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July 17, 1998

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
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PROCUREMENT SPECIFICATION FOR THE ANDROGYNOUS PERIPHERAL DOCKING SYSTEM FOR ISS MISSIONS

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1. SCOPE

1.1 SCOPE

This specification defines the required performance and configuration of the integrated Androgynous Peripheral Docking System (APDS) for use in the International Space Station (ISS) Program. The APDS will be used during orbital docking operations. There will be two types of docking systems covered by this document: active docking system and passive docking system. The term active mechanism refers to the hardware capable of capture, attenuation, structural alignment, and structural lock-up. The term passive mechanism refers to the hardware which can only perform structural alignment and structural lock-up. Active mechanisms will be installed on three Space Shuttle Orbiters (OV-103, OV-104, and OV-105) and on one ISS Pressurized Mating Adapter (PMA) (PMA-1). Passive mechanisms will be installed on two ISS PMAs (PMA-2 and PMA-3).

The requirements for engineering development, design, and verification of the integrated system are defined in terms of specific functional requirements and equipment characteristics to meet operational needs within the constraints imposed by ISS and Orbiter vehicle characteristics, operational interfaces, and external equipment or conditions with which the integrated system must operate.

1.2 ORGANIZATION

The body of the specification is organized to present system requirements for system characteristics and interface requirements, and overall design criteria. Specific product design requirements for Line Replaceable Units (LRUs) are covered in separate appendices. Line Replaceable Unit specific information and definitions are presented in separate appendices following the body of the specification.

2. APPLICABLE DOCUMENTS

2.1 APPLICABILITY

The following documents of the exact issue form part of this specification to the extent specified herein. In the event of a conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall take precedence.

SPECIFICATIONS

International

SSP 50094 29 February 1996	NASA/RSA Joint Specifications Standards Document for the ISSA Russian Segment
SSP 42121	U.S. On-Orbit Segment Pressurized Mating Adapter-1 to Russian Segment FGB Interface Control Document Part 1
SSP 42121	U.S. On-Orbit Segment Pressurized Mating Adapter-1 to Russian Segment FGB Interface Control Document Part 2

Federal

IATA	International Air Transport Association

3. REQUIREMENTS

3.1 APDS DEFINITION

The Androgynous Peripheral Docking System is an integrated turnkey system which provides the means to connect the USA Orbiter to and from the ISS spacecraft. The APDS consists of mechanical and electrical equipment configured to allow for Orbiter-to-ISS docking and undocking using both Orbiter- and ISS-based accommodations. The key elements of the APDS are the passive and the active Androgynous Peripheral Docking Assemblies (APDAs) and the avionics to control the active APDA. Both active and passive APDAs provide status of critical functions during docking and undocking operations. The APDS also provides the ability to control a second, ISS-based active APDA from the Orbiter via a switching system and to control the ISS-based passive APDA exclusively from the Orbiter.

3.1.1 APDS Functional Diagram

Figure 1 is a simplified diagram of the integrated active APDS showing the functional distribution among Line Replaceable Units and showing the passive APDA. In the diagram, the APDS functions are shown distributed between the APDA, crew displays-and-controls panel, and the control boxes.

The APDS consists of the following elements:

A.	MC621-0087-9003	Brassboard
B.	MC621-0087-3002	Androgynous Peripheral Docking Assembly (active, Orbiter ODS, Mission 2A)
	MC621-0087-6001	Androgynous Peripheral Docking Assembly (active, Orbiter ODS)
	MC621-0087-7001	Androgynous Peripheral Docking Assembly (active, ISS PMA-1)
	MC621-0087-8001	Androgynous Peripheral Docking Assembly (passive, ISS PMA-2, -3)
C.	MC621-0087-2002	Docking System Control Unit
D.	MC621-0087-2003	Power Switching Unit
E.	MC621-0087-2004	Latch Actuator Control Unit
F.	MC621-0087-0005	Docking Mechanism Control Unit
G.	MC621-0087-0006	Pyro Firing Control Unit
H.	MC621-0087-0007	Pressurization Actuator Control Unit
I.	MC621-0087-0008	Data Collection Unit
J.	MC621-0087-0009	Docking Control Panel
K.	MC621-0087-0010	APDS Field Support Equipment
L.	MC621-0087-0020	Pyrotechnic Release Devices

M. (No Buyer Number) Orbiter Pigtails (See Appendix XIII)

(No Buyer Number) ISS PMA Pigtails (See Appendix XIII)

N. MC621-0087-0011 Connector Switch Box (See Appendix XIV)

3.1.1.1 ISS Mission Configurations

Equipment procured under this specification will be utilized on ISS missions in the following combinations:

For ISS Mission 2A:

The existing active APDA No. MC621-0087-3002, made from the APDA previously procured under specification JSC-26877 and used on STS-71, will be installed on the OV-105 Orbiter external airlock for berthing with PMA-2 on the ISS Node 1. This APDA will be controlled on the Orbiter by second set of avionics elements and cables previously delivered for use on the Multi-Mir missions. The configuration of this APDA for this mission is shown in Figure 20-A. Also installed on the Orbiter for this mission will be the existing connector switch box No. MC621-0087-0011, previously procured under specification JSC-26877 and used for the STS-74 missions.

A new passive APDA No. MC621-0087-8001 and its associated electrical cables, which are procured under this specification, will be installed on ISS PMA-2 for berthing with the Orbiter and will remain there for future ISS missions.

The new active APDA No. MC621-0087-7001 and its associated electrical cables, which are procured under this specification, will be installed on ISS PMA-1 for berthing with the FGB and will remain there as a structural element of the ISS.

For ISS Missions 3A and Subsequent:

A new active APDA No. MC621-0087-6001, procured under this specification, will be installed on the Orbiter for docking with the passive APDA already installed on ISS PMA-2. Identical new APDA units will subsequently be installed on two other Orbiters. These APDAs will be controlled on the Orbiters by the new avionics elements and cables to be procured under this specification. The connector switch box used on Mission 2A is not planned for installation on this or any subsequent ISS missions.

A second, new passive APDA No. MC621-0087-8001, procured under this specification, will subsequently be installed on ISS PMA-3 and will remain there.

3.1.2 Interface Definition

The APDS shall be designed to meet the interface requirements defined herein on a system basis and Line Replaceable Unit interface requirements as defined in the appendix applicable to that Line Replaceable Unit. Interface requirements are defined for both active and passive APDA functions such as power, wiring, control signals, and data, as shown in Figure 2. Where interface requirements are unique to Line Replaceable Unit, they are defined in the appendix applicable to that Line Replaceable Unit.

3.1.2.1 Electrical Characteristics

Electrical characteristics at the APDS interface and of the APDS equipment will be in accordance with the following requirements:

3.1.2.1.1 Orbiter Main DC Power

28 Vdc nominal, two wire, structure grounded system.

3.1.2.1.2 Orbiter Steady-State Limits

24 to 32 Vdc: continuous duty
23 to 32 Vdc: intermittent duty

3.1.2.1.3 Orbiter Transient Voltage

3.1.2.1.3.1 Surge

Transient surge voltages, when converted to their equivalent step functions, as defined in Figures 3 and 4, shall be within the limits of Figures 5, 6, and 7 herein for normal, abnormal, and emergency conditions respectively.

3.1.2.1.3.2 Spike

Transient spikes will not exist at the power input terminals of equipment greater than twice the line voltage or 100v, whichever is less, in accordance with Figure 8.

3.1.2.1.3.3 Ripple

The maximum individual ripple component will not exceed 0.9 volts peak-to-peak. The total broadband ripple content will not exceed a maximum of 1.6 volts peak-to-peak. The frequency characteristics of the ripple voltage are shown in Figure 9.

3.1.2.1.4 Orbiter Primary Power Grounding System

The Orbiter electrical system has a primary power grounding system whereby the vehicle structure is the referenced ground for the negative of the dc in the power generation and distribution subsystems as shown in Figure 10.

3.1.2.1.5 Utilization of Orbiter Electrical Power

3.1.2.1.5.1 Normal Electrical System Operation

During the transient and steady-state conditions associated with normal operation (load switching) of the primary electrical system, utilizing equipment shall perform in accordance with Figure 5 and as specified below:

A. Shall provide 100% performance. No performance of utilizing equipment is required during the voltage supply interruption associated with bus switching.

B. Shall remain safe.

3.1.2.1.5.2 Abnormal Electrical System Operation

During the transient and steady-state conditions associated with abnormal operation of the primary electrical system, utilizing equipment shall perform in accordance with Figure 6 and as specified below:

A. Shall remain safe.

B. May have momentary loss of function; this momentary loss, however, shall not affect later equipment performance.

C. Shall, after abnormal operation of the electric system and with return of the electric system to normal operation:

   1. Recover automatically to specified performance.

   2. Have reliability negligibly affected owing to the abnormal electric-system operation.

3.1.2.1.5.3 Emergency Electrical System Operation

During the transient and steady-state conditions associated with the emergency operation of the primary electrical system, utilizing equipment shall perform in accordance with Figure 7 and as stated below:

A. Shall remain safe.

B. Shall have 100% performance with return to operation of the primary electrical power system and after any necessary system initialization has been accomplished.

3.1.2.1.5.4 Influence on Electrical Systems

There shall be no influence by utilizing equipment on the characteristics of power at the input to its terminals which causes these characteristics to go beyond the limits in 3.1.2.1.

3.1.2.1.5.5 Isolation of Power Source

The Orbiter power distribution system utilizes three redundant and isolated dc buses to distribute power to all subsystems. Equipment requiring electrical power from two or more sources shall have isolation such that no single failure will result in the loss of more than one source. Typical isolation is referenced in Figure 11.

3.1.2.1.5.6 Power Transfer

Interface characteristics of power to be transferred through the APDS are per 3.1.2.6.

3.1.2.1.6 General Electrical Equipment Requirements

3.1.2.1.6.1 Separation of Redundant Equipment

As a design goal, redundant systems, redundant subsystems, and redundant major elements of subsystems such as assemblies, panels, power supplies, controls, and associated wiring shall be separated by the maximum practical distance or otherwise protected. This requirement does not apply to existing designed hardware.

3.1.2.1.6.2 Inadvertent Electrical Performance Due to Debris

Equipment design shall prevent malfunction or inadvertent operation of equipment exposed to conducting or non-conducting debris or foreign matter in any specified gravity state and zero "G".

3.1.2.1.6.3 System Checkout Provisions

Sufficient test capability shall be provided to permit normal planned checkout of subsystems without disconnecting connectors normally connected in flight. Test cables shall be provided as extensions to accessible panels. In that equipment containing redundant circuits, provision shall be made for verifying proper operation of each of the redundant circuits.

3.1.2.1.6.4 Equipment Accessibility

Systems, subsystems, equipment, and components shall be designed with features that contribute to the ease and rapidity of maintenance. To the extent practicable, equipment expected to require servicing, replacement or maintenance shall be designed to be accessible without removal of other equipment or wiring. Cable installations shall be designed with sufficient length, flexibility, and protection to permit disconnection and reconnection without damage to wiring or connectors.

3.1.2.1.6.5 Insulation Resistance

The insulation resistance to the case or enclosure shall be as specified below using a potential of 100 Vdc unless otherwise specified in the procurement specification. The insulation resistance shall be measured between mutually insulated parts with all power sources and loads disconnected.

A. ≥20 MOhms at a temperature of 77 ± 18 °F (25 ± 10 °C) and relative humidity of 45 to 80%

B. ≥ 1 MOhm at a temperature of 68 ± 9 °F (20 ± 5 °C) and relative humidity of 95 ± 3%

C. 5 MOhms at a temperature of 95 to 140 °F (35 to 60 °C), and minus 58 to plus 59 °F (-50 to 15 °C), both with a relative humidity of 80 to 90%

3.1.2.1.6.6 Dielectric Withstanding Voltage

Equipment shall be capable of withstanding 200 Vac for 1 second. There shall be no arc-over or leakage greater than 100 milliamperes. The Seller's installation drawing and other applicable documents shall include any necessary caution notes regarding dielectric or other test voltages with regard to connected terminals, terminals across capacitors, integrated circuits, semiconductors, and other polarity sensitive devices. Buyer must approve any variation with this requirement.

3.1.2.1.6.7 Corona, High-Voltage Breakdown, Multipaction

Equipment external to pressurized compartments shall be selected or designed where applicable to prevent high-voltage breakdown and to be free of corona and multipaction. This applies to connectors, wires, and cabling, to pressurized components, and to vented boxes exposed to a cyclic space environment from 14.7 psia (760 mm Hg) through 1.9 X 10^{-6} psia (1 X 10^{-4} mm Hg) for a duration of one day to 30 days at 1.9 X 10^{-6} psia (1 X 10^{-4} mm Hg).

3.1.2.1.7 Grounding and Bonding

3.1.2.1.7.1 Equipment and Subsystem Returns and Grounding

A controlled primary power grounding system in accordance with 3.1.2.1.4 is used on the Orbiter Vehicle. All equipment installed in the Orbiter and major elements interfacing with the Orbiter shall have dc power return and signal return which are dc isolated from each other and from equipment chassis, case, or enclosure by a minimum of two megohms except for circuits using coaxial cables.

Harness shields external to the equipment, requiring grounding at the equipment, shall have provisions for grounding the shields to the equipment chassis through the harness connector backshell or by other Buyer-approved grounding techniques. Equipment or element internal secondary power supplies and signal and shield networks shall utilize grounding techniques adequate for the application as long as the isolation specified above is maintained for all circuits that interface with vehicle systems.

3.1.2.1.8 Wiring

3.1.2.1.8.1 Integral Leads

A. Lead wires or "pigtails" of the Russian-American Interconnecting wiring shall only be used for the electrical connections which are to be terminated by the Buyer.

B. Unless otherwise specified, the lead wires shall be individually identified with lengths defined in Appendix XIII and Appendix XIV. The identifications shall be durable and legible, and shall not degrade the wire and cable or equipment performance.

3.1.2.1.8.2 Circuit Protection

Where three or more parallel wires are used to share the current, protection at both ends of the wiring, by fuses or other Buyer-approved wire-protection devices, is required, and each of the parallel wires shall be protected. Buyer will install fuses at Buyer's end and Seller shall install at his end fuses or other protective devices with fusing characteristics electrically equivalent to the characteristics of the fuses at Buyer's end.

3.1.2.1.8.2.1 Exception for Power Transfer Umbilicals

Exceptions to those requirements for power transfer umbilicals is defined in 20.3.1.2.1.3.1.

3.1.2.1.8.3 Strain Relief

The equipment shall incorporate adequate strain relief for the lead wires and their terminations.

3.1.2.1.8.4 Pyro Circuit Wiring

A. The pyro firing circuit for each initiator shall be supplied by a balanced, shielded, twisted-pair line. The line shall not be connected directly to vehicle structure and will be isolated from vehicle direct current returns through a minimum of 100k ohms resistance. The pyro firing circuit is defined as that portion of the firing control system which is isolated and which carries the initiator firing current.

B. Shielding. The firing circuit from the current source shall be twisted, shielded pairs. Good radio-frequency (RF) shielding practices shall be implemented. Such practices include multipoint grounding, no unshielded portions, and RF type shield termination (360 degree shielding coverage on the backshell). Shields shall be grounded to vehicle structure through the pyrotechnic initiator connector body.

C. The firing circuit shall limit the power produced at each pyrotechnic device by the electromagnetic environment acting on the subsystem to a level at least 20 dB below the maximum pin-to-pin DC no-fire power of the initiator. A 20 dB margin shall also exist in the pin-to-case mode of firing relative to maximum no-fire RF levels.

D. The pyrotechnic devices shall not fire in either the pin-to-pin or pin-to-case mode due to direct coupling of the specified electromagnetic environment into the firing circuit.

3.1.2.1.8.5 Wire Sizing

Wire and cable types, sizes, and ratings shall be compatible with the equipment and its installation in the Orbiter under applicable conditions of environment, voltages, and currents.

3.1.2.1.8.6 Circuit Separation

Connectors shall be wired in such a manner that adjacent pins shall not be used for circuits where a single short between them or to case could result in the failure of a circuit that causes a loss of crew. Wiring to connector pins shall be arranged with consideration of corona-adjacency effects and to separate switching and power, low- and high-level inputs, and signal circuits from power and control circuits.

3.1.2.1.8.7 Wiring Identification

All accessible internal and external wiring of electrical equipment shall be positively identified by legible markings as defined in the Seller's detail wiring diagram. Only one marking system shall be used and shall be consistent throughout the equipment. For wiring or jumpers too short to be marked, such wiring or jumpers shall be legibly indicated on the Seller's detail wiring diagram, and the termination points shall be positively identified. The identification method used shall not degrade insulation and shielding and shall be selected to facilitate maintenance and repair of the equipment to the greatest extent practicable.

3.1.2.1.8.8 Wire Insulation Protection

Wire passing through metal structures shall be adequately protected from chafing, abrasion, and cold flow compression.

3.1.2.1.8.9 Redundant Electrical Circuits

As a design objective, wiring of redundant systems, subsystems, or major elements of subsystems shall not be routed in the same bundle or through the same connector along with wiring of any other similar system element such that a single connector demate will cause loss of crew. Where such routing is not feasible, the routing shall be identified by color coding and drawings, with the reason for deviation.

3.1.2.1.8.10 Wire Harness Protection

Wire and cable installation shall be designed so as to minimize potential damage. Wires and cables shall be protected by proper supporting devices, by removable covers, or by other suitable protective measures. Cables and connectors not used in flight shall be removed prior to flight, or if permanently installed, shall be properly identified and stowed with metal connector caps. No cable, connector, or metal cap shall be unsupported or loose during flight.

3.1.2.1.8.11 Visual Verification

As a design objective, consideration shall be given to permit visual inspection of proper connector mating and wire harness condition during initial installation and during vehicle turn-around operations.

3.1.2.1.8.12 Wire Bundling

Reduction of electromagnetic effects in interconnecting wiring shall be accomplished through circuit classification and isolating incompatible circuits via wire cable bundling, routing, and separation. Wire classification shall be in accordance with the data listed in Table 130-F. Wire separation and bundle requirements shall in accordance with the requirements listed in Table 130-G. These requirements do not apply to existing designed hardware.

3.1.2.2 Mechanical Interface

The design of the equipment shall be such that it is compatible with the mechanical interfaces specified in applicable Appendices for equipment mounted in the external airlock, internal airlock, and crew compartment.

3.1.2.2.1 Mounting

The mounting provisions of the equipment shall be as specified in the applicable Line Replaceable Unit appendices.

3.1.2.2.2 Connector Location and Pin Function Assignments

Electrical connectors and pin assignments shall be as specified in the applicable Line Replaceable Unit and mechanism appendices. Interconnecting wiring between the APDS Line Replaceable Units and the Orbiter and between Line Replaceable Units and PMA-1, -2, and -3 shall be as specified in Appendix XIII.

3.1.2.3 Cooling

APDS Line Replaceable Units shall not require active or forced air cooling, unless otherwise specified in applicable appendices.

3.1.2.4 Instrumentation

The design of the equipment shall be such that it is compatible with the instrumentation interfaces specified in applicable Appendices for equipment mounted in the external airlock, internal airlock, and crew compartment.

3.1.2.5 Field Support Equipment

The interfaces between the APDS and Field Support Equipment (FSE) shall be defined in Appendix XI.

3.1.2.6 Electrical Resource Transfer

The transfer of electrical resources across APDAs will be performed via the X1 thru X4 umbilical connectors as defined in Appendix II. Resource transfer will only be performed in the mated condition, and all transferred functions will be deadfaced prior to mate and after demate activities.

3.1.2.6.1 Resources Transferred from Orbiter to ISS PMA-2, -3

Shielding characteristics for circuits used for transfer of electrical resources across APDAs -6001 and -8001 shall be as follows:

A. 1553 Data Bus. EMC as identified for such circuits in Tables 20-G-1 and -2.

B. Audio. EMC as identified for such circuits in Tables 20-G-1 and -2.

C. Video. EMC as identified for such circuits in Tables 20-G-1 and -2.

D. 28-Volt Discretes. EMC as identified for such circuits in Tables 20-G-1 and -2.

E. 5-Volt Analog. EMC as identified for such circuits in Tables 20-G-1 and -2.

3.1.2.6.1.1 Electrical Power

Electrical power capability for circuits used for transfer of power across APDAs-6001 and -8001 shall be as follows:

- Nominal Operating Voltage = 140 +/-4 Vdc
- Nominal Continuous Output Current = 14.7 A
- Overcurrent Protection = current limiting between 14.7 and 44 amps for a minimum of 25 milliseconds followed by shutdown within 30 to 60 milliseconds. Shutdown will occur between 30 and 60 milliseconds if output exceeds 35 amps
- Overvoltage = power transfer will shut down within 10 microseconds if output voltage exceeds 178 + -2 Vdc or within 5 milliseconds if output voltage exceeds 165 + -2 Vdc for more than 10 milliseconds
- Redundant power transfer circuits

3.1.2.6.2 Resources Transferred from Orbiter or ISS Node 1 to ISS FGB

Shielding characteristics for circuits used for transfer of electrical resources across APDA -7001 shall be as follows:

A. 1553 Data Bus. EMC as identified for such circuits in Table 20-G-3.

B. Audio. EMC as identified for such circuits in Table 20-G-3.

C. Video. EMC as identified for such circuits in Table 20-G-3.

D. 28-Volt Discretes. EMC as identified for such circuits in Table 20-G-3.

E. 5-Volt Analog. EMC as identified for such circuits in Table 20-G-3.

3.1.3 Major Component Identification

The major components of the APDS equipment are identified in applicable Appendices.

