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Title

HTV2 Departure from the ISS and Re-entry into the Atmosphere

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HTV2 Departure from the ISS and Re-entry into the Atmosphere

April 6, 2011

Japan Aerospace Exploration Agency (JAXA)
Kuniaki Shiraki, Executive Director
Yukio Koyari, HTV project manager

1. Overview of the HTV2's post-berthing operations

(All times and dates are JST)

1. The ISS crew opened the hatch of KOUNOTORI2 and entered the HTV2's Pressurized Logistics Carrier (PLC) at 5: 47 a.m. on January 28, 2011 (1 day earlier than initial schedule).

2. Cargo transfer between HTV2's PLC and the ISS began on January 31. The ISS crew completed the installation of JAXA's two science experiment racks, KOBAIRO Rack and Multi-purpose Small Payload Rack (MSPR,) in KIBO module on February 1, 2011.

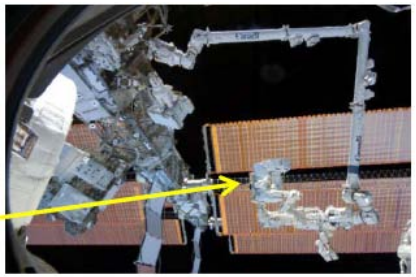
3. Transfer of the Exposed Pallet (EP) by the Space Station Remote Manipulator System (SSRMS) began on February 1. The EP was handed off to Kibo's robotic arm (JEM Remote Manipulator System: JEMRMS) and then attached to Kibo's Exposed Facility (EF) on February 1, 2011.

4. The Cargo Transport Container (CTC) and the Flex Hose Rotary Coupler (FHRC) carried on the EP were transferred to their temporary storage locations by the Special Purpose Dexterous Manipulator (SPDM), from February 3 to February 4, 2011.

5. The emptied EP was returned to HTV2 by SSRMS on February 7.

The inside of HTV2's PLC

Transfer of the Exposed Pallet (EP)



FHRC installation to the temporary storage location

1. Overview of the HTV2's post-berthing operations (continued)

(All times and dates are JST)

6. HTV2 was relocated to the zenith port of Node2 on February 18 to prepare for the docking of the STS-133 space shuttle on February 27. HTV2 was monitored by proximity communication or intersatellite communication.

7. After the departure of the STS-133 space shuttle from the ISS, the ISS crew performed HTV2 relocation to the nadir port of Node2 (completed on March 11). Shortly after completion of the relocation, a gigantic earthquake occurred in the Tohoku and Kanto regions. This temporarily shut down the mission control facilities at JAXA's Tsukuba Space Centre (TKSC) in Ibaraki prefecture and left them unable to send commands to HTV2. The commands were sent from NASA's Mission Control Center in Houston following the operator's audio instructions from Tsukuba.

8. TKSC returned to routine operation on March 22, after implementation of the ground network switching*1 and the control system checking.

9. 5.3 tonnes of supplies were transferred from HTV2 to ISS and HTV2 was loaded with 2.8 tonnes from the ISS. These operations were completed on March 25.

*1 The existing Pacific line switched to the line via Hong Kong due to the earthquake.

