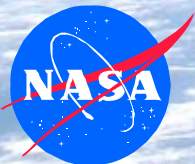


# **International Space Station Maintenance Cargo Familiarization**

**ISS Commercial Cargo Service  
Industry Day Conference**

**NASA Johnson Space Center  
Houston, TX**

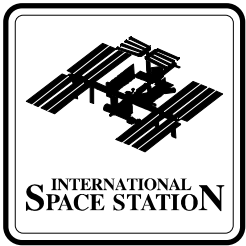
**April 25, 2005**



**Cathy Dempsey**

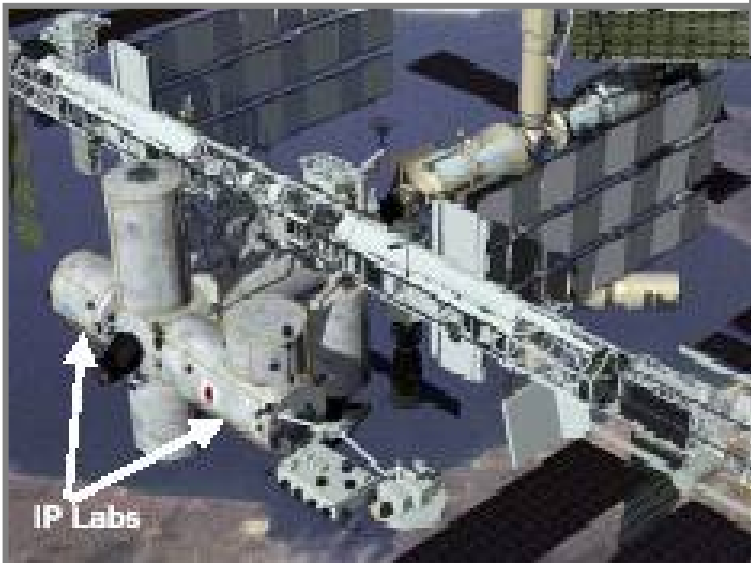
**Logistics & Maintenance Office/OB5**

**Strategic Maintenance Analysis/Planning Team**



# Purpose

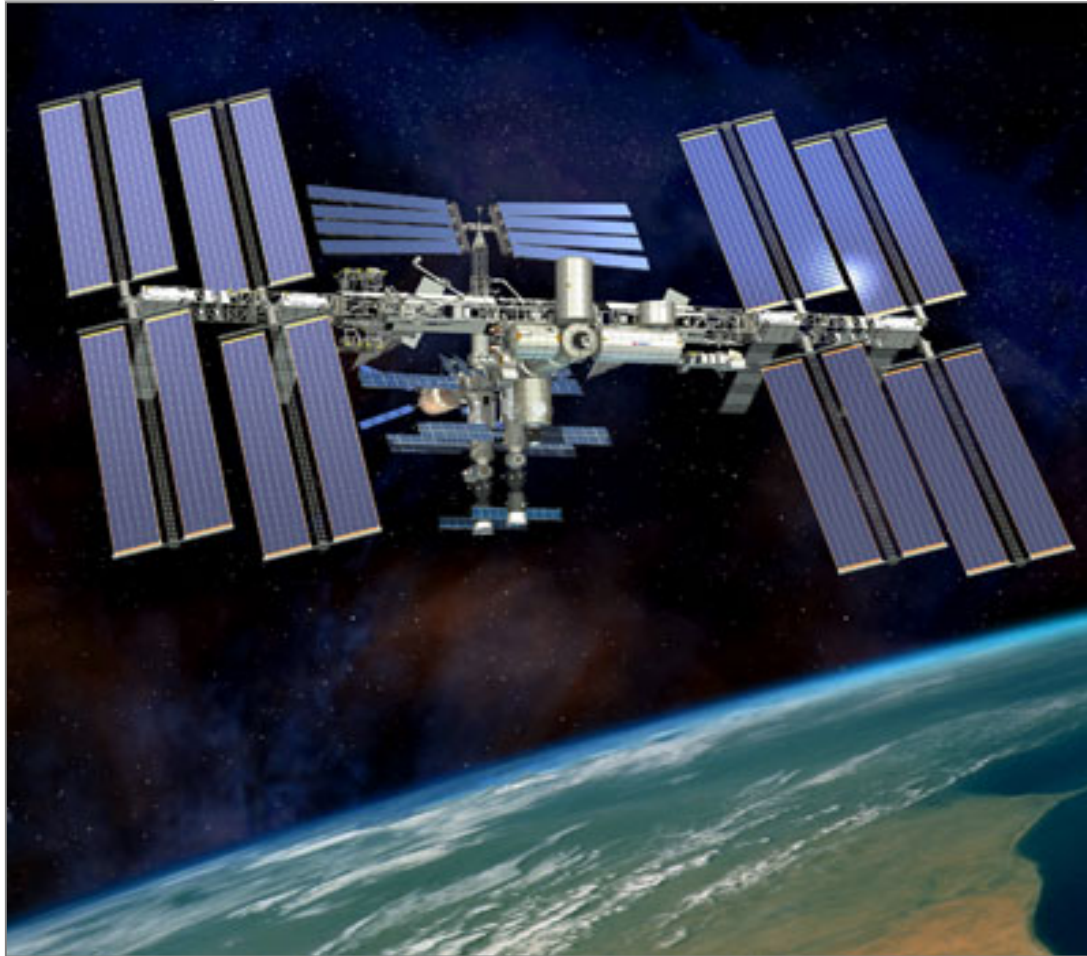
**Provide a sample of the types of internal and external Orbital Replacement Unit (ORU) hardware required to be launched and returned to support the maintenance of the International Space Station (ISS) vehicle**



