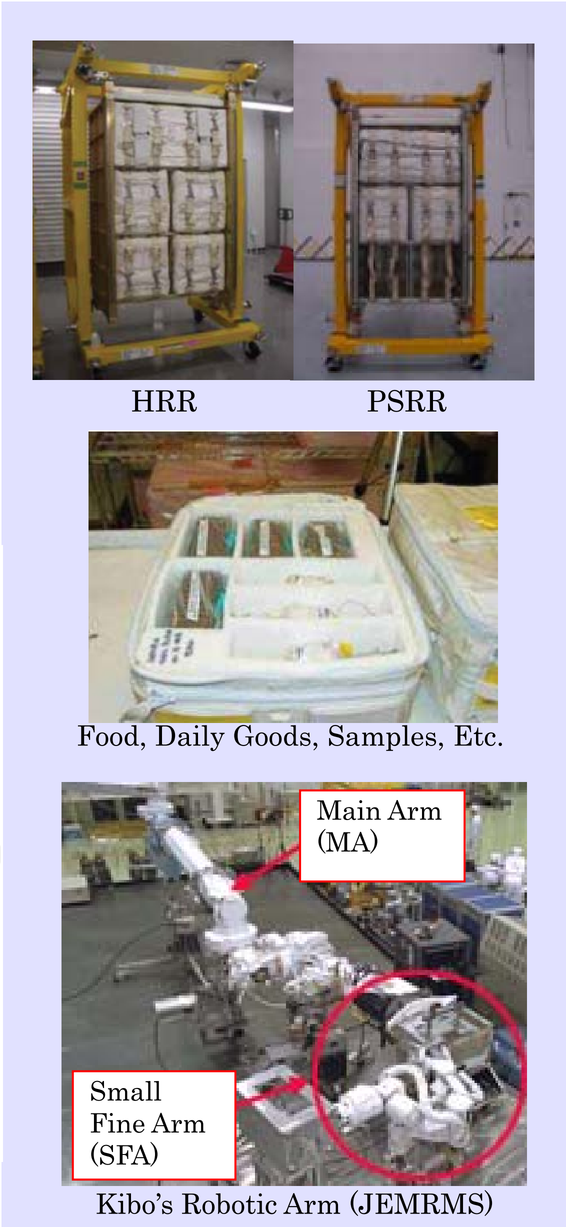


Fig. 2.3.1-3 Items to Be Carried on the HTV-1 Mission

Fig. 2.3.1-4 CTBs being installed in HRRs

Fig. 2.3.1-5 CTB

Fig. 2.3.1-6 Cargo Layout inside the PLC (HTV-1)
(*CTBs are also installed on the front side of the HRRs)

2.3.2 Payload Carried on the ULC

The HTV Unpressurized Logistics Carrier (ULC) will carry two external experiments on the HTV-1 Mission.

- Japanese external experiment (475 kg)
- NASA's external experiment (381 kg)

(1) Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)

Fig. 2.3.2-1 SMILES

【Objectives】

SMILES aims at demonstrating a sensitive submillimeter-wave sounder and monitoring global distributions of stratospheric trace gases.

SMILES is the first experiment to use a superconductive low-noise receiver with a mechanical 4K refrigerator in space, and it enables global mappings of stratospheric trace gases.

Atmospheric changes, such as ozone depletion and global warming, which are attributed to human activities, are becoming a serious environmental issue. The ozone layer protects the creatures of Earth from direct exposure to solar radiation by absorbing the hazardous ultraviolet rays. However, due to Freon gas produced by modern human activities, the ozone layer is being depleted rapidly.

Waves emitted from the molecules spread on lower pressure areas, such as at an ozone layer altitude, can be identified by frequency measurements. A submiliwave, which has a high frequency, can be especially useful for indentifying ozone-related molecules. From the ISS, SMILES will measure submiliwaves emitted from the trace gases with its highly sensitive submillimeter-wave sounder.

