

EXPRESS Rack: The Extension of International Space Station Resources for Multi-Discipline Subrack Payloads

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Abstract -- The EXPedite the Processing of Experiments to Space Station or¹ EXPRESS Rack System was developed to provide Space Station accommodations for subrack payloads. The EXPRESS Rack accepts Space Shuttle middeck locker type payloads and International Subrack Interface Standard (ISIS) Drawer payloads, allowing previously flown payloads an opportunity to transition to the International Space Station. The EXPRESS Rack provides power, data command and control, video, water cooling, air cooling, vacuum exhaust, and Nitrogen supply to payloads. The EXPRESS Rack system also includes transportation racks to transport payloads to and from the Space Station, Suitcase Simulators to allow a payload developer to verify data interfaces at the development site, Functional Checkout Units to allow payload checkout at KSC prior to launch, and trainer racks for the astronauts to learn how to operate the EXPRESS Racks prior to flight. Standard hardware and software interfaces provided by the EXPRESS Rack simplify the integration processes, and facilitate simpler ISS payload development. Whereas most ISS Payload facilities are designed to accommodate one specific type of science, the EXPRESS Rack is designed to accommodate multi-discipline research within the same rack allowing for the independent operation of each subrack payload. On-orbit operations began with the EXPRESS Rack Project on April 24, 2001, with one rack operating continuously to support long-running payloads. The other on-orbit EXPRESS Racks operate based on payload need and resource availability. Sustaining Engineering and Logistics and Maintenance functions are in place to maintain operations and to provide software upgrades.

INTRODUCTION

The EXPRESS Rack concept was derived from the researchers' desire to have a simple hardware interface and a streamlined process to get their experiments to orbit quickly. The EXPRESS Rack provides simple, standard interfaces. Two types of payload accommodations are offered: Middeck Locker type interfaces and International Subrack Interface Standard drawer interfaces. Middeck Locker interfaces are offered to allow payloads (a middeck locker or equivalent replacement container) that had previously flown in the shuttle middeck, Spacelab, SpaceHab, or MIR to transition to ISS using the same interface. The EXPRESS Rack offers eight single middeck locker positions. In the locker positions, the EXPRESS Rack may accommodate single, double, or quad equivalent containers. The ISIS drawer is based on the Standard Interface Rack (SIR) drawers previously flown on Spacelab and MIR by Life Science payload developers. Two 4 Panel Unit (7 inch height) ISIS type drawers can be accommodated in the EXPRESS Rack. Two drawer configurations have been developed. The powered drawers have rear power and data connectors that mate once the drawer is installed and locked into position in the rack. The stowage drawers do not have rear connectors, but utilize a sliding lid for access to the drawer content.

The payloads that occupy these 10 positions in the rack can be provided by multiple science disciplines and can be operated independently of each other in the rack. The EXPRESS Rack Integration Process supports a payload developer in preparation for flight. An EXPRESS Payload Integration Manager (EPIM) is assigned as a point of contact for the developer with the ISS Program. The EPIM coordinates the provision of documentation and ground hardware used to checkout the payload interfaces, as well as supporting the payload developers in providing the interface information required for the ISS program.

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HARDWARE PROVISIONS

Eight EXPRESS flight racks are provided, extending the accommodations of ISS to subrack payloads. All of these racks provide 8 single middeck locker type mounting locations and 2 ISIS Drawer interfaces. Four of these racks include the Active Rack Isolation System (ARIS) to isolate payloads in the rack from disturbances outside the rack. Four of the racks are non-ARIS. The EXPRESS Rack utilizes some ISS-provided components and provides unique structure and subsystem hardware to provide a simple interface for the subrack payloads. The International Standard Payload Rack (ISPR) is provided by the ISS program and serves as the primary structure for the EXPRESS Rack. Secondary structure is added to support the payloads and to provide mounting for the EXPRESS Rack subsystems. Subsystem hardware is located primarily in the back of the rack to maximize front access locations for the payloads. The racks have connector panels at the top of the rack and approximately in the middle of the rack. These connector panels provide data and power interfaces for the middeck payloads and quick disconnects for the fluid interfaces for locker or drawer payloads to access. The EXPRESS Rack Project provides standard cables and lines to connect the payloads to the connector panels.