***Logistics & Maintenance***



# International Space Station Assembly Complete Configuration



## Major ISS Systems:

- Electrical Power System
- Communication & Tracking
- Thermal Control System
- Environmental Control & Life Support System
- Guidance, Navigation & Control System
- Command & Data Handling System
- Robotics System
- Crew Health System
- Flight Crew System

## Maintenance Cargo Summary:

	<u>Types</u>	<u>Total</u>
• Internal ORUs	202	1942
• External ORUs	160	739



# ISS Maintenance Philosophy

- **NASA's baseline approach is for the ISS Crew to remove & replace ORU hardware items for on-orbit Preventative and Corrective maintenance actions**
- **ORU replacement reduces amount of crew training and on-orbit crew time to perform maintenance actions**
- **Intermediate-level on-orbit repair is limited by ORU design**
- **Failed ORUs are returned to the ground for depot maintenance repair and then return to ground spare status**





# Hardware Launch Environments

- **All ISS hardware certified for the Space Shuttle Launch / Landing Environments**
  - Vibration Loads
  - Thermal Loads
  - Structural Loads
  - Materials
  - Electrical (EMI/EMC)
  - Safety
- **ORU spares fly unpowered**
  - Carrier / Flight Support Equipment (FSE) compliment provides the environmental support for ORU non-operating limits