【Operations】

SMILES will be installed on Kibo's Exposed Facility (EF) at attachment position number three (Exposed Facility Unit 3: EFU3). Expected operational duration of SMILES (life expectancy of the SMILES equipment) is about a year after starting operations. However, SMILES will be operated as long as it supports observation and measurement activities.

http://kibo.jaxa.jp/en/experiment/ef/smiles/ (JAXA HP_SMILES)

(2) Hyperspectral Imager for the Coastal Ocean (HICO) and Remote Atmospheric & Ionospheric Detection System (RAIDS) Experiment Payload: HICO and RAIDS Experiment Payload (HREP)

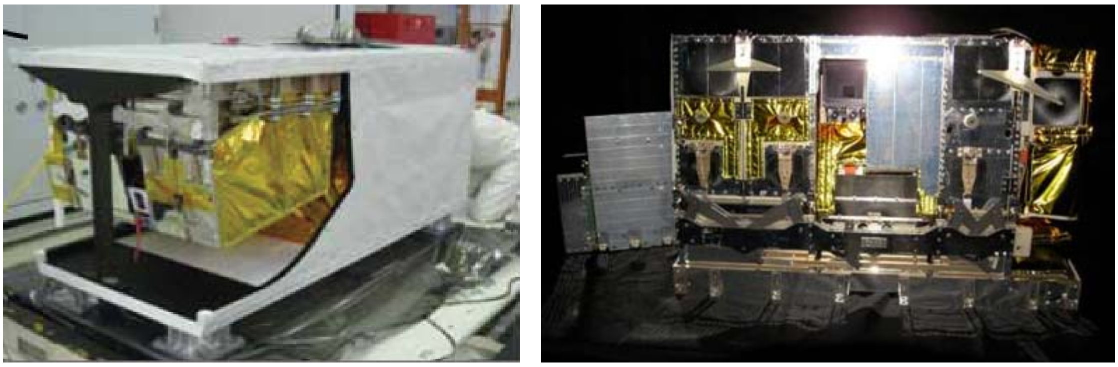


Fig. 2.3.2-2 HREP

【Objectives】

HREP combines two experiment sensors into one payload: the Hyperspectral Imager for the Coastal Ocean (HICO) and the Remote Atmospheric and Ionospheric Detection System (RAIDS).

HICO demonstrates space-based Maritime Hyper-Spectral Imagery (MHSI) for characterization of littoral regions (the coast of an ocean or sea) on Earth.
RAIDS is an ultraviolet (UV) and visible remote sensing instrument that measures limb profiles of electron density and neutral density to improve ionospheric (the upper part of the atmosphere) and satellite drag models.

【Operations】

HREP will be installed on Kibo's Exposed Facility at attachment position number six (Exposed Facility Unit 6: EFU6). Operations of the experiment will be performed via the Payload Operations Integration Center (POIC) in Huntsville, Alabama, and no crew activity is planned other than installation and removal of the experiment by Kibo's robotic arm (JEMRMS).

http://www.nasa.gov/mission_pages/station/science/experiments/HREP-RAIDS.html (NASA HP_HREP-RAIDS)

http://www.nasa.gov/mission_pages/station/science/experiments/HREP-HICO.html (NASA HP_HREP-HICO)