3.2 CHARACTERISTICS

3.2.1 Performance Characteristics

A. The APDS functions shall provide the means to connect and disconnect the active and passive docking halves and to provide for on-orbit shirt-sleeve transfer of crew and equipment between the Orbiter crew cabin and the ISS.

B. The APDS shall provide the ability to transfer power, data, audio, and video resources between Orbiter and ISS and between ISS PMA-1 and FGB.

C. Sequencing of APDS functions may be automated from initial contact until full dock; the automated sequence, however, shall be able to be interrupted at any point. Subsequent to interruption, the sequence shall be able to be completed manually or terminated manually. Interruption of the automated sequence shall not prevent remating to the ISS.

D. Means shall be provided to monitor safety-critical functions, system verification, checkout, and operations. Health monitoring and communications shall be provided to both flight crew and ground operations.

3.2.1.1 Life

3.2.1.1.1 APDA

3.2.1.1.1.1 Service Life

A. -6001 APDA The -6001 APDA shall be capable of performing all of the applicable operations specified herein with maintenance for a minimum of the following cycles.

On-Orbit Vacuum Cycles	40
Ground No-Load Cycles	288
Ground Load Cycles	7

B. -7001 APDA The -7001 APDA shall be capable of performing all of the applicable operations specified herein without maintenance for a minimum of the following cycles.

On-Orbit Vacuum Cycles	2
Ground No-Load Cycles	9
Ground Load Cycles	2

C. -8001 APDA The -8001 APDA shall be capable of performing all of the applicable operations specified herein without maintenance for a minimum of the following cycles. Hatch seals may be replaced as required.

Subsystem Classification	I	II
On-Orbit Vacuum Cycles	107	10
Ground No-Load Cycles	9	9
Ground Load Cycles	2	2

Subsystem Classification I hardware is that hardware used for a nominal docking, including the passive structural latches, the thermal, capture and undocking sensors, the structure (base, stationary guide ring and seals), the resource electrical connectors, pushers and hatch assembly.

Subsystem Classification II hardware is that hardware used for a contingency docking requiring the active structural latch mechanism.

3.2.1.1.1.2 Operating Life

The APDA shall have a minimum operating life of the cycles specified in 3.2.1.1.1.1 which are equivalent to the following.

A. -6001 APDA — 33 Orbiter missions in a 15 year life with maintenance.

B. -7001 APDA — 2 Orbiter mission in 15 year life without maintenance.

C. -8001 APDA — 3 Orbiter mission in a 15 year life without maintenance.

An Orbiter mission is defined as including all applicable operations and environments including launch, on-orbit and landing phases.

3.2.1.1.1.3 Shelf Life

The APDA shall be capable of operating in accordance with the requirements specified herein any time within a period of 15 years from the date of delivery when exposed to the applicable environments of 3.2.5.

3.2.1.1.2 Avionics

Except as specified otherwise in this document, the avionics elements of the APDS shall have a minimum service life without failure as follows:

A. 165 hours on-time operation in space

B. 990 hours total on-time

C. 264 power-on-power-off cycles in space

D. 1584 total power-on-power-off cycles

E. 15 year guaranteed life

F. 200 hours Vacuum exposure

Replacement of Line Replaceable Units is an acceptable means of meeting this requirement. Unique service life requirements are specified for the Pyro Firing Control Unit in Appendix VII and for the Interconnecting Wiring in Appendix XIII.

3.2.1.1.2.1 Pyrotechnic Release Devices

Unique service life requirements for pyrotechnic release devices are specified in Appendix XII.

3.2.1.1.2.2 APDS Switching System

Unique service life requirements for the APDS switching system are specified in Appendix XIV.

3.2.1.2 Design Approach

The system shall be designed to use existing components and circuits for those functions that are similar to the APDA and associated avionics control hardware. It is the goal of this specification that a straightforward approach be used in meeting requirements. In this approach, the following guidelines shall apply:

A. Maximum use shall be made of mature electrical and mechanical designs and design techniques with required modifications to meet safety and failure tolerance specifications.

B. Weight and power consumption shall be minimized.

C. Where implementation of failure tolerance is not feasible or practical, a design-for-minimum-risk approach may be used.

D. Specific changes to be made from the existing designs of components and circuits are defined in the applicable LRU appendices. For purposes of this specification, the "existing design" shall be assumed to be that used for the APAS on the Mir-1 (STS-71) mission in June 1995.

3.2.1.3 Spacecraft Docking and Berthing

Figure 2 illustrates the location of the PMAs and shows active and passive elements involved in spacecraft docking. The APDS shall allow the U.S. Orbiter to dock to PMA2 or PMA3 and allow the berthing of the Russian-made FGB segment to PMA1. The Russian FGB segment interface will consist of a passive APDA not covered by this specification. The ISS PMA2 and PMA3 interfaces consist of passive APDAs. PMA2 will be the primary shuttle docking port. PMA3 will be a backup Orbiter docking port. The Orbiter will be in free drift from contact through structural latching. The ISS will be in an active attitude control mode until completion of capture. The Orbiter and ISS will be in free drift from completion of capture until completion of mating. Positive verification of the following events as they occur shall be made available for transmittal to either ISS or Orbiter crew, to the ground, or to any ISS systems requiring confirmation of these events: contact, capture complete or capture failed, mating complete or mating failed, and undocking complete or undocking failed. All APDAs are controlled and powered from the Orbiter.

3.2.1.3.1 Contact Conditions

The APDS shall be designed to accomplish docking given the relative velocities and relative misalignments defined in Appendix II, Table 20-A-1.

3.2.1.4 Mass Properties and Control Weights

The APDS shall be designed to accommodate the ISS mass properties identified in Appendix II, Table 20-F and the Orbiter mass properties envelope defined in Appendix II, 20-E.

3.2.1.5 Contingency Operations

3.2.1.5.1 Docking Operations Termination

The APDS shall allow for termination of Orbiter-to-ISS docking operations and for separation at any point in the docking process. This shall not prevent the remating of the Orbiter to the ISS after nominal separation.

3.2.1.5.2 Time Critical Separation

The APDS shall be designed to permit closure of all required hatches, partial or complete pre-separation vestibule venting, and APDA separation to all be completed within ten minutes in response to Orbiter or ISS non-nominal situations. The capability for the APDS to subsequently clear the payload bay door envelope shall be retained. Only one zero-failure-tolerant means of accomplishing time-critical separation is required. The means used to provide the two-failure-tolerant nominal demating capability specified in 3.2.3.1a may be utilized to meet the contingency separation requirements.

3.2.1.5.3 Extravehicular/Intravehicular Activity (EVA/IVA)

The APDS shall not require EVA for performance of any nominal operation. The APDS shall not preclude EVA egress capability and operations while either attached or detached from the ISS. The APDS shall accommodate a fully-suited Orbiter IVA crew member performing the manual backup capture- latch release function.

3.2.1.6 Inhibits

Inhibits shall be designed to provide a physical interruption between the energy source and the function. Any function with a potential critical hazard shall have two independent inhibits whenever the hazard potential exists. Any function with a potential catastrophic hazard shall have three independent inhibits whenever the hazard potential exists.

3.2.1.6.1 Inhibit Control

The device or function that operates an inhibit is referred to as a control for an inhibit. Controls for an inhibit need not satisfy the inhibit or failure-tolerance requirements for hazardous functions.

3.2.1.7 Health Status

The APDS shall have the capability to monitor and announce the health statu the functions and devices. In the event of change in the health status of a particul changed monitor signal shall be provided in real time for notifying the crew.

3.2.2 Physical Characteristics

3.2.2.1 Envelope

The envelope of each APDS unit shall not exceed the dimensions defined in applicable app

3.2.2.2 Weight

The weight of each of the APDS Line Replaceable Units shall not exceed the limits defined i applicable appendices. The total weight of the APDS equipment shall not exceed 800 lbs (3 9 kilograms) without the switching system and 936.1 lbs (424.7 kilograms) with the switching system. Target weights are as follows:

Avionics	TBD kg
APDA -6001	300.0 kg
APDA -7001	300.0 kg
APDA -8001	210.0 kg
Connector Switching System	See Appendix XV

3.2.2.3 Surface Wear

Interacting surfaces in the APDS shall be sufficiently smooth and wear resistant such that particle generation will not preclude the normal functioning of the item as specified herein.

3.2.3 Reliability

3.2.3.1 Redundancy

The APDS shall be single-failure-tolerant (exclusive of structural components) for docking. Single failure-tolerant docking requirements shall be met by two independent mechanical strings. E shall not be used as a means of meeting the single-failure-tolerant docking requirement. The APDS shall be dual-failure-tolerant (exclusive of structural components) for nominal undockir Dual-failure-tolerant undocking requirements shall be met by three independent mechanical strings. EVA may be utilized as a means of actuating the third string. The electrical portion the APDS shall be single-failure-tolerant whereby it has the capability to sustain a failure and remain in a safe, but degraded mode.

Exceptions:

A. Passive -8001 APDA unit may be single-failure-tolerant. The unit shall be capable of providing back-up structural latching.

B. -7001 active ISS APDA may be zero-failure-tolerant for undocking.

C. If sequencing of APDS functions is automated, the sequencing shall be single-failure-tolerant to failures which require time critical crew intervention.

D. The means of moding of the ISS attitude control to free drift upon capture shall be single-failure-tolerant. The means of moding of the ISS attitude control back to active upon release shall also be single failure tolerant.

E. Wire harnesses are excepted in accordance with 3.1.2.1.8.9.

3.2.3.2 Failure Deterrence and Detection

The design of the APDS units shall incorporate the following:

A. Each APDS Line Replaceable Unit shall be designed such that transient out-of-tolerance conditions or component failures will not cause failures of other APDS Line Replaceable Units or Orbiter systems.

B. Within the procured item, where similar connections are in close physical proximity, the design shall preclude the possibility of cross-connection.

C. Fasteners and threaded parts, including electrical connectors, shall be positively locked to prevent loosening during service. The locking method shall be subject to Buyer approval.

D. Bypass circuits designed for use in checkout or calibration shall not override electrical system protective devices.

E. Gearboxes shall be designed to preclude entry of foreign material, loss of lubricant, and jamming of gears.

F. Fault detection and annunciation shall be supported as needed for critical hardware failure isolation. Failure isolation capability shall be provided to limit failure propagation effects and to ensure that failure of a redundant element does not adversely affect system operations.

G. APDS isolation between test/monitor points and internal circuits shall be such that misapplication of plus or minus 28 Vdc to any test/monitor point or a sustained pin-to-pin or pin-to-ground short circuit shall not degrade the equipment.

H. Motors and relay coils shall have arc or transient suppression.

I. All critical functional circuits shall be designed that they are not inadvertently activated by a single action; i.e. all such circuits shall require at least two positive actions before initiation is accomplished. These critical circuits shall be verifiable by non-invasive ground test.

J. Pyrotechnic circuits shall be designed to require a minimum of two separate actions in order to activate a pyrotechnic initiator.

K. Pyrotechnic firing circuits for explosive devices employing hot bridge wire initiators shall include a means of limiting current surges resulting from multiple simultaneous firings, and protection for the power supplies to prevent power loss or voltage drops which can result from post-firing short circuits in the devices. These protection means shall in no way degrade operation or reliability of the electro-explosive devices (fusistors may be used to fulfill these requirements).

3.2.3.3 Reliability Predictions

The Seller shall perform reliability predictions for the Androgynous Peripheral Docking System (APDS) in support of maintainability analyses. The Seller shall calculate the Mean Cycles Between Failure (MCBF) for the APDA, and the Mean Time Between Failure (MTBF) for each element of the avionics hardware. The sources of failure rates used in the reliability predictions shall be documented. If a government handbook is used, then a copy of the handbook shall be appended to the analysis. If historical data is used, then failure rate documentation shall include the use environment, the approximate use environment temperature range, the sample size of the data, and the number of failures in the sample. This document shall also include an analysis which correlates these data to the predicted ISS usage environment. Moving mechanical equipment such as pulleys, cables, shafts, bearings, actuators should have cycle dependent failure rates, and electronic equipment should have time dependent failure rates. This document shall also include an analysis which correlates these data to the predicted ISS usage environment. It is expected that static mechanical elements, such as structure, shall be shown to be designed with sufficient margin that the failure rate is effectively zero. This documentation shall be provided to the Buyer per PDRD RA01 in Appendix XV.

3.2.3.4 Reliability Management

The Seller shall maintain a reliability activity planned and developed in conjunction with other Seller elements. Reliability functions shall be an integral part of the design and development process, and shall include the evaluation of hardware reliability through a program of analysis, review, and assessment. Timely status reporting will be utilized to facilitate control of the reliability effort.

3.2.3.4.1 Reliability Organization

The Seller shall have a clearly identified reliability function which shall be responsible for the management of the Reliability Program. Where implementation of some of the tasks described herein is not a direct responsibility of the reliability group, then it is required that the reliability group monitor these tasks to assure their effective accomplishment.

3.2.3.5 Reliability Progress Reporting

The Seller shall report on the progress of the reliability effort through periodic reliability management meetings with the Buyer, as scheduled jointly by the Seller and Buyer.

3.2.3.6 Supplier Control

The Seller shall verify that the reliability of hardware elements obtained from its suppliers meets the reliability requirements in this procurement specification. This applies to items obtained from any supplier, whether in the first or any subsequent tier or whether the item is obtained by an intracompany order from any element of the Seller's parent organization. The Seller shall provide requirements, guidance, and controls to verify the adequacy of sub-tier supplier reliability implementation. The level of reliability requirements imposed on the suppliers shall be appropriately tailored and identified to be consistent with those imposed by this specification, and shall include consideration of the state of hardware development and complexity, supplier experience, and the critical nature of the function.

3.2.3.7 Reliability Design Requirements

Reliability design requirements for each Seller equipment element shall be developed and utilized in the design in accordance with the Buyer's procurement specification, and shall serve as a checklist to ensure compliance of the design to the requirements.

3.2.3.7.1 Design Specification

The Seller's reliability effort shall include a system for the review of and concurrence with design specifications and changes.

3.2.3.8 Failure Mode Effects Analysis (FMEA) and Single Failure Point Summary (SFPS)

The Seller shall perform a failure mode effects analysis (FMEA) and summarize all single failure points on the Docking System and provide a report in conformance with PDRD RA22 of Appendix XV.

3.2.3.9 Design Review and Readiness Review

The Seller's reliability activities shall include support of or participation in design trade studies, internal and sub-tier supplier design reviews, and acceptance or test readiness reviews. This activity shall include an assurance function for compliance of the design criteria defined for the subsystem, subassembly, and component levels.

3.2.3.9.1 Change Assessment

Each engineering design change package (EDCP) shall contain a reliability assessment which includes the effect of the change on the hardware contained on the SFPS or any hardware changes.

3.2.3.10 Problem Reporting and Corrective Action System

The Seller shall implement, for the control and assurance of the quality, reliability, and safety of the end item, a formal and controlled closed-loop system for the reporting, analysis, correction/prevention, and data feedback of failures of components and deliverable end items during and subsequent to acceptance testing with exception to overstress and potential overstress as noted below.

Reportable problems also include those occurring subsequent to acceptance testing where the article configuration is similar to a production design, is dedicated to the certification program, and data from the test is intended to be used for, or to supplement, qualification testing. The Seller shall distinguish between failures, problems, and quality discrepancies and assure that the failure and problem control system is complementary to, but not redundant with, such quality assurance systems such as repetitive discrepancy control and material review. This system shall emphasize reporting, analysis, and corrective action for immediate resolution of failures and problems that occur, regardless of their apparent magnitude, giving priority to significant nonconformances, failures and unsatisfactory conditions. The Seller shall accomplish timely and appropriate action to prevent recurrence of those failures and problems and support the fast turnaround required to alleviate flight schedule impact.

Problem occurrences involving any departure from specified design or test limits resulting in actual or suspected overstress to deliverable hardware, occurring during any phase of fabrication, inspection, or test, regardless of cause or circumstance, shall also be reported. Reporting is not required if an engineering analysis shows no overstress or potential overstress has occurred; however, the Seller must maintain a file copy of the analysis within his internal problem reporting system for future reference and possible audit.

3.2.3.10.1 Problem Report Documentation

The Seller shall document failures, mishaps and problems on a report format which provides information to adequately describe the failed hardware or problem, the operation in progress, the conditions of the failure or problem, the action taken at the time of failure or problem identification, and the opinions of those who observed the failure or problem as to the probable causes and possible methods of corrective action. The problem report shall be transmitted to the Seller's organizational elements affected, and shall be filed for ready reference in a central location.

3.2.3.10.2 Problem Analysis

A. The Seller shall analyze failures and problems commencing normally with initial acceptance test to determine true causes. The results of analyses shall be concurred in by the Seller organizational element responsible for the implementation of corrective action in each case. Where available technical facts are adequate to determine the true cause of failure or problem, a paper analysis will suffice in lieu of hardware tear down analysis.

B. Any time the Seller determines that hardware has been overstressed or potentially overstressed - regardless of cause (test equipment, handling, human error, internal, etc.), The following overstress analysis requirements must be satisfied: (1) damaged and potentially degraded components must be identified and replaced, and (2) adequate rationale must be provided to assure components not replaced that were involved in the incident, have not been degraded.

C. The Seller shall analyze failures to determine true causes. The extent of this analysis shall be determined by the Buyer. The first phase of failure analysis begins upon completion of the Test, Teardown, and Evaluation (TT&E.) As part of TT&E, non-destructive testing verifies the reported problem and establishes the lowest non-repairable/replaceable subassembly causing the anomaly. Special care shall be exercised in conducting the TT&E to ensure that evidence of a failure cause remains undisturbed when isolating and removing the failed subassembly. The Seller shall document results of the TT&E. Upon receipt of the TT&E report, the Buyer will instruct the Seller on the disposition of the failed parts which should be placed in storage, as described in 3.4.10.3 and 3.4.11.1, until failure analysis is required.

3.2.3.10.3 Corrective Action

The Seller shall implement corrective action to prevent recurrence of failures when the analysis reveals the causes to be within his control. A problem report shall be considered closed when corrective action has been implemented. Notification of corrective action for all failures and problems shall be on a closeout problem analysis. Corrective actions which result in a change to configuration baseline documentation shall be processed in accordance with the change management system.

3.2.3.10.4 Problem Status

The Seller shall maintain a status of all open problems and an inventory of parts that have been designated as "trend" and put into bonded storage. The method(s) employed by the Seller to status problems and maintain accountability for the trend hardware in bonded storage shall be capable of responding to the Seller's needs as well as being able to respond to Buyer requests for information.

3.2.3.10.5 Storage of Trend Hardware

The Seller shall maintain a secured storage area as described in 3.4.10.3 and 3.4.11.1 for non-reparable failed hardware.

3.2.4 Maintainability

The design shall use existing tool kit tools and minimize the requirement for nonstandard tools and support equipment. Where nonstandard tools are required an analysis will be performed to substantiate the requirement. Perform Maintainability program requirements tasks and input into maintenance and spares planning. Perform maintainability assessment to determine that the quantitative maintainability characteristics of the equipment design have been properly evaluated to assure an adequate support interface has been established and is being utilized. This task includes adequacy and accuracy of fault isolation capabilities to a restorable/ replaceable unit, availability of spares and provisioning requirements, status and adequacy of maintenance manuals, handbooks and instructions, evaluate reliability estimates as it correlates to the resolution of any maintainability issue that has been identified. Maintainability activities are to be documented in accordance with PDRD LS01 of Appendix XV.

3.2.4.1 Design Allocations

Scheduled maintenance required for equipment shall be limited to replacement of time/cycle sensitive equipment. Physical inspection of installations and lubrication of mechanical devices shall be permitted with minimum interruption and only while the device remains installed in its location.

3.2.4.2 Design Features

The design shall incorporate the following maintainability features. Deviations require prior approval from Buyer.

3.2.4.2.1 Maintenance

A. Scheduled maintenance of the system when installed shall be limited to organizational maintenance.

B. The necessity for any in-flight maintenance, servicing or checkout tasks, other than built-in test capability, is prohibited.

C. No on-vehicle adjustments or calibration shall be required except as identified elsewhere in this specification.

D. Items requiring forming (rolling) or welding of attaching surfaces at disassembly points shall be designed so that removal of material upon disassembly during repair, overhaul, or modification does not destroy or render unusable any repairable subassemblies or components of the item.

E. Standard torque values shall be used for fittings, fasteners and threaded fasteners that require torque.

F. The system shall be designed so as to preclude the need for carry-on support equipment for organizational level maintenance.

3.2.4.2.2 Installation

A. The equipment design shall physically prevent the incorrect installation of organizational level removable items. In addition, clearly visible color coding and labeling in close proximity to maintenance disconnect points shall be used to facilitate removal and replacement of any item of equipment.