Space shuttle and HTV2

HTV2 berthing the zenith port

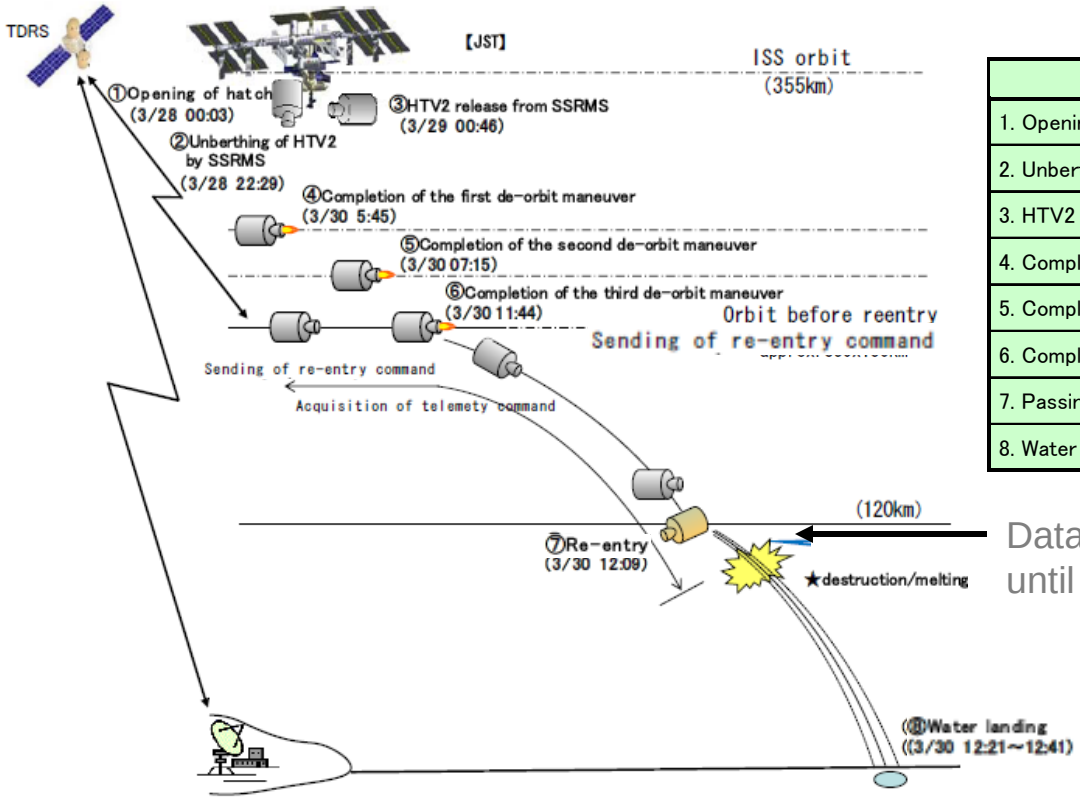
HTV2 loaded with waste

2. Result of the HTV2 departure and re-entry

(All times and dates are JST)

10. The ISS crew closed the hatch at 0:03 a.m. on March 28, and HTV2 was released from ISS by SSRMS at 0:46 a.m. on March 29

11. HTV2 performed four separation maneuvers and three de-orbit maneuvers, and reentered the atmosphere at 12:09 p.m. on March 30 (at 120km altitude).



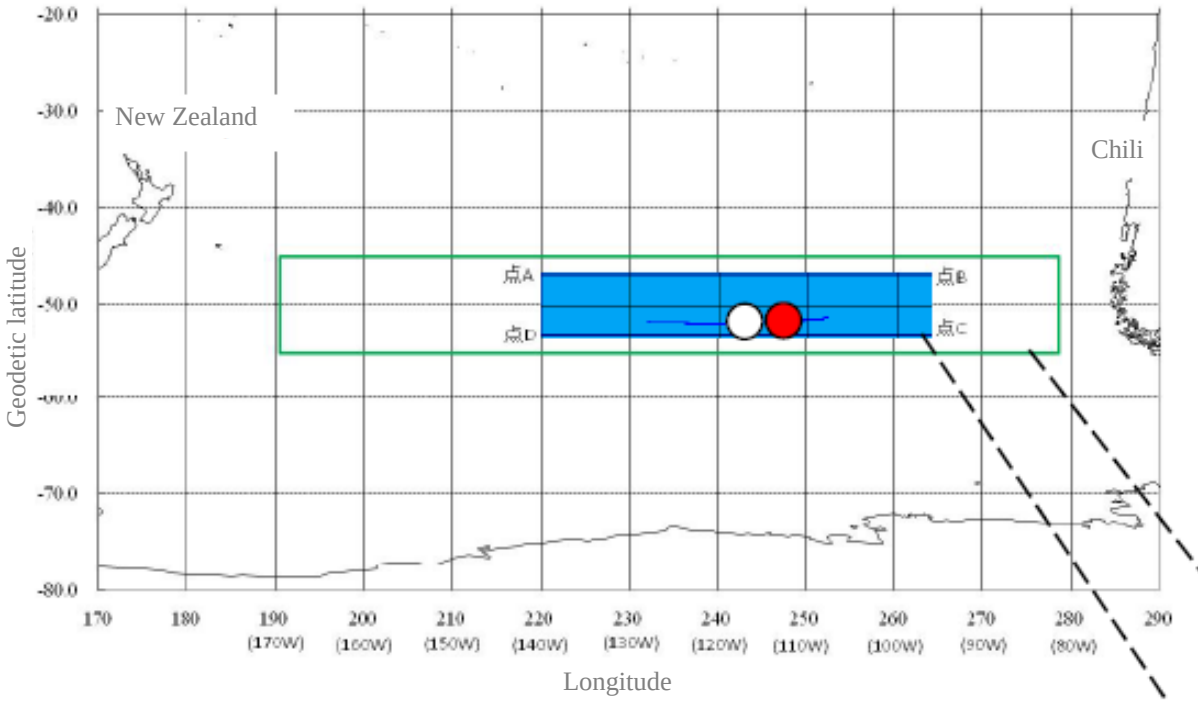
Result of events

Event	Date	Schedule	Result
1. Opening of the hatch	3/27	23:30	3/28 00:03
2. Unberthing of HTV2 by SSRMS	3/28	22:25	22:29
3. HTV2 release from SSRMS	3/29	00:45	0:46
4. Completion of the first de-orbit maneuver	3/30	05:45	05:45
5. Completion of the second de-orbit maneuver	3/30	07:15	07:15
6. Completion of the third de-orbit maneuver	3/30	11:44	11:44
7. Passing the re-entry interface point	3/30	12:09	12:09
8. Water landing	3/30	12:21~12:41	12:21~12:41

Data reception:
until 12:13 p.m. March 30, at 88.7km altitude

2. Result of the HTV2 departure and re-entry (continued)

Possible HTV debris water-landing area calculated from navigation data at an altitude of 90km was within expected debris water-landing area.