【Reference】Accommodation Layout of Exposed Facility Payloads

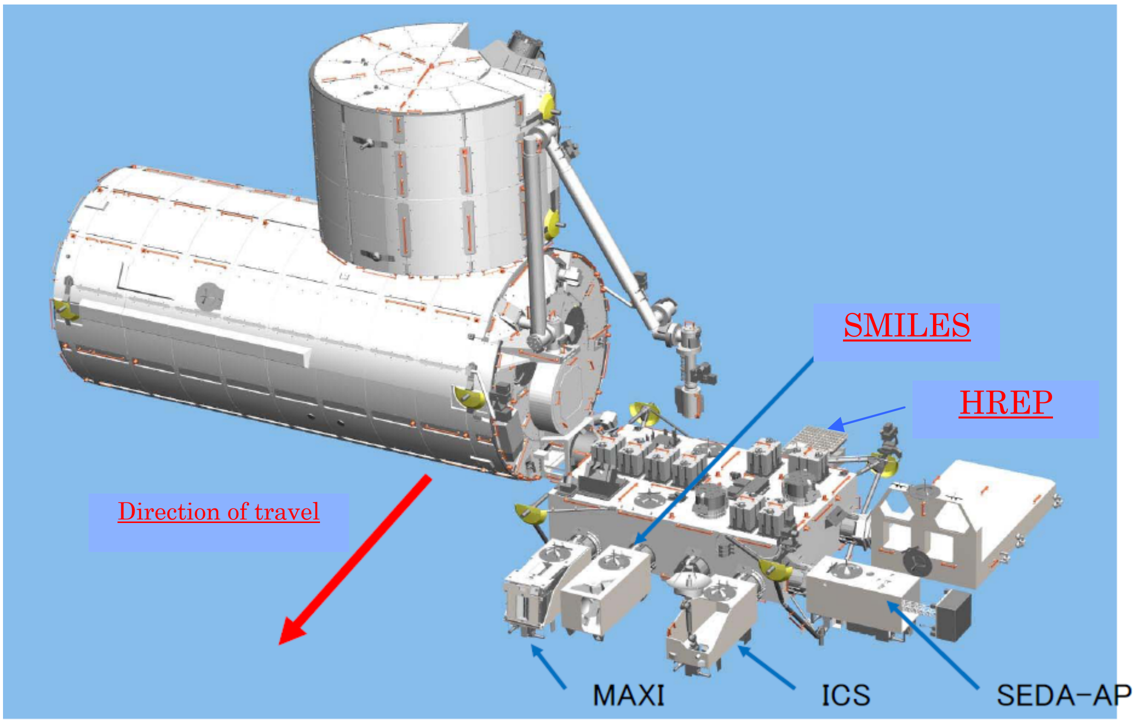


Fig. 2.3.2-3 Attachment Positions of HREP and SMILES

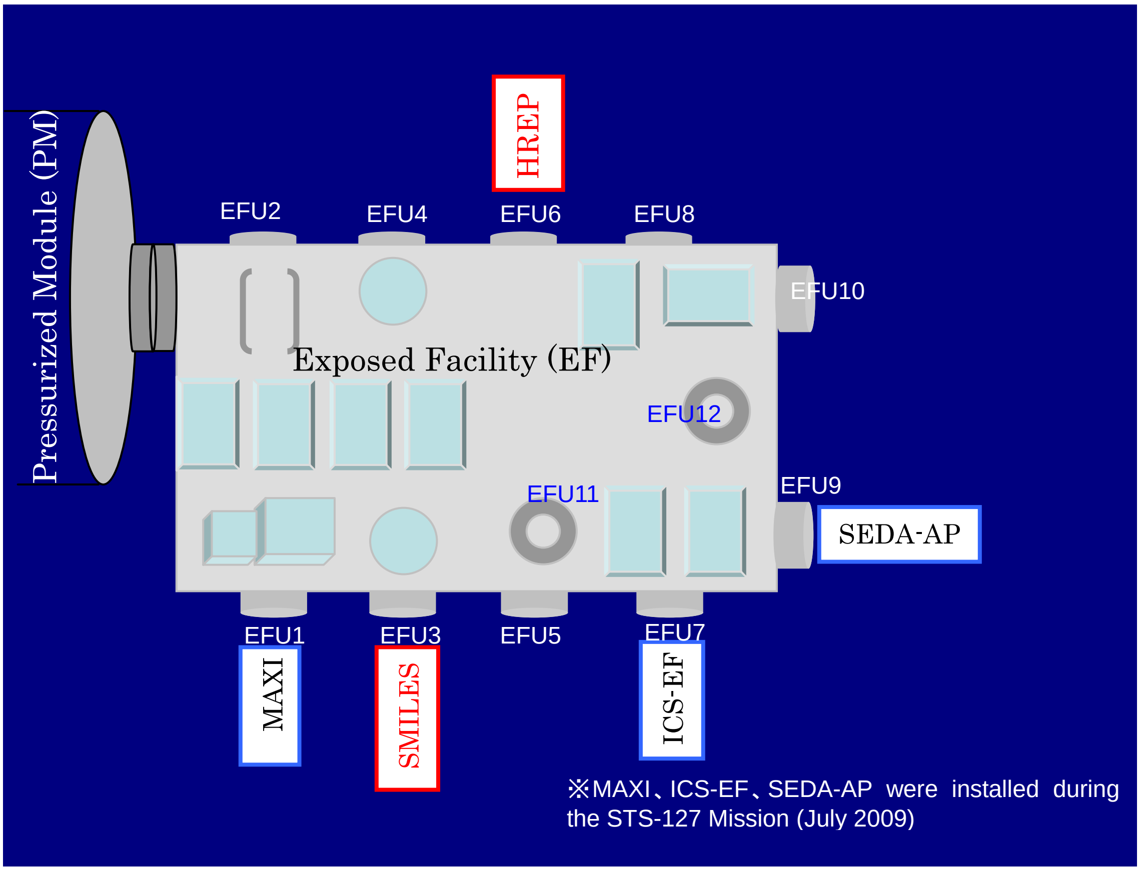


Fig. 2.3.2-4 Attachment Positions of the EF Payloads

Fig. 2.3.2-5 Exposed Facility (EF) with External Experiments (STS-127)