B. Equipment installed within the procured item shall be mounted in a manner to avoid blind adjustment.

C. Mechanical retention devices for Line Replaceable Units and those SRUs that require frequent removal shall not require safety wiring; mechanical locking devices shall be used.

D. If an item is mounted and secured by bolts, a pilot keyhole mounting or similar installation aid shall be provided to hold it in place until the bolts are engaged.

E. Threaded fasteners used for securing a single item, where practical, shall be the same type, size and tensile strength.

F. On items installed by the Seller, Line Replaceable Unit/Shop Replaceable Unit installations shall be designed such that access to threaded fasteners may be accomplished without the use of universal joints, angular extensions, handle extensions, or combinations thereof, in conjunction with torque tools. Captive fasteners shall be utilized to fasten Line Replaceable Units.

G. Threaded fasteners installed into aluminum shall interface with inserts.

3.2.4.2.3 Accessibility

A. Line Replaceable Unit servicing and test points shall be clearly marked and shall be accessible without requiring removal of Seller installed access plates or covers, except service caps. Calibration controls shall be accessible and clearly marked.

B. All fasteners on a single access cover shall be of the same length, diameter and type.

C. On Line Replaceable Units installed by the Seller, external electrical connectors shall be accessible without disassembly or removal of functional equipment or components.

3.2.4.3 Test Provisions

The Equipment shall be designed for testability, so as to permit the operational status of the system to be confidently determined and reported. Equipment shall be designed to facilitate the detection of mission critical faults to support maintenance operations.

3.2.4.3.1 Test and Monitoring Points

Each Line Replaceable Unit within the system shall have sufficient test and monitoring points accessible from the accessible connector panels to enable the stimulus or measurement of internal circuit nodes to achieve an inherently high level of fault detection and isolation. This will include: (1) the ability to initialize all sequential logic in the Line Replaceable Unit to a known condition for testing, (2) the ability to control the Line Replaceable Unit from the connector and insert the required test stimulus, and (3) the ability to observe the response of the Line Replaceable Unit to the applied stimulus to determine the status of the elements tested.

3.2.4.3.2 Line Replaceable Unit Peculiar Requirements

Provisions shall be incorporated to detect and report failure of redundant capabilities. This level of failure detection is required for both automatic reconfiguration and for those cases where reconfiguration is under external control.

A. Capability to provide status of redundant functional paths in the installed flight configuration shall be provided.

B. Provisions to enable loop test verification utilizing the integrated avionics system shall be incorporated in the docking system.

C. The avionics LRUs shall provide failure detection of peculiar failure modes.

D. Means of indicating operating modes (operational, acquisition, self-test and stand-by) shall be provided.

3.2.4.4 Maintainability Analysis

The Seller shall conduct and document a maintainability analysis to provide verification that design features specified in the Buyer's procurement package and are incorporated in all significant levels of equipment maintenance. Documentation of this shall be in accordance with DPRD LS01 of Appendix XV.

3.2.4.4.1 Assessment

Integral to maintainability analysis, assessments shall be developed for organizational and depot maintenance level tasks. As a minimum, assessments shall be developed for those LRUs that have maintainability time constraints.

3.2.4.4.2 Problem Reporting

The Seller shall initiate problem reports for those problems uncovered during the maintainability design review and analysis processes. Problem reports that cannot be readily resolved will provide a basis for trade-off studies and subsequent resolution.

3.2.4.4.3 Design Reviews

Seller's maintainability personnel shall actively participate in Seller design reviews and configuration inspections. Maintainability documentation shall be available at each of these reviews.

3.2.4.4.4 Design Changes

The Seller shall ensure that the maintainability requirements are not adversely affected by individual design changes.

3.2.5 Environments

The APDS system shall be divided into five categories for environmental verification:

Category I:	Crew Compartment
Category II:	Airlock Floor
Category III:	-6001 Orbiter Active APDA
Category IV:	-7001 ISS Active APDA and CSB
Category V:	-8001 ISS Passive APDA

The LRUs in each category are identified in the applicable appendices.

3.2.5.1 Operating

The APDS shall be capable of meeting the operating performance requirements specified herein during and after exposure to any feasible combination of the following environmental conditions.

3.2.5.1.1 Crew Compartment

A. Pressure
- Minimum: 8 psia (413.6 mm Hg) for up to 165 minutes,
- Nominal: 10.2 to 14.7 psia (527.3 to 760 mm Hg) for 165 hours
- Maximum: 16.0 psia (827.2 mm Hg)

B. Temperature
- Minimum: Plus 61 °F (16.1 °C)
- Maximum: Plus 120 °F (48.9 °C)

C. Humidity
- Maximum: 85 percent relative
- Minimum: 17 percent relative

D. Salt Fog

Exposure to 1 percent salt solution by weight.

E. Radiation

(1) Proton radiation of $2.5x10^4$ rad ($1x10^6$ rad for 4.5 years)
(2) Electron radiation of $3x10^3$ rad (maximum extraction dose rate = $1x10^5$ rad/sec)
(3) Integral neutron stream (with energy more than 0.1 MeV) of $1x10^{12}$ cm^{-2}; gamma rays exposure dose: $1x10^3$r
(4) Integral solar radiation with stream density of 0.14 W/cm^2 (without shield)
(5) Maximum gamma rays exposure dose rate of $1x10^8$ rad/sec; electromagnetic pulses with electric field intensity of 2 kV/m and magnetic field intensity of 5 A/m.

3.2.5.1.2 Airlock Floor

A. Pressure

10.2 to 16 psia (527.3 to 827.2 mm Hg) with a rate of depressurization of 2 psi (103.4 mm Hg) per minute; rate of repressurization of 1 psi (51.7 mm Hg) per minute, and 8 psia (413.6 mm Hg) for 165 minutes

B. Temperature — Minimum: Plus 14 °F (-10 °C); Maximum: Plus 122 °F (50 °C)

C. Humidity — Minimum: 0 percent relative; Maximum: 95 percent relative

D. Salt Fog — Exposure to 1 percent salt solution by weight.

E. Radiation — Same as 3.2.5.1.1.E

3.2.5.1.3 -6001 Orbiter Active APDA

A. Pressure — Minimum: 1.93×10^{-12} psia (1×10^{-10} mm Hg); Maximum: 15.23 psia (787.4 mm Hg)

B. Temperature

1. APDA Non Capture — Minimum: Minus 58 °F (-50 °C); Maximum: Plus 122 °F (50 °C)

2. Capture — Minimum: Minus 22 °F (-30 °C); Maximum: Plus 122 °F (50 °C)

C. Humidity — Maximum: 100 percent relative; Minimum: 0 percent relative

D. Radiation

(1) Proton radiation of 2.5×10^4 rad (1×10^6 rad for 4.5 years)
(2) Electron radiation of 3×10^3 rad (maximum extraction dose rate = 1×10^5 rad/sec)
(3) Integral neutron stream (with energy more than 0.1 MeV) of 1×10^{12} cm^{-2}; gamma rays exposure dose: 1×10^3r
(4) Integral solar radiation with stream density of 0.14 W/cm^2 (without shield)

E. Salt Fog — Exposure to 1 percent salt solution by weight.

F. Load Spectrum for Mated Loads — See Table 20-H

3.2.5.1.4 -7001 ISS Active APDA and CSB

A. Pressure — Minimum: 1.93×10^{-12} psia (1×10^{-10} mm Hg); Maximum: 15.23 psia (787.4 mm Hg)

B. Temperature

1. Non Capture — Minimum: Minus 58 °F (-50 °C); Maximum: Plus 122 °F (50 °C)

2. Capture	Minimum:	Minus 22 °F (-30 °C)
	Maximum:	Plus 122 °F (50 °C)
3. CSB	Minimum:	Minus 58 °F (-50 °C)
	Maximum:	Plus 122 °F (50 °C)

C. Humidity — Maximum: 100 percent relative; Minimum: 0 percent relative

D. Radiation — Same as 3.2.5.1.3.D

E. Salt Fog — Exposure to 1 percent salt solution by weight.

F. Load Spectrum for Mated Loads — See Table 20-H

3.2.5.1.5 -8001 ISS Passive APDA

A. Pressure — Minimum: 1.93×10^{-12} psia (1×10^{-10} mm Hg); Maximum: 15.23 psia (787.4 mm Hg)

B. Temperature

1. Guide rings and petals, protective shrouds, capture sensors:	Minimum:	Minus 130 °F (-90 °C)
	Maximum:	Plus 221 °F (105 °C)
2. All other components:	Minimum:	Minus 58 °F (-50 °C)
	Maximum:	Plus 122 °F (50 °C)

C. Humidity — Maximum: 100 percent relative; Minimum: 0 percent relative

D. Radiation — Same as 3.2.5.1.3.D

E. Salt Fog — Exposure to 1 percent salt solution by weight.

F. Load Spectrum for Mated Loads — See Table 20-H

3.2.5.2 Non operating

The APDS shall be capable of meeting the operating performance requirements specified herein after exposure to any feasible combination of the following conditions:

3.2.5.2.1 Crew Compartment

A. Pressure — Maximum 30.0 psia (1551 mm Hg); Minimum 3.28 psia (48.2 mm Hg)

B. Temperature — Minimum Plus 35 °F (1.7 °C); Maximum Plus 120 °F (48.9 °C)

C. Shock

Basic Design: One 100g half sine shock pulse of 1 to 3 milliseconds duration and two 40g half sine shock pulse of 3 to 5 milliseconds; in each direction of three orthogonal axes for a total of 9 shocks.

D. Ozone — 3 to 6 parts per hundred million (phm).Total oxidant concentrations may reach 60 phm for 1 to 3 hours in any 24 hour period.

E. Fungus — As specified in 3.3.1.1.2.

F. Vibration

	Acceleration Spectral Density
20 to 80 Hz	Increasing, at plus 3 dB/octave, to 0.067 g^2/Hz at 80 Hz
80 to 350 Hz	Constant 0.067 g^2/Hz
350 to 2000 Hz	Decreasing, at minus 3 dB/octave, from 0.067g^2/Hz at 350 Hz

Duration: 900 seconds per axis

G. Ultimate Acceleration — Plus and minus 5 g's in each major axis.

H. Crash Safety Acceleration — The equipment shall be designed to withstand the following acceleration loads for a minimum of 30 seconds. The equipment and its mounting attachments shall not break loose, create a hazard to personnel, or prevent egress from a crashed vehicle. Operating performance is not required after exposure to this environment.

Acceleration, g's, in Orbiter X, Y, and Z Axes		
gx + Aft	gy + Starboard	gz + Up
+20.0, -3.3	± 3.3	+10.0, -4.4

NOTES:

a. The +x-axis load shall be directed in all rearward directions within 20° of the + x axis.
b. The specified load factors shall be taken to act separately.

I. Lightning — The equipment shall designed to withstand the induced voltages and currents resulting from the effects of a 200 kiloampere lightning strike to the vehicle.

3.2.5.2.2 Airlock Floor

A. Pressure — 9.65×10^{-8} to 16 psia (5×10^{-6} to 827.2 mm Hg); with a rate of depressurization of 0.1 psi (5.17 mm Hg) per minute and rate of repressurization of 1 psi (51.7 mm Hg) per minute. Maximum exposure to Vacuum is 250 hours.

B. Temperature — Minimum: Minus 76 °F (-60 °C); Maximum: Plus 140 °F (60 °C)

C. Humidity — Minimum: 0 percent relative; Maximum: 95 percent relative

D. Shock — One 100g half-sine shock pulse of 1 to 3 milliseconds duration and two 40g half-sine shock pulses of 3 to 5 milliseconds duration; in each direction of three orthogonal axes for a total of 9 shocks.

E. Ozone — 3 to 6 parts per hundred million (phm).Total oxidant concentrations may reach 60 phm for 1 to 3 hours in any 24 hour period.

F. Fungus — As specified in 3.3.1.1.2.

G. Vibration

	Acceleration Spectral Density
20 to 80 Hz	Increasing, at plus 3 dB/octave, to 0.067 g^2/Hz at 80 Hz
80 to 350 Hz	Constant 0.067 g^2/Hz
350 to 2000 Hz	Decreasing, at minus 3 dB/octave, from 0.067g^2/Hz at 350 Hz

Duration: 900 seconds per axis

H. Acceleration — Plus and minus 5 g's in each major axis. Accelerations shown in results of coupled dynamic loads analyses shall be assessed.

I. Lightning — The equipment shall be designed to withstand the induced voltages and currents resulting from the effects of a 200 kiloampere lightning strike to the vehicle.

3.2.5.2.3 -6001 Orbiter Active APDA

A. Pressure — Maximum: 15.23 psia (790 mm Hg); Minimum: 1.93 x 10^{-12} psia (1 x 10^{-10} mm Hg)

B. Temperature

1. Guide rings and petals, protective shrouds, and capture sensors: — Minimum: Minus 130 °F (-90 °C); Maximum: Plus 221 °F (105 °C)
2. All other components: — Minimum: Minus 67 °F (-55 °C); Maximum: Plus 167 °F (75 °C)

C. Vibration

Acceleration Spectral Density

20 to 80 Hz	Increasing, at plus 3 dB/octave, to 0.067 g^2/Hz at 80 Hz
80 to 350 Hz	Constant 0.067 g^2/Hz
350 to 2000 Hz	Decreasing, at minus 3 dB/octave, from 0.067g^2/Hz at 350 Hz

Duration: per paragraph 20.4.2.4.1.3

D. Liftoff/Landing Acceleration The equipment shall be designed to withstand the following acceleration static equivalent limit load factors

Condition	Nx	Ny	Nz
Liftoff	±5.98g	±2.72g	±3.83g
Landing	±6.2g	±3.8g	±7.4g

E. Shock

1. Basic Design: 20g terminal sawtooth shock pulse of 11 ms duration in each direction of three orthogonal axes.

2. Pyrotechnic Shock The equipment shall be able to withstand the shock from the pyrotechnic devices.

F. Humidity
Maximum 100% relative
Minimum 0% relative

G. Sand and Dust As encountered in desert and ocean beach areas, equivalent to 140 mesh silica flour with particle velocity up to 500 feet per minute and a particle density of 0.25 grams per cubic foot.

H. Ozone 3 to 6 parts per hundred million (phm).Total oxidant concentrations may reach 60 phm for 1 to 3 hours in any 24 hour period.

I. Fungus As specified 3.3.1.1.2.

J. Lightning The equipment shall be designed to withstand the induced voltages and currents resulting from the effects of a 200 kiloampere lightning strike to the vehicle.

3.2.5.2.4 -7001 ISS Active APDA and CSB

A. Pressure
Maximum 15.23 psia (790 mm Hg)
Minimum 1.93×10^{-12} psia (1×10^{-10} mm Hg)

B. Temperature

1. Guide rings and petals, protective shrouds, and capture sensors:
Minimum Minus 130 °F (-90 °C)
Maximum Plus 221 °F (105 °C)

2. All other components:
Minimum: Minus 67 °F (-55 °C)
Maximum: Plus 167 °F (75 °C)

3. CSB — Minimum: Minus 76 °F (-60 °C)
Maximum: Plus 140 °F (60 °C)

C. Vibration

Acceleration Spectral Density

20 to 80 Hz	Increasing, at plus 3 dB/octave, to 0.067 g^2/Hz at 80 Hz
80 to 350 Hz	Constant 0.067 g^2/Hz
350 to 2000 Hz	Decreasing, at minus 3 dB/octave, from 0.067g^2/Hz at 350 Hz

Duration: per paragraph 20.4.2.4.1.3

D. Liftoff/Landing Acceleration The equipment shall be designed to withstand the following acceleration static equivalent limit load factors:

Condition	Nx	Ny	Nz
Liftoff	+1.5/-5.0g	±2.0g	±12.3g
Landing	±1.5g	±1.9g	+7.1/-2.6g

E. Shock

Basic Design: 20g terminal sawtooth shock pulse of 11 ms duration in each direction of three orthogonal axes.

F. Humidity — Maximum 100% relative
Minimum 0% relative

G. Lightning — The equipment shall be designed to withstand the induced voltages and currents resulting from the effects of a 200 kiloampere lightning strike to the vehicle.

3.2.5.2.5 -8001 ISS Passive APDA

A. Pressure — Maximum 15.23 psia (790 mm Hg)
Minimum 1.93×10^{-12} psia (1×10^{-10} mm Hg)

B. Temperature

1. Guide rings and petals, protective shrouds, and capture sensors: — Minimum Minus 130 °F (-90 °C)
Maximum Plus 221 °F (105 °C)

2. All other components: — Minimum: Minus 67 °F (-55 °C)
Maximum: Plus 167 °F (75 °C)

C. Vibration

Acceleration Spectral Density

20 to 80 Hz	Increasing, at plus 3 dB/octave, to 0.067 g^2/Hz at 80 Hz
80 to 350 Hz	Constant 0.067 g^2/Hz
350 to 2000 Hz	Decreasing, at minus 3 dB/octave, from 0.067g^2/Hz at 350 Hz

Duration: per 20.4.2.4.1.3

D. Liftoff/Landing Acceleration The equipment shall be designed to withstand the following acceleration static equivalent limit load factors:

Condition	Nx	Ny	Nz
Liftoff	+1.5/-5.0g	±2.0g	±12.3g
Landing	±1.5g	±1.9g	+7.1/-2.6g

E. Shock

Basic Design: 20g terminal sawtooth shock pulse of 11 ms duration in each direction of three orthogonal axes.

F. Humidity

Maximum 100% relative
Minimum 0% relative

G. Lightning The equipment shall be designed to withstand the induced voltages and currents resulting from the effects of a 200 kiloampere lightning strike to the vehicle.

3.2.5.3 Transportation and Storage

The APDS LRUs shall be protected from the environments in 3.2.5.2 by adequate packaging or protective processes unless the design to vehicle flight requirements precludes the need.

3.2.6 Transportability

The APDS LRUs shall be designed to be capable of being handled and transported to using facilities without damage or degradation, utilizing available methods of transport with the item prepared for shipment in accordance with Section 5 requirements. The planned packaging shall be compatible with the equipment design and transportation system to the extent that loads induced in the equipment during transportation will not produce stresses, internal loads or deflections resulting in damage to the equipment. Shipping containers shall be designed to be reusable.

3.2.6.1 Tiedown Capability

The equipment design shall incorporate structural provisions adequate to permit the hardware to be secured to the transport vehicle, device or container by bolting, blocking, strapping, or other feasible means.

3.3 DESIGN AND CONSTRUCTION

3.3.1 Materials, Processes, and Parts

3.3.1.1 Materials and Processes

Materials and processes for the APDS equipment shall be in accordance with SSP 50094.

3.3.1.1.1 Cleanliness

3.3.1.1.1.1 Category I and II LRUs

The significant surfaces shall be cleaned to Generally Clean level. Generally Clean means free of manufacturing residue, dirt, oil, grease, processing debris or other contamination.

3.3.1.1.1.2 Category III LRUs

The significant surfaces shall be cleaned to Visibly Clean level. Visibly clean is the absence of all particulate and nonparticulate visible to the normal unaided eye. Particulate is defined as matter of miniature size with observable length, width and thickness. Nonparticulate is film matter without definite dimensions.

3.3.1.1.2 Moisture and Fungus Resistance

Materials which are non-nutrient to fungi shall be used. When fungus-nutrient materials must be used, they shall be sealed or treated to prevent fungus growth.

3.3.1.2 Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Control

3.3.1.2.1 General

The Seller shall implement a system for controlling selection, reduction in number of types, specifications, application reviews, analyzing failures, stocking and handling methods, installation procedures, and establishing reliability and quality requirements for EEE and mechanical parts to be used in the contract hardware, including off-the-shelf hardware. The Seller shall establish and maintain an adequate procedure to monitor and control the use of irregular parts in Seller and Supplier equipment at all levels of procurement, test, and fabrication. The procedure shall provide for the prompt identification, reporting, review, and approval/disapproval disposition of the irregular parts.

3.3.1.2.2 Parts Selection

The Seller and Suppliers shall select parts on the basis of suitability for their application(s) and proven qualification of each to the requirements of its specification. Qualification data shall be current, applicable, and adequate for use in the Shuttle equipment environment. Items selected shall be qualified to pertinent specifications, and selection shall minimize the number of styles of each generic type. The Seller is fully responsible for the satisfactory performance of each part in accordance with the design and control requirements regardless of the source from which the part was selected or the agency who wrote or approved the controlling documentation.

3.3.1.2.2.1 Parts Standardization

Part utilization shall be based upon: (1) selection of qualified parts, (2) proper derating and application, and (3) minimizing the number of part types. Parts used in design and fabrication shall be selected on bases of suitability for their applications and proven qualification to the requirements of their specifications. Selection shall minimize the number of styles and generic types. Parts with proven technologies and with inherent space rated reliability features will be selected.

3.3.1.2.3 Parts Specifications

Each EEE and Mechanical part shall be controlled by a specification (or combination of specifications) which delineates as a minimum: complete identification of the part; physical, environmental, and performance requirements; quality and reliability assurance requirements including inspections and tests for qualification, acceptance, and lot sampling where required.

EEE part specifications shall contain screen and burn-in; packaging, storage, and handling requirements; traceability requirements; and data retention and submittal requirements. Where a combination of specifications is used collectively to provide all of the above requirements for a single part type, the detail specification for that part shall provide detailed cross-reference to all other applicable specifications. Each specification shall be identified by a unique number and all specifications shall be subject to a formal system of change control.