An EXPRESS Rack Solid State Power Control Module (SSPCM) interfaces with the ISS provided 120 v dc power, distributes it to the other EXPRESS Rack subsystems, and converts it to 28 v dc for distribution to the payloads. The EXPRESS Rack Interface Controller (RIC) and Payload Ethernet Hub/Bridge (PEHB) interface with the ISS data and video services and provides simple data and video interfaces to the payloads. These units, in conjunction with the EXPRESS Memory Unit (EMU), control the EXPRESS Rack subsystem operations, support the configuration of the rack for the payloads located in it, and support the communication with payloads from the ground or on-orbit. Provided with the rack is a laptop for the crewmembers to operate and monitor EXPRESS Rack systems and payloads within the rack.

Cooling is provided in the rack by utilizing the ISS moderate temperature cooling loop. This cooling loop is extended into the EXPRESS Rack and controlled by automatic valves. The EXPRESS Avionics Air Assembly (AAA) interfaces to the moderate temperature loop and includes a water-to-air heat exchanger and fan that provides cooling air to the payload locations. It also circulates the air within the rack past the smoke detector, which is connected to the ISS Caution and Warning system. The EXPRESS Rack distributes cooling air to interface to the rear of the middeck lockers, compatible with the redesigned Orbiter middeck. ISIS drawer payloads are cooled by circulating air through the drawer. The EXPRESS Rack systems are water-cooled through the use of ISS-developed

coldplates, leaving almost all of the AAA-generated cooling air available to the payloads. Payloads can also interface to the moderate temperature cooling loop by interfacing to one of two sets of quick disconnects located on the rack connector panels, through the use of EXPRESS-provided interconnect lines.

The ISS Nitrogen distribution is extended by the EXPRESS Rack to one payload quick disconnect located on the front of the EXPRESS Rack. Likewise, the ISS Vacuum Exhaust System is extended to one location on the front of the rack that a payload can interface to via an EXPRESS-provided fluid line and quick disconnect.

For the EXPRESS Racks with ARIS, additional internal units are included to control and monitor the ARIS portion of the rack. The ARIS components are provided by the ISS program. In addition, a Glenn Research Center provided Space Acceleration and Mapping System II (SAMS II) Remote Triaxial Sensor Electronics Enclosure (RTS-EE) is included in the EXPRESS Racks with ARIS, as a subsystem to interface to a sensor in payloads to monitor the specific microgravity environment at that location.

The EXPRESS Racks are integrated with payloads at Kennedy Space Center and launched, unpowered, to the ISS in the Multi-Purpose Logistics Module (MPLM). Once on-orbit the racks will be transferred to the U.S. Lab module. Later, once the international modules are on-orbit, the EXPRESS Racks may be integrated into the U.S. payload locations of those modules. EXPRESS Transportation Racks will be used to carry additional payloads to and from space. The transportation racks accommodate 6 ISIS 4 PU drawers and 6 middeck locker type payloads. The transportation rack provides only a structural and mechanical interface for the payloads. The transportation racks will remain in the MPLM and the payloads exchanged with the EXPRESS Racks. The exchanged payloads will be loaded into the transportation racks for return to earth. Any payloads requiring power, cooling, or late access will be transported to ISS in the Shuttle middeck, and then relocated to the EXPRESS Rack on-orbit. Four transportation racks have been provided and are currently located at KSC in preparation for launch. The EXPRESS Rack Project provides ISIS drawers for use by payloads. Powered and stowage drawers are provided.

Ten Suitcase Simulators are provided by EXPRESS Rack as portable units to be used at a payload developer's site to support their software development and to verify data interfaces between the payload and the EXPRESS Rack. The suitcase simulator is composed of a computer with cards and software to simulate the EXPRESS Rack. Cables and a laptop are provided for a payload to do an end-to-end communication check prior to delivering the payload to the integration site. Suitcase simulators are provided and

distributed to payload developers based on their flight dates and developmental stage.

A Functional Checkout Unit (FCU) provides simulated EXPRESS Rack interfaces for use in ground testing and is used to check out payloads not being launched in an EXPRESS Rack. A FCU is planned for use at the integration site prior to the integration of an EXPRESS payload into a Transportation Rack or the Shuttle Middeck. The Functional Checkout Unit will interface with KSC Ground Support Equipment that simulates the Lab interfaces.

EXPRESS trainer racks are provided for crew training in the Payload Training Complex. These trainers have the physical interfaces of the rack and simulates, with software, the operation of the EXPRESS Rack subsystems to support training for the basic operations of the rack. In addition to simulating the EXPRESS Rack subsystems, the trainers include software to simulate malfunctions.

ACCOMMODATIONS

The accommodations provided by the EXPRESS Rack for the complement of payloads are provided in Table 1.

Table 1. Total Rack Level Payload Accommodations

Type Accommodation	Total Rack Accommodation
Structural Attachment	8 MDLs and 2 4-PU ISIS Drawers
Power	2000 W 28 VDC power supplied to payloads
Thermal Control	2000 W Payload heat rejection - air and water
Data	RS-422 Analog Ethernet Bi-directional Discrete
Video	One NTSC feed from each payload source
Vacuum Exhaust System	One Payload connection
Nitrogen	One payload connection

The accommodations for individual middeck locker and ISIS payload locations are provided in Table 2.

Table 2. Payload Level Accommodations.

	Amount per Payload	
	MDL	ISIS
Structural Attachment	72 lb @ +10in	64 lb within cg constraints
Power	5 / 10 / 15 / 20 A 28 Vdc	5 / 10 / 15 / 20 A 28 Vdc
Air Cooling	Nominal : 150 W	Nominal : 150
Water Cooling	500 W (two positions maximum in rack)	500 W (two positions maximum in rack)
Data	RS422 Analog Ethernet Discrete	RS422 Analog Ethernet Discrete
Video	1 - NTSC/RS 170A feed	1 - NTSC/RS 170A feed
Vacuum Exhaust	1	1
Nitrogen	1	1

PAYLOAD INTEGRATION

The EXPRESS Rack Integration team is responsible for the development of the requirements definition, analysis, and verification of the integrated EXPRESS Rack. An EXPRESS Payload Integration Manager (EPIM) is assigned to a payload as a single point of contact for a Payload Developer(PD). The EPIM is responsible for working with the PD to document integration requirements in the EXPRESS Integration Agreements (EIAs), Interface Control Documents(ICDs), and Payload Verification Plans (PVPs). The EPIM also assists the PD in providing inputs into the Payload Data Library (PDL) and can provide support to the PD during integration at Kennedy Space Center (KSC) and flight operations. The EI team includes engineers who are responsible for the review of the verification submitted by the PDs and development of integrated rack compatibility analyses. The EI team is also responsible for documenting the integrated rack configuration and planning the manifesting of EXPRESS Rack support hardware.

PRE-MANIFEST AND MANIFEST SUPPORT

The EXPRESS Rack EI team also offers limited assistance to EXPRESS Rack payloads that are not manifested. The EXPRESS Rack EI team will participate in design reviews and technical interchange meetings upon request of a PD. The EXPRESS Rack EI team provides support from the engineering and operations disciplines to address PD issues. The time available to support a PD review depends on the

activities of the EXPRESS Rack EI team in preparing for an upcoming Space Shuttle flight to the ISS.

The EXPRESS Rack EI team participates in the planning of EXPRESS Rack utilization via the Research Planning Working Group (RPWG) activities. During the development of planning periods, increments, and stages, multiple telecons and meetings are held with the Research Program Office (RPO) sponsors and the individual PDs to learn as much as possible about the payload and the interface requirements. Based upon the available data gathered for each payload, the EXPRESS Rack EI team performs top-level analyses to determine the location of payloads in the EXPRESS Rack. The layout, referred to as topologies, is distributed to and reviewed by the science, engineering, and operations communities to assess compatibility. After all groups have reviewed and approved the topologies, the final manifest comprising all payloads is baselined via a Change Request (CR) approved by the ISS Payloads Office and their designated members at the Payload Control Board (PCB). Any subsequent changes required by a PD once a manifest has been baselined is handled through Change Evaluation Forms (CEFs). These CEFs are typically first proposed to the RPWG. Once the RPWG concurs with the CEF, it is forwarded to the Payload Mission Integration Team (PMIT) for review and approval. CEFs that affect manifests are folded into the topologies at which time the topologies are updated as required and distributed by the PMIT. Upon PMIT approval the CEF is presented to the PCB as a CR for approval. The EXPRESS Rack EI team supports the PD with the CR and CEF submittal process.

REQUIREMENTS COLLECTION AND DEFINITION

Once a payload is manifested for a specific stage, the process of payload requirement collection and definition begins. The process is comprised of two major aspects: collection and assessment of payload processing and operational requirements; and definition of the requirements that must be satisfied by the payload in order to be certified as flight-ready. The primary documentation used to accomplish this is the EXPRESS Integration Agreement (EIA) and the Interface Control Document (ICD). The PD and the EI team work together to develop these documents. The purpose and use of each document is described in the following sections. The EXPRESS Rack payload delivery schedule for these products is specified in the Hardware Integration Template Blank Book, SSP-57057. Delivery dates are coordinated with the EPIM.

EXPRESS Integration Agreement

The EIA is the primary management and technical agreement between the Payload Organization and the International Space Station (ISS) Program. The EIA

consists of a main volume, an Increment-specific addendum, and a collection of Data Sets. The main volume documents the static requirements of the payload and the general roles and responsibilities of the parties involved in the processing, transporting and operation of the payload. It also contains information pertaining to specific reviews, schedules and hardware commitments that must be supported by the payload organization. The EIA Addendum is increment-specific and documents the tactical parameters and commitments for a specific transportation flight and on-orbit operation period. Information defined in the increment-specific EIA Addendum includes resource allocations for the payload, consumable products to be provided and crew time and training required. Inputs to the EIA are provided by the PD through the use of an on-line database application called the Payload Data Library (PDL). Required inputs are identified in the electronic forms associated with the Main Volume and Addendum EIA.

Payload Data Sets

In addition to the EIA, there are other Data Sets in PDL which the PD must complete and get approved prior to integration and flight of the payload. Detailed requirements for payload integration, transportation and operation, as well as the payload resource and consumable requirements are defined in these Data Sets. The Data Sets are arranged into the following categories of information:

-Payload Configuration

(physical configuration, dimensions, stowage requirements, schematics, drawings)

-Payload Command and Data Requirements

(uplink, downlink and commanding requirements, definition of data type and format)

-Payload Training Requirements

(crew training requirements)

-Ground Data Service Requirements

(ground data processing requirements)

-Payload Operations Requirements

(procedures, guidelines, constraints, photo/video requirements)

-Kennedy Space Center Support Requirements

(Launch Site Support Plan)

-Kennedy Space Center Technical Requirements

(testing and maintenance requirements and criteria)

The data required for each Data Set and the instructions for providing it are contained in SSP 52000-PDS, "Payload Data Sets Blank Book" and on-line help menus. Each completed Data Set is assessed by the appropriate disciplines or organizations and is placed under configuration control following approval.

Interface Control Document

Definition and control of the interfaces between the payload and the EXPRESS Rack or Orbiter Middeck is accomplished through a combination of the EXPRESS Rack Interface Definition Document and a payload-specific Interface Control Document. The generic EXPRESS Rack interfaces, accommodations and requirements are defined in SSP 52000-IDD-ERP, "EXPRESS Rack Interface Definition Document" (IDD). The IDD defines the EXPRESS Rack mechanical interfaces, quasi-static and random vibration loads environments and environmental conditions to which a payload may be exposed during transportation and on-orbit phases. The payload ICD includes a tabular listing of the IDD paragraphs and each is dispositioned as "Applicable", "Not-Applicable", "Unique" or "Exception" based on the payload configuration and use of specific Rack interfaces. Orbiter interfaces for payloads transported to orbit in the middeck are also addressed in this document by incorporation of the applicable requirements from the Middeck Interface Definition Document. This provides one consolidated list of interface requirements for the payload and eliminates the need for the PD to submit interface verification data to multiple organizations.

For each paragraph identified as applicable in the payload ICD, the associated paragraph in the IDD contains specific interface implementation data such as connector pin-outs and part numbers, and requirements that the PD must meet. The document contains sufficient detail to allow the Payload Organization to utilize this document as a stand-alone source for hardware and software engineering design. The method for verifying compliance with the requirement levied by each paragraph is defined in the payload verification plan, described in the following section.

Requests for an "Exception" are submitted by the PD to address cases where the interface requirement will be met by non-standard means or a waiver is required. Assessment of the request is accomplished in accordance with the process for the particular type of Exception requested (i.e. Exceedance, Deviation or Waiver) and may require a unique analysis be performed. Definition of the specific types of Exceptions is included in the payload ICD and the process for approval is described in the EXPRESS Rack Generic Payload Verification Plan Instruction Annex. In all cases, processing of the Exception is coordinated with the proper approval authority by the ER Team and the EPIM. The unique paragraph, superceding the generic IDD version, is documented in the payload ICD following approval.

The ICD also includes documentation of the electrical and thermal resources provided to the payload through EXPRESS Rack interfaces. These resources are ultimately

received from the ISS and are therefore restricted to the agreements documented in the payload EIA. Flow rates for forced-convection cooling provided by the rack air or water loop, as well as requirements for vacuum venting and GN2 consumption are also documented in the ICD.

Payload Verification

For each payload ICD, a corresponding Payload Verification Plan (PVP) is developed by the PD and submitted to the ER Team for approval. This plan incorporates a specific Verification Requirement Definition Sheet (VRDS) for each IDD requirement applicable to the payload. A set of generic VRDSs are published in SSP 52000-PVP-ERP, "Generic Payload Verification Plan, EXPRESS Rack Payloads". Paragraphs that are dispositioned in the payload ICD as "Unique" or "Exception" have corresponding tailoring applied to the appropriate VRDS such that it reflects the unique verification for that requirement. The submittal date and required data for each requirement is defined on the VRDS. The verification data submittals are provided to the EPIM who then coordinates any required review with the appropriate engineering discipline. A tracking and reporting system is used to provide feedback of VRDS closure or identify any additional data that is required. The EXPRESS Rack payload verification process follows the ISS Program model in relying primarily on Certificates of Compliance (CoC) as the closure method for most requirements. Payloads are required to archive supporting test, analysis or inspection data and be prepared to make it available if required. Notable exceptions are data required to support integrated rack analyses or integrated ISS analyses, such as structural, thermal, acoustic and electromagnetic emission analyses. In these cases, specific test or analysis results must be submitted. Finite-element models of the payload are also required to enable rack-level structural analyses and development of integrated rack models. A detailed summary of the test reports, models, drawings and analyses required from the payload organization to support the complement-level integration process is provided to the PD once the payload is officially manifested.

Verification Data is also used to develop the payload compatibility analysis for the integrated rack. This analysis is performed by the EI team and provided to the ISS payloads office.

Safety

The responsibility for assuring the safety of the payload and associated GSE is assigned to the PD and is accomplished in accordance with NSTS 1700.7, "Safety Policy and Requirements for Payloads Using the Space Transportation System and NSTS 13830, "Payload Safety Review and

Data Submittal". Compliance with the EXPRESS Rack IDD requirements defined by the PVP is utilized primarily to verify compatibility between the payload and the EXPRESS Rack interface and is not intended to satisfy the safety requirements applicable to the payload.

The payload organization is responsible for development and submittal of required safety data packages and the coordination and completion of each safety review with the Ground and Flight Payload Safety Review Panels. The payload safety analysis must include definition of assumptions made by the PD with respect to EXPRESS Rack services and operations associated with hazardous payload functions. The analysis must also include identification of any potential payload failures that could propagate to the EXPRESS Rack and exceed the design criteria in the payload ICD. An Integrated Safety Data Package for each EXPRESS Rack is developed by the ER Team for each ISS utilization stage or flight and includes assessment of any unique hazards that may exist once the payload complement is integrated into the rack.

Experiment Integration Readiness Review

Pre-flight interface verification testing is conducted at the Kennedy Space Center (KSC) utilizing either an EXPRESS Rack or the Functional Checkout Unit (FCU). Approximately one month prior to payload installation into the rack or FCU, an Experiment Integration Readiness Review (EIRR) is conducted by the ER Team and supported by the payload organization and KSC. The EIRR serves as a forum for assessment and discussion of the status of payload's verification requirements and flight and ground safety review process. The payload Safety Verification Tracking Log (SVTL) is also reviewed for both the ground and flight hazard reports. In most instances, a letter from the Ground Safety Review Panel stating the payload is approved to begin processing at KSC is also required. As stated earlier the primary means of ensuring compatibility between the payload and the EXPRESS Rack interface is through compliance with the applicable EXPRESS Rack IDD requirements. The status of a specific subset of the payload's complete set of interface requirements is reviewed during the EIRR and any work yet to be completed is noted. Since this set of requirements is considered the minimum required to assure testing can be undertaken with no risk of hardware damage or personnel injury, any open work may be identified as a constraint to either integration into the rack or testing. A Test Readiness Review (TRR) is conducted by KSC following delivery of the payload for testing. During this review, each open item identified during the EIRR as a constraint is reviewed and the status is updated. All constraints to testing must be removed before checkout of the payload is initiated.

Test requirements for ground processing and the pass/fail criteria for each are provided to KSC by the Payload Organization by submitting them into the payload's KSC Technical Requirements Data Set. KSC develops test procedures that implement the requirements identified in the Data Set. The status of this Data Set and the corresponding procedures is also statused as part of the EIRR.

GROUND PROCESSING SUPPORT

Although KSC has the responsibility for processing the payloads, the EXPRESS Rack EI team provides support to the PD during ground processing. The support ranges from helping payloads get on dock at KSC to support during installation and testing.

The ground processing activity begins with the identification of requirements in PDL. With the knowledge gained from previous payload ground processing activities, the EXPRESS Rack EI team can provide insights to the PDs about their requests for KSC services and support and provide advice to the feasibility of processing requirements. Applying lessons learned results in smoother ground operations activities for the PD.

The EXPRESS Rack EI team draws on the resources of the MSFC Resident Office at KSC. The resident office can help PDs, especially new PDs, navigate their way through the requirements and paperwork that accompanies real time ground operations. Assisting PDs to get the right training and badging for access to areas a PD needs to perform testing, helping to coordinate last minute equipment support services KSC provides, or assisting in the shipping and receiving of hardware are examples of the ways the MSFC resident office can assist the PD during ground processing.

After the payload hardware is received, the PD will test their hardware in an off-line lab at KSC. When the payload is ready for turnover, KSC will conduct a turnover meeting. At this meeting the PD will provide KSC an Integration Data Package (IDP). The EXPRESS Rack EI team will provide support to the PD during their off-line activities and with the development of their IDP.

After turnover, the payload will begin on-line testing. The payload will be checked out in a EXPRESS flight rack or the FCU. EXPRESS team members support payload testing, monitoring the testing from the Huntsville Operations Support Center or on-site at KSC, depending on the testing requirements. The EXPRESS team helps with troubleshooting and test anomaly resolution.

Upon completion of testing the hardware is ready for integration into the carrier that will transport the payload to the ISS. If the payload is planned to be loaded late, it may

be returned to the PD to complete science preparations. If not, the payload would be installed for launch. Prior to installation, astronauts will perform a physical review of the hardware and stowage locker configurations. This review is known as a bench review. The EXPRESS team supports the bench reviews to assist the PD in preparation for the review. During the review the EXPRESS team is available to help disposition any comments received and to help resolve any hardware issues identified at the bench review.

During the ground processing activities the EXPRESS team is available to assist PDs. That support can be provided through the EXPRESS team in Huntsville or the MSFC residence office at KSC.

CONSOLIDATED LOGISTICS AND MAINTENANCE AND SUSTAINING ENGINEERING

Logistics and Maintenance and Sustaining Engineering efforts are in place to support EXPRESS Rack hardware and software on the ground and on-orbit. These efforts also support the EXPRESS Rack derivative hardware for the Human Research Project, the Window Observational Research Facility, and the Biological Research Project Habitat Holding Racks, providing efficiencies for the program. Under the Consolidated Logistics and Maintenance activities, Logistics Support Analysis is performed, Spare Orbital Replacement Units and System Replacement Units are delivered, and Operations and Organizational Maintenance Manuals are developed to support hardware maintenance and operations. Consolidated Sustaining Engineering maintains key critical skills to support on-orbit operations, any associated anomalies, capture key design knowledge, and provide studies/upgrades as directed. Also included are software activities to resolve software anomalies and include in upgraded software releases, along with the implementation of enhanced software requirements to improve/enhance on-orbit operations.

FLIGHT OPERATIONS

After the Shuttle has docked to the ISS, the transfer activities occur according to the timeline developed by MSFC payload operations. When an EXPRESS Rack payload has been transferred to the ISS, it will be installed, activated, and checked-out based on pre-defined procedures

to ensure that the interfaces are properly mated and the payload is operating as expected.

EXPRESS Rack and EXPRESS Rack payload operations occur under the guidance and control of the Payload Rack Operators (PROs). The PROs are part of the flight operations group located at MSFC in the Payload Operations Integration Center (POIC). The PDs can perform science operations from the POIC User Room in Huntsville, Alabama, a Telescience Support Center (TSCs), or a remote site. The PD determines the location to perform their science operations. The Sustaining Engineering Team provides on-call support to EXPRESS Rack operations, pulling in subsystem, software, or integration support personnel, as needed, to resolve issues. The EXPRESS Rack EI team provides support to the payload developer to retrieve their payload after returning from the ISS. This support includes helping to assure the post-landing requirements are documented and can include support at the landing location if requested.

CONCLUSION

The EXPRESS Rack provides a versatile facility for use by all payload disciplines. It has also served as a basis of design for the HRF, BRP, and WOLF racks. Designing and building the derivative racks in conjunction with the EXPRESS Racks has been a benefit to all. Some requirements have been incorporated in all the rack designs, while others have been developed uniquely for a specific configuration. In addition to the synergy provided by building these racks together, it has allowed lessons learned from one rack to be implemented in the others. Efficiencies in building all these racks have benefited all projects involved.

The EXPRESS Rack integration process is designed to minimize impacts to PDs by offering a solution that allows for quick integration of payloads. The EXPRESS Rack EI team is ready to support PDs to ease the process of flight preparation and operations. The EXPRESS Rack EI team does this by ensuring payloads are compatible with the EXPRESS Rack and assisting PDs during integration and operation activities. The EXPRESS Rack EI team takes advantage of lessons learned to make improvements to the analytical integration process.