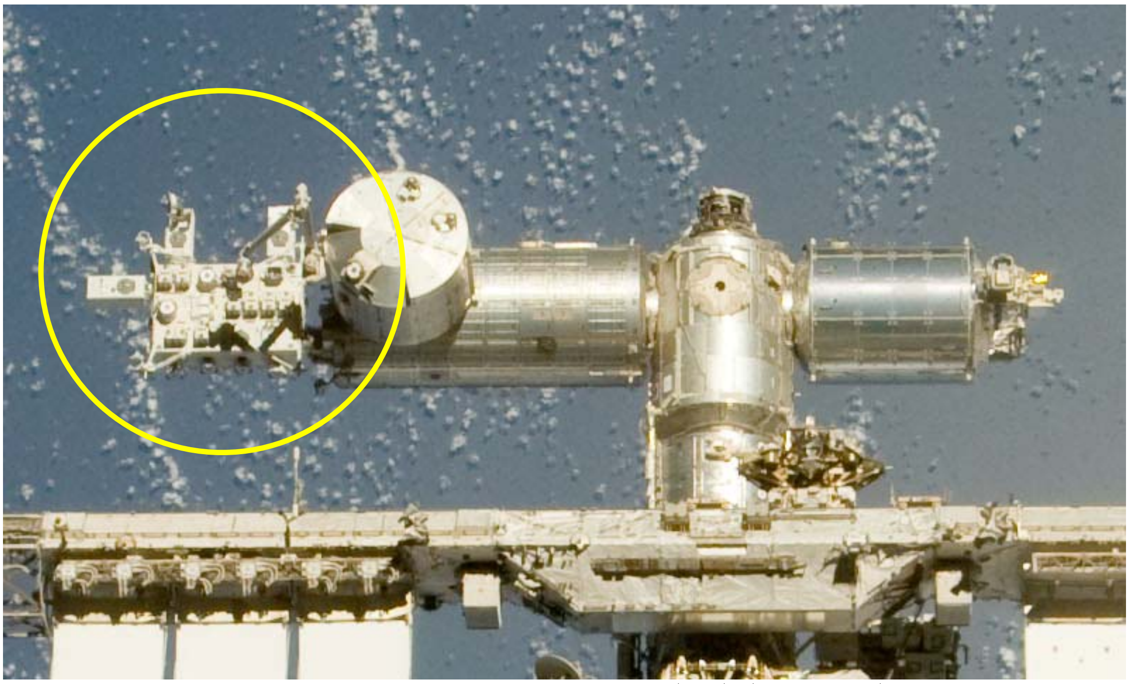


Fig. 2.3.2-6 Exposed Facility (EF) (STS-127)

This page is intentionally left blank

3. HTV Operations Support

3.1 HTV Mission Control Room (HTV MCR)

HTV's flight will be monitored and controlled by the HTV Mission Control Room (HTV MCR).

The HTV MCR is located at the Space Station Operations Facility (SSOF) in JAXA's Tsukuba Space Center (TKSC) and controls and manages HTV operations in collaboration with the Mission Control Center (MCC-H) at NASA's Johnson Space Center (JSC) in Houston.

Space Station Operations Facility (SSOF)

HTV Mission Control Room (HTV MCR)

Mission Control Center (MCC-H)

3.2 HTV Operations Control Overview

Following separation from the H-IIB launch vehicle, the HTV will automatically activate the HTV subsystems, stabilize its attitude, and perform self-checks on the HTV components. Then, the HTV will establish communications with the TDRS and initiate communications with the HTV MCR at TKSC.

Once communications between the HTV and the HTV MCR is established, HTV flight control by the HTV MCR will begin. The HTV MCR will monitor HTV's telemetry and flight data, and send commands for controlling the HTV subsystems and maneuvering its flight.