3.3.1.2.4 EEE Parts Qualification

Qualification of EEE parts shall be at the part level to the requirements of the applicable specifications. Where adequate qualification data are not available (as determined jointly by the Seller and Buyer), the Seller shall be responsible for the development and conduct of qualification tests on parts to determine their adequacy in meeting specification requirements and for development of criteria to be used in acceptance testing. The Seller shall prepare test plans for those parts which it will subject to qualification testing. Delta qualification of parts shall be conducted as necessary (as determined jointly by the Seller and Buyer) to ensure continued control over design, materials, manufacturing processes, and quality controls after initial qualification. Qualification test plans, reports, and data which substantiate qualification and status shall be in accordance with the Data Requirements Document. The Seller shall maintain a data file which identifies the basis and substantiates the status of qualification for each part type used on the project. The file for each part type shall:

A. Completely identify the part by generic part type and name, controlling specification name, and number, common designation and manufacturer's name and part number.

B. Contain a summary of and provide complete cross-reference to existing data used to substantiate the qualification of the part to the controlling specification. When the basis of qualification is similar to an already qualified part, complete identification and supporting data for the similar part shall be included together with the analysis that establishes similarity. The qualification data file shall be maintained for Buyer review on request.

3.3.1.2.4.1 Mechanical Parts

Mechanical (and fluid) parts may be qualified at the use level (with Seller assemblies,) by attributes or historical data.

3.3.1.2.5 EEE Parts Where-Used List

The Seller shall prepare and maintain a composite where-used parts list for EEE parts used in Seller equipment in accordance with PDRD RA19 in Appendix XV.

3.3.1.2.6 Parts Application Review

To verify proper applications of EEE and Mechanical parts in the design, the Seller (or supplier, if appropriate) shall conduct thorough parts stress analysis and parts applications reviews on the design of each Line Replaceable Unit at appropriate milestones during its design and development. The results of these reviews shall be input to design reviews. Each application of each EEE part shall be examined in light of its rated capabilities in comparison to the design requirements of that application and conformance to the established derating criteria. Consideration shall be given to anticipated life requirements, functional and environmental usage stresses, and historic and current failure experience (i.e., results of analysis of EEE parts, failures which have occurred in higher level assemblies.) The review output recommendation shall include or reference justification for each such usage. The Seller shall take immediate action to correct identified deficiencies. The Buyer will review the Seller's review findings.

3.3.1.2.7 Parts Problem Reporting and Corrective Action

The Seller shall investigate the cause of each EEE and Mechanical part failure and determine remedial and preventive actions; reference 3.2.3.10. The significance of each failure as related to like parts or materials used elsewhere in the design, and the possibility of the occurrence of additional failures shall be determined and documented as part of the problem disposition in accordance with Data Requirements.

3.3.1.2.8 EEE Parts Control for Off-The-Shelf Equipment

EEE parts used in off-the-shelf equipment shall conform to the requirements of 3.3.1.2.4 and 3.3.1.2.5. A "where-used" parts list in accordance with 3.3.1.2.5 is required. A parts application review in accordance with 3.3.1.2.6 must be accomplished and must verify the adequacy of each part in each application and assure compliance with any applicable Buyer restriction on specific parts usage or application. Problem reporting and corrective action are required in accordance with 3.2.3.10.

3.3.1.2.9 EEE Parts Handling

The Seller's method for control storage, stocking , and installation procedures for parts shall be documented and implemented. These controls shall prevent use of parts which may be in a questionable condition and prevent degradation of parts due to environments of faulty manufacturing or assembly techniques.

3.3.1.2.10 EEE Parts Traceability

EEE parts shall be traceable in accordance with 3.3.6.11.10.

3.3.1.2.11 Part Construction

Parts shall be designed and constructed of such materials as to prevent hazardous conditions, such as; arc generation, flammability, offgassing, and toxicity. Parts shall be designed and constructed of corrosion resistant materials.

3.3.1.2.12 Part Derating

All parts shall be derated by at least 25% of the maximum electrical and thermal ratings. In no case shall the junction temperature of a semiconductor device exceed 257 °F (125 °C). Capacitors shall be derated such that the sum of the applied dc voltage and the peak ac ripple voltage does not exceed 75% of the rated voltage. Resistors and resistor networks shall be derated in power (in lieu of voltage); power shall not exceed 60% of rated power at ambient temperature. Carbon composition resistors shall not be used in high-humidity or high-temperature environments.

3.3.1.2.13 Parts with Cavities

All micro-circuits and cavity semiconductors are required to either have internal coating or a "getter" to minimize contamination. When these are not possible or feasible, a Particle Impact Noise Detection (PIND) test may be substituted.

3.3.2 Selection of Specifications and Standards

Not applicable

3.3.3 Electromagnetic Compatibility and Electrical Design

3.3.3.1 Electromagnetic Compatibility

3.3.3.1.1 Limits

This section contains the limits applicable to the tests required by Section 4.0 of this specification. Where both U.S. Orbiter and ISS electromagnetic environments are applicable, only the more severe of the two will be imposed on the APAS. An equipment emitting both broadband and narrowband signals at the same frequency shall meet both requirements.

3.3.3.1.2 Limits for CE01 and CE02

Electromagnetic emission in the frequency range of 30 Hz to 20 kHz shall not appear on power leads, control leads, signal leads, and interconnecting cables between parts, sources and loads of an equipment in excess of the values shown on Figure 12. The broadband test is not required. Only leads going external to the subsystem/equipment shall be measured. Intentional transmissions by conduction on signal leads are exempt.

3.3.3.1.3 Limits for CE03 and CE04

Electromagnetic emissions in the frequency range of 20 kHz to 50 MHz shall not appear on power leads, control leads, signal leads, and interconnecting cables between parts, sources and loads of an equipment in excess of the values shown on Figure 13. The broadband test is not required. Only leads going external to the subsystem/equipment shall be measured. Intentional transmissions by conduction on signal leads are exempt.

3.3.3.1.4 Limit for CS01

The performance characteristics of the subsystem/equipment shall not be degraded beyond the tolerances given in the individual equipment specification or approved test plan, in the frequency range of 30 Hz to 50 kHz, when subjected to electromagnetic energy injected on its power leads equal to or less than the values shown on Figure 14. The reduced limits of Figure 15 shall apply to equipment powered from Orbiter +28 Vdc.

3.3.3.1.4.1 Test Power Limit

The requirements for this test are also met if the required voltages cannot be generated by 50 watts dissipated into a 0.5 ohm load and the test sample is not susceptible to the lower voltage 50 watt source output setting.

3.3.3.1.5 Limit for CS02

The performance characteristics of subsystems and equipment shall not be degraded beyond the tolerances given in the individual equipment specification or approved test plan, in the frequency range of 50 kHz to 400 MHz, when subjected to 1 volt from a 50-ohm source applied to the equipment power input terminals (excluding power cable). The test limit shall be 0.22 volt for equipment powered from Orbiter +28 Vdc.

3.3.3.1.5.1 Test Power Limit

When a one-watt source of 50-ohm impedance cannot develop the required voltage at the test-sample power-input terminals (excluding power cable) and the test sample is not susceptible to the output of this signal source, then the equipment may be considered non-susceptible.

3.3.3.1.6 Limit for CS06

The test sample shall not exhibit any malfunction, degradation of performance or deviation from specified indication beyond the tolerances given in the test sample's individual equipment specification or approved test plan when the spike shown on Figure 8 is applied to the dc power input lines of the test sample.

3.3.3.1.7 Limits for RE02

3.3.3.1.7.1 Narrowband

Narrowband E-field emissions in the frequency range of 14 kHz to 15 GHz shall not be generated and radiated in excess of the values shown in Figure 16.

3.3.3.1.7.2 Broadband

Continuous or repetitive broadband E-field emissions shall not be generated and radiated in excess of the values shown in Figure 17. Broadband E-field emissions resulting from equipment turn on/off and switching transients are exempt from this requirement. Switching transient requirements are covered by the time domain transient and ripple test described in 3.3.3.1.1.10.

3.3.3.1.7.3 Polarization

In the frequency range of 25 to 200 MHz, the limit shall be met for both horizontally and vertically polarized waves, except for electric hand tools. For these tools the limits apply only to vertically polarized waves.

3.3.3.1.8 Limit for RS02

The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indication beyond tolerances given in the individual equipment specification or approved test plan when subjected to the following fields:

A. Power Frequency Test. Twenty (20) amperes applied to the test wire at the power frequency (ies).

B. Spike Test. The same spike shape shown in Figure 8 where E = 100 volts across 5 ohms applied to the test wire.

3.3.3.1.9 Limit for RS03

The test sample shall not exhibit any malfunction, degradation of performance, or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected to 2 volts/meter from 14 kHz to 25 MHz, 4 volts/meter ramping to 20 volts/meter from 25 MHz to 1.2 GHz, and 20 volts/meter from 1.2 GHz to 18 GHz. For testing purposes a 6 dB safety margin shall be utilized for non ordnance and 20 dB safety margin for ordnance.

3.3.3.1.10 Time Domain Transient and Ripple Test (TT01)

Any load on the 28 Vdc power bus system shall not generate a transient in excess of $\pm$ 30 Vdc (+58 or -2 volts maximum peak) when measured at the power input terminals of the test sample, as described in Figure 18, and when using test Line Impedance Stabilization Network (LISN) as described in Figures 19 and 20. This requirement applies to turn-on and switching through all operational modes and turn-off. Hard copies shall be made of the real-time transients and submitted to the procuring agency as proof of compliance. The instrument for measuring real-time transients shall have a minimum bandwidth of 50 MHz. All hard copies submitted to meet these requirements shall have sweep speed and vertical deflection sensitivity identified. In addition, representative hard copies of characteristic steady-state ripple of the load, as measured across the power input terminals to the load, shall be submitted to the procuring agency for evaluation in determining Orbiter subsystem ripple allocation. Sweep speed and vertical deflection sensitivity shall also be identified for these hard copies.

3.3.3.2 Electrical Design Requirements

3.3.3.2.1 Power Consumption

Power consumption of all APDS LRUs shall not exceed the following values:

A. During normal docking operations with 32 Vdc Orbiter supply bus power the APDS power consumption shall be less than 1300 watts.

B. During pyro firing operations with 32 Vdc Orbiter supply bus power the APDS power consumption shall be less than 2300 watts. Maximum allowable power consumption for the PFCU when pyros are not being fired is specified in 70.3.3.1.

C. Power will not be applied continuously to the system control units longer than two hours. After two hours of power-on time, the units will be powered down for at least 30 minutes.

This is applicable to all units except the PFCU and DCU. Power applied is determined by the "POWER ON" switch being depressed on the DCP.

3.3.3.2.2 Metals and Metal Couples, Restriction on Use

Metal joints which require electrical bonding shall be precise, dry, and conducting. Nonconducting corrosion inhibitors may be added after joint assembly. Conducting metal joints shall be required for electrical circuit fault-current return, electrostatic corona prevention, and structural shielding from lightning-strike induction and avionics interference.

3.3.3.2.3 Bonding

All metallic items shall be permanently bonded to structure. Design of the mounting and selection of the surface finish shall ensure that the operational vibration and other environmental conditions do not cause intermittent electrical contact between the vehicle structure and the part. Bonding requirements specific to the interface between the PMA-1 active APDA (-7001) and the FGB are described in Figure 20-C, Note 16.

3.3.4 Identification and Marking

3.3.4.1 Identification of Parts

Each part fabricated shall be identified with a part number. The same specification or part number shall be used to identify all like materials, processes, and parts. Seller shall assign a new part number to the part when authorized changes make the superseded part not interchangeable with respect to interface, reliability, safety, logistics, or performance. The part identification shall additionally include the manufacturer's identification code and be serial numbered as illustrated below.

	Mfr No.						Mfr Assigned Serial No.								
Digit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mfr's No. and Serial No. (EXAMPLE)	0	3	9	5	3	-	0	0	0	0	A	B	0	0	1

3.3.4.2 Identification of All Development/Qualification Test Specimens

Test specimens shall be permanently and obviously identified prior to testing with the words "ENG TEST ONLY," in addition to the identification required by the Drawing/Specification to preclude their use on production items. The letters shall be indelible and provide a distinctive and vivid contrast with the color of the specimen. The lettering size and identification location shall be clearly visible to casual observation. Materials used for the identification shall be compatible with the test specimen and its operating environment. When the size or configuration of the test specimen is such that identification cannot appear on the specimen, other suitable means such as attached metal tags shall be used.

3.3.4.3 Nameplates

Nameplates shall be in accordance with the following:

3.3.4.3.1 Marking Information

The following information shall be marked on major assemblies and units shall include (as applicable); (1) item name; (2) Buyer's control number; (3) manufacturer; (4) date of manufacture; and manufacturer's serial number, (5) part number, and (6) code identification number. Abbreviations, with Buyer's approval, may be used.

3.3.4.3.2 Methods of Applying Nameplates

The required marking shall be applied to an identification plate securely fastened to the item; or shall be applied directly to the surface of the item by metal stamp, vibro peening, acid, electric or electro chemical etching, embossing, forging, blasting, casting, or molding. When these methods are not practicable, the marking shall be applied directly on the item by environmentally protected decalcomania transfer, metal wrap-around tag, stencil, silk screen, or by any other method suitable for the use intended which is compatible with 3.3.4.3.3.

3.3.4.3.3 Permanency and Legibility

The marking shall be as permanent as the normal life expectancy of the item on or to which it is applied and capable of withstanding the environmental tests and cleaning procedures specified for the item. Legibility shall be such as required for ready readability and identification marking on identification plates shall be of a color which is in contrast to the color of the surface of the plate. Identification tag marking, when used, shall be permanent to the extent required for utilization of the item. Marking materials creating hazardous conditions shall not be used.

3.3.4.3.4 Location

Whenever practicable, the marking of the item shall be located in such a manner as to allow its being visible during use. When the location of marking is specified in a drawing or other document, the location of the marking shall be as specified in the document.

3.3.4.3.5 Modified Items

When an item is altered or modified from the baseline configuration, the identifying number assigned by the activity specifying the alteration or modification shall be marked on the item and the original identification number shall be obliterated without damage to the item.

3.3.4.3.6 Type of Lettering

Letters shall be without serifs (sans-serifs) such as "Gothic" or "Futura" capitals, and the numerals shall be Arabic. Other characters shall be of a similar appearance. Letters, numerals, and other characters shall be of such size as to be clearly legible. All lettering shall be in English.

3.3.5 Interchangeability

The APDS LRUs and the items identified in 3.1.3 shall be interchangeable in accordance with the definition of Section 6 of this specification. Interchangeability shall be a design feature for all removable items/subassemblies/parts designated as LRUs or SRUs. When removable items/subassemblies contain controls, wiring, hydraulic lines, etc., interchangeability shall be provided at the attachments of these items to their next assembly as well as for structural attachments of the assembly.

3.3.6 Configuration Management (CM)

3.3.6.1 General Requirements

3.3.6.1.1 Management

The Seller shall provide a disciplined approach to CM to include requirements/design solution verification, configuration baselines, drawing preparation and maintenance, engineering release, change management, and configuration accounting and verification. Configuration management procedures are to be documented in accordance with DPRD CM01 of Appendix XV.

3.3.6.1.2 Procedures

Seller shall have written procedures to define the techniques to be used for CM which insure compliance with the requirements of this specification.

3.3.6.1.3 Management Review

The Seller shall permit review by the Buyer of the Seller's compliance with the Seller's CM procedures. The Seller shall correct, at no cost to the Buyer, any non-compliance with this specification.

3.3.6.1.4 Baseline Management

The Seller and Buyer shall use documented baselines as a common reference for change control of technical requirements and product configuration. This specification defines those items that establishes the initial baseline. The Seller's configuration baseline document (SCBD) (Reference 3.3.6.4.2) and As-built configuration record (ABCR) (Reference 3.3.6.10.1) shall define, respectively, the as-designed and as-built product configuration baselines.

3.3.6.2 Detail Requirements

3.3.6.2.1 Configuration Identification

Configuration Identification shall be established in the form of technical documentation for the Seller End Item (SEI) and major components identified in this specification or drawings for the items. This technical documentation shall relate system and item performance, interface, and design requirements and acceptance tests requirements, and shall be defined by the SCBD.

3.3.6.2.2 Specifications

The Seller shall provide technical specifications, end item detail, or procurement, for Buyer review (Reference 3.3.6.5a) and approval for incorporation into an SCBD for those items identified in the major components list in this specification when:

A. Performance, design, or test requirements specified in this specification are further allocated or developed by the Seller.

B. The item is a Seller or sub-tier-supplier item whose next assembly is other than a Seller drawing.

Specification format and content shall be in accordance with the procurement data requirements document (PDRD) Number CM03 in Appendix XV.

3.3.6.3 Engineering Drawings

3.3.6.3.1 Preparation

Drawings shall provide the design, engineering, manufacturing and Quality Control information directly or by reference necessary to control the product configuration as specified in this specification for the items.

3.3.6.3.2 Retention of Design

The configuration identification of each SEI (including subordinate subassemblies and parts) accepted by the Buyer shall be permanently retained on Seller's drawings. Separate parts lists (not integral with drawing format) and Engineering Orders (EO's) shall be considered part of the drawing.

3.3.6.3.3 Identification of Parts

Each part fabricated shall be identified with a part number. The same specification number or part number shall be used to identify all like materials, processes, and parts. Seller shall assign a new part number to the item when authorized changes make the item non-interchangeable with respect to interface, reliability, safety, reprocurement, traceability, or performance.

3.3.6.3.4 Equipment Identification Marking

Deliverable items and their shipping and storage containers shall be identified with nameplates and markings as prescribed in this specification for the item.

3.3.6.3.5 Parts and Standards Marking

As a minimum, all removable parts and company standards shall be marked or stamped with their identifying (part) number, serial, or lot number, (if used), and when space permits, the manufacturer's assigned identification code.

3.3.6.3.6 Buyer Assigned Item Identification Numbers

Buyer- or Seller-assigned part and specification-control numbers shall appear on the item as prescribed by drawing or by this specification or as specified in 3.3.6.3.5 above.

3.3.6.4 Configuration Control

3.3.6.4.1 Baselines

Control of the configuration of a Supplier End Item (SEI) shall be established by means of incremental and summary reviews and progressive baseline development. As a product of the reviews, the Seller shall prepare and maintain a Seller's Configuration Baseline Document (SCBD) for each SEI and, when applicable, its series of configurations. Upon Buyer acceptance of the first qualified or qualifiable production SEI, a completed SCBD shall be established.

3.3.6.4.2 Seller Configuration Baseline Document (SCBD)

The SCBD shall consist of a listing of all significant hardware configuration documents (specifications, drawings, and lists) that define an SEI. An SCBD shall be prepared for each deliverable SEI type-model-series (family number) and when changes are authorized, include subsequent configurations of the basic requirement. The SCBD shall be prepared and submitted in accordance with the PDRD Number CM03 in Appendix XV for Buyer approval of baseline documentation definition.

3.3.6.4.3 SCBD Control

The Seller prepared, Buyer approved, SCBD (including revisions) shall be formally issued by the Seller. All changes to the imposed baseline shall be subject to formal change control and be processed as Class I changes in accordance with 3.3.6.8.3. The SCBD issue, in effect, plus all authorized changes outstanding, shall constitute the current baseline at any point and time.

3.3.6.4.4 SCBD Maintenance

The Seller shall maintain the SCBD in accordance with his published procedures. The SCBD shall be prepared and submitted in accordance with the PDRD Number CM03 in Appendix XV for approval of the Seller's progressive baseline documentation definition as an output of design review, Seller's configuration inspection, or product audit.

3.3.6.5 Design Reviews

A design review process shall be implemented by the Seller to assure that requirements are defined to the proper level of detail and that Buyer and Seller management control is in pace with design development. Design reviews may be conducted incrementally and summarized to document the progressive baseline development of the SCBD:

A. Review of technical specifications provided by the Seller, or a sub-tier supplier (refer to 3.3.6.2.2) shall ensure that these specifications cover all items of hardware at appropriate levels, that each is complete in its contents, and that each is functionally (and physically) consistent with interfacing design specifications, including environmental requirements and qualification- and acceptance-test requirements.

B. Reviews of the evolving detail design shall assure that the design approach is consistent with objectives and requirements of this specification, and that the hardware baseline (drawings, materials, and process specifications) have been evaluated and approved for addition to the SCBD. Review of the documented design shall additionally assure that an adequate qualification program exists.

Note: Buyer approval of, or concurrence with, the Seller's design is not to be construed as divestiture of the Seller's basic design responsibility.

3.3.6.5.1 Seller Preliminary Design Review (SPDR)

This review will determine the integrity of the Seller's overall design concept, the compatibility with performance and design requirements of this specification and the producibility of the design with respect to cost and schedule. The Seller's configuration documentation approved during the review shall be incorporated into the Buyer-approved SCBD and the configuration accounting records.

