EXPRESS Racks and Materials Science Research Rack
Annette Sledd

International Space Station Panel
Payload Facilities

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EXPRESS Rack Background

• In early years of ISS planning, Research representatives and advocates discussed a multi-use Research facility
  • Modular concept
  • Simple/standard interfaces
  • Streamlined integration processes
  • Accommodation of small experiments on the Space Station

• Early 1990’s the EXpedite the PRocessing of Experiments to Space Station “EXPRESS” Rack Concept was developed

• One Year Study (1993) approved
  • Ground Demonstration Unit
  • Trade Studies for packaging, avionics, cooling
  • Operations concepts
EXPRESS Rack Flight Project

- Flight EXPRESS Rack Project approved in 1994
- Collaborative team consisting of various scientific Disciplines and sponsoring organizations (research, commercial, technology) established to develop top level requirements
- Precursor programs, Space Shuttle Middeck and SpaceLab, highly influenced the requirements
  - Physical Sciences desired Shuttle Middeck Locker-type interfaces
  - Life Sciences preferred a Standard Drawer-type interface
- Power, Data, Video, and Cooling requirements defined
- Eight EXPRESS Racks planned
- Ground support hardware to support payload testing and crew training
- Space Station/US Lab design and build occurred concurrently
Maximizes front accessible volume for payloads with subsystems packaged efficiently in the back of the rack and behind connector panels
EXPRESS Rack Flight Demonstration

- Flight Demonstration of EXPRESS Rack approved for SpaceLab, Materials Science Lab -1
- SpaceLab provided interfacing hardware to accommodate ISS Rack structure
  - PHASE payload integrated into lower portion of rack for launch
  - Astro/PGBA launched in Shuttle Middeck and relocated to EXPRESS Rack on-orbit to validate ISS Operations concept
EXPRESS Rack Overview

8 ISS LOCKERS ACCOMMODATED
• Single, double, & quad lockers accommodated

POWER CONNECTIONS
• 28 VDC
• Automatic failover to auxiliary power

SEAT TRACK

2 ISIS DRAWERS ACCOMMODATED
• Blind mate connectors for power and data

Upper control panel (lockers 1,2,5,6):
• Power and data connections
• Power switch/indicator lights
• MTL supply and return supports water-cooled payloads

Lower control panel (lockers 3,4,7,8):
• Upper panel contents +
• Vacuum Exhaust System connection
• Nitrogen supply connection
• Rack Power Switch
• Laptop power/data/switch
• Smoke indication light
• Fireport
• ISIS drawer power switch/indicator lights

AVIONICS AIR VENTS
• Supports air-cooled payloads
• Provides smoke detection

RACK-TO-ISS INTERFACES
• Common Avionics and Software has resulted in synergy and savings in provision of spares and software updates
Window Observational Research Facility

- The **Window Observational Research Facility (WORF) Rack** facilitates Earth Viewing Science using Optical Quality Window in US Lab
  
  - Provides Power and Data interfaces for up to 5 payloads
    - Up to 3 internal, depending on space needed, and
    - Up to 2 external
  
  - Provides avionics air cooling for instruments and crew comfort
  
  - Moderate Temperature Loop Water cooling for avionics
  
  - Provides stable mounting platform and “darkroom” environment for payload instruments
  
  - The Bump Shield provides protection to the US Lab window when crewmembers are working inside the payload volume
  
  - The **Shutter Actuation System (SAS)** allows the external shutter to be ground commanded open and closed
Basic EXPRESS Rack Overview

- **USER PANEL**
  - Rack Maintenance Switch
  - Payload power switches

- **8 ISS LOCKERS ACCOMMODATED**
  - Single, double, & quad+ lockers accommodated

- **POWER CONNECTIONS**
  - 28 VDC
  - Automatic failover to auxiliary power

- **LOWER SHELF ASSY**

- **TCS MANUAL VALVES**

- **PAYLOAD MOD TEMP TCS SUPPLY/RETURN**
  - Supports water-cooled payloads

- **ETHERNET PANEL**
  - 10 RJ45 connectors
  - 4 EXPRESS-type connectors
  - 100 Mbps Hirschmann Switch

- **AVIONICS AIR VENTS**
  - Supports air-cooled payloads
  - Provides smoke detection

- **LAPTOP POWER**
  - 120VDC to 120VAC POWER INVERTER
    (accommodated, not shown)
  - Supports water-cooled payloads
  - Provides smoke detection

- **RACK-TO-ISS INTERFACES**
**Materials Science Research Rack**

**NASA/MSFC**
- MSRR interfaces with the ISS providing the necessary resources for MSL operations
  - Structure
  - Power
  - C&DH
  - Vacuum
  - MTL

**ESA**
- Materials Science Laboratory (MSL) consists of 2 furnace insert(s) and subsystems for processing of investigations

- **Power Supply Unit**
- **Facility Control Unit/Electronics**
- **Process Chamber/Core Facility**
- **Vacuum Gas Subsystem/Internal Water Cooling Loop**
- **Gas Supply Drawer**

- Stowage of MSRR/Science Hardware
- Thermal & Environmental Control (TEC) System Shelf
- Vacuum Access (VAS)/Avionics Shelf
### MSFC ISS Payload Facility Operational History

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Summary

- 8 EXPRESS Racks and 2 Basic EXPRESS Racks are supporting research in areas ranging from physical sciences, life sciences, plant growth research, technology development hardware, and station support hardware.
- Synergy from derivative racks has reduced number of spares required to be available on-orbit.
- WORF has accommodated optical instruments in support of agriculture, humanitarian efforts in responding to natural disasters, Educational/STEM, and meteor viewing.
- MSRR, collaboratively supported by NASA and ESA, facilitates high temperature materials research utilizing the microgravity environment.
- Payload Facilities are supporting research, technology development, and commercial utilization of ISS.