From 90 minutes before the HTV reaches 5 km behind the ISS (Approach Initiation (AI) point), the MCC-H at JSC will begin monitoring HTV operations. Thereafter, the HTV MCR and MCC-H will collaboratively operate the HTV mission.

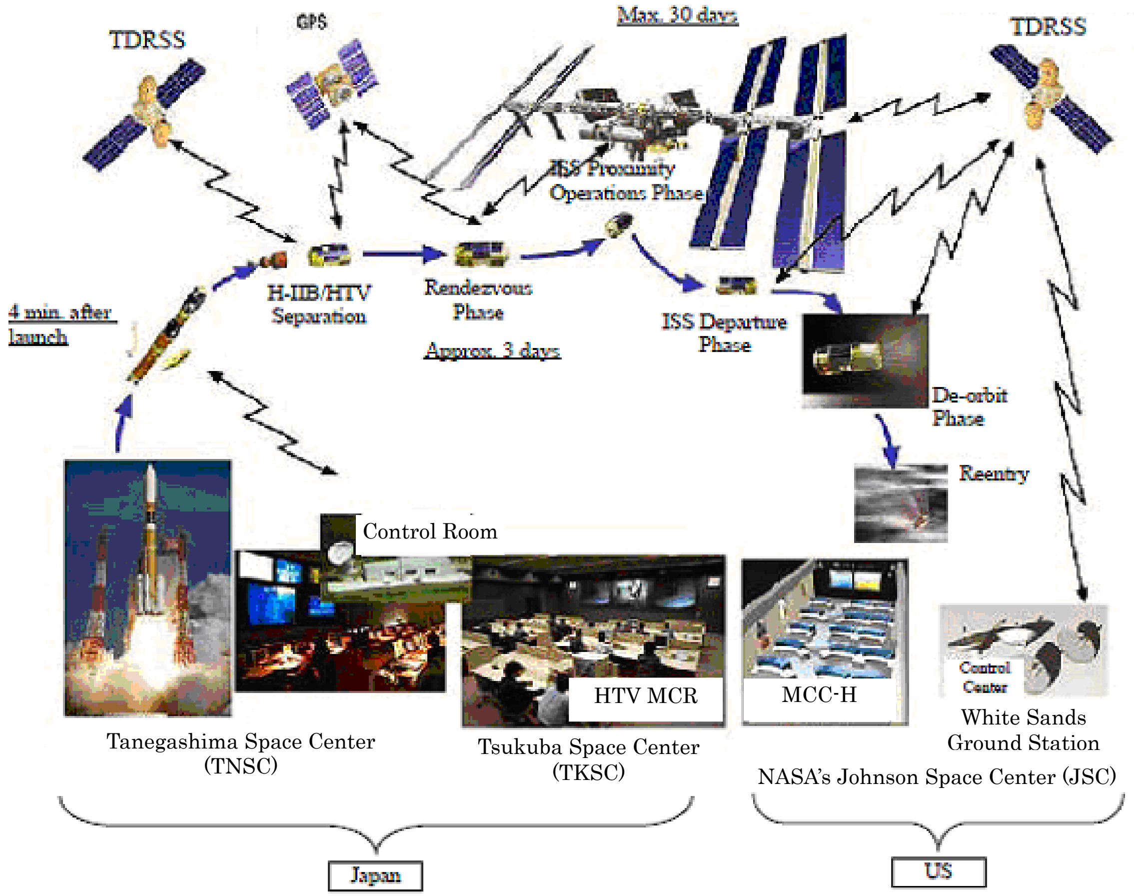


Fig. 3.2-1 HTV Operation Control Overview

3.3 HTV Flight Control Team (HTV FCT)

HTV's flight will be controlled by the HTV Flight Control Team (HTV FCT).