3.3.6.5.2 Seller Critical Design Review (SCDR)

This review will be conducted when the detail design is essentially complete. The review will assure the integrity of the completed design, the compatibility of the technical requirements of this specification and the approval to release the progressively baselined detail design to manufacturing. The approved configuration documentation shall be incorporated into the appropriate Buyer-approved SCBD and configuration accounting records.

3.3.6.6 Seller Configuration Inspection (SCI)

An SCI will be conducted on the first deliverable qualified or qualifiable production SEI of a given baseline configuration:

A. The Seller shall provide, at the SCI, verification of the following:

1. The configuration and performance of the deliverable SEI matches the baselined documentation incorporated within the SCBD, and authorized changes thereto.

2. SEI meets quality assurance (test) requirements of this specification and Seller/subordinate-supplier technical specification's (when applicable).

B. The SCI shall be considered complete with the Buyer's formal approval of:

1. The complete SCBD for the CEI.

2. The verified acceptance test data in accordance with an approved acceptance test procedure (ATP).

3. Acceptance of the audited and approved production SEI.

3.3.6.7 Engineering Release Management

Seller's engineering documentation (i.e., production and test drawings, specifications, baselines, etc.) used to define the configuration of each SEI shall be released in a disciplined and controlled manner for the purpose of formally establishing Seller's engineering documents and controlling changes thereto.

3.3.6.7.1 Release System

The Seller's engineering release system shall provide a single point of release and a formal procedure of assigning and controlling document numbers, approving titles, verifying release requirements, effectivity, approval signatures, and recording and transmitting engineering documentation.

3.3.6.8 Configuration Change Control

3.3.6.8.1 Change Management

The Seller shall maintain an efficient, disciplined control of changes to established baselines. The change management technique employed by the Seller for the control of changes, including sub-tier supplier changes, shall be documented by the Seller and verified by the Buyer, and utilized throughout the contractual period of performance. The technique utilized shall assure all changes are properly evaluated, documented, and processed, and ensure that only those changes approved for incorporation are implemented as authorized.

3.3.6.8.2 Change Classifications

Engineering Change - The term "engineering change" is any design change to an end item, or part, delivered, or to be delivered, which will require revision to the contract specification or engineering drawings, or to the documents referenced therein which are approved or authorized for applicable items.

Engineering changes shall be designated as Class I or Class II.

All proposed Engineering changes to accepted or unaccepted end items shall be designated as Class I whenever one or more of the following is affected.

A. Procurement Technical Specification and documents referenced therein.

B. Contract provisions, i.e., cost, contract delivery, contract test schedules, etc.

C. Test Requirements and Specification Document (only acceptance requirements).

D. Hardware accepted by the Buyer. This includes all changes to hardware following delivery of the first unit of a part number.

E. Buyer baseline requirements.

F. Changes to the Orbiter baseline.

G. Change in procurement source as defined by source control drawings.

H. Verification/qualification.

I. Changes to Critical processes per applicable contract), Safety, Reliability, Maintainability, and Quality Provisions for the Space Shuttle Program.

J. After design certification, changes to drawings, material and process specifications, acceptance test requirements, certification/ verification/ safety/ qualification requirements.

K. Operational documentation such as Maintenance Requirements, Operations and Maintenance Instructions (OMI), Intermediate Depot Maintenance Requirements Document (IDMRD), flight plans, crew procedures, etc.

All Class I changes require Buyer approval and when required a corresponding change to the part numbers.

Any change that does not fall within the Class I definition is designated as Class II.

3.3.6.8.3 Control of Changes

Concurrent with acceptance of the purchase order, change control shall be implemented. All Class I changes shall be documented on an Engineering Design Change Proposal (EDCP) form and submitted to Buyer for review and approval in accordance with the PDRD CM01 in

Appendix XV. All Class I changes must be dispositioned by the Buyer. Class II changes are dispositioned by the Seller in accordance with 3.3.6.8.4.

3.3.6.8.4 Approval of Changes

The EDCP shall be used to document information for a proposed Class I change and shall be the basic instrument to transmit to the Buyer the change description, definition, and methodology for incorporation. EDCP approval is by Purchase Order Change Notice (POCN) which also authorizes implementation of the change (refer to 3.3.6.8.5). Other changes (Class II) need not be approved by Buyer but shall be submitted to Buyer concurrent with release on Seller's form for concurrence of classification and for information only. Any change so implemented and then rejected as a Class II change by the Buyer shall require resubmittal and approval as a Class I change, or cancellation and removal of the change in its entirety at no cost to the Buyer.

3.3.6.8.5 Authority to Implement Changes

The Seller, upon receipt of a Buyer's POCN, shall implement the Buyer approved change in accordance with the contractual documentation.

3.3.6.8.6 Buyer Proposed Changes

The Seller, upon receipt of a Buyer generated EDCP, shall complete the EDCP form and identify the impact on technical performance, interface conditions, schedule, and cost and submit this information to the Buyer. Seller shall include, where practical, trade-offs or alternate recommendations. No further action shall be taken by the Seller until authority is provided by the Buyer to implement the change.

3.3.6.8.7 Seller Requested Changes

For changes requiring prior Buyer approval, per 3.3.6.8.3, the Seller shall submit to Buyer a formal EDCP including supplemental exhibits; or the Seller may elect to place an inquiry relative to a change under consideration to determine the advisability and direction of continued expenditure of resources to develop a formal EDCP.

3.3.6.8.7.1 Seller's Changes to Proprietary Hardware

When the Seller initiates or has cause to effect a change to a proprietary SEI or to proprietary hardware assembled in an SEI, the Seller shall notify the Buyer of the change and state the impact, if any, on the functional, physical, or qualification characteristics of the CEI.

3.3.6.8.7.2 Sub-Tier Supplier Changes

The Seller is responsible for monitoring and controlling his sub-tier supplier changes, to the same degree required of the Seller by this specification. In the event a sub-tier supplier change impacts the SCBD or Buyer control documentation as defined in 3.3.6.8.2, the Seller shall prepare and submit a formal EDCP to Buyer.

3.3.6.9 Configuration Verification

The Seller shall have a formal method for verifying that the configuration of each SEI submitted for Buyer acceptance is in accordance with contractual requirements. Verification shall consist of the following:

3.3.6.9.1 Hardware Verification

The Seller's verified inspection records for hardware fabrication, assembly, and test, and as-built configuration record (ABCR) for each SEI shall be reconciled with the technical description and released engineering documentation. All differences shall be resolved to the satisfaction of the Buyer.

3.3.6.9.2 Change Verification

The Seller, upon request, shall provide documented evidence that verifies the incorporation of any or all engineering changes including authorization for such changes.

3.3.6.10 Configuration Accounting

The Seller's configuration accounting technique shall be capable of maintaining, storing, and correlating configuration documentation records and providing current change incorporation status information upon Buyer request. Accounting records shall be capable of providing a completely documented record of the evolution of the SEI in terms of procurement specifications, performance, and design specifications, drawings, process specifications, test procedures, and associated manufacturing and inspection records.

3.3.6.10.1 Configuration Accounting Records

As a minimum, the Seller's status and accounting methods shall be capable of providing the following records/documents:

A. Records of the incorporation status of authorized engineering changes and the identity of the Seller's change directive or Buyer's POCN which authorized the change.

B. Records that reflect the procured SEI, as manufactured, assembled, and tested, contains only approved engineering changes and that all engineering changes are included.

C. An as-built configuration record (ABCR), per PDRD CM04 in Appendix XV, which defines the as-delivered configuration of an SEI. This record shall include record of authorized deviations and waivers by part number.

3.3.6.11 Traceability and Serialization

3.3.6.11.1 Traceability

Traceability shall be provided by assigning traceability identification to end items or major components as identified in this specification. Each component, part, subassembly comprising or contained within the end item or major component shall be classified and processed as exempt or traceable, in accordance with the criteria contained herein.

3.3.6.11.2 Traceability Classification

Each component, subassembly, and part within the end item shall be evaluated and receive a traceability classification. Seller and subordinate supplier engineering documentation (e.g., drawings and specifications) shall specify the traceability classification for each part, component, and subassembly as classified by the Seller.

3.3.6.11.3 Serial Traceability (TS)

Serial traceability requires the assignment of a unique serialized identifier and processing of each part, subassembly, major component, or end item identified (TS) as a separate item, and maintaining historical records pertaining to that item alone. The historical records in turn will provide the capability for backward traceability to the identification of its procurement, fabrication, inspection, processing, test, and operating records and any other pertinent data deemed necessary by the Seller. The capability shall also provide for backward traceability to the procurement(s) and receiving record(s) of part(s), components, and subassemblies within the end item designated as traceable (exempt items excluded).

3.3.6.11.4 Serial Traceability Criteria

Sub-tier items comprising or contained within the end item which satisfy any of the following criteria shall be traceable by serialization:

A. Limited Life

B. Fracture Control

C. Requires progressive fracture control measurements of performance

D. Contains traceable subordinate items, assemblies, or parts.

3.3.6.11.5 Lot Traceablity (TL)

Lot traceability requires lot serial numbering of sub-tier items produced by the lot, batch, mix, heat, or melt in a given time sequence and the maintaining of historical data equally pertinent to all items in the lot. Separate lot numbers shall be assigned when planned differences between individual items in the lot occur due to changes in materials (substitution) or processes which affect fit, form or function. The given time sequence includes identification of work on the production order for a specific part number, from initiation of work through completion of last operation.

3.3.6.11.6 Lot Traceability Criteria

Sub-tier items which satisfy the following criteria shall be lot traceable:

A. All functional electrical, electronic, and electromechanical (EEE) parts.

B. Parts with materials identified by the Seller as critical.

C. Parts identified by the Seller as controlled by unique manufacturing process(es).

3.3.6.11.7 Exempt From Traceability (E)

This classification identifies those items which are exempt from traceability requirements. All items which have not been classified and identified as TS or TL shall be exempt (E) from traceability.

3.3.6.11.8 Traceability Identification

Each item identified as traceable (TS or TL) shall have a traceability identifier consisting of the manufacturer's code identification number (assigned by the Buyer to the Seller) and a serial or lot number as illustrated below. The serial or lot number shall be assigned by the manufacturer and shall not exceed ten (10) characters (alphas, numerics, dashes, etc.)

	MFG Code No.					MFG Assigned Traceable No.									
Digit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MFR's Code and						- - Example - -									
Traceability No.	0	3	9	5	3	T	T	A	0	6	7	8	5	6	9

Serialization may be accomplished in accordance with Seller's internal procedures; however, the serial numbers shall not exceed 15 characters, including manufacturers' identification code. Each dash (-) or other unique symbol is also counted as a character.

3.3.6.11.9 Changes

The serial number of an item shall not be changed when the article is reworked or retrofitted.

3.3.6.11.10 EEE Parts Traceability

EEE parts shall be traceable in accordance with the following:

1. For EEE devices, the formation of lots and the definition of inspection lots are as follows:

1.1 Formation of Lots - The product shall be assembled into an identifiable inspection lot or collection of inspection sublots.

1.1.1 Production Lot - A group of electronic parts manufactured during the same time period from the same basic raw materials processed under the same specifications and procedures, produced with the same equipment, and identified by the documentation defined in the manufacturer's reliability assurance program through all signification manufacturing operations, including final assembly operations. (Final assembly operations shall be considered the last major assembly operations such as casing, hermetic sealing, or lead attachment, rather than painting or marking.)

1.1.2 Inspection Lot - A group of EEE devices offered for inspection at one time and in combinations authorized by the applicable specification.

1.1.3 Traceability - Conforming materials shall be identified upon receipt, and where possible, throughout the production process to the accepted product. Where another basis of part production lot identification (e.g., the time period during which certain operations are performed) is used, the accepted product shall be identified with the appropriate production lot, and records of conforming material batches or lots in each production lot shall be maintained. Completed parts shall be identified to permit positive correlation to the production lot.

2. Description of Production Processes and Controls - Documentation shall include when applicable such items as:

Procedure for identification of each production lot through all significant manufacturing operations, including final assembly operations such as casing, hermetic sealing, or lead attachment. Alternately, where this procedure is impractical (e.g., where a part cannot be identified until after final assembly and determination of its performance characteristics,) the manufacturer shall as a minimum be able to identify the time period during which the final production operation was performed on each item of product prior to final test. The date or lot code marked on each part shall be identified to a production lot.

3.3.6.12 Engineering Drawings for Designated Development Items and Non-Flight Equipment Items

When maintainability or reprocurement of identical items is not a constraining requirement of the procurement technical specification and purchase order, drawing content for designated development flight items, development test items, and non-flight equipment items such as intermediate and non-critical field support equipment (FSE), mockups, and trainers may be prepared to lesser design disclosure levels of detail in accordance with the Procurement Data Requirement Document.

3.3.6.13 Deviations and Waivers

3.3.6.13.1 Deviation Definition

A specific written authorization, granted by the Buyer prior to manufacture, to depart from a particular performance or design requirement of a specification, drawing, or other document for a specific number of CEIs or a specific time period. A Deviation differs from an engineering change in that an approved change requires corresponding revision of the documentation defining the affected hardware, whereas a Deviation does not contemplate revision of the applicable documentation.

3.3.6.13.2 Waiver Definition

A written authorization, granted by the Buyer prior to acceptance of an SEI, to accept an non-conformance which during production or after having submitted for inspection is found to depart from specified requirements, but nevertheless is considered suitable for use "as is" or after rework by an approved method.

3.3.6.13.2.1 Request for Deviation or Waiver

Seller requests for Deviations to baseline documentation as defined in the SCBD shall be submitted in writing to the Buyer for evaluation and approval prior to implementation. Waivers shall be submitted for review and approval prior to submittal of the SEI for Buyer acceptance. Buyer will evaluate each request for a Deviation or Waiver as it is received and will provide written response.

Approval by the Buyer shall not be construed to extend to any item not covered by the response and shall not be deemed to be a Waiver of any of the Buyer's other rights under the purchase order.

3.3.6.13.3 Accounting for Deviations or Waivers

Records of Buyer approved Deviations or Waivers to the SCBD shall be accounted for in the ABCR as specified in 3.3.6.10.1c.

3.3.7 Documentation

The procurement data requirements are specified in Appendix XV.

3.3.8 Logistics Support System

The contractor shall develop and maintain a logistics support system for the life of the Seller hardware. The logistics support system consists of the following:

A. Maintenance (off-line)

B. Supply support management

C. Packaging, Handling, Storage and Transportation (PHS&T)

D. Technical data

E. Training

3.3.8.1 Off-Line Maintenance

3.3.8.1.1 Maintenance Engineering Analysis

The Seller shall conduct and document a maintenance engineering analysis to define the support resources required for deliverable hardware use in the performance of repair activities. The Seller shall define the accountability and traceability requirements for work at off-line sites. These work requirements shall fall into four identified categories:

A. Failed or suspected failure

B. Modifications

C. Time/age/cycle life repair, refurbishment, or recertification

D. Maintenance inspection and sampling (Teardown analysis)

Implementation shall be accounted against the IDMRD by the Buyer. Problem reporting and corrective action requirements shall apply at all off-line maintenance and manufacturing facilities starting with initial hardware acceptance test and continuing through the life of the hardware (reference, Problem Reporting and Corrective Action [PRACA] System Requirements).

3.3.8.1.1.1 Scheduled Maintenance

Scheduled maintenance tasks at the off-line level shall be planned and scheduled to support the mission baseline. Unscheduled maintenance resulting from the following shall be documented to assure accountability and traceability.

A. Flight/ground problem reports

B. System/subsystem/Line Replaceable Unit/Shop Replaceable Unit performance trend monitoring

C. Special requests

D. Removal and replacement of hardware during flow processing

E. Damage

3.3.8.1.1.2 Tracking and Accounting

The Seller shall provide tracking and accounting systems to assure that flight hardware and GSE retain the design performance, reliability, configuration and interchangeability contained in the design specification and does not invalidate the original certification after repair and refurbishment, modifications, deferred work, and time/age/cycle hardware replacement.

3.3.8.1.2 Maintenance

The Seller shall develop a maintenance concept, perform a logistics engineering analysis, define the maintenance certification process, perform maintenance trending, and supply documentation associated with these tasks in accordance with Appendix XV. The Seller shall assure the design, performance, safety, and reliability of the flight and ground hardware is retained through the performance of maintenance tasks. The following defines the maintenance requirements that must be implemented by the depot level maintenance.

3.3.8.1.2.1 Maintenance Concept

The Seller shall develop a maintenance concept consistent with the following requirements:

A. Maintenance shall be performed within a two-level maintenance structure (organizational or depot) in which each repair action is assigned to the properly certified level at which it can be most effectively accomplished.

B. Removal and replacement of LRUs shall be at the organizational level, either on a scheduled for unscheduled basis.

C. Both levels of maintenance shall be accomplished in a manner that provides support of operational time constraints, prevents deterioration of reliability and operating safety, ensures timely return of failed items to serviceable stocks, and accomplishes this support at minimum practical costs.

3.3.8.1.2.2 Logistics Engineering Analysis (LEA)

Seller shall ensure that a LEA be conducted to identify requirements for logistics resources which are necessary to support their equipment requirements at launch sites during Space Shuttle operations. A LEA shall consist of a Support Requirements Analysis (SRA) and an Optimum Repair Level Analysis (ORLA). In lieu of the SRA or ORLA, other comparable analysis currently used by the Seller may be used.

3.3.8.1.2.2.1 Logistics Engineering Analysis Results Baselining

The maintenance requirements that result from the LEA shall be presented and approved by the Buyer in accordance with PDRD LS01 in Appendix XV. These requirements shall be used to develop maintenance resources required for item support. These resources include maintenance manuals, specialized maintenance training courses, and maintenance ground equipment.

3.3.8.1.2.2.2 Support Requirements Analysis (SRA)

The SRA defines the requirements for support equipment, spare parts, consumables, personnel, specialized maintenance training, maintenance documentation, and any special facilities requirements; e.g., temperature/humidity, cleanliness, etc. The analysis shall be performed to the depth necessary to identify acquisition of resources as determined by the ORLA.

3.3.8.1.2.2.3 Optimum Repair Level Analysis (ORLA)

An ORLA shall be conducted for each reparable assembly. The ORLA shall form the basis for a repair item disposition, repair at depot level or discard-at-failure, based on economic considerations. Results of the ORLA shall provide a basis for the update of the initial assignment of Source, Maintenance, Recoverability (SMR) codes. Recommended SMR codes shall be assigned.

3.3.8.1.2.3 Maintenance Data

Maintenance data consists of that data necessary to plan and accomplish maintenance. The Seller shall provide maintenance documentation to meet operational maintenance requirements. Existing documentation shall be used to the maximum extent possible. Requirements for organizational level maintenance data will be contained in the Operations and Maintenance Requirements Specifications Document (OMRSD), and released engineering.

Intermediate and Depot Maintenance Requirements Document (IDMRD), will be used for development, planning and acquisition of off-line maintenance resources for flight and ground hardware. It will define the off-line maintenance requirements for reparable assemblies of flight and ground hardware, as well as any ground hardware interfacing with flight units, and applies to all organizations involved in planning and implementation of maintenance capabilities for the system.

3.3.8.1.2.3.1 Maintenance Data Content

Maintenance plans/maintenance planning data shall contain, as a minimum, the information defined in PDRD LS01 in Appendix XV:

3.3.8.1.2.3.2 Intermediate and Depot Maintenance Manuals (IDMMs)

IDMMs are required for all equipment requiring depot maintenance and will consist of technical instructions for performing such depot maintenance, on LRUs/SRUs and GSE models/components. If the designated repair agency is other than the OEM, the Seller shall prepare the IDMMs and subsequent support or providing depot maintenance requirements and engineering data packages.

Existing seller documentation which meets the users' needs may be used as IDMMs.

3.3.8.1.3 Limited Life Items

Based on current technology, the Seller shall conduct an equipment life analysis to determine the life capabilities of the hardware, and then compare these capabilities to the life requirements delineated in the Buyer procurement specification. Items having evidenced capabilities which are inadequate to meet the requirements shall be designated as limited life items. Emphasis shall be placed on minimizing the design application of limited life items.

3.3.8.1.4 Limited Operating Life Items

Limited life parts, components, assemblies, where time/cycle (wearout/degradation) is directly related to the primary cause of failure modes within the operating/shelf life specified in the Buyer procurement specification for the end item, shall be designated as limited operating life items. Items requiring servicing action, such as inspection, maintenance, or replacement, as a function of operating time or cycles within the specified operating/shelf life shall also be included as limited operating life items. Limited operating life items shall also be identified at the line replaceable unit, or higher, and shall be listed in the End Item Limited Life list, which will be provided in accordance with PDRD LS04 in Appendix XV.

3.3.8.1.5 Limited Shelf Life Items

Limited life parts and materials which are subject to failure due to aging or environment as a function of time since manufacture and/or installation shall be designated as limited shelf life items. The end item assembly shall have a shelf life that complies with requirements of the procurement specification and the "age control date" shall be provided at the line replaceable unit level or higher, for the age-sensitive part-material which must be replaced at the earliest date subsequent to manufacture of the end item. Limited Shelf Life items shall be identified in the End Item Limited Life List which will be provided in accordance with PDRD LS04 in Appendix XV.