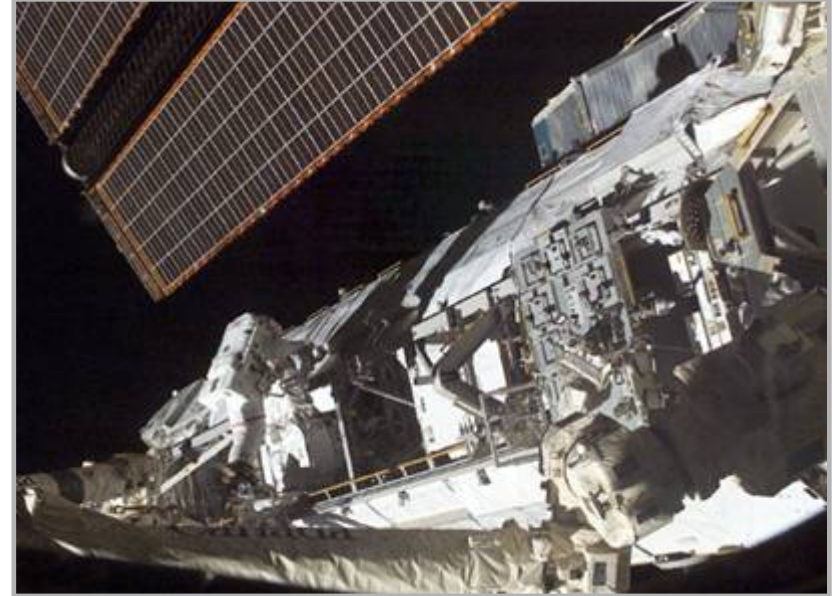
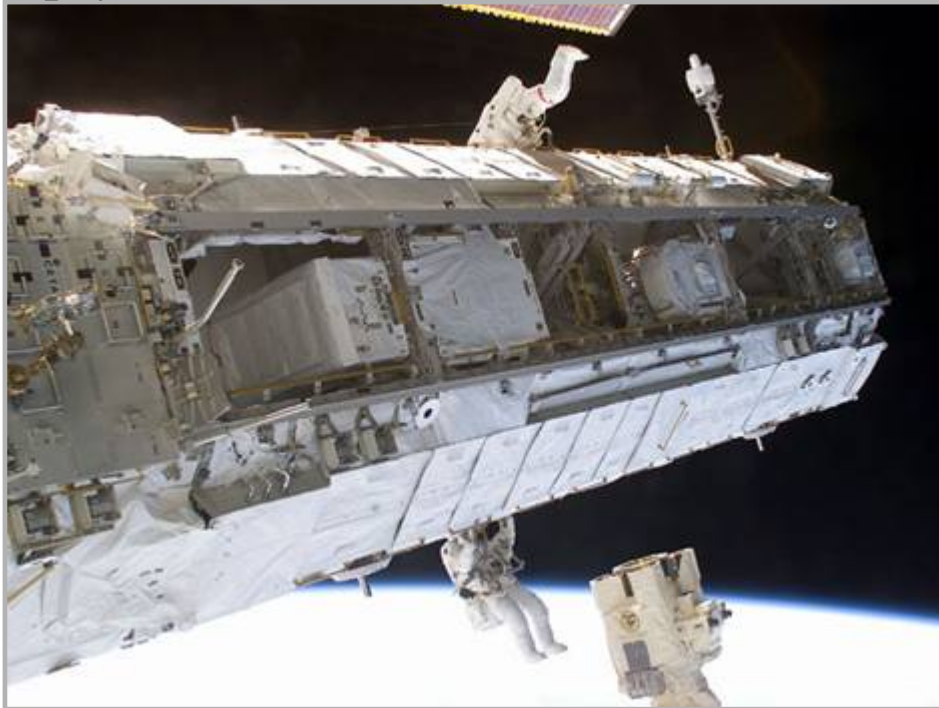


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# External Hardware

- 160,000 lbs of hardware launched to ISS in 2001 & 2002; building mainly the Inboard Truss structure that supports the solar arrays, thermal control system, mobile servicing system and external payload sites

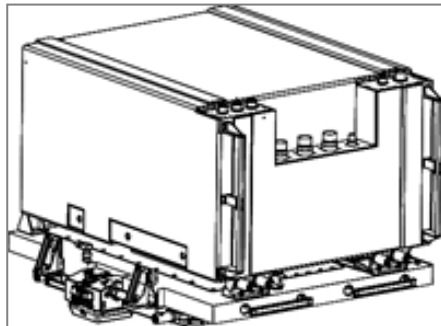


- Extravehicular Activity (EVA) and Extravehicular Robotic (EVR) handling requirements for External ORU hardware maintenance are documented in SSP 50610



# External Hardware

## Pump Module



### **Integrated Assembly (IA)**

IA Weight: 1,393 lbs.  
IA Envelope: 62"L x 72"W x 56" H  
IA c.g.: X=1.82", Y=25.3", Z=10.1"

### **ORU**

ORU Weight: 794 lbs.  
ORU Envelope: 49.8"L x 68.1"W x 35.2"H  
ORU Non-Op Thermal Limits: -45F to +140F

### **FSE / OSE / Attachment Hardware**

FSE Weight: 182 lbs.  
LAPA Weight: 417 lbs.

Projected Replacement Rate: 1 every 2 Years



# External Hardware

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## Control Moment Gyro



### **Integrated Assembly (IA)**

IA Weight: 1,211.7 lbs.