The roles and responsibilities of the HTV FCT are as follows:

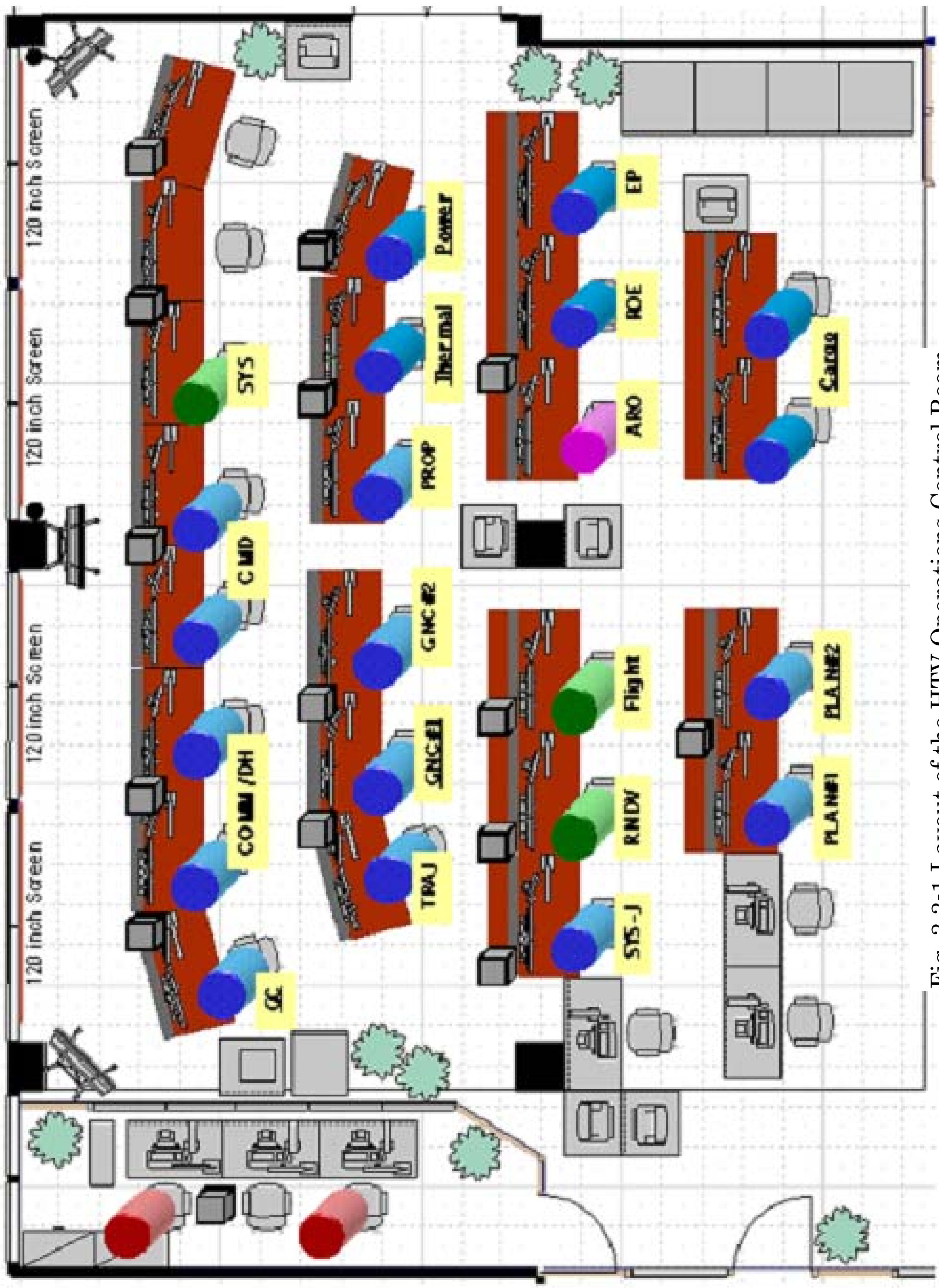


Fig. 3.3-1 Layout of the HTV Operations Control Room

HTV-FLIGHT:
HTV-FLIGHT is the leader of the HTV Flight Control Team (HTV FCT). HTV-FLIGHT will oversee the overall operations of the HTV, from operations planning through actual operations. HTV-FLIGHT has the authority to make final decisions throughout the mission.

Koji Yamanaka, HTV Flight Director (HTV-FLIGHT)
On duty during launch, HTV's berthing/unberthing from the ISS, and reentry operations

Dai Aso, HTV Flight Director (HTV-FLIGHT)
On duty during HTV's berthed operations

HTVSYS:
HTVSYS is responsible for HTV's system operations. HTVSYS monitors system telemetry data of the HTV and coordinates with NASA's Mission Control Center (MCC-H).

CMD:
CMD is responsible for sending commands to control HTV's flight according to HTV flight operations procedures.

HTVGC:
HTVGC is responsible for managing the facilities and networks to be used for HTV operations.