3.3.8.1.6 Work Unit Code (WUC) Documentation

WUCs shall be developed in accordance with coordination with the Buyer to form a listing of unique codes identifying the flight and ground systems hardware components as to their physical and functional locations within the end item. WUC listing shall be provided for integration into a Shuttle program WUC data base. The Buyer will integrate and update the project element listings into an integrated WUC data base.

3.3.8.2 Supply Support Management

The following key subjects shall be included in developing and maintaining a logistics support system. This section specifies the requirements for a supply support management system to support the Seller hardware. Resource planning for operational support shall base calculations on the anticipated flight rates. Included are the functions and actions necessary to accomplish acquisition and management of the inventory of parts, materials, supplies, tools, and services necessary to support operation and maintenance of the Seller's hardware.

3.3.8.2.1 Supply Support

Supply support planning shall include the following as a minimum:

A. Spares provisioning and replenishment, to include, Government Furnished Equipment (GFE) spares, national stock number acquisition, configuration control, and provisioning data controls

B. Liquid propellants, pressurants, and other fluids

3.3.8.2.1.1 Spares Concept

Spares will be provisioned for and managed by the Seller. The identification, acquisition and distribution of spares will be compatible with the planned activities within the level of required maintenance and will be provided to the Buyer in accordance with PDRD LS06 in Appendix XV.

3.3.8.2.1.4 Spares Provisioning Data

The Seller shall provide all provisioning technical documentation associated with all items provisioned.

3.3.8.2.1.5 Cannibalization

Sufficient spares and provisions shall be available at or accessible to the launch and landing sites to permit replacement of failed or limited life hardware during flight preparation. Cannibalization is prohibited except by specific Buyer approval.

3.3.8.3 Transportation

Transportation planning shall include packaging, handling, storage, and transportation as a minimum.

3.3.8.4 Training

The purpose of this section is to specify the requirements for identifying and implementing the personnel technical training and certification prerequisite to perform maintenance on all hardware.

3.3.8.4.1 Authority

Personnel training and certification requirements are defined by the Buyer or are derived from Buyer specifications and are mandatory.

3.3.8.4.2 Requirements

The Seller shall identify a maintenance training program which supports the operational hardware under their jurisdiction. The extent of this training will be determined by the established maintenance concept as identified in maintenance documentation. The systems employed to implement training and certification shall provide for:

A. Identification of tasks requiring certification.

B. Communication of requirements for training and certification to work planning function, line supervision, and quality assurance.

C. Records of training conducted and personnel certification.

D. Plans and procedures to document the requirements of Seller maintenance training program.

E. Verification that personnel assigned to perform tasks requiring training and/or certification have been trained and/or certified.

F. Verification that tasks requiring training and/or certification are performed by trained, certified personnel.

G. The Buyer will review, evaluate, and approve training course material, proficiency examinations, and the certification and recertification criteria for new, changed or design-unique critical processes. All other training for the performance of critical processes will be audited by the Buyer. Certification is the responsibility of the Seller, and the application of these skills, i.e., the performance of the individual, is also the responsibility of the Seller.

3.3.8.4.2.1 Training and Certification Documentation

Training and certification documentation shall, as a minimum, define the task the trainee will be qualified to perform upon completion of training and specify how the certifying agent determines when the trainee possesses those qualifications. Records of training and certification shall be maintained for the operational life of the hardware and software for which the training was developed to support. Training and certification procedures, documentation, and records shall be made available for periodic verifications to determine compliance.

3.3.9 Safety

APDS design and operation, including Field Support Equipment (FSE) as applicable, shall comply with the following safety provisions and requirements.

3.3.9.1 Hazards

The APDS elements shall be designed such that all potentially catastrophic or critical hazards are either eliminated or sufficiently controlled to be candidates for acceptance by the customer. For a hazard to be a candidate for acceptance by the customer, the assessment of the risk resulting from the severity of the hazard and its likelihood of occurrence must fall in the CONTROLLED or ACCEPTED RISK blocks of the risk assessment matrix shown in Figure 24. After review, the customer may find the risk resulting from the candidate hazard to be acceptable to the program, or may decide that further redesign or added controls are required to bring the risk to a level acceptable to the program.

3.3.9.2 Hazard Reduction Precedence Sequence

To eliminate or control hazards, the contractor shall use, as a minimum, the following sequence or combination of items:

A. Design for Minimum Hazard. The major goal throughout the design phase shall be to ensure inherent safety through the selection of appropriate design features and safety factors. Hazards shall be eliminated by design, where practical. Where elimination is not practical, the design shall include features to control the hazard to the greatest practical extent. Damage control, containment, and isolation of potential consequences of hazards shall be included in design considerations.

B. Safety Devices. Identified hazards which cannot be eliminated or controlled through design shall be reduced to the greatest practical extent through the use of appropriate safety devices as part of the system, subsystem, or equipment. A safety device is any device employed in a system, subsystem, or component to reduce exposure of the system or crew to a hazardous event or condition, such as switch covers, switch guards, interlocks, etc.

C. Warning Devices. Where it is not possible or practical to preclude the existence or occurrence of an identified hazardous event or condition, devices shall be employed for the timely detection of the event or condition the generation of warning signal. Warning signals and their applications shall be designed to minimize the probability of wrong signals or improper personnel reaction to the signals.

D. Special Procedures. Where it is not possible to eliminate or adequately reduce the level of risk resulting from identified hazards through design or the use of safety and warning devices, special procedures shall be developed to counter hazardous conditions, for enhancement of ground and flight crew safety. Precautionary, i.e. Caution and Warning, notations shall be standardized.

3.3.9.3 Margin of Safety Testing

Provisions shall be made to assure that verification tests are performed on critical devices or components to determine the degree of hazard or margin of safety of design. These tests are specified in the verification requirements of Table I.

3.3.9.4 Sharp Edges

The design of flight equipment shall consider edge, cover, and protrusion criteria. Potentially hazardous flight equipment items that could injure crew members or damage equipment (i.e., entrapment, snagging, tearing, protruding, cutting, or abraiding) are subject to design criteria relative to sharp edges and protrusions for flight equipment as provided in Table I and Table II when such features are required for mission accomplishments, then suitable guards shall be provided for ground or flight handling operations.

Table I. Edge, Corner, And Protrusion Criteria For Edge And In-Plane Corner Radii

Application	Radius				Remark
	Outer		Inner		
	cm	in	cm	in	
Openings, panels, covers (corner radii in plane of panel)	0.64 0.30	0.25 0.12	0.30 0.15	0.12 0.06	Preferred Minimum
Exposed sheet-metal edges and flanges, latches, controls, hinges, and other small hardware	0.10	0.04	—	—	Minimum Required
Small protrusions (less than approximately 0.48 cm (3/16 in.) on toggle switches, circuit breakers, connectors, latches, and other manipulative devices.	0.10	0.04	—	—	Absolute minimum unless protruding corner is greater than 120°

A 45° chamfer by 0.06 in. (0.15 cm) (minimum) with smooth broken edges is also acceptable in place of a corner radius. The width of chamfer should be selected as approximately the corner radius described above.

Table II. Edge, Corner, And Protrusion Criteria For Protrusions And Outside Corners

Application	Criteria/remarks
Latching devices	All manual latching devices shall be covered in a manner that does not allow gaps or overhangs. All surfaces and edges shall be smooth, rounded, and free of burrs.
Lap joints in sheet metal and mis-matching of adjacent surfaces.	All surfaces shall be mated within 0.03 in. (0.08 cm) of flat surface at edges, or shall be butted or recessed. All exposed edges must be smooth and radiused 0.06 in. (0.15 cm) minimum (as above), chamfered 45°, or shall be covered with an appropriate material.
Sheet metal structure, box and cabinet three-plane intersecting corners.	Spherical welded or formed radii are required unless corners are protected with covers.
Screw heads, bolts, nuts, and nut plates, excess threads and rivets that can be contacted by crew members.	All screw heads and bolt heads shall face the outside of the structure, if possible. Where nuts, nut plates, and threads are exposed, they shall be covered in a secure manner. Recessed heads shall protrude no more than 0.125 in. (0.32 cm) from the mating surface or shall be covered unless spaced more than 7 head diameters apart from center to center. Height of roundhead or ovalhead screws is not limited. Screw heads or bolt heads more than 0. 25 in. (0.64 cm) deep must be recessed or be covered with a fairing.

Table II. Edge, Corner, And Protrusion Criteria For Protrusions And Outside Corners (continued)

Application	Criteria/remarks
	Rivet heads shall face out on all areas accessible to crew members and shall protrude no more than 0.06 in. (0.15 cm) unless spaced more than 3.5 head diameters from center to center. In all exposed areas where unset ends of rivets extend more than 0.12 in. (0.31 cm), or 0.50 in. (1.27 cm) of unset and diameter of more than 0.12 in. (0.31 cm), a fairing shall be installed over them. This applies to explosive, blind, or pull rivets, etc. Unset ends of rivets must have edges chamfered 45° or ground off to a minimum radius of 0.15 cm (0.06 in.)
	A maximum gap of 0.02 in. (0.05 cm) will be allowed only between one side of a fastener head and its mating surface.
	Burrs must be prevented or eliminated. Use of allen heads is preferred. Torque-set, slotted, or phillips head screws must be covered with tape or other protective materials or be individually deburred before flight.

3.3.9.5 Protective Covers on Exposed Protrusions

Protective covers, cases, or padding shall be used on protrusions or other hazardous objects that cannot be made completely hazard free.

3.3.9.6 Holes

Holes that are uncovered and are round or slotted in the range of 0.4 to 1.0 in (10.0 to 25.0 mm) shall be avoided.

3.3.9.7 Latches

Manual latches or similar manual devices that can pinch fingers shall not be used. A protective guard or cover shall be used where suitable substitutes cannot be found.

3.3.9.8 Screws and Bolts

Screws or bolts with more than two exposed threads shall be capped to protect against the sharp threads.

3.3.9.9 Securing Pins

Securing pins in handrails shall be designed to prevent their inadvertently backing out above the handhold surface.

3.3.9.10 Levers, Cranks, Hooks, and Controls

Levers, cranks, hooks, and controls shall not be located where they can pinch, snag, or cut the crew member or clothing.

3.3.9.11 Burrs

Exposed surfaces that can be grasped by the bare hand shall be free of burrs.

3.3.9.12 Deleted.

3.3.9.13 Factors of Safety for Pressurized Manned Compartments

The manned pressurized portion of the Docking system shall meet the requirements in the table provided below and have a maximum operating pressure of 16.0 psia (827.2 mm Hg). The docking system shall be Proof Pressure tested, in combination with mated loads, at 110% of a maximum differential pressure value of 16.0 psid (1.12 kgf cm^2 differential), and Pressure vessel components of the docking system shall be proof tested with pressure alone at 150% of this maximum differential pressure value. The Docking System shall meet the following Factors of Safety:

Item	Factor of Safety
Orbiter mounted structures	1.4
ISS mounted structures	1.5
Capture/Attenuation mechanisms	1.5
Structural Hook Mechanisms	1.5
Pressurized Compartments	1.5
Seals	3.0

Seal margins = Contact stress/(3 x Internal pressure) -1

3.3.9.14 Pressure Vessels

The fluids used in cleaning, testing, and operation shall be compatible with the pressure vessels.

3.3.9.15 Debris Prevention

The APDS shall be designed to preclude the shedding of debris during prelaunch and flight operations that would jeopardize the flight crew, vehicle, or mission success. Debris is defined as broken and/or scattered remains emanating from the element(s) of any flight or ground systems.

3.3.9.16 Electrical Hazards Design

Equipment design shall include provisions for protection of the crew members from electrical hazards.

3.3.9.17 Chassis Leak Current

Crew members shall not be exposed to excessive levels of leak current from contact with the exterior of electrically powered equipment. The maximum chassis leak current shall not exceed 100 milliamperes rms. Electrical equipment shall meet this maximum current limitation for any combination of the following conditions:

A. Electrical supply polarity normal and reversed.

B. Power switch on and off.

C. Ground open and intact.

3.3.9.18 Crew Member Protection

Crew members shall be protected from electrical hazards by one or more of the following methods.

3.3.9.18.1 Grounding

External metal parts subject to crew contact shall be at ground potential.

3.3.9.18.2 Protective Covers

Equipment shall provide grounded or nonconductive protective covers for all electrical hardware.

3.3.9.18.3 Interlocks

Equipment access doors or covers shall incorporate interlocks to remove all potentials in excess of 150 V when open.

3.3.9.18.4 Warning Labels

Warning labels shall be provided where potentials are hazardous to crew members.

3.3.9.18.5 Plugs and Receptacles

Plugs and receptacles design shall prevent a plug of one voltage rating from being inserted into a receptacle of another rating.

3.3.9.18.6 Insulation

All exposed electrical conductors shall be insulated.

3.3.9.18.7 F.SE Power Cords

Portable equipment shall be designed with three-wire power cords with one wire at ground potential. A system of double insulation or its equivalent when approved by the procuring agency, may be used without a ground wire.

3.3.9.18.8 Spacing Between Connectors

Equipment shall be designed so that a connector installation/removal tool will not make contact between the adjacent connectors.

3.3.9.18.9 Electrical Systems

Electrical power distribution circuitry shall be designed so that failures internal to the flight equipment do not damage any interfacing circuitry, and do not create ignition sources.

3.3.9.18.10 Electrostatic Discharge

Circuits sensitive to electrostatic discharge shall not cause a critical or catastrophic hazard.

3.3.9.18.11 Wire Bundles - Protective Coating

Where protective coating or sheathing is added to wire bundles, wire bundles shall withstand anticipated handling (including crew handling), thermal cycling, and operating deformations without wire damage.

3.3.9.19 Deleted

3.3.9.20 Equipment Failure - Verification of Flight Readiness

Where flight or flight-like equipment has failed, launch-to-orbit of like equipment, either as an initial assembly or as an on-orbit replacement, shall not be permitted unless the following occurs:

A. An analysis of the failure has established that the basic deficiency which caused the failure is not present in the replacement equipment.

B. The basic deficiency has been counteracted by changes in operational procedures to a degree that eliminates it as a significant threat to the success of the mission or the safety of the crew.

C. The basic deficiency as determined by the Buyer to represent no significant threat to the success of the mission and safety of the crew.

Equipment that exhibits or has exhibited intermittent malfunctions, failures, or anomalies shall not be used for flight until the malfunction, failure, or anomaly has been corrected or resolved to the satisfaction of the Flight Readiness Review Board.

3.3.9.21 Safety Precautions - Test and Operating Procedures

Procedures developed for testing and operating spacecraft or field support equipment shall clearly indicate any step which, if not correctly followed, would result in injury to personnel, damage to a system or equipment, or an environmental impact, after the equipment has been delivered to the Buyer. All procedures shall be reviewed and approved by System Safety.

The cover sheet of the procedure shall identify it as a safety-critical operation.

3.3.9.22 Field Support Equipment Protective Devices

Field Support Equipment (FSE), facility equipment, or test equipment used in ground or flight operations shall be equipped with protective devices to preserve safe operating margins of the spacecraft subsystems.

3.3.9.23 Emergency Safing Electrical System

The APDS electrical power distribution system shall have the capability to remove all electrical power from the APDS. This capability shall be available to the crew in the Orbiter.

3.3.10 Human Performance/Human Engineering

The design shall consider the capabilities and limitations of the human operator whenever a man-machine interface exists, including torques, forces, and other functional design characteristics of controls, displays, and work stations.

3.4 QUALITY ASSURANCE PROGRAM

The following quality requirements are applicable to all RSC Energia hardware designated as deliverable under this specification and related contracts.

3.4.1 Management and Planning

3.4.1.1 Planning

Quality Assurance activities shall be an integral part of design, development, test and evaluation, production, operational activities and refurbishment/overhaul. Scheduled status reporting will be used to provide visibility and assist in controlling the Quality Assurance effort. Objectives will be to define the major Quality Assurance tasks and their place as an integral part of the design and development process; and to assure the effective implementation of Quality Assurance requirements. Quality Assurance program planning shall address all program phases and shall provide a comprehensive management approach to preventing, detecting, documenting, and resolving actual or potential nonconformances.

3.4.1.2 Organization

Organizations and personnel responsible for implementing and performing Quality Assurance functions shall have well defined responsibilities, authority, and organizational freedom to develop and implement Quality Assurance disciplines and controls. One designated person shall have the responsibility and authority for directing and managing the Quality Assurance activity. That person shall have unimpeded access to the management level having full responsibility for the program/project work and shall report regularly on the status and effectiveness of quality activities.

3.4.1.3 Quality Program Plan

The quality organization shall prepare, implement, and maintain a quality plan which describes the compliance with requirements set forth herein. New or existing policies and procedures cited in the plan shall be available for NASA review. The plan shall serve as the master planning and control document and shall be submitted in accordance with contract NAS15-10110, Volume IV of data requirement RSM-06 and with PDRD QA01 in Appendix XV.

3.4.1.4 Management Assessment Data

The quality organization shall provide periodic quality progress and status reports to their respective program management office and the Buyer.

3.4.1.5 Deleted

3.4.1.6 Milestone Reviews

Quality Assurance activities shall include supporting project milestones such as design, acceptance, and readiness reviews. Participation in reviews shall assure that quality requirements are considered in decisions which affect hardware design, configuration controls, initiation of subsystem and integrated testing, shipment, and readiness for flight. Quality Assurance data presented will contain sufficient detail to allow management to assess the acceptability to proceed with the next program phase activity.

3.4.2 Design and Development Controls

3.4.2.1 Technical Documents

Quality Assurance shall conduct timely reviews of technical documents and changes thereto prior to document release. Technical documents include, but are not limited to, specifications, engineering drawings, engineering change orders, program plans, implementing procedures, work instructions, deviations, waivers, etc. Designs produced by automated systems shall have an equivalent level of control.

3.4.2.1.1 Quality Assurance shall verify that the contractor's documentation system assures the inclusion of quality characteristics and acceptance criteria in specifications, procedures, drawings, fabrication and inspection planning, and test documents.

3.4.2.1.2 Quality Assurance shall assure that the drawing system and other specifications identify hardware characteristics requiring verification with particular emphasis on critical characteristics. This identification shall be used in developing quality inspection and test verification planning and procedures.

3.4.2.2 Change Control Verification

Engineering changes shall be reviewed by Quality Assurance to determine the quality impact, such as modified inspection/test requirements, identification of new or modified tooling, gauging, or test equipment needs, and identification of changes to critical inspection/test procedures. Change incorporation shall be verified in accordance with specified effectivity with special attention to changes involving controlled interface dimensions.

3.4.2.3 Product/Process Development

Quality Assurance shall participate in product and process development activities to ensure that fabrication quality requirements are defined in concert with product requirements. Quality shall assure criteria for material, and process controls are consistent with quality requirements. Product and process development activities include, but are not limited to development of mockups, engineering models, qualification/ prototype units, development test units, and development of processes and fabrication methods. Commensurate with these activities, Quality Assurance shall develop methods and plans for verification of these requirements with particular emphasis on early identification of critical characteristics.

3.4.3 Identification and Data Retrieval

3.4.3.1 General

A documented identification and data retrieval system shall be developed, implemented, and maintained. The Contractor shall use identification numbers related to the engineering design. Criticality, design complexity, application, performance characteristics, manufacturing, processing or environmental conditions, and limited-life sensitivity shall be used to determine the level of control applied through identification and data retrieval requirements. An identification and data retrieval system shall be provided for installed part and material traceability as follows:

3.4.3.1.1 Each traceable article and material shall be identified by a unique combination of part or type number, one or more of the following identification methods as applicable:

3.4.3.1.2 Requirements shall be established for electrical, electronic, and electromechanical (EEE) parts which shall provide the capability of tracing backwards from fabricated hardware to the lot from which the part originated.

3.4.3.2 Retention of Records

Records shall be retained in a safe, accessible location for the period specified in the contract. Records shall not be destroyed unless authorized by the NASA's contracting officer.

3.4.3.3 Record Retrieval

Record systems shall ensure that records are identified and related to the applicable articles and materials. The system shall be organized so that these records and the related articles and materials may be rapidly located and retrieved.

3.4.4 Procurement

3.4.4.1 Procurement Controls

The contractor is responsible for assuring that purchased articles, materials, and services conform to the requirements specified in this document and other program requirements. Control of procurements shall include identification of contract quality requirements, selection of qualified suppliers, verification of product quality and compliance with contractual requirements, and provisions for reporting and correcting nonconformances.

3.4.4.2 Quality Assurance Personnel at Supplier

The contractor shall assign resident or itinerant Quality Assurance personnel at subcontractor or supplier facilities based on the criticality and complexity of the equipment and experience with the source, when testing or critical inspections cannot be accomplished by the contractor, or when articles or materials are designated for direct shipment from the supplier to a NASA Center or the using site. The contractor shall provide written instructions for its Quality Assurance personnel at the supplier which will include a requirement to record the history and results of source activities in the following areas: general information, system control, product control, and process control.

3.4.4.3 Receiving Inspection

Quality Assurance shall develop, implement, and maintain a documented receiving inspection activity to ensure that procured articles comply with procurement document requirements, inspection and test data are accurate and acceptable, evidence of contractor and NASA source inspection has been provided as required, specified identification and data retrieval requirements have been met, time/cycle sensitive articles are identified, expended and remaining time/cycle information is provided, chemical analysis and physical tests are performed, and receiving inspection results and status of articles are maintained. Procedures shall provide for laboratory analysis and testing on a sampling basis to verify the validity of test reports received from suppliers.