IA Envelope: 58.1"L x 46.8"W x 53.3"H

IA c.g.: X=0.67", Y=19.93", Z=14.33"

Projected Replacement Rate: 1 every 4 Years





# External Hardware

## Battery



### **Integrated Assembly (IA)**

IA Weight: 707.3 lbs.  
IA Envelope: 56.75"L x 53"W x 29.5"H  
IA c.g.: X=-0.2", Y=19.9", Z=4.0"

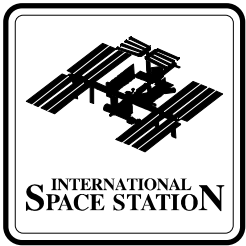
### **ORU**

ORU Weight: 364.4 lbs.  
ORU Envelope: 40.4"L x 36.8"W x 18.9"H  
ORU Non-Op Thermal Limits: -13F to +86F

### **FSE / OSE / Attachment Hardware**

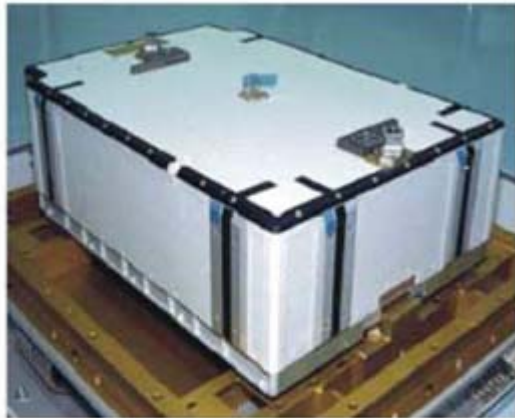
FSE Weight: 77 lbs.  
MAPA Weight: 265.9 lbs.

Planned Replacement: 6.5 Years  
Total Batteries Installed: 48

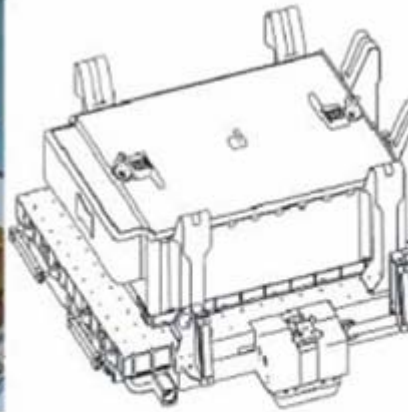


# External Hardware

## Battery Charge / Discharge Unit



ORU



FSE

### **Integrated Assembly (IA)**

<u>IA Weight:</u>	547.6 lbs.
<u>IA Envelope:</u>	47"L x 43"W x 18" H
<u>IA c.g.:</u>	X=-1.7", Y=16.3", Z=2.3"

### **ORU**

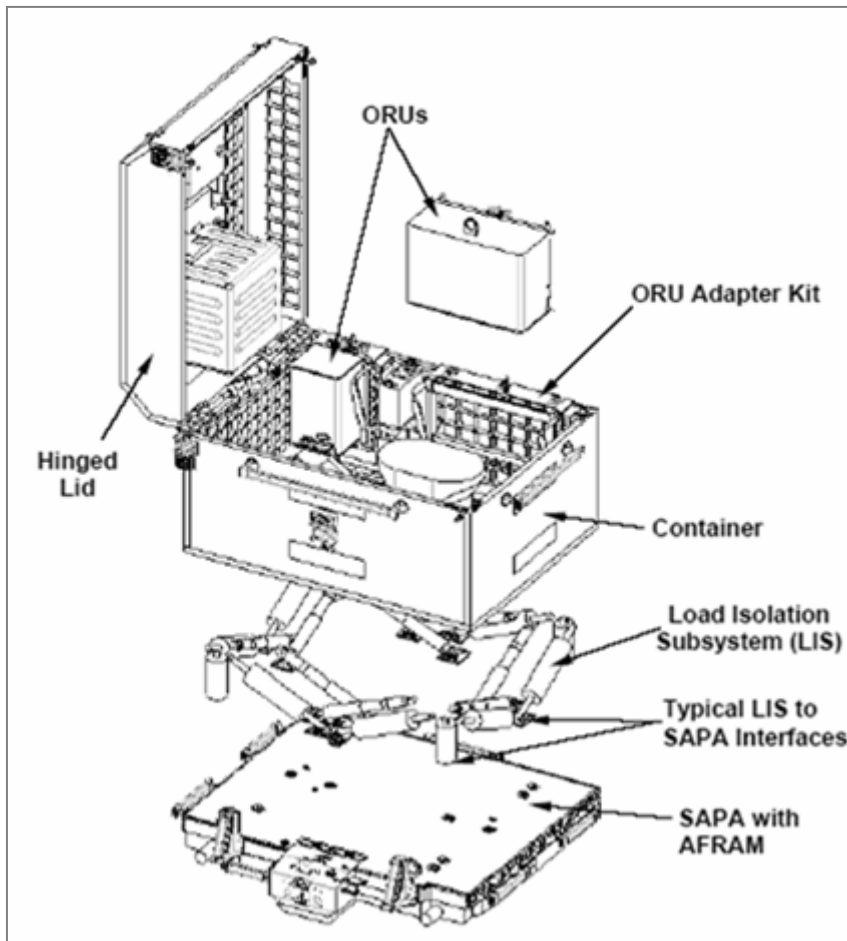
<u>ORU Weight:</u>	232.5 lbs.
<u>ORU Envelope:</u>	40.4"L x 28.1"W x 13.7H