HTVPLAN:
HTVPLAN is responsible for planning HTV's actual flight operations. HTVPLAN will amend or modify the operations plans during the mission when necessary.

HTVSYS-J:
HTVSYS-J supports HTV-FLIGHT by managing HTV operations procedures.

RNDV:
RNDV is responsible for HTV's rendezvous operations. RNDV will monitor and update the status of the HTV and coordinate with NASA's MMC-H.

GNC:
GNC is responsible for HTV's Guidance & Navigation Control operations.

TRAJ:
TRAJ is responsible for HTV's orbital phase adjusting maneuvers.

POWER:
POWER is responsible for HTV's electrical subsystem.

THERMAL:
THERMAL is responsible for HTV's thermal control subsystem and environment control subsystem of the HTV Pressurized Logistics Carrier (PLC).

COMM/DH:
COMM/DH is responsible for HTV's data handling and communications subsystems.

PROP:
PROP is responsible for the propulsion system of the HTV.

CARGO:
CARGO is responsible for operations related to HTV's cargo and payloads. CARGO will coordinate with NASA for operations related to cargo and payloads.

EP:
EP is responsible for the Unpressurized Logistics Carrier and the Exposed Pallet (EP) of the HTV.

ROE:
ROE will make independent assessment of reentry planning. ROE will also monitor and assess reentry status.

ARO:
ARO is NASA's rendezvous expert, and ARO will support and coordinate international coordination between JAXA and NASA.

On the HTV-1 Mission, JAXA's astronaut Akihiko Hoshide will serve as a CAPCOM at the MCC-H. He will be on-console on the days of robotic transfer operations.

This page is intentionally left blank

Appendix HTV／ISS Acronym

ACRONYM	NAME (Category)
ACU	Abort Control Unit (HTV)
AI	Approach Initiation(HTV)
AM	Avionics Module (HTV)
ARO	American Rendezvous Officer
ATV	Automated Transfer Vehicle
BCS	Berthing Camera System (HTV)
BDCU	Battery Discharge Control Unit (HTV)
CAPCOM	Capsule Communicator (ISS)
CAM	Collision Avoidance Maneuver (HTV)
CARGO	(HTV Flight Control Team)
CBM	Common Berthing Mechanism (ISS)
CM	Co-elliptic Maneuver
CMD	Command (HTV Flight Control Team)
CTB	Cargo Transfer Bag (ISS)
CZ	Communication Zone (HTV)
DMS	Data Management System
DOM	Deorbit Maneuver (HTV)
DSM	Descending Maneuver (HTV)
EF	Exposed Facility (JEM)
EFU	Exposed Facility Unit (JEM)
ELM-ES	Experiment Logistics Module-Exposed Section (JEM)
ELM-PS	Experiment Logistics Module-Pressurized Section (JEM)
EP	Exposed Pallet (HTV)
EP-CON	Exposed Pallet Controller (HTV)
EPS	Electrical Power System (HTV)
ESA	European Space Agency
ESA	Earth Sensor Assembly (HTV)
FD	Flight Day
FD	Flight Director
FDS	Fire Detection and Suppression
FRGF	Flight Releasable Grapple Fixture
GCC	Guidance Control Computer (HTV)
GMT	Greenwich Mean Time
GNC	Guidance Navigation Control
GNC	(HTV Flight Control Team)
GPS	Global Positioning System
GPSR	GPS Receiver
HAM	Height Adjusting Maneuver
HBCS	HTV Berthing Camera System (HTV)
HC	Hand Controller
HCCM	HTV Cargo Attachment Mechanism (HTV)
HCSM	HTV Connector Separation Mechanism (HTV)
HCP	HTV Hardware Command Panel (HTV)
HDM	Holddown Mechanism (HTV)
HEFU	HTV Exposed Facility Unit (HTV)
HGAS	HTV GPS Antenna Subsystem
HPIU	HTV Payload Interface Unit (HTV)
HREP	Hyperspectral Imager for the Coastal Ocean(HICO) &Remote Atmospheric & Ionospheric