3.4.4.4 Supplier Data

Inspection and test results commencing with receiving inspection shall be recorded to reflect, on a continuous basis, the qualitative and quantitative performance of individual suppliers and the quality histories of the supplied articles and materials. Quality Assurance shall maintain data to aid in the selection of suppliers, establish trends of potential problems, and initiate action to resolve any negative trends.

3.4.5 Fabrication Controls

3.4.5.1 Fabrication Operations

Quality Assurance shall support fabrication operations, including assembly and test, to verify that critical characteristics of the design are identified and their conformance to engineering specifications are maintained in all articles produced. Critical characteristics shall be selected by quality, manufacturing, and engineering personnel and shall be derived from drawings, specifications, Failure Modes, Effect and Criticality Analysis (FMECA), Hazard Analysis, etc. Critical characteristics shall be designated as inspection points that must be verified by Quality Assurance personnel. Identification of these characteristics, definition of methods, and sequence of operation shall be consistent with the criteria, methods, and plans developed during product development and reviewed at design reviews. Detailed fabrication and inspection planning shall contain the following as a minimum:

3.4.5.1.1 Nomenclature and identification of the article to be fabricated.

3.4.5.1.2 Drawings and specifications required.

3.4.5.1.3 Tooling, jigs, fixtures, and other fabrication equipment to be utilized.

3.4.5.1.4 Detailed instructions for fabrication and assembly of articles.

3.4.5.1.5 Critical characteristics and tolerances required.

3.4.5.1.6 Detailed procedures for controlling processes and cleaning, preservation, and packaging operations.

3.4.5.1.7 Special conditions to be maintained such as environmental controls, specific cleanliness levels, and precautions to be observed.

3.4.5.1.8 Workmanship standards.

3.4.5.1.9 Specific inspections and/or test operations to be performed during fabrication to provide verification of design characteristics.

3.4.5.1.10 Special handling equipment and protective devices [e.g. Electrostatic Discharge (ESD) control].

3.4.5.1.11 Traceability to the individual performing the operation and to the inspection personnel verifying compliance.

3.4.5.1.12 Traceability to the FMECA where applicable.

3.4.5.1.13 Configuration data, including parts lists, drawings, changes, specifications, and identification data, to ensure fabrication to the proper design requirements.

3.4.5.1.14 Reserved

3.4.5.1.15 When NASA has specified source control inspections for subtier purchases (as identified in 3.4.4.2) the contractor's QA organization shall ensure that NASA Mandatory Inspection Points(MIPs) [in accordance with criteria provided to the contractor by the NASA Quality Assurance Representative (QAR)] are incorporated into the detailed planning. The contractor's quality organization shall then coordinate with the government QAR for MIP coverage.

3.4.5.1.16 For in-house fabrication, assembly and test the contractors quality organization shall ensure NASA MIPs (in accordance with criteria provided to the contractor from the NASA QAR) are incorporated in the detailed planning. Quality Assurance shall then coordinate with the NASA QAR for MIP coverage.

3.4.5.2 Article and Material Control

The following controls shall ensure that only conforming articles and materials are accepted and used:

3.4.5.2.1 Data shall be maintained for articles identified as having characteristics of quality degradation or drift with age and/or use. The date, time, or cycle from which useful life is calculated; the date, time, or cycle at which the useful life will be expended; and the incurred operating time or cycles shall be recorded.

3.4.5.2.2 Quality Assurance shall verify that requirements for articles and materials to be fabricated, processed, inspected, or tested in a temperature, humidity, electrostatic discharge (ESD), or contamination-controlled environment are properly implemented.

3.4.5.2.3 Quality Assurance shall verify, prior to initial use and at established intervals thereafter, the accuracy of production jigs, fixtures, tooling masters, templates, patterns, and other devices used for inspection.

3.4.5.3 Contamination Control and Cleanliness

Quality Assurance shall assure that contaminant-sensitive items are cleaned and controlled in accordance with documented procedures to the levels specified in the applicable technical documents and are maintained to these cleanliness levels. These procedures shall cover hardware, equipment, and personnel, and control of such areas as fabrications, assembly, inspection, test, and storage. Specific cleanliness levels to be maintained for systems, subsystems and major components shall be indicated on drawings, specifications, or other documents controlling the manufacture and test of those items. Quality Assurance shall assure that cleanroom disciplines and procedures are properly implemented and monitored to assure continuing compliance with requirements.

3.4.5.4 Process Controls

3.4.5.4.1 Quality Assurance shall implement controls for those processes where uniform, high quality cannot be assured by inspection of articles alone. These processes include, but are not limited to, metallurgical and chemical processes, soldering, welding, potting, bonding processes, plating and coating processes, and surface treating processes. These controls shall assure that special processes are performed by certified personnel; that facilities, equipment, materials, and procedures are adequate, maintained, and properly used; and that records are controlled.

3.4.5.4.2 An up-to-date list shall be maintained of all process-control procedures and process specifications used in the fabrication, control, and inspection of the materials and articles. Seller process specifications shall be available for review by the Buyer or its delegated representative. The Seller shall also furnish singular information from the subcontractors upon request. Requirements for disclosure of contractor's and subcontractor's proprietary process specifications shall be established with NASA on an individual basis.

3.4.5.5 Nondestructive Evaluation

Nondestructive Evaluation (NDE) methods shall be used, as required by engineering specifications, and controlled to ensure quality hardware. NDE standards shall be used or prepared based on hardware configurations and geometry. Quantitative acceptance or rejection criteria shall be established for each NDE application. Personnel performing NDE processes shall be trained and certified in their proper use and application.

3.4.5.6 Workmanship

Where samples or visual aids showing acceptable workmanship are necessary, they shall be selected by the contractor, subject to review by NASA or its designated QAR. Standards shall be reviewed and revised or replaced, as necessary, to satisfy current requirements. Standards shall contain appropriate product acceptance/rejection criteria.

3.4.5.7 Control of Temporary Installations and Removals

Quality Assurance shall maintain a log or otherwise ensure the management and control of articles or components that are temporarily installed or removed to facilitate manufacturing, testing, shipping, or handling of the end item. The control shall be initiated upon installation or removal of the first temporarily installed or removed item and shall be maintained until delivery to prevent them from becoming a part of the final configuration.

3.4.5.8 Quality Assurance Designees

A systematic approach may be developed to designate certain trained and qualified engineers, manufacturing and test personnel to represent Quality Assurance in performing selected inspection and test functions. The approach shall be described in the Quality Plan. The selected inspection and test functions shall exclude those processes, inspections, and tests that are required to verify critical characteristics or where reinspection cannot be readily accomplished due to further assembly or installation of hardware.

3.4.5.9 Inspection Procedures

Where inspection operations are complex and difficult to perform, Quality Assurance shall assure the preparation of specifically planned procedures to assure accuracy and validity of data and supplement the normal fabrication and inspection planning. These procedures shall be controlled and shall be based on current design information.

3.4.6 Test Controls

3.4.6.1 Verification

Quality Assurance shall verify tests that demonstrate program, contract, drawing, and specification requirements have been satisfied on all articles and materials procured and produced. Quality Assurance approval of test results shall be provided to show that the quality inherent in the design is maintained in the articles produced. Quality Assurance shall review the test or verification plan to ensure inclusion of pertinent quality requirements.

3.4.6.2 Test Procedures

Approved test procedures shall be readily available to inspection and test personnel at the applicable location at the time of inspection or test. Quality Assurance shall assure that test procedures include the following information:

3.4.6.2.1 Nomenclature and identification of the test article or material.

3.4.6.2.2 Characteristics and design criteria including values and tolerances for acceptance and rejection.

3.4.6.2.3 Identification of characteristics and design criteria specified for verification.

3.4.6.2.4 Detailed steps and operations to be taken in sequence including verifications to be made before proceeding.

3.4.6.2.5 Identification of measuring or NDE equipment to be used specifying range and type.

3.4.6.2.6 Details or instructions for operation of special data recording equipment.

3.4.6.2.7 Layout of interconnection of test equipment and articles.

3.4.6.2.8 Identification of hazardous situations or operations.

3.4.6.2.9 Precautions to comply with established safety requirements, ensure safety of personnel, and to prevent damage or degradation of articles and measuring equipment.

3.4.6.2.10 Environments and other conditions to be maintained.

3.4.6.2.11 Identification of any reference drawings, specifications, workmanship standards, and/or reference documents required to enable full comprehension of test requirements.

3.4.6.2.12 Constraints on inspection or testing.

3.4.6.2.13 Special instructions for nonconformances, anomalous occurrences, or results.

3.4.6.2.14 Details of sampling plans used.

3.4.6.2.15 Details of NDEs.

3.4.6.2.16 Identification of steps that involve critical items or requirements.

3.4.6.2.17 Configuration/revision level of hardware/software used during test.

3.4.6.3 Test Performance

Quality Assurance shall assure that tests are performed in accordance with approved procedures and that any deviations to the test procedures are properly recorded and approved. Each test operation shall be traceable to the individual responsible for its accomplishment. Articles undergoing test shall not be adjusted, modified, repaired, reworked, or replaced except as authorized by properly approved documents. Quality Assurance test verification shall include the following:

3.4.6.3.1 Prior to testing, Quality Assurance shall verify that approved test procedures are available, that test equipment is calibrated and properly configured, that the facility is properly configured, that all manufacturing and lower level test operations are complete, and that the configuration of the test article is correct and ready for test.

3.4.6.3.2 During testing, Quality Assurance shall verify that testing is performed in accordance with approved test procedures or that procedure deviations are recorded, that test data are accurately recorded, and that all known nonconformances are documented.

3.4.6.3.3 Subsequent to testing, Quality Assurance shall verify that test results and data are complete and traceable to the test articles, that proper dispositions of articles have been made, that nonconformances are documented, that remedial action and recurrence control action are initiated and that integrity control of test articles is properly established and implemented.

3.4.6.3.4 Documentation shall include procedures for the development, verification and control of computer software/firmware used in conjunction with measurement and test equipment for acceptance of articles.

3.4.6.4 Inspection and Test Records and Data

3.4.6.4.1 Records

Records and data of all inspections and tests performed shall be prepared and maintained in sufficient detail to verify and evaluate the status of articles and materials.

3.4.6.4.2 Acceptance Data Package (ADP)

ADPs shall be prepared and maintained in accordance with contract data requirements and with PDRD QA12 in Appendix XV. Quality Assurance shall ensure the ADPs are prepared and maintained.

3.4.6.4.3 Acceptance Review (AR)

Quality Assurance shall participate in ARs to assure compliance with documentation requirements. The following information, items 3.4.6.4.3.1 through 4.3.6.4.3.10, shall be provided for review at the AR. Additionally, item 4.3.6.4.3.11 shall be readily retrievable at the AR.

3.4.6.4.3.1 A summary of test and checkout operations and results with anomalies encountered, failure history, remedial actions, and recurrence control.

3.4.6.4.3.2 The status of any open work, including open items from previous reviews, shortages, nonconformances, unincorporated engineering changes, etc., and constraints on further activities.

3.4.6.4.3.3 Identification of waivers/deviations and verification of approvals.

3.4.6.4.3.4 Identification of limited life components and their remaining life.

3.4.6.4.3.5 A comparison of as-designed versus as-built configuration listings and rationale for any differences from approved baseline designs.

3.4.6.4.3.6 The test procedure and test data for all end item acceptance tests including strip charts, deviations, and other data applicable to evaluate test records.

3.4.6.4.3.7 Completed deliverable ADPs.

3.4.6.4.3.8 A "Material Inspection and Receiving Report" (DD Form 250) and/or other contractually authorized documents prepared for signature.

3.4.6.4.3.9 Records of all open nonconformances occurring during manufacturing and test of the end-item.

3.4.6.4.3.10 Handling, shipping, storage, preservation, packing, and packaging instructions, including environmental constraints, identification of hazards, and maintenance requirements and user manuals.

3.4.6.4.3.11 In addition, all supporting documentation, which may be required to establish equipment acceptability, should be readily retrievable. This includes, but is not limited to, engineering drawings, schematics, supplier ADPs, test specifications, closed nonconformances, fabrication, inspection, and test records, etc.

3.4.7 Nonconforming Articles and Materials

3.4.7.1 Nonconformance Control System

Quality Assurance shall establish, implement, and maintain a documented closed-loop system for controlling nonconformances. This system shall include provisions for recording, analysis, remedial action, recurrence control, verification, and feedback of data on articles and materials which do not conform to drawings, specifications, or other requirements. Special emphases shall be placed on tracking and resolving repetitive nonconformances. The contractor shall assure that subcontractors and suppliers implement a closed-loop system which complies with the requirements of this paragraph.

3.4.7.2 Identification of Nonconformances

Nonconformances shall be documented in accordance with contract data requirements. Nonconformance recording shall commence with initial receipt of materials or articles for NASA procurement and continue through all subsequent phases of the program. Nonconforming articles or materials shall be identified, segregated to the extent practicable, and held for disposition.

3.4.7.3 Nonconformance Evaluation

Appropriate analysis and examination of nonconforming articles, materials, or conditions shall be conducted to determine the cause or reason for the nonconformance and to record further action.

3.4.7.4 Nonconformance Dispositions

The contractor may disposition nonconforming articles or materials without the participation of NASA or its delegated representatives as follows:

3.4.7.4.1 Return to Supplier

When, on receipt, an article or material is found to be nonconforming, it should be returned to the supplier. The contractor shall provide the supplier with sufficient nonconformance information to allow correction of the defect and development of corrective action to preclude recurrence.

3.4.7.4.2 Return for Rework or Completion of Operations

Rework or completion of operations shall be performed using established fabrication, inspection, and test documents.

3.4.7.4.3 Recurrence Control

Quality Assurance shall assure the evaluation of all nonconformances to determine cause and action required to preclude recurrence. Evidence of such action shall be documented on each nonconformance report prior to close-out. Recurrence control shall include, but shall not be limited to, correction of technical documents and correction of other articles and materials at all locations. Recurrence control shall not preclude continued processing of the nonconforming article or material during the investigation for identification of cause and corrective action.

3.4.8 Metrology

3.4.8.1 Metrology Controls

A documented metrology system shall be established and maintained to ensure that measurement standards and equipment provide objective evidence that articles and materials produced or procured are in compliance with specifications, drawings, and program and contractual requirements. All new or repaired measurement standards and equipment shall be inspected and/or tested prior to use. Documentation of this effort shall be maintained and made available for review by the designated NASA QAR.

3.4.8.2 Calibration Records

Individual records of measurement standards and equipment calibration shall be maintained. These records shall include, but are not limited to, the following:

3.4.8.2.1 Identification of standard or equipment to be calibrated.

3.4.8.2.2 Identification of standard or equipment and calibration procedure used in the calibration process.

3.4.8.2.3 Calibration intervals.

3.4.8.2.4 Dates and results of each calibration.

3.4.8.2.5 Due date of next calibration.

3.4.8.2.6 Individual(s) performing calibration.

3.4.8.2.7 Calibration facility.

3.4.8.2.8 Degree of nonconformance of standards or equipment received for calibration.

3.4.8.3 Measurement Accuracy

Random and systematic errors in any calibration measurement shall not exceed 25 percent of the tolerance of the parameter being measured. The contractors calibration system description may include provisions for deviating from the uncertainty requirements provided the adequacy of the calibration is not degraded. All deviations shall be recorded.

3.4.8.4 Calibration Controls

3.4.8.4.1 Facility

Each organization shall have its own facility for calibrating measurement standards and equipment or shall use the services of an outside facility which meets the requirements of this paragraph.

3.4.8.4.2 Traceability

All measurement standards shall be traceable to standards maintained by the National Institute of Standards and Technology (or equivalent) or their values shall be derived from a controlled measurement process utilizing a fundamental constant of nature.

3.4.8.4.3 Handling, Storage, and Transportation

All measurement standards and equipment shall be handled, stored, and transported in accordance with documented procedures which shall preclude equipment damage or degradation of accuracy.

3.4.8.4.4 Identification and Labeling

All measurement standards and equipment shall be uniquely identified and labeled, tagged, or coded to indicate calibration status and due date of next calibration.

3.4.8.4.5 Calibration Intervals

Calibration intervals shall be established, documented, and periodically reviewed. Intervals shall depend upon the use, accuracy, type of standard or equipment, and other conditions affecting the measurement process.

3.4.8.4.6 Recall System

All standards and equipment used in measurement processes shall be recalled and recalibrated at established intervals. Standards and equipment not recalibrated on or before the recall due date or damaged in use shall be removed from service or otherwise restricted from use. Authorization for exception shall be obtained for the Buyer.

3.4.8.4.7 Environmental Requirements

Environmental conditions (i.e. temperature, humidity, vibration, cleanliness) shall be compatible with the requirements of the article and material and calibration measurement process.

3.4.8.5 Action and Recurrence Control

Recurrence control shall be taken relative to nonconforming measurement standards or equipment. The calibration authority shall notify program users of the nonconforming measurement standards or equipment as to the extent of nonconforming measurements. The responsible users shall perform a risk assessment for articles or material previously measured using such equipment and take remedial action if necessary.

3.4.9 Stamp Controls

Quality Assurance shall establish and maintain documented stamp and marking-material control systems with procedures that provide for the following:

3.4.9.1 Stamp and Marking Materials

Stamps, decals, seals, torque wax, paints, signatures, and other marking devices or materials shall be used, as appropriate, to identify that articles and materials have undergone source and receiving inspection; in-process fabrication and inspection; end-item fabrication and inspection; and end-item testing, storage, and shipment.

3.4.9.2 Stamp Traceability

Stamps shall be traceable to individuals responsible for their use, and records shall be maintained to identify individuals with specific stamps. Unissued stamps shall be kept secure to prevent unauthorized use. Stamps issued to personnel being transferred or terminated shall be returned and shall not be reissued for a period of at least six months. Worn or damaged stamps shall be destroyed at the time replacements are issued. The identification symbols (e.g., numbers and letters) of lost stamps shall be withdrawn from use. The use of any stamp by an individual other than the holder of record is specifically prohibited. Periodic checks shall be made to assure that stamps are in possession of the individual to whom they are issued and that they are not worn or damaged.

3.4.9.3 Stamp Application

Stamps shall be applied to records to indicate the fabrication or inspection status of associated articles and materials.

3.4.9.4 Electronic Data Control

Verification/validation/acceptance requirements for computerized data entry and retrieval systems and computer generated drawings and documents shall address alternatives to stamp use for certification.

3.4.9.5 Stamping and Marking Application

Stamps shall be applied to tags, cards, or labels or attached to individual articles and materials or their containers as appropriate.

3.4.9.6 Status Stamping

Stamps indicating that fabrication, inspection, or test operations have been performed may be applied directly to articles and materials.

3.4.9.7 Stamping Methods

Stamping methods and marking materials must be compatible with the articles and their use.

3.4.9.8 Stamp Significance

An up-to-date description and explanation of the significance of all stamps shall be maintained.

3.4.9.9 Contractor Stamp Design

The design of contractor's stamps shall be such that fabrication and inspection stamps are distinctly different. Contractor stamps shall not exhibit the designation NASA, or abbreviations of any NASA installation without NASA consent.

3.4.10 Handling, Storage, Preservation, Marking, Labeling, Packaging, Packing, and Shipping

3.4.10.1 Procedures and Instructions Control

Quality Assurance shall review and approve, prior to their release, all technical documents pertaining to handling, storage, preservation, marking, labeling, packaging, and shipping operations.

3.4.10.2 Handling, Hoisting, or Lifting

3.4.10.2.1 All handling equipment used to handle Program Hardware shall be prominently marked to indicate the maximum load capacity.

3.4.10.2.2 Hoisting or lifting equipment (e.g. slings) shall be prominently marked to indicate the maximum load capacity and the due date of the next rated or periodic load test. Quality

Assurance personnel will verify that the required test and maintenance are accomplished within the specified frequency.

3.4.10.3 Storage

Storage areas for articles and materials shall be controlled. The controls shall include the following:

3.4.10.3.1 Controlled acceptance into and withdrawal from the storage area.

3.4.10.3.2 Positive identification of limited-life material and removal of materials with expired shelf life.

3.4.10.3.3 Periodic inspection of stored material, housekeeping, and record keeping.

3.4.10.3.4 Systematic inspection and/or testing necessary to ensure maintenance of preservation including special environments.

3.4.10.4 Preservation

Quality Assurance shall verify that articles and materials subject to deterioration, corrosion, or contamination are preserved by documented methods.

3.4.10.5 Packaging and Packing

3.4.10.5.1 Quality Assurance shall verify that packaging and packing material, procedures, and instructions are used.

3.4.10.5.2 Special attention shall be directed toward critical, sensitive, dangerous, and high-value articles. Reusable containers shall be inspected prior to each use.

3.4.10.6 Marking and Labeling

Quality Assurance shall verify that marking and labeling for packaging, storage, and shipping of articles and materials are performed in accordance with applicable specifications. Special attention shall be given to critical, sensitive, dangerous, and high-value articles.

3.4.10.7 Shipping

3.4.10.7.1 Control

Quality Assurance shall verify the following:

3.4.10.7.1.1 Articles and materials have been prepared and packaged in accordance with applicable procedures and requirements and have been properly identified and marked. In the absence of special packing and marking requirements, packing and marking shall comply with United States Department of Transportation, Interstate Commerce Commission, and other governmental rules and regulations, as applicable.

3.4.10.7.1.2 Accompanying documents have been properly identified as to inspection status by appropriate inspection stamps and the data package is complete.

3.4.10.7.2 Unscheduled Removal

The contractor shall notify the designated NASA QAR in the event of any unscheduled removal of an article or material from its container. The extent of reinspection and retest shall be authorized by NASA QAR.

3.4.11 Control of NASA Property

3.4.11.1 Contractor Responsibility

Contractor Quality Assurance shall ensure that a documented system for controlling NASA property and associated documentation has been established and is maintained as follows:

3.4.11.1.1 Upon receipt, contractor Quality Assurance shall inspect NASA property to detect damage in transit and to verify that the article and its ADP are complete and as specified in the shipping documents. Articles found to be serviceable shall be represerved and repackaged unless the articles are to be used immediately. Should there be evidence of damage in transit, the article shall be inspected to determine the extent of damage and a report of the damage provided to the designated NASA representative. Receiving inspection results shall be recorded in the historical record for the article.

3.4.11.1.2 When functional testing is performed on NASA property during receiving inspection or prior to installation into the next level of assembly, the designated NASA representative shall be notified and may participate in the testing activity.

3.4.11.1.3 Documented procedures shall describe the control of approved storage areas for NASA property. Controls shall include limited personnel access, controlled receipt and withdrawal, identification of article status, inventory list of articles in the area, scheduled inspection of the area and periodic verification of the inventory list, controls for items that must be environmentally protected.

3.4.11.1.4 The contractor shall provide for the protection, maintenance, calibration, periodic inspection, segregation, and controls necessary to ensure that quality of NASA property is maintained and that damage and deterioration do not occur during handling, storage, installation, or shipment.

3.4.11.1.5 NASA property shall not be diverted or loaned from its assigned purpose without the prior approval of the designated NASA representative.

3.4.11.2 Unsuitable NASA Property

NASA property found to be damaged or otherwise unsuitable for its intended use shall be identified as nonconforming, segregated to the extent practicable, held for review, and analyzed to ascertain the probable cause of damage. When cause is determined to be in the contractor's operations or activities, action shall be taken to prevent recurrence. Disposition shall not be assigned to discrepant NASA property nor shall this property be reworked, repaired, modified, or replaced without the specific written authorization of NASA . NOTE: Paragraph 3.4.7.5 may apply.

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4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL REQUIREMENTS

4.1.1 General Verification Guidelines and Criteria

The Seller shall use the following general requirements in developing a verification program.

A. Each performance and design requirement specified in Sections 3 and 5 of this specification shall be verified by test, assessment, or analysis in support of certification of the design for operational use.

B. Verification of maintainability, accessibility, and ease of operation shall be demonstrated.

C. As a general guideline, off-limit testing will not be conducted. However, off limit testing will be considered:

1. When design margins are relatively small with respect to off-nominal abort conditions.
2. When uncertainty exists in the definition of the design criteria.
3. When single failure point modes exist.
4. When corresponding analysis is insufficient or more costly than test.

Testing of this nature must have prior approval of the Buyer and must have considered preservation of at least one specimen of certification hardware for later testing.

D. Application of non-destructive evaluation (NDE) techniques for materials and parts shall be verified.

E. Certification shall be structured to verify the full range of the design requirements under specified environments.

F. Wherever practical and technical sound, accelerated life test techniques shall be utilized.

G. Testing shall be conducted at the most cost effective level of assembly.

H. All qualification test specimens shall be processed through specified acceptance testing prior to qualification test.

I. Where redundancy in design exists, each redundancy shall be verified through normal output sources designed for that purpose.

4.1.2 Test Conditions

4.1.2.1 Standard Test Conditions

Environmental standard test conditions for tests required by this specification shall be: an atmospheric pressure of 13.8 plus 1 or minus 2.2 psia (28.5 plus 2 or minus 4.5 inches of Hg), a temperature of 73 plus or minus 18 °F (22.8 plus or minus 32.4 °C) and a relative humidity of 50 plus or minus 30 percent.

4.1.2.1.1 Forced Air Cooled Equipment

When operation of the unit under test is required during environmental exposure, coolant in accordance with specification requirements shall be supplied. During tests in which the ambient temperature is other than standard room ambient, the coolant temperature shall be at design extremes and "in-phase" with the test chamber temperature. If the use of coolant will have no effect upon test results for a particular environment, the requirement to use cooling shall be at the discretion of the Seller.

4.1.2.1.2 Forced Air Temperatures

Inlet air temperature ranges for forced air cooled equipment shall be plus 60 °F to plus 80 °F (plus 15.6 to 26.7 °C) unless otherwise specified herein.

4.1.2.2 Test Tolerances

Test tolerances shall be used as follows:

A. Pressure:	±5 percent or ±1.5 mm. (0.059 inch) of mercury, whichever provides the greatest accuracy.
B. Temperature:	±2.5 °F (1.4 °C) at the control sensor. The equipment sensor response time (T) shall be 20 seconds or less. Temperature gradient across the cross-sectional area occupied by the test item shall not exceed 0.5 °F (0.3 °C) per foot in any direction, but never more than 4 °F (2.2 °C) total (equipment nonoperating).
C. Humidity	±5 percent at the control sensor

Note: (T) is the time required for the sensing system to respond to 62.3 percent of a step change in temperature in the measured environment.

4.1.2.2.1 Random Vibration

Test tolerances and procedures for random vibration shall be in accordance with the following:

4.1.2.2.1.1 Acceptance Test

The following test tolerances shall apply for parameters associated with acceptance tests.

A. The tolerances on acceleration spectral density shall vary with analyzer filter bandwidth. The desired analysis system should provide more than 100 statistical degrees of freedom; however, in no case shall the analysis system provide less than 50 degrees of freedom. Tolerances on acceleration spectral density are as follows:

Spectrum frequency band, Hz	Normal filter band-width, Hz	Tolerances, dB
20-100	10 or less	1.0 -3.0
100-350	25 or less	1.0 -3.0
350-2000	50 or less	1.0 -3.0
20-100	5 or less	1.0 -4.5
100-350	10 or less	1.0 -4.5
350-2000	25 or less	1.0 -4.5

Note: Normal filter bandwidths are the difference in frequency as determined at the half-points.

B. Exception to the preceding acceleration spectral density tolerances in frequency range of 200 Hz to 2000 Hz are permitted according to the following criteria which shall be used for approval of random vibration acceptance tests.

1. The total number of allowable peaks and valleys is not to exceed four in any combination which complies with the criteria below.
2. Peaks which exceed the upper tolerance limit are acceptable if there are not more than three, the tolerance limit is not exceeded by more than +1.5 dB, and the peak width at the 1/2-power point is less than 5 percent of the center frequency of the peak.
3. Valleys which extend below the lower tolerance limit are acceptable if there are no more than three, the tolerance limit is not exceeded by more than -3 dB, and the valley width at 50 percent of the valley depth is less than 5 percent of the center frequency of the valley.

C. The tolerance on overall root-mean-square acceleration shall be ±10 percent as measured by a true rms voltmeter with a 200-Hz cutoff filter of at least 12 dB per octave.

D. The tolerance on frequency shall be ±10 percent.

E. The tolerance on test duration shall be +10 percent, -0.

4.1.2.2.1.2 Qualification Test

The following test tolerances shall apply for parameters associated with qualification tests.

A. The tolerances on acceleration spectral density shall very with analyzer filter bandwidth. The desired analysis system should provide more than 100 statistical degrees of freedom; however, in no case shall the analysis system provide less than 50 degrees of freedom. Tolerances on acceleration spectral density are as follows:

Spectrum frequency band, Hz	Normal filter band-width, Hz	Tolerances, dB
10-100	10 or less	3.0 -1.0
100-350	25 or less	3.0 -1.0
350-2000	50 or less	3.0 -1.0
10-100	5 or less	4.5 -1.0
100-350	10 or less	4.5 -1.0
350-2000	25 or less	4.5 -1.0

Note: Normal filter bandwidths are the difference in frequency as determined at the half-points.

B. Exception to the preceding acceleration spectral density tolerances in frequency range of 200 Hz to 2000 Hz are permitted according to the following criteria which shall be used for approval of random vibration acceptance tests.

1. The total number of allowable peaks and valleys is not to exceed four in any combination which complies with the criteria below.
2. Peaks which exceed the upper tolerance limit are acceptable if there are not more than three, the tolerance limit is not exceeded by more than +3 dB, and the peak width at the 1/2-power point is less than 5 percent of the center frequency of the peak.
3. Valleys which extend below the lower tolerance limit are acceptable if there are no more than three, the tolerance limit is not exceeded by more than -3 dB, and the valley width at 50 percent of the valley depth is less than 5 percent of the center frequency of the valley.

C. The tolerance on overall root-mean-square acceleration shall be +15 percent and -5 percent as measured by a true rms voltmeter with a 2000-Hz cutoff filter of at least 12 dB per octave.

D. The tolerance on frequency shall be ±10 percent.

E. The tolerance on test duration shall be +10 percent, -0.

4.1.2.2.2 Shock

	Peak amplitude:	+/- 10%
(acceleration vs. time)	Pulse duration:	+/- 10%

4.1.2.2.3 Acceleration

Specified acceleration: +10%,-0%
Specified duration: +10%, -0%

4.1.2.2.4 Measuring Instrumentation

Allowable error shall not exceed one-tenth of the tolerance specified for the parameter being measured.

4.1.2.3 Thermal Instrumentation

Instrumentation for thermal monitoring and control, as applicable, shall be as follows:

4.1.2.3.1 Test Chamber

Thermal Test chamber shall be as follows:

4.1.2.3.1.1 Volume of Test Chamber

The volume of the test chamber shall be such that the bulk of the item under test will not interfere with the generation and maintenance of the test conditions. When testing multiple items simultaneously, the test chamber shall be of sufficient size so that each test unit is provided uniform environmental conditions and is not subject to nontest environments.

4.1.2.3.1.2 Heat Source

The heat source of the test facility shall be so located that radiant heat from the source will not fall directly on the test item, except where application of radiant heat is one of the test conditions.

4.1.2.3.1.3 Location of Temperature Sensors

Unless otherwise specified, thermocouples or equivalent temperature sensors utilized to determine or control the specified chamber temperature shall be located centrally within the chamber, in the supply airstream, or in the return airstream whichever provides the specified test conditions at the items under test and shall be baffled or otherwise protected against radiation effects.

4.1.2.3.1.4 Internal Air Circulation

The conditioned air flow shall be suitably baffled to provide uniform air flow around the test item. If multiple test items are tested, they shall be so spaced as to provide free circulation between the test items and the chamber walls.

4.1.2.3.2 Test Article

All test articles shall be instrumented in a manner conducive to monitoring the largest internal mass of the test article for thermal stabilization and the operating temperature of critical components. The following shall also apply as applicable:

A. Thermal Vacuum: Thermal sensors shall be located on the test article surfaces being irradiated and be thermally insulated from the radiation source.

B. Ambient Pressure: Thermal sensors shall be located on the test article surfaces, but not between the test article and the heat exchanger.

C. Air Cooling: Sensors shall be located at the cooling air inlet and outlet of the test article to monitor the delta temperature and delta pressure across the test article.

4.1.3 Test Responsibility and Location

The Seller shall be responsible for implementing the quality assurance requirements specified herein. Except as otherwise noted, the Seller may use his own facilities or any commercial laboratory acceptable to the Buyer.

4.2 QUALITY CONFORMANCE

The following paragraphs of this section define the tests, analyses, simulations and assessments necessary to verify that the requirements of Sections 3 and 5 of this specification are met.

4.2.1 Development

The Seller shall perform development engineering evaluation of hardware, software, manufacturing processes, and techniques for the purpose of acquiring engineering data; identifying sensitive parameters; evaluating the development configuration; providing the necessary confidence that the hardware will meet the specification requirements; and assurance that the manufacturing process will produce an acceptable product. Development objectives shall encompass the following as a minimum:

A. Design and performance capability, including redundancy.

B. Ability to meet specified requirements with adequate design margin.

C. Integration of each component and subsystem with other components, subsystems, facilities, support equipment, etc., to be provided for delivery by the Seller.

D. Establishment of process, procedures, equipment requirements, and test levels for manufacturing, acceptance testing, maintenance, checkout, and operational phases of the program.

E. Identification of significant failure mode and effects.

F. Determination of the effect of various combinations of tolerance and drift of design parameters.

G. Determination of the effect of combinations and sequences of environments and varying stress levels.

H. Identification of safety hazards, parameters, requirements, and procedures.

4.2.2 Acceptance

Acceptance tests and inspections shall be performed on all APDS LRUs to be employed in qualification test programs and on all APDS LRUs delivered to the Buyer. The minimum number of tests and inspections, and the sequence there of, shall be as specified in Table III. The Seller shall perform any other test deemed necessary, subject to approval of Buyer.

Table III. Acceptance Requirements

Inspection & Test	Paragraphs listed in Recommended Sequence
Examination of Product	4.2.2.1
Insulation Resistance	4.2.2.2.1
Dielectric Strength Test	4.2.2.2.2
Functional and Performance	4.2.2.2
Acceptance Vibration Test	4.2.2.3
Acceptance Thermal Test	4.2.2.4
Acceptance Humidity Test	4.2.2.5
Functional and Performance Recheck	4.2.2.2
Post Test Examination of Product	4.2.2.1

NOTE: Performance tests of 4.2.2.2 shall be conducted on equipment before and after acceptance vibration tests, acceptance thermal tests, and acceptance humidity tests. Selected performance tests shall be conducted during these environmental tests as specified in the following paragraphs.

4.2.2.1 Examination of Product

Each APDS Line Replaceable Unit shall be carefully examined to determine conformance to the requirements of this specification. Particular attention shall be given to weight, workmanship, finish, dimensions, construction, cleanliness, identification marking, traceability level, and that certified materials and processes have been used.

4.2.2.2 Functional and Performance Tests

Functional and performance tests shall be conducted on all deliverable equipment to establish compliance with the functional/performance requirements of Section 3. Tolerance bands or pass-fail performance criteria, based on performance design requirements, shall be established for each parameter.

4.2.2.2.1 Insulation Resistance Test

The APDS LRUs shall be subjected to an insulation resistance test in accordance with 3.1.2.1.6.5.

4.2.2.2.2 Dielectric Strength Test

The APDS LRUs shall be subjected to a dielectric strength test in accordance with 3.1.2.1.6.6.

4.2.2.3 Acceptance Vibration Test (AVT)

The APDS LRUs shall be subjected to random vibration, in each of three orthogonal axes, in accordance with the spectral density envelope specified below. The vibration duration shall be 60 seconds per axis. Should retest be required, the total accumulative vibration test time in any axis shall not exceed 900 seconds without prior Buyer approval. Tolerances, procedures and test criteria for vibration shall be in accordance with 4.1.2.2. Full performance tests in accordance with 4.2.2.2, including continuity checks of selected circuits, shall be conducted before and after the vibration test.

Acceleration Spectral Density:

20 to 80 Hz	Plus 3 dB/octave
80 to 350 Hz	0.04 g^2/Hz
350 to 2000 Hz	Minus 3 dB/octave

4.2.2.4 Acceptance Thermal Test (ATT)

The APDS LRUs shall be thermal cycled from ambient to maximum operating temperature, to minimum operating temperature, to maximum operating temperature, and back to ambient temperature with continuity monitored throughout: Rate of change shall not exceed 648 °F (360 °C) per hour, nor be less than 60 °F (33°C) per hour. Dwell at each limit temperature shall be a minimum of 60 minutes after thermal stabilization of the test article. Insulation resistance tests in accordance with 4.2.2.2.1 shall be conducted at each high and low temperature extreme. Should retest be required, the total accumulative thermal test cycles shall not exceed 5 cycles without prior Buyer approval. Full performance tests in accordance with 4.2.2.2 shall be conducted before and after the thermal test.

4.2.2.5 Acceptance Humidity Test

The APDS LRUs shall be subjected to a humidity test in accordance with the following:

4.2.2.5.1 Chamber

The chamber and accessories shall be constructed and arranged in such a manner as to avoid condensate dripping on the equipment. The chamber shall be trap-vented to the atmosphere to prevent the buildup of total pressure. Relative humidity shall be determined from the dry bulb-wet thermometer comparison method or an equivalent method approved by the Buyer. When readout charts are used, they shall be capable of being read with a resolution within 0.6 °C (1 °F). When the wet bulb control method is used, the wet bulb and tank shall be cleaned and a new wick installed at least every 30 days. The air velocity flowing across the wet bulb shall be not less than 900 feet per minute. Provisions shall be made for controlling the flow of air throughout the internal chamber test space where the velocity of air shall not exceed

150 feet per minute. Steam or distilled, demineralized, or deionized water having a pH value between 6.0 and 7.2 at 23 °C (73 °F) shall be used to obtain the specified humidity.

4.2.2.5.2 Procedure

<u>Step 1</u> Conduct performance tests per 4.2.2.2.

<u>Step 2</u> Place equipment in test chamber per 4.1.2.3.1.

<u>Step 3</u> Expose the equipment to a temperature of 68 to 77 °F (20 to 25 °C) at a relative humidity of 95 ± 3 % for 48 hours, and conduct insulation resistance tests per 4.2.2.2.1 in the test chamber at the end of this exposure.

<u>Step 4</u> Dry the equipment at 95 to 122 °F (35 to 50 °C) for 2 hours.

<u>Step 5</u> Remove equipment from test chamber.

<u>Step 6</u> Conduct performance tests per 4.2.2.2 and inspect equipment to detect evidence of physical degradation (such as corrosion of metal parts, distortion, and insufficient lubrication of moving parts). At the Seller's option, these performance tests may be conducted at the end of the exposure with the equipment still in the test chamber.

4.2.3 Assessment

Verification by assessment methods shall be used to verify design features. These methods employ the orderly review and evaluation of design documentation or visual inspection techniques e.g., mockup forms, fit checks, maintainability access, tolerances, safety wiring and placards.

4.2.3.1 Reliability

Compliance with the reliability requirements of 3.2.3 shall be verified by assessment of design drawings.

4.2.3.2 Materials and Processes

Compliance with requirements for materials and processes in 3.3.1.1 which cannot be verified by test or analysis shall be verified by assessment of design drawings and process specifications.

4.2.3.3 Parts Standardization

Compliance with standard parts in accordance with 3.3.1.2 shall be verified by assessment of design drawings.

4.2.3.4 Electrical Design Requirements

Compliance with the electrical design requirements of 3.3.3.2 which cannot be verified by analysis or test shall be verified by assessment of design drawings.

4.2.3.5 Interchangeability

Compliance with the interchangeability requirements of 3.3.5 shall be verified by assessment of design documentation.

4.2.3.6 Human Performance/Human Engineering

Compliance with the human-performance and human-engineering requirements of 3.3.10 shall be verified by assessment of the design drawings.

4.2.3.7 Safety

Compliance with the safety requirements of 3.3.9 shall be verified by analysis, review of implementation of hazard controls, and evaluation of design drawings and test data, as applicable.

4.2.3.8 Identification and Marking

Compliance with the identification and marking requirements of 3.3.4 shall be verified by visual inspection and assessment of design drawings.

4.2.3.9 Maintainability

Compliance with the maintainability requirements of 3.2.4 shall be verified by assessment of design drawings.

4.2.4 Certification

The Seller shall certify the requirements of Section 3 and 5 by the methods specified below; however, the Seller shall utilize his expertise and experience in the hardware design and submit to the Buyer for approval, his most cost effective and practical approach to certify these requirements wherever possible by analysis or assessment in lieu of test.

4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements specified in the performance and design verification matrix (Table V) shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in Table IV. The test sequence shall be submitted for Buyer approval.

Table IV. Qualification Requirements

Sequence	Paragraphs
Acceptance Test (REF)	4.2.2
Performance Tests	4.2.4.1.2
Transportation Test	4.2.4.1.11
Power Test	4.2.4.1.7
Vibration	4.2.4.1.4
Acceleration	4.2.4.1.5
Shock	4.2.4.1.6
Thermal Vacuum Test	4.2.4.1.10
Qualification Humidity Test	4.2.4.1.3
*EMC Test	4.2.4.1.9
*Lightning	4.2.4.2.12
Life	4.2.4.1.12
Final Performance Tests	4.2.4.1.2

NOTE: Performance tests of 4.2.4.1.2 shall be conducted on equipment before and after every qualification test sequence. Selected performance tests shall be conducted during these tests as specified in the following paragraph.

* Test and analysis will be conducted and documented by Buyer

4.2.4.1.1 Test Hardware

Qualification-test hardware shall be of the same configuration as flight hardware.

4.2.4.1.2 Performance Requirements

The APDS LRUs shall be subjected to complete performance tests before and after each environmental test and to selected functional and performance tests during each environmental exposure. Parameter shifts during or after each environment shall not exceed the absolute value of the allowable difference between the acceptance and qualification test limits for each