Projected Replacement Rate: 2 to 3 per Year



# External Hardware

## Cargo Transport Container (CTC)



- Container for Small ORUs
- Maximum Weight 1320 lbs
- Load Isolation System (LIS) allows CTC to move relative to carrier
- Power used for heaters to thermally condition ORUs



# Internal Hardware



- Most Internal ORU hardware typically carried in soft stowage

- Internal ORU Annual Upmass prediction is documented in ISS Supportability Assessment and Traffic Model Reports



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# Internal Hardware

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## Pump Package Assembly



### ORU

ORU Weight: 195 lbs.

ORU Envelope: 17"L x 17"W x 29"H

Projected Replacement Rate: 2 per Year



# Internal Hardware

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## Light Housing Assembly



### ORU

ORU Weight: 2.56 lbs.

ORU Envelope: 24"L x 3"W x 2.8"H

Projected Replacement Rate: 15 per Year



# Internal Hardware

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## Video Tape Recorder



### ORU

ORU Weight: 32 lbs.

ORU Envelope: 15.8"L x 8"W x 7.6"H

Projected Replacement Rate: 2 per Year



# Internal Hardware

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## Sorbent Bed



### ORU

ORU Weight: 9.2 lbs.

ORU Envelope: 14.8"L x 6.3"W x 8.2"H

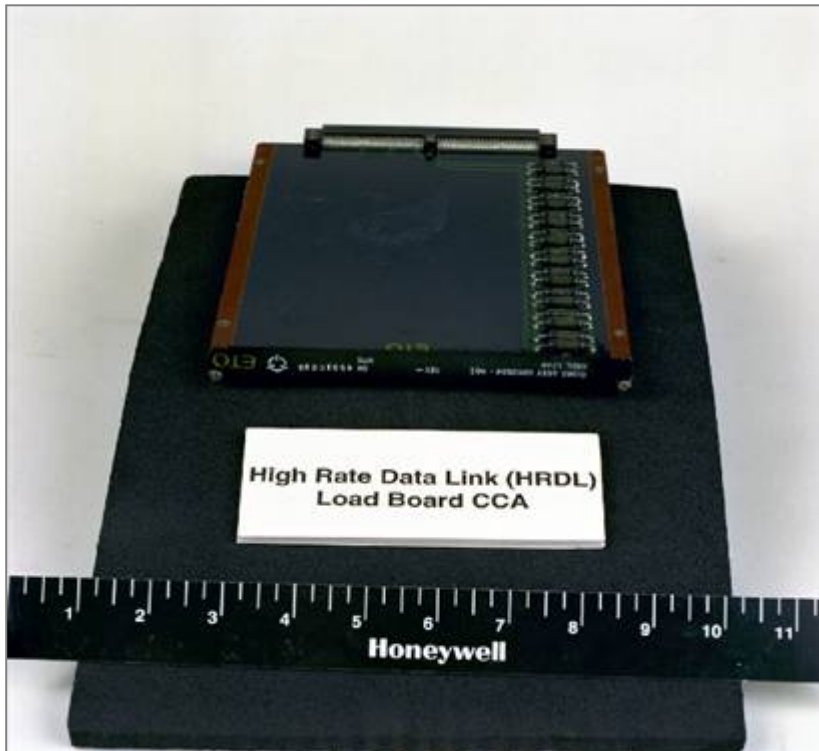
Projected Replacement Rate: 1 every 2 Years





# Internal Hardware

## High Data Rate Link Card



### ORU

ORU Weight: 1 lbs.

ORU Envelope: 8.7"L x 0.7"W x 6.6"H

Projected Replacement Rate: 1 every 3 Years



# Summary

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- **Great variety of ORU hardware types are required for maintenance of ISS vehicle systems**
- **Provided representative example of large, medium and small maintenance ORU cargo items**
- **New Commercial Cargo Service must be responsive to maintenance demand rate to sustain station operations and support ORU environmental certification limit**