ACRONYM	NAME (Category)
	Detection System (RAIDS)Experimental Payload : HICO&RAID Experimental Payload
HRR	HTV Resupply Rack (HTV)
HSM	Harness Separation Mechanism
HTV	H-II Transfer Vehicle
HTV FCT	HTV Flight Control Team
HTV-FLIGHT	(HTV Flight Control Team)
HTVGC	(HTV Flight Control Team)
HTV MCR	HTV Mission Control Room
HTV OCS	HTV Operations Control System (HTV)
HTVPLAN	(HTV Flight Control Team)
HTVSYS	(HTV Flight Control Team)
HTVSYS-J	(HTV Flight Control Team)
ICS	Inter-orbit Communication System (JEM)
IMMT	ISS Mission Management Team (NASA)
IMV	Inter-Module Ventilation (ISS)
IOS	Inter-Orbit Link System
ISPR	International Standard Payload Rack (ISS)
ISS	International Space Station
JAXA	Japan Aerospace Exploration Agency
JEM	Japanese Experiment Module (JEM)
JEMRMS	JEM Remote Manipulator System (JEM)
JSC	Johnson Space Center
JST	Japanese Standard Time
KOS	Keep Out Sphere
KOZ	Keep Out Zone
LP1	Launch Pad1
LP2	Launch Pad2
LRR	Laser Rader Reflector (HTV)
MAXI	Monitor of All-sky X-ray Image (JAXA's EF Payload)
MBS	Mobil Base System (ISS)
MCC-H	MCC-Houston
MET	Mission Elapsed Time
MLI	Multi-Layer Insulation
MMH	Monomethylhydrazine (HTV)
MSS	Mobile Servicing System (ISS)
NASA	National Aeronautics and Space Administration
NTO	Nitrogen Tetroxide
ORU	Orbital Replacement Unit
PAO	Public Affair Office
P-BAT	Primary Battery (HTV)
PBA	Portable Breathing Apparatus (ISS) (HTV)
PCBM	Passive CBM (ISS/HTV)
PCU	Power Control Unit
PFE	Portable Fire Extinguisher (ISS) (HTV)
PEV	Pressure Equalization Valve
PIU	Payload Interface Unit
PLC	Pressurized Logistics Carrier (HTV)
PLS	Proximity Link System (HTV)
PM	Pressurized Module (JEM)
PM	Propulsion Module (HTV)

ACRONYM	NAME (Category)
PM	Phase Maneuver
POA	Payload / ORU Accommodation
POCC	Payload Operations Control Center (NASA)
POIC	Payload Operations Integration Center (NASA)
POWER	(HTV Flight Control Team)
PPRV	Positive Pressure Relief Valve
PROP	(HTV Flight Control Team)
PROX	Proximity Communication System (HTV)(JEM)
Psi	Pounds per square inch
PSRR	Pressurized Stowage Resupply Rack
PYR	Pitch, Yaw, and Roll
PVGF	Power& Video Grapple Fixture (ISS) (HTV)
R-Bar	Radius Vector
RGPS	Relative GPS
RNDV	(HTV Flight Control Team)
ROE	(HTV Flight Control Team)
RVFS	Rendezvous Flight Software (HTV)
RVS	Rendezvous Sensor (HTV)
RVSE	Rendezvous Sensor Electronics (HTV)
SAP	Solar Array Panel (HTV)
SCU	Signal Control Unit (HTV)
SEDA-AP	Space Environment Data Acquisition equipment-Attached Payload (JEM EF Payload)
SFA	Small Fine Arm
SFA2	Second Spacecraft and Fairing Assembly Building
SIGI	Space Integrated GPS/INS
SMILES	Superconducting Submillimeter-Wave Limb-Emission Sounder
SRB	Solid Rocket Booster (H-IIB)
SSIPC	Space Station Integration and Promotion Center (TKSC)
SSM	Shockless Separation Mechanism (HTV)
SSOF	Space Station Operations Facility
SSRMS	Space Station Remote Manipulator System (ISS)
S-BAT	Secondary Battery (HTV)
TCS	Thermal Control System (HTV)
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TDSP	Tie-down Separation Plane (HTV)
THERMAL	(HTV Flight Control Team)
TSM	Tie-down Separation Mechanism (HTV)
TKSC	Tsukuba Space Center
TNSC	Tanegashima Space Center
ULC	Unpressurized Logistics Carrier (HTV)
ULC-CON	ULC Controller (HTV)
VAB	Vehicle Assembly Building
VDC	Volt Direct Current
ZOE	Zone of Exclusion

This page is intentionally left blank