The development of Multi-Purpose Type Exposed Pallet for HTV

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H-II Transfer Vehicle (HTV) is the transportation system for the International Space Station (ISS) launched by H-II B launch vehicle from Tanegashima in Japan. The external cargo is not located directly to unpressurized carrier of HTV. They are installed on the Exposed Pallet to support the ISS robot arm operation. After Space Shuttle retirement, HTV Exposed Pallet is the only unpressurized cargo transport system which can support the large size external cargo. Then, It is necessary for Exposed Pallet to have a flexible capability to transport not only for experiment payload but ISS external maintenance item. Multi-Purpose Type Exposed Pallet (EP-MP) has been designed to respond to the requirement for several combination of cargo. Also in case of contingency case, like an emergency maintenance item replacement case, it is necessary to change the cargo. It is so-called Launch on Need capability. This paper outlined the design of EP-MP and the analysis result of the several combination of cargo transportation capability.

Key Words: HTV, EP, LON

1. Introduction

The H-II Transfer Vehicle (HTV) transports the re-supply cargo to International Space Station (ISS). At the HTV1, Two external experiment payloads were brought to Kibo, Japanese Experiment Module Exposed Facility (JEM-EF), at HTV2 two Orbital Replacement Unit (ORU) were sent to NASA ISS truss location. The Exposed Pallet (EP) has no flexibility for combination of cargo type and interface. The EP was designed to bring only JEM-EF attached experiment payload or ISS battery. Then if it was required to bring another type of cargo, the EP should be modified. At the HTV2 case, to bring NASA ORU, EP was modified its surface structure to adapt the cargo. The background of cargo re-supply demand change is due to Space Shuttle retirement. The external cargo transport method to ISS will be very limited. It is necessary for Exposed Pallet (EP) to have a flexible capability to transport cargo more flexible combination. Then from HTV3 flight the Multi-Purpose Type Exposed Pallet (EP-MP) has been designed to respond to this situation.

2. Outline of EP

2.1 The EP Configuration

HTV is composed by Avionics, Propulsion module and Logistic carrier. The Logistics Carrier is divided to pressurized section which carries the pressurized cargos and the unpressurized section which carries the Exposed Pallet. The external cargo is located on the EP. The EP is inserted in the Unpressurized section of Logistic carrier of HTV (ULC) during flight phase. Fig -1 shows the HTV overall configuration 1). Fig -2 shows HTV2 on orbit configuration and Space Station Robot Manipulator System (SSRMS) grapple the EP.

HTV has the capability to transport total 6ton cargo weight. The EP can load maximum 1500 kg external cargo. Basically each cargo is removed by SSRMS or JEM Remote Manipulator System (JEMRMS). As the contingency Extra-vehicular activity (EVA) compatible design is required.
2.2 EP Operation Scenario

Figure 3 shows the operation outline of EP at HTV1. In this flight, external cargos are transferred to Kibo, Exposed Facility (JEM-EF). Even the EP-MP operation scenario is almost same. The Space Station Remote Manipulator System (SSRMS) grapple the EP and extract from HTV-ULC. The EP is transferred to near the JEM by SSRMS and handover to Japanese Experiment Module (JEM) Remote Manipulator System (RMS). JEMRMS berths EP to JEM-EF. The external cargos are off loaded from EP and attached to JEM-EF by JEM RMS during EP berthed to JEM-EF. If the Cargo has the NASA ORU interface case like HTV2 case, each cargo will be removed from EP by Special Purpose Dexterous Manipulator (SPDM).

3. EP-MP configuration

At the HTV1 and HTV2, the interface between cargo and EP was designed for each cargo. Then it was necessary to modified EP for each cargo interface. From HTV3 the EP has been modified as the Multi-Purpose Type Exposed Pallet (EP-MP) to have flexibility for combination of cargo interface.

To have flexibility the EP-MP has 15”x15” grid point cargo interface for Mechanical Cargo Interface. To minimize the impact to the NASA cargo FSE interface, 15”x15” grid interface similar to NASA ExPRESS Logistic Carrier (ELC) are applied.

The EP-MP is respond to two mechanical interface. One is the HTV Cargo Attachment Mechanism (HCAM) which is unique interface between JEM-EF attached type experiment payloads. HCAM is driven by JEM and release the payload. Another mechanism is Flight Releasable Attachment Mechanism (FRAM) which is developed by NASA to interface with ISS external cargo except HCAM. FRAM interface can select any location of 15inch grid interface. FRAM is driven by SPDM and SPDM release the ORU from EP.

If the cargo does not use both HCAM and FRAM, the cargo is directly mounted on the EP-MP. In this case, cargo shall prepare Unique FSE to interface to EP-MP grid point directly.

As the electrical cargo interface, to provide same level of cargo service as NASA ELC, EP-MP provides dual string 50V heater power supply during HTV flight. During RMS operation and ISS location both JEM-EF and ISS, 120V heater power is provided.

The another design concept of EP-MP is to have the capability to change from the planned external cargo to another one when ISS maintenance ORU is needed to replace. After cargo plan decided, the EP-MP can exchange the cargo at 12 months before launch. This is so-called Launch on Need (LON). Usually external cargo interface is defined at 24months before launch and to evaluate cargo integration design feature, i.e. structure and thermal integrity or EVA interface. But in case of the contingency, the cargo plan may be changed. To respond to this requirement, several combination of cargo as Design Reference Case (DRC) was analyzed. DRC is the combination of different cargo condition, for example, heavy weight case, maximum size evaluation against cargo allocated envelope, and or minimum weight and different mechanism combination. Then it is clear that EP-MP has the LON capability.

The EP-MP is classified as three types. One type has the capability to be berthed to JEM-EF to carry the experiment payload to JEM-EF. The other one has the capability to berth directly to ISS Mobile Servicing System (MSS) on the MBS Payload ORU Accommodation (POA) to delivery the ISS ORUs. Third configuration is ISS battery transport type. The ISS battery shall be transported 6 set at one flight. Then unique interface is required to EP-MP.

Fig 4 shows the major three type of EP-MP configuration. (a): JEM-EF attached type has the mechanical interface between JEM-EF and EP-MP. (b): ISS POA Attached type has ISS interface PVGF. (c): ISS battery transport type has unique interface between cargo and EP-MP. Fig 4(a) shows EP3 flight configuration.

The surface component of EP-MP can be removed. it will be converted between these types to respond LON requirement.
4. Expanding the capability of EP-MP

HACM Cargo has unique interface, it is necessary to have dedicated disposal mechanism. To using Interface mechanism between JEM-EF and payload is one of the solutions. Then EP-MP has a plan to provide disposal mechanism for future flight. Although EP-MP function is mainly to transport external cargo to ISS, it can have function interface with ISS during berthing to ISS. To investigating the capability to using the EP-MP as the test bed for ISS facility is the future activity.

5. Conclusion

This paper describes outline of HTV EP-MP. The first flight of EP-MP is HTV3, which will be launched in 2012. The EP-MP will support ISS external logistics not only for system support but utilization.

References