

Interface Control Document Principal Investigator Equipment to PI Rack to Aircraft System SI_AS_01

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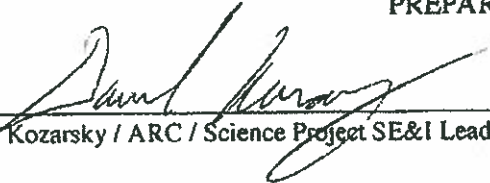


German Space Agency, DLR
Deutsches Zentrum für Luft
und Raumfahrt

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Interface Control Document
Principal Investigator Equipment to PI Rack to Aircraft System
SI_AS_01

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REVISIONS

| REV | DATE | DESCRIPTION | APPROVAL |
|------------|-------------|--|-----------------|
| - | 6/4/2004 | Initial USRA release, never approved by NASA. | |
| A | 4/18/2011 | <p>Clarified and formed “shall” statements. Renumbered sections, figures, and tables. Corrected information in figures and tables.</p> <p>Added requirements for MADS unit space allocation, rack bar-handle clearance, attachment of SI equipment, analysis of COTS equipment, structural-support hardware, and fastener hardware. Revised requirements for attachment of SI equipment on top of the PI rack, sliding rails, and bearing angles. Added information for recommended fastener material and number of fasteners. Removed section load limit and hardware substitution list. Added SI Compliance Authority table.</p> | PMB |
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Table of Contents

| | |
|---|-----------|
| 1. SCOPE | 1 |
| 1.1 PURPOSE | 1 |
| 2. APPLICABLE DOCUMENTS | 1 |
| 2.1 ORDER OF PRECEDENCE | 1 |
| 2.2 APPLICABLE AND REFERENCE DOCUMENTS | 1 |
| 3. INTERFACE REQUIREMENTS | 2 |
| 3.1 RACK DESCRIPTION | 2 |
| 3.2 RACK LOCATION | 6 |
| 3.3 MADS EQUIPMENT | 7 |
| 3.4 RACK INSTALLATION..... | 7 |
| 4. RACK ASSEMBLY LOAD LIMITATIONS / SPECIAL CONDITIONS | 9 |
| 4.1 PI EQUIPMENT ATTACHMENT AND CONTAINMENT | 9 |
| 4.2 RACK LOAD LIMITATIONS..... | 9 |
| 4.3 MAXIMUM TOTAL AND BAY LOADING | 10 |
| 4.4 MAXIMUM OVERTURNING MOMENT..... | 11 |
| 4.5 SUPPORT TRAY LOADING | 12 |
| 4.6 SI EQUIPMENT LOADING | 15 |
| 4.7 SPECIAL CONDITIONS | 19 |
| 4.7.1 <i>Equipment Installation on Top of the PI Rack</i> | 19 |
| 4.7.2 <i>Sliding Rails</i> | 19 |
| 4.7.3 <i>Structural Modifications</i> | 19 |
| 5. QUALITY ASSURANCE PROVISIONS | 20 |
| 6. DEFINITIONS, ABBREVIATIONS, ACRONYMS | 20 |
| 7. APPENDIX A | 20 |
| 8. APPENDIX B | 23 |

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List of Figures

| | |
|--|----|
| Figure 1. General Description, PI Rack | 4 |
| Figure 2. General Dimensions, PI Rack | 5 |
| Figure 3. PI Rack Locations | 6 |
| Figure 4. Rack Tie-Down Hardware | 8 |
| Figure 5. Rack Loading Limitations | 10 |
| Figure 6. Rack Overturning Moment Calculation | 11 |
| Figure 7. Support Tray Maximum Loads, SEM-1-909-0516-1 | 14 |
| Figure 8. Bearing Angles, Fabrication and Installation | 18 |

List of Tables

| | |
|---|----|
| Table 1. Summary of Rack Load Limitations | 9 |
| Table 2. PI Rack Fastener Recommendations | 13 |
| Table 3. Weight/Moment Limitations for Panel-Mounted Chassis | 17 |
| Table 4. Science Instrument Compliance Authority | 21 |
| Table 5. PI Equipment Rack – Weight/Moment Consolidation Sheet | 24 |
| Table 6. SEM-1-909-0516-1 Support Tray – Weight/Moment Consolidation Sheet..... | 25 |

Interface Control Document

Principal Investigator Equipment to PI Rack to Aircraft System

SI_AS_01

1. SCOPE

The scope of this document is to define the physical, functional, and safety-related interface requirements between Principal Investigator (PI) Equipment and Principal Investigator Rack(s) as well as the Principal Investigator Rack(s) to the Aircraft System.

1.1 Purpose

This ICD consists of two parts. The first part (Section 3) presents a description of the PI rack and provides guidelines and requirements for its installation and use in the B-747SP (Modified) SOFIA aircraft. Also covered in this section is the installation of Mission Audio Distribution System (MADS) equipment in the PI rack. The second part (Section 4) provides guidelines and requirements for rack attachment hardware for SI equipment, limitations on rack loading, use of support trays, and special conditions.

2. APPLICABLE DOCUMENTS

The data referenced in this ICD represents the latest version at the time of issuance of this ICD, unless otherwise stated, and forms a part of these requirements to the extent specified herein.

2.1 Order of Precedence

In the event of a conflict between the text of this ICD and the referenced cited herein, the text of this ICD takes precedence. Nothing in this ICD however, supersedes the contractual requirements unless a specific exemption has been obtained and approved. As appropriate, reference is made to other project documentation for use as guidance in developing the context of this ICD and as such forms a basis for requirements to the extent specified herein.

2.2 Applicable and Reference Documents

| | |
|---------------------------|--|
| L-3 Comm Dwg 96139420 | Pallet Instl, PI Rack |
| L-3 Comm Dwg 96139421-003 | Single Pallet |
| L-3 Comm Dwg 96139421-001 | Double Pallet |
| L-3 Comm Dwg 96116108 | Support Instl – Primary / Auxiliary PI Racks |
| SE12-001 | Layout of Personnel Accommodations (LOPA) |

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|----------------------|---|
| SEM-1-909-0512 | C-141 Inst (PI) Rack Assembly |
| SEM-1-909-0516 | Tray Assembly – Experimenter Rack, Equipment Support |
| SER-MSG-001 | Stress Analysis, Principal Investigator (PI) Rack for SOFIA B-747SP (Modified) |
| SCI-AR-PLA-PM21-2000 | Science Project System Safety and Mission Assurance Plan |
| SCI-US-PRO-OP02-2029 | PI Rack Installation Procedure |
| SOF-AR-ICD-SE03-2029 | ICD MCCA_S1_05, Interface Control Document Principal Investigator Patch Panel to Principal Investigator Equipment Rack(s) |
| SOF-AR-SPE-SE01-2028 | SOFIA Science Instrument System Specification |
| SOF-1030 | SOFIA Systems Interface Requirements |

3. INTERFACE REQUIREMENTS

3.1 Rack Description

The PI rack is an open-section frame structure consisting of standard sheet-stiffened panels supported by edge attached angle chord members running longitudinally and post members running vertically. The sheet-stiffened panels form shear walls along both sides of the rack with an intermediate shear wall dividing the open section longitudinally into two bay halves. Figure 1 shows an isometric view of the PI rack structure positioned on top of a single support pallet.

The overall dimensions of the rack are: 40.62 inches (1031.75 mm) high, 42.50 inches (1079.50 mm) wide (side-to-side), and 24.25 inches (615.95 mm) deep (fore-aft). The empty rack weight is approximately 64 pounds. Figure 2 shows general dimensions of a combined rack and support pallet assembly. Each rack has five placards; these placards provide information about rack identification, direction, and limitations. One identification placard displays the part number (P/N SEM-1-909-0512) and the individual serial number of the rack. One directional placard (FWD) identifies the face of the rack that will be oriented towards aircraft-forward. One directional placard (AFT) identifies the face of the rack that will be oriented towards aircraft-aft. There are two identical placards that display the maximum equipment weight and maximum overturning moment of the populated rack.

The PI rack will be transported within the ground facility and aircraft by means of a PI rack dolly. The dolly is owned by NASA Mission Operations. When installed in the aircraft, the rack is located on and attached to the top of a single or double support pallet. These support pallets

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are permanently attached to hard-point fittings over the center wing section of the main deck floor.

The rack is designed to accommodate standard 19"-wide front-panel chassis equipment with packaged electronics installed or free-standing equipment secured to a support tray unit. Chassis and tray assemblies are attached to vertical attach strips that are located at the corner and center posts of the rack. Limitations on equipment weight for packaged chassis equipment and support tray units are detailed in Section 4. All references to support trays in this ICD refer to support tray units (P/N SEM-1-909-0516-1) provided by NASA unless otherwise stated.

The design of the PI rack structure in the SOFIA aircraft has been approved for airworthiness. The assembly drawings for the rack as well as the substantiating stress analysis have been reviewed and approved by NASA.

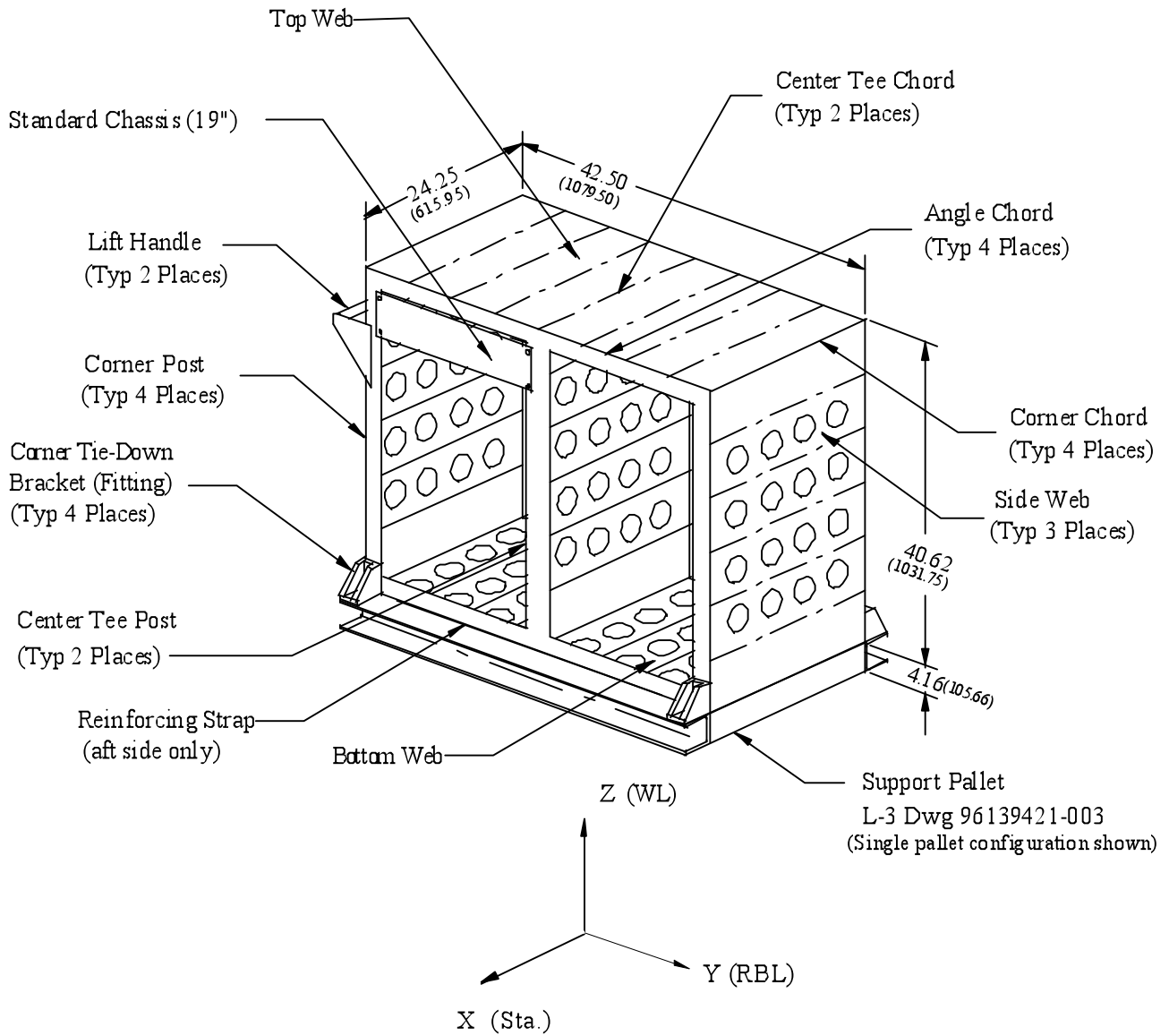


Figure 1. General Description, PI Rack

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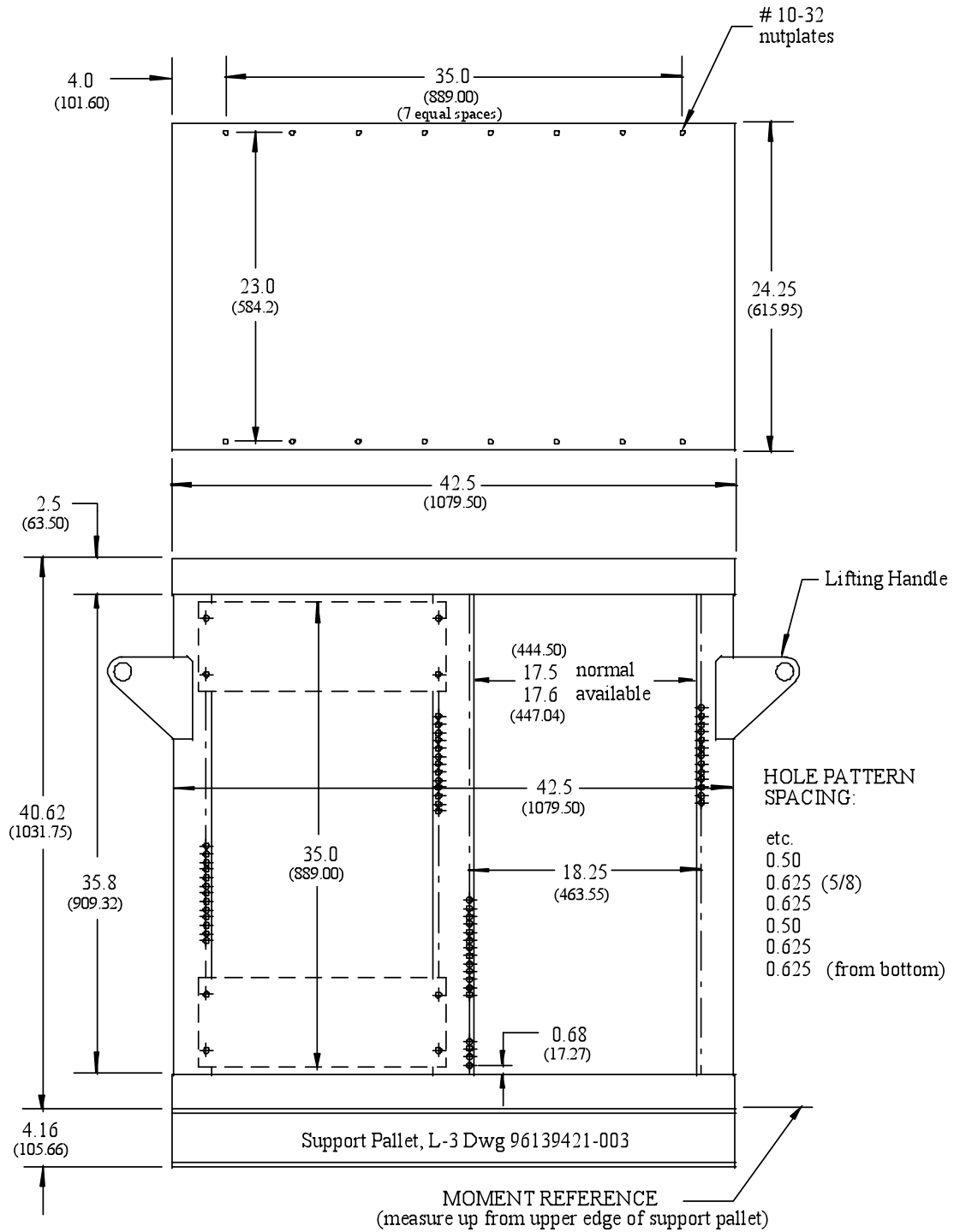


Figure 2. General Dimensions, PI Rack

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3.2 Rack Location

SE12-001, LOPA (Layout of Personnel Accommodations), shows an allowance for two PI racks; a primary and secondary rack placed side-by-side on the main deck floor between FS 1148 and FS 1180, from LBL 68.54 to RBL 18.26. The designated location of the primary rack is towards aircraft-right on the double support pallet. The location of the secondary rack is towards aircraft-left on the double support pallet. An optional third rack location is between FS 1206 and FS 1235, from LBL 28 to RBL 12. Figure 3 shows the rack locations on the aircraft.

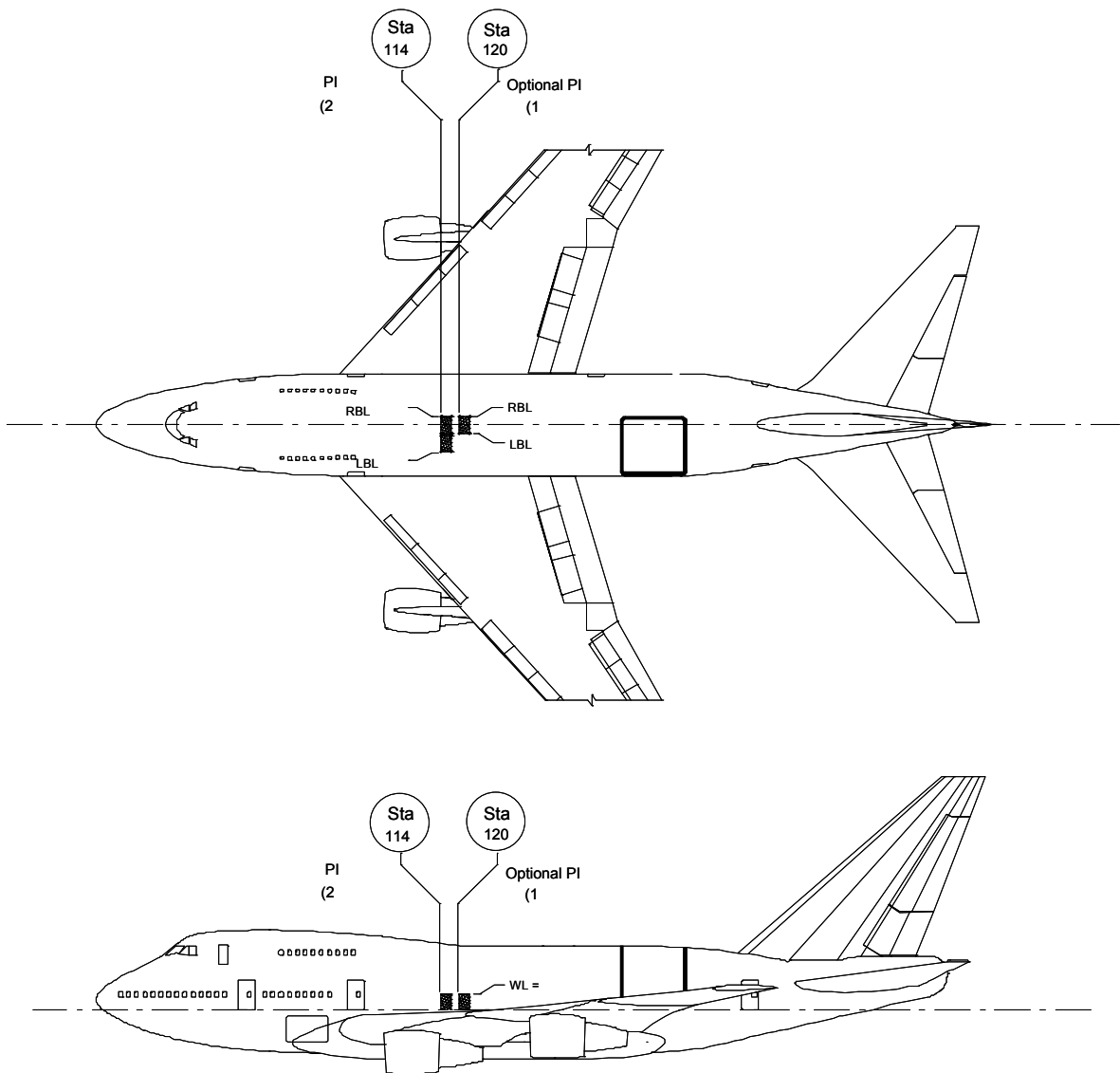


Figure 3. PI Rack Locations

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3.3 MADS Equipment

Mission Audio Distribution System (MADS) equipment will be installed in the primary or the secondary rack. This equipment enables the PI and SI team members seated near the PI racks to communicate with various personnel onboard SOFIA. The installed PI Rack MADS unit consists of one Mission Control Panel (MCP) and three Audio Control Panels (ACPs). The MCP provides channel selection and control features to accommodate communication between personnel on the aircraft. Personnel communicate through microphone headsets which are connected to an ACP. The MCP and ACPs are connected through cables to the Fiber Connection Device (FCD) that is located in the recessed palette area for the primary rack. NASA will provide cables and perform installation of the MADS unit.

The default position of the installed MADS unit is in the upper-forward half of the secondary rack. The PI may request that the MADS unit be installed in the primary rack or an alternate position within the secondary rack. For a PI rack that will contain both SI equipment and the MADS unit, the PI shall allocate sufficient space for the installation of the MADS unit and cable connections to the FCD. The PI shall also include the MADS unit in the rack loading and overturning moment considerations as described in Section 4.2 for a PI rack that will contain both SI equipment and the MADS unit.

The MADS mounting faceplate is 19 inches wide and has a height of 4 panel units (1 PU is 1.75 inches). The depth of the unit including cable and connector hardware inside the PI rack for connections between the FCD and MADS unit is approximately one section-depth of the PI rack. The MADS unit has a weight of 6 lbs excluding cables. The middle-center location of the MADS unit faceplate should be used for moment calculations of the unit. The weight of the MADS unit, excluding cables to the unit, should be included in the total SI equipment weight for a PI rack that contains both SI equipment and the MADS unit.

3.4 Rack Installation

When located in the aircraft, the primary and secondary racks are placed on and attached to a double pallet assembly (L-3 Dwg 96139421-001) which has a height of 4.16 inches (105.66 mm). The pallet is permanently attached to the overwing center section floor utilizing floor support provisions per L-3 Dwg 96116108. The optional third rack is placed on and attached to a single pallet assembly which also has a height of 4.16 inches (105.66 mm).

The required hardware for attaching the rack fittings to the support pallet (four attach points) is shown in Figure 4. Installation hardware and details are provided in L-3 Dwg 96139420, Sheet 4. The PI Rack Installation Procedure is detailed in SCI-US-PRO-OP02-2029.