Estimated water-landing point
(ballistic coeffient:approx. 390)

REBR primary data
(ballistic coeffient:approx. 60)

REBR: Re-entry Breakup Recorder
Re-entry data collector provided by NASA

169.5° west longitude	45° south latitude
81.5° west longitude	45° south latitude
81.5° west longitude	55° south latitude
169.5° west longitude	55° south latitude

140.0° west longitude	47° south latitude
96.5° west longitude	47° south latitude
96.5° west longitude	53° south latitude
140.0° west longitude	53° south latitude

Estimated water-landing area

Expected water-landing area

3. HTV2 accomplishments

The HTV2 accomplishments on this mission were as follows

1. All of the mission objectives were successfully completed, with little trouble on HTV2, throughout the entire mission period.

2. Flight demonstration of on-board components (transponder, telemetry command antenna, LED light, high-capacity primary battery) was performed.

3. Flight period to the ISS was shortened by 2 days compared to the technical demonstration vehicle (total 5 days), and HTV2 successfully berthed with the ISS as planned.

4. Complicated operation, i.e. HTV2 relocation to the zenith port of Node2, was conducted though it was not expected when developing HTV2.

5. Nominal 30-day berthing duration was extended to 60 days, demonstrating operational flexibility.

6. Technical data for future operation of Cargo Return Vehicle were collected by the acquisition of the flight and destructive data of post re-entry.
   Acquisition of telemetry data up to 88.7 km altitude.
   Acquisition of data regarding the destructive altitude and water-landing location of HTV2 by REBR (Re-entry Breakup Recorder)

4. Result and action items for the future HTV flights

1. HTV2 safely accomplished all of its mission objectives as planned.

2. JAXA will implement a detailed evaluation on the acquired data from this mission as well as improvement of HTV3 based on the evaluation, and will work on the steady implementation of launch and operation of HTV3 and its successors

3. JAXA will incorporate technology required for future manned space activity, making HTVs as one of the reliable transport system to the ISS.

Reference 1. Cargo Disposed by HTV2

Waste	Item
NASA system structural parts	Supply-transport panel and 2 mounting panels, etc.
Crew commodities	Bodily waste, Flashlights, Resistance measurement equipment, etc.
Science experiment equipment	Used sampler, Refrigerants, Desiccants, etc.
Transport foam material and bags	Shipping foam material, cushions, food containers, shipping material for Robonaut, etc.

Reference 2. HTV2 mission schedule (accomplished)

Entry of the ISS crew

Docking of 41P

Relocation to the zenith port of Node2

Inserting of EP

Docking of AVT2

Relocation to the nadir port of Node2

Completion of Transfer to the cargo

Undocking of 24S

ISS time-line (UT)

1/27	1/28	1/30	2/1	2/2~4	2/7	2/18	2/24	2/26~3/7	3/10	3/11~21	3/24	3/27

Docking to the ISS

transfer of EP cargo

Dismount of EP/mounting of JEM

Docking of ULF5 (8days berthing)

Operation responding to the disaster

Closing of the hatch

Final approach / Captured by SSRMS

De-orbit maneuvers

3/29	3/30

Departure from the ISS

Re-entry

HTV2 time-line (JUT)

1/22	1/23	1/24	1/25	1/26

Initial height adjustment maneuvers

Establishing attitude

Closest approach to the ISS

SSRMS: The Space Station Remote Manipulator System
EP: the exposed pallet
JEM: Japanese experiment module
UT: Universal time
JST: Japanese standard time

Reference 3. Mission success criteria and their result

Mission success criteria		Result	
Minimum success	N/A	–	–
Full success	Completion of shipment of supplies to ISS based on the plan Re-entry and safe ocean disposal of HTV2	Accomplishment	All supplies were shipped to the ISS. After unberthing/Separation from the ISS, Re-entry and safe ocean disposal of HTV2 were implemented.
Extra success	Accomplishments of one of the following extra success were expected. Review of resource, such as the amount of propellant, electrical power, etc., based on the result of operations, and prediction on performance improvement of subsequent vehicles, such as transportation capability, operational flexibility and user-friendliness. Prediction on cost reduction and flexible supply plan by shortening the period of mission at each phase, such as plant work, launch site work including cargo loading, and orbital operation. Implementation of extra mission, such as orbital demonstration including maneuver experiment, installing and injection of small satellite, contributing to development of future space technology.	Under evaluation	Accomplishments of extra success are expected as follows. Operational flexibility: demonstration of reduction of primary battery and solar battery power generation during the berthing period, relocation (port transfer), and 60 day-extended berthing duration. Cost reduction: elimination of entire system assembly test at launch site, reduction of personnel during berthing operation. Implementation of extra mission: data acquisition by REBR.