The PI rack has two removable bar handles for handling purposes. Caution should be exercised when lifting a populated rack, as the populated rack weight could approach 664 pounds, the maximum allowable weight of a populated rack. Additionally, rack loading may not be evenly

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distributed. Before attempting to lift a populated rack, the weight of the populated rack should first be determined and then a lifting crew be assembled accordingly. It is acceptable to use the upper angle chords along the forward and aft sides of the rack when lifting a rack.

To accommodate space for the installation of the primary and secondary racks on the double pallet assembly, the bar handles between the two racks will be removed as detailed in SCI-US-PRO-OP02-2029. Additional bar handles may also be removed if it is determined that more space around the racks is needed. PI equipment attached to the rack shall not interfere with the removal or re-installation of the PI Rack bar handles.

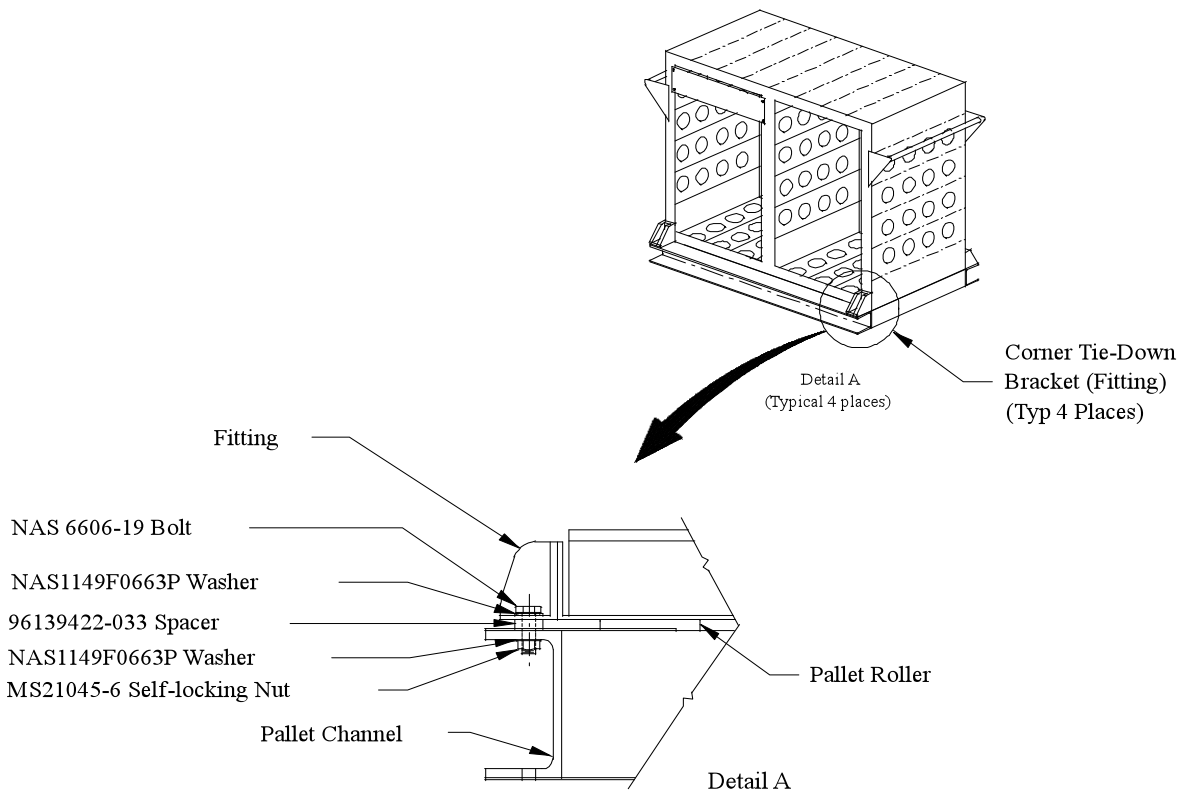


Figure 4. Rack Tie-Down Hardware

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4. RACK ASSEMBLY LOAD LIMITATIONS / SPECIAL CONDITIONS

4.1 PI Equipment Attachment and Containment

The PI rack is designed as an open face and back structure; therefore, each piece of PI equipment must remain attached to the rack under emergency landing conditions. Required stress analyses for PI equipment are detailed in Section 4.5, 4.6, and 4.7. Analyses should show positive Margins of Safety (MS), based on the Ultimate Load Factors specified in the Cabin/Airframe column of SOF-AR-SPE-SE01-2028, Table 3.5-1. As the emergency landing load conditions are prescribed in terms of ultimate loads, it is not necessary to apply a Safety Factor in these analyses.

4.2 Rack Load Limitations

Limitations on placing equipment in the PI rack are outlined in Table 1.

Table 1. Summary of Rack Load Limitations

| Limitations | See Details |
|--|---|
| <p><u>Maximum Rack Loading</u> Max. total rack loading = 600 lbs Max. bay loading (two bays per rack) = 300 lbs per bay Max. rack overturning moment (measured from base of rack) = 1000 ft-lbs or 12,000 in-lbs</p> | <p>Section 4.3 Section 4.3 Section 4.4 Table 5</p> |
| <p><u>Maximum Tray (SEM-1-909-0516-1) Loading</u> Max. tray loading = 150 lbs Max. tray equipment overturning moment (secured free-standing equipment) = 900 in-lbs</p> | <p>Section 4.5 Section 4.5</p> |
| <p><u>Special Conditions</u> Equipment installation on top of the rack = Contact NASA Chassis installation on sliding rails = Contact NASA Major structural modifications = Contact NASA</p> | <p>Section 4.7.1 Section 4.7.2 Section 4.7.3</p> |

4.3 Maximum Total and Bay Loading

The PI rack is divided longitudinally into two bays having two sections per bay. The total SI payload loading of the PI rack structure shall be 600 lbs or less. The weight of payload attached to the top of the rack is included in this weight limit. Weight contribution from elements such as fastener hardware, mounting hardware, and cables that interface between payload equipment within or on the rack should be included in the total payload weight but may be provided as estimated weights for analysis purposes. The total payload weight for any individual bay shall be 300 lbs or less. Figure 5 shows the location of the RH and LH bays and the corresponding two sections per bay.

NOTE: Interactive spreadsheets are available for PI use in the Appendix B section of this document. The spreadsheets may be used to calculate weights and overturning moments associated with a populated PI rack.

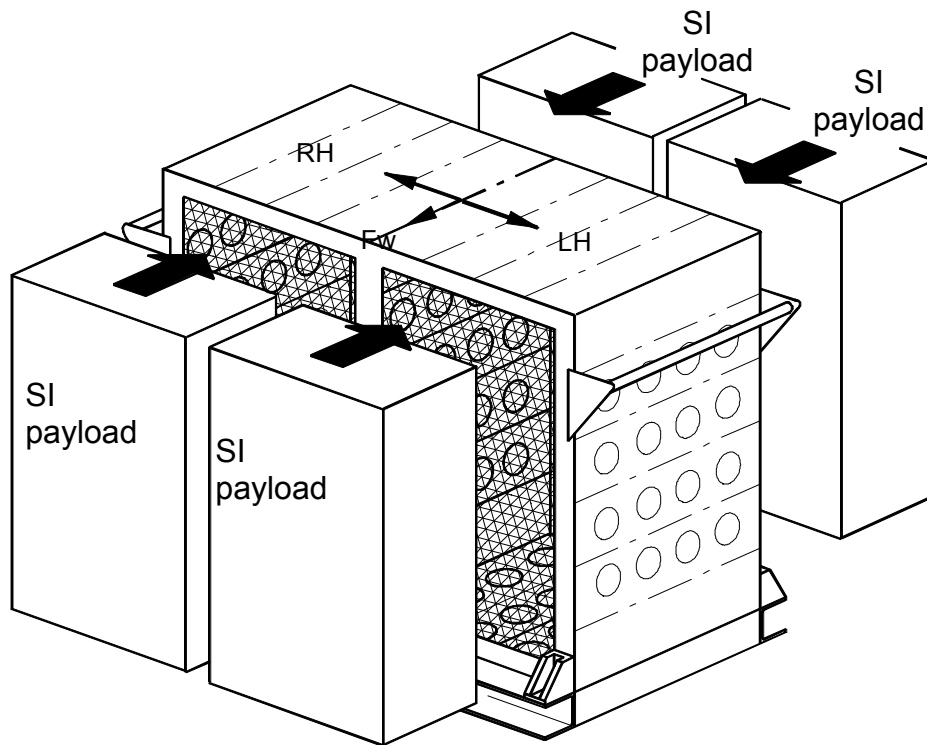


Figure 5. Rack Loading Limitations

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4.4 Maximum Overturning Moment

The PI rack overturning moment consists of all moment contributions from equipment placed in the rack including chassis assemblies and support-tray assemblies, as well as equipment placed on top of the rack. The moment contribution from each item is measured from the base of the rack or the top face of the support pallet. The overturning moment for the rack shall be 1000 ft-lbs (12,000 in-lbs) or less. Figure 6 shows an illustration and sample calculation for calculating rack overturning moment.

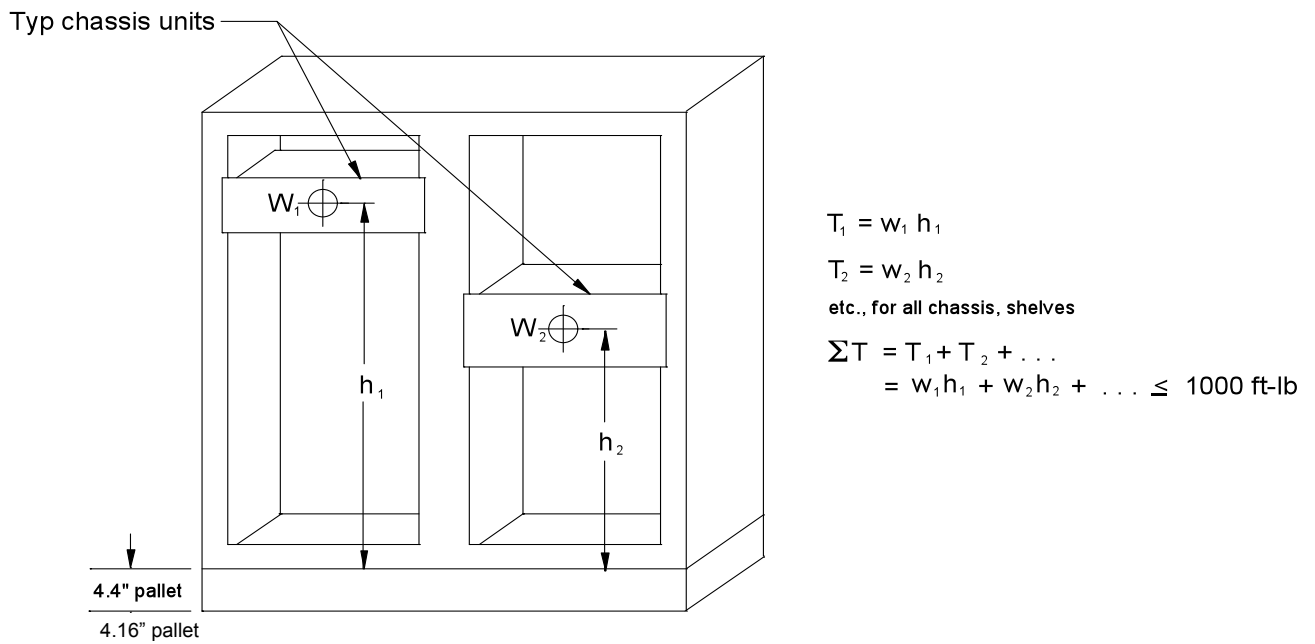


Figure 6. Rack Overturning Moment Calculation

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4.5 Support Tray Loading

Support trays shall be used to support all free-standing equipment with the exception of those items placed on top of the rack. Free-standing equipment is classified as any equipment that is not directly attached to the PI rack attach posts (e.g., equipment not attached to the PI rack by faceplates). Any support tray used shall be attached to both the forward and aft attach posts of a bay. An analysis shall be provided showing that free-standing equipment secured to a support tray withstands the emergency landing load conditions. The use of aircraft-certified fastener hardware is the preferred method for securing free-standing equipment to a support tray. Use of other attachment methods (such as Velcro) may be acceptable with approval from the Science Instrument Airworthiness Team (SIAT). Aircraft-certified fastener hardware shall be used to attach any support tray to the PI rack. A list of recommended fastener hardware is provided in Table 2. Figure 7 shows a possible fastener configuration consisting of a bolt, washer, and clip nut.

The load per tray shall be 150 lbs or less for either free-standing equipment or when supporting a chassis assembly. 150 lbs is the maximum weight the tray can support. The cumulative overturning moment of all the equipment on a tray shall be 900 inch-pounds or less as measured from the upper surface of the tray. Figure 7 shows an isometric view of a possible tray and equipment configuration. The weight of the support tray is 8 lbs. See the note below for requirements for PI-provided support trays.

NOTE: The PI may provide his/her own support tray but must provide a structural analysis of any PI-provided tray for airworthiness review. PI-provided support trays must receive airworthiness approval for use in any flight configuration of the PI rack. PI-provided support trays shall withstand the emergency landing load conditions for the maximum payload-weight the tray is designed to handle. The tray structure as well as the tray attachment points to the PI rack structure must be analyzed. The maximum payload-weight on the tray is determined by the PI in the design of the tray but must not exceed 150 lbs for free-standing equipment or when supporting a chassis assembly. The maximum cumulative payload overturning moment of all equipment on the tray is determined by the PI in the design of the tray but must not exceed 900 inch-pounds from the upper surface of the tray. PI-provided support trays are subject to the same free-standing equipment attachment analysis and aircraft-certified fastener requirements as NASA-provided support trays.

Table 2. PI Rack Fastener Recommendations

| Hardware | Part Number^{1,2} | Type³ | SI Teams using the hardware |
|-----------------|----------------------------------|--|------------------------------------|
| BOLTS | NAS 603 | Screw, Machine, Pan head, Full-threaded | |
| | NAS 623 | Screw, Machine, Pan head, Grip | |
| | NAS 1100-3 | Screw, Machine, Pan head | |
| | NAS 1101-3 | Screw, Machine, Flat fillister head | |
| | NAS 1102-3 | Screw, Machine, Flat 100 deg, Flush head screw | |
| | NAS 1123 | Screw, Machine, Flat fillister head, grip | |
| | NAS 1143 | Screw, Machine, Pan head, grip | |
| | NAS 1153 | Screw, Machine, Flat 100 deg, Flush head screw, Grip | |
| | NAS 1163 | Screw, Self-locking, Flat 100 deg head, Grip | |
| | NAS 1351-3 | Screw, Cap, Socket head | |
| | NAS 1352-3 | Screw, Cap, Socket head | |
| | NAS 1578*3 | Bolt, Flat Pan head | |
| | NAS 1801-3 | Screw, Hex head, Cruciform recess | GREAT |
| | NAS 6203 | Bolt, Hex head | |
| | NAS 6603 | Bolt, Hex head | HIPO |
| NUTS | NASM 21042-3 | Nut, 450°F, Reduced hex, Reduced height, Ring base, NON-CRES | HIPO |
| | SL 210-3-1 | Nut, Clip | FORCAST, GREAT, HIPO |
| | MS 21075L3 | Nut, Self-locking, Plate, Two lug, Floating | FORCAST |
| | NAS 1033*3 | Nut, Self-locking, Right angle | |
| | MS 21051-3 | Nut, Self-locking, One lug | |
| | NAS 679*3 | Nut, Hexagon, Low height | |
| WASHERS | NAS 1149 | Washer, Flat | HIPO |
| | NASM 970 | Washer, Flat large area | HIPO |
| | NAS 620 | Washer, Flat reduced diameter | |
| | MS 35338 | Washer, Lock spring, Helical | |

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NOTES:

- ¹ The preferred fastener material has 160 ksi ultimate tensile strength, 95 ksi shear strength, and is corrosion resistant.
- ² #10-32 fasteners should be used for the attachment of SI equipment to the PI rack.
- ³ It is recommended that fasteners with sufficiently long grip length be used for attachment of SI equipment to the PI rack to avoid fastener threads bearing in holes.
- * This symbol represents a code letter for fastener material type.

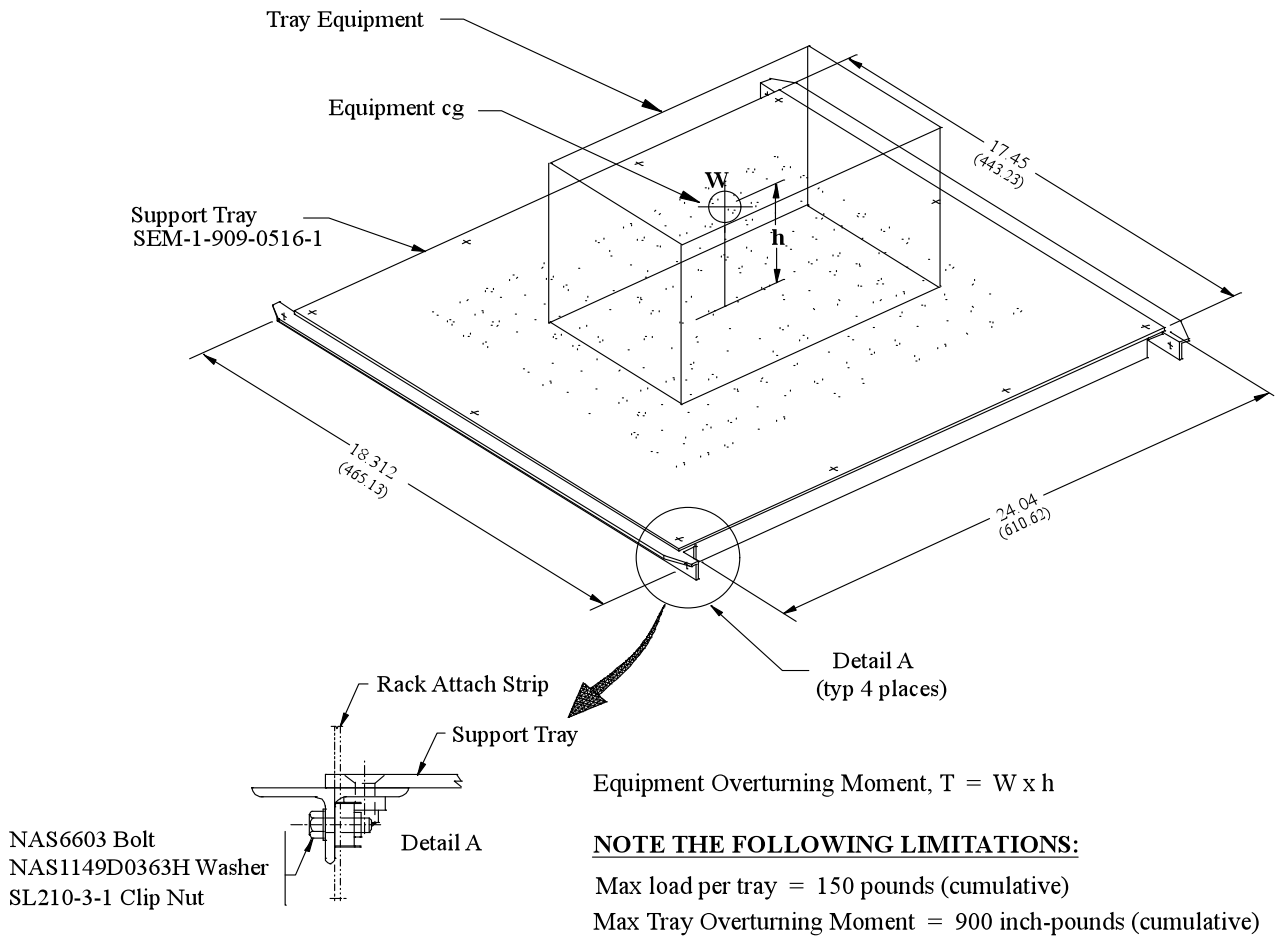


Figure 7. Support Tray Maximum Loads, SEM-1-909-0516-1

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4.6 SI Equipment Loading

An analysis shall be provided showing that attachment of SI equipment to the PI rack structure withstands the emergency landing load conditions. This includes the SI-equipment assembly attachment locations as well as the fastener hardware used. Aircraft-certified fastener hardware shall be used to attach SI equipment to the PI rack. A list of recommended fastener hardware is provided in Table 2. It is recommended that a minimum of four fasteners be used to attach panel-mounted equipment with faceplate heights from 1 PU to 5 PU and eight or more fasteners for faceplate heights greater than 6 PU.

Table 3 is provided as a reference, listing the maximum allowable chassis assembly weights for standard 19"-width panel-mounted equipment with variable panel heights when installed on the forward or aft sides of the rack with or without a support tray. The following faceplate parameters were assumed in the generation of Table 3: 6061-T6 aluminum material, 0.125 sheet thickness, NAS6603 fasteners used (160-180 ksi ultimate tensile strength, 95 ksi shear strength), four fasteners used for attachment of faceplate to the PI rack. Details of the loads analysis for this table can be found in SER-MSG-001, Section 10.1. This table is valid for panel-mounted SI equipment only. The PI may use this table directly to show compliance of panel-mounted SI equipment if the faceplate dimensions, material and fasteners used are equal to or better than the faceplate parameters assumed in Table 3.

SI equipment may be supported by additional structural-support hardware such as a tray or brace to reduce loading on the attach posts. The way by which SI equipment is supported or secured to a tray will determine how the tray will support the equipment in the various cabin/airframe loading directions; i.e. a panel-mounted piece of equipment supported by a support tray and shim will provide structural support only in the down direction, whereas a panel-mounted piece of equipment that has a structural attachment to a support tray will be supported in forward, aft, down, up, and lateral directions. Brace hardware may be used such that the SI equipment is attached to the forward and aft attach posts of a bay. An analysis shall be provided showing that PI-provided structural-support hardware withstands the emergency landing load conditions in its used configuration.

Bearing angles or large-area washers shall be used with any panel-mounted chassis unit that has slotted attach-holes. The PI is responsible for providing any needed bearing angles. Figure 8 provides details for fabricating and installing bearing angles.

NOTES: Analysis of SI equipment also includes COTS equipment and hardware used by the PI. Manufacturer specification sheets may contain information needed for an analysis. In cases where specific needed information is unknown, the PI must make conservative assumptions in his/her analysis. If the analysis does not meet an ICD requirement when conservative assumptions were made, it will be necessary to modify the COTS equipment in order to meet the requirement.

It is recommended that a support tray be used whenever equipment totaling over 65 pounds is assembled within a single chassis unit.

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Table 3. Weight/Moment Limitations for Panel-Mounted Chassis

| Standard Panel Height h (In.) | Panel Mounted Chassis | | | | |
|---|---------------------------------------|--------------------------------|--------------------------------|---|---|
| | No Tray ¹ | | | With Tray | |
| | | Fwd Side Mount | Aft Side Mount | Fwd Side Mount | Aft Side Mount |
| | M_{max} (In-Lbs) ² | W_F (Lbs) ³ | W_A (Lbs) ³ | W_F (Lbs) ³ ⁴ | W_A (Lbs) ³ ⁵ |
| 3.5 | 151 | 41 | 28 | 65 | 57 |
| 5.25 | 227 | 41 | 43 | 65 | 86 |
| 7.0 | 319 | 44 | 57 | 65 | 100 |
| 8.75 | 335 | 45 | 69 | 65 | 100 |
| 10.5 | 354 | 92 | 69 | 131 | 150 |
| 12.25 | 374 | 95 | 69 | 131 | 150 |
| 14.0 | 396 | 95 | 69 | 131 | 150 |

NOTES:

¹ Chassis is face plate mounted only (cantilevered).

² M_{max} is 1g allowable moment about point "B" (in the plane of the panel). See Figure 5-4.

See Figure 8.

³ W_F and W_A are 1g allowable weights at the cg of the chassis.

⁴ These values assume that no equipment is mounted directly in line on the aft side of the rack.

⁵ These values assume that no equipment is mounted directly in line on the fwd side of the rack.

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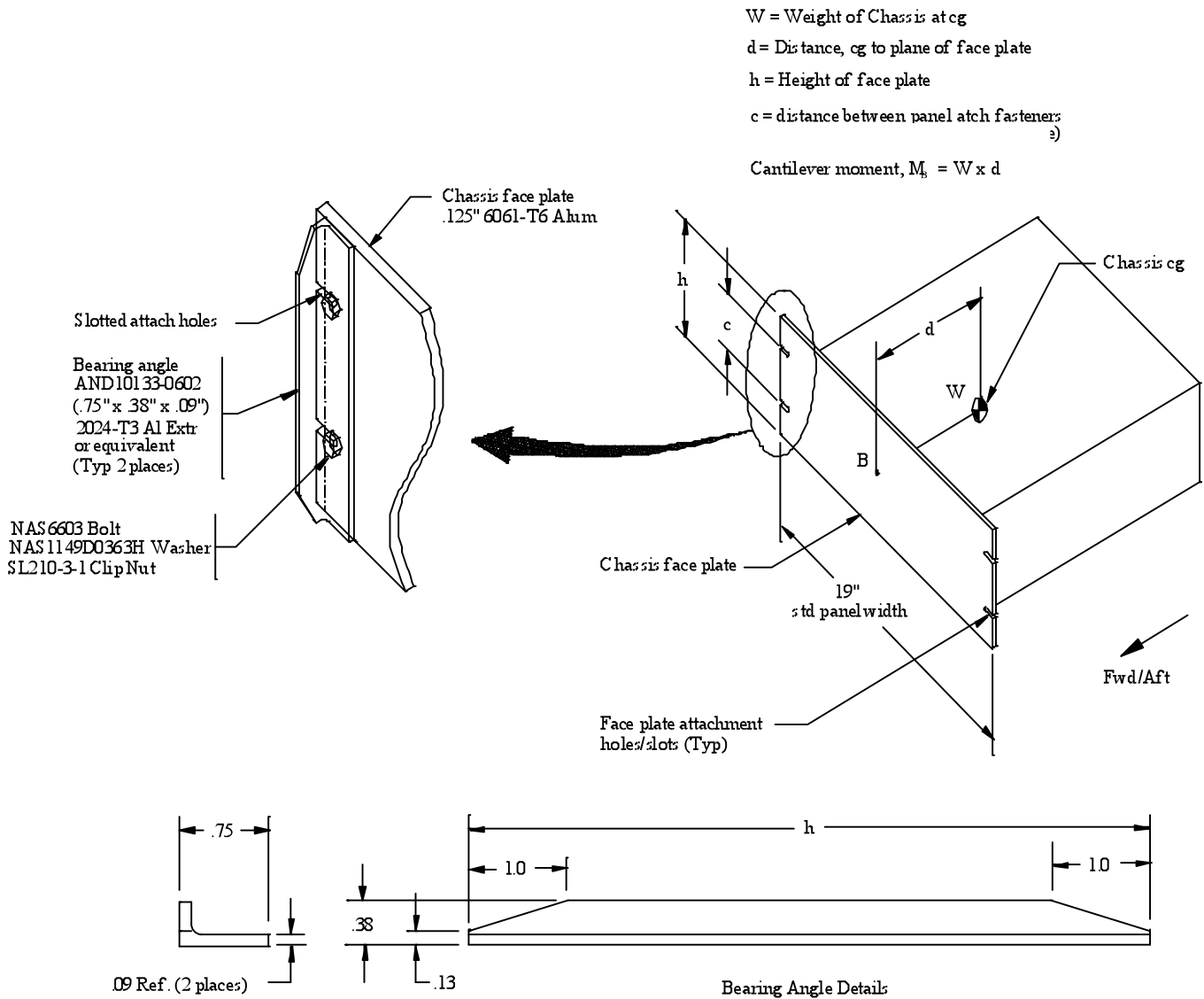


Figure 8. Bearing Angles, Fabrication and Installation

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4.7 Special Conditions

This section covers other limitations for which detailed and all encompassing guidelines have not or cannot be pre-established. In these cases, NASA is prepared to assist in determining what measures can be taken to quantify the problem as well as propose acceptable solutions.

4.7.1 Equipment Installation on Top of the PI Rack

The top of the PI rack has provisions for mounting free-standing equipment. See Figure 2 for locations of available attach points and fastener hardware. An analysis shall be provided showing that equipment installed on the top of the rack withstands the emergency landing load conditions. This includes the SI-equipment attachment locations as well as the fastener hardware used. The use of aircraft-certified fastener hardware is the preferred method for attaching SI equipment to the top of the PI rack. Use of other attachment methods (such as Velcro) may be acceptable with approval from the SIAT.

4.7.2 Sliding Rails

Sliding rail fixtures may be used for the attachment of SI hardware to the PI rack or used internally within SI hardware. The motion of sliding rails shall be constrained in the stowed position. An analysis shall be provided showing that the sliding-rail mechanism and lock mechanism withstand the emergency landing load conditions in the stowed position. Sliding rails directly attached to the PI rack must meet the attachment analysis and aircraft-certified fastener requirements detailed in Section 4.6.

NOTE: As a general rule during flight, SI equipment on sliding rails may be left in the “slide-out” position for short periods of time, incidental for purposes of access and/or maintenance of internal components. For SI equipment used in the slide-out position for prolonged periods of time, the PI shall provide an analysis showing that the sliding-rail mechanism and lock mechanism withstand the maximum in-flight inertia load conditions defined in SOF-1030.

4.7.3 Structural Modifications

Any modification of a NASA-provided PI rack structure or support tray will require NASA approval. A proposed modification will be submitted to NASA that provides drawings and an analysis that show that the proposed modification does not affect airworthiness of the PI rack or support tray.

5. QUALITY ASSURANCE PROVISIONS

Quality Assurance will verify SI compliance with this ICD in accordance with SCI-AR-PLA-PM21-2000, Science Project System Safety and Mission Assurance Plan.

6. DEFINITIONS, ABBREVIATIONS, ACRONYMS

| | |
|----------|---|
| DCN | Drawing Change Notice |
| DWG | Drawing |
| ECO | Engineering Change Order |
| FS | Fuselage Station |
| FWD | Forward |
| ICD | Interface Control Document |
| LBL | Left Butt Line |
| LH | Left hand |
| LOPA | Layout of Personnel Accommodations |
| MS | Margin of Safety |
| P/N | Part Number |
| PI | Principal Investigator |
| PU | Panel Unit |
| RBL | Right Butt Line |
| RH | Right hand |
| SI | Science Instrument |
| SIAT | Science Instrument Airworthiness Team |
| SSP SE&I | SOFIA Science Project Systems Engineering and Integration |
| STA | Station |
| STD | Standard |

7. APPENDIX A

Table 4 lists the responsible NASA compliance authority for each verifiable SI requirement in this ICD. The Science Instrument Airworthiness Team (SIAT) is responsible for assessing SI compliance to all the airworthiness-related SI requirements contained in this ICD. SOFIA Science Project Systems Engineering and Integration (SSP SE&I) is responsible for assessing SI compliance to all other SI requirements in the ICD.

Table 4. Science Instrument Compliance Authority

| Paragraph ID | Requirement | SI Compliance Authority |
|--------------|--|-------------------------|
| 3.3 | For a PI rack that will contain both SI equipment and the MADS unit, the PI shall allocate sufficient space for the installation of the MADS unit and cable connections to the FCD. | SSP SE&I |
| 3.3 | The PI shall also include the MADS unit in the rack loading and overturning moment considerations as described in Section 4.2 for a PI rack that will contain both SI equipment and the MADS unit. | SIAT |
| 3.4 | PI equipment attached to the rack shall not interfere with the removal or re-installation of the PI Rack bar handles. | SSP SE&I |
| 4.3 | The total SI payload loading of the PI rack structure shall be 600 lbs or less. | SIAT |
| 4.3 | The total payload weight for any individual bay shall be 300 lbs or less. | SIAT |
| 4.4 | The overturning moment for the rack shall be 1000 ft-lbs (12,000 in-lbs) or less. | SIAT |
| 4.5 | Support trays shall be used to support all free-standing equipment with the exception of those items placed on top of the rack. | SIAT |
| 4.5 | Any support tray used shall be attached to both the forward and aft attach posts of a bay. | SIAT |
| 4.5 | An analysis shall be provided showing that free-standing equipment secured to a support tray withstands the emergency landing load conditions. | SIAT |
| 4.5 | Aircraft-certified fastener hardware shall be used to attach any support tray to the PI rack. | SIAT |
| 4.5 | The load per tray shall be 150 lbs or less for either free-standing equipment or when supporting a chassis assembly. | SIAT |
| 4.5 | The cumulative overturning moment of all the equipment on a tray shall be 900 inch-pounds or less as measured from the upper surface of the tray. | SIAT |
| 4.5 | PI-provided support trays shall withstand the emergency landing load conditions for the maximum payload-weight the tray is designed to handle. | SIAT |
| 4.6 | An analysis shall be provided showing that attachment of SI equipment to the PI rack structure withstands the emergency landing load conditions. | SIAT |
| 4.6 | Aircraft-certified fastener hardware shall be used to attach SI equipment to the PI rack. | SIAT |

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| Paragraph ID | Requirement | SI Compliance Authority |
|--------------|---|-------------------------|
| 4.6 | An analysis shall be provided showing that PI-provided structural-support hardware withstands the emergency landing load conditions in its used configuration. | SIAT |
| 4.6 | Bearing angles or large-area washers shall be used with any panel-mounted chassis unit that has slotted attach-holes. | SIAT |
| 4.7.1 | An analysis shall be provided showing that equipment installed on the top of the rack withstands the emergency landing load conditions. | SIAT |
| 4.7.2 | The motion of sliding rails shall be constrained in the stowed position. | SIAT |
| 4.7.2 | An analysis shall be provided showing that the sliding-rail mechanism and lock mechanism withstand the emergency landing load conditions in the stowed position. | SIAT |
| 4.7.2 | For SI equipment used in the slide-out position for prolonged periods of time, the PI shall provide an analysis showing that the sliding-rail mechanism and lock mechanism withstand the maximum in-flight inertia load conditions defined in SOF-1030. | SIAT |

VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE

8. APPENDIX B

This section contains two interactive Excel spreadsheets that the PI may use to calculate various weights and overturning moments. Use of these tables is optional and the tables are provided here for convenience. Table 5 can be used to calculate bay weights, total rack weight, and the total overturning moment of a populated PI rack. Table 6 can be used to calculate tray weights and tray-overturning moments of SEM-1-909-0516-1 support trays with free-standing equipment attached.

These interactive features are available in the Word document version of this ICD; a Word version of this ICD is available upon request from NASA. To modify and use the tables, double-click inside the table and input data accordingly.

Table 5. PI Equipment Rack – Weight/Moment Consolidation Sheet

| | | | | |
|-------------------------------------|--|-----------------------|--|--|
| SOFIA PI EQUIPMENT RACK | | Date: _____ | | |
| WEIGHT / MOMENT CONSOLIDATION SHEET | | Rack Serial No: _____ | | |

| | LEFT BAY ITEMS (including top surface) | F* or A | WEIGHT W (pounds) | ARM h (inches) | MOMENT T (in-lbs) |
|----------|---|---------------|-------------------------|----------------------|-------------------------|
| 1: | | | | | |
| 2: | | | | | |
| 3: | | | | | |
| 4: | | | | | |
| 5: | | | | | |
| 6: | | | | | |
| 7: | | | | | |
| 8: | | | | | |
| 9: | | | | | |
| 10: | | | | | |
| TOTALS : | | | | | |

| | RIGHT BAY ITEMS (including top surface) | F* or A | WEIGHT W (pounds) | ARM h (inches) | MOMENT T (in-lbs) |
|----------|--|---------------|-------------------------|----------------------|-------------------------|
| 1: | | | | | |
| 2: | | | | | |
| 3: | | | | | |
| 4: | | | | | |
| 5: | | | | | |
| 6: | | | | | |
| 7: | | | | | |
| 8: | | | | | |
| 9: | | | | | |
| 10: | | | | | |
| TOTALS : | | | | | |

NOTE THE FOLLOWING LIMITATIONS:

| | | |
|---------------------------------------|---------------------------------|--|
| Max. Rack Total Weight = 600 lbs | Total Rack Weight = | 0 lbs |
| Max. Wt Each Bay = 300 lbs | Left Bay Wgt. = | 0 lbs Right Bay Wgt. = 0 lbs |
| Max. Overturning Mom. = 12,000 in-lbs | Total Rack Overturning Moment = | 0 in-lbs |

* Indicate Fwd (F) or Aft (A) item placement in bay

Table 6. SEM-1-909-0516-1 Support Tray – Weight/Moment Consolidation Sheet

SUPPORT TRAY EQUIPMENT *

WEIGHT / MOMENT CONSOLIDATION SHEET

Date: _____
Rack Serial No: _____

| Tray 'A' Description: _____ Location: _____ | WEIGHT W (pounds) | ARM h (inches) | MOMENT T (in-lbs) |
|--|-------------------------|----------------------|-------------------------|
| 1: | | | |
| 2: | | | |
| 3: | | | |
| 4: | | | |
| 5: | | | |
| Totals: | | | |

| Tray 'B' Description: _____ Location: _____ | WEIGHT W (pounds) | ARM h (inches) | MOMENT T (in-lbs) |
|--|-------------------------|----------------------|-------------------------|
| 1: | | | |
| 2: | | | |
| 3: | | | |
| 4: | | | |
| 5: | | | |
| Totals: | | | |

| Tray 'C' Description: _____ Location: _____ | WEIGHT W (pounds) | ARM h (inches) | MOMENT T (in-lbs) |
|--|-------------------------|----------------------|-------------------------|
| 1: | | | |
| 2: | | | |
| 3: | | | |
| 4: | | | |
| 5: | | | |
| Totals: | | | |

* Applies to free-standing equipment only

NOTE THE FOLLOWING LIMITATIONS:

| | | | | |
|---|----------------------------|----------|----------|----------|
| Max. Allowable Tray Weight = 150 lbs | Tray Weights = | 0 lbs | 0 lbs | 0 lbs |
| Max. Tray O'turning Moment = 900 in-lbs | Tray Overturning Moments = | 0 in-lbs | 0 in-lbs | 0 in-lbs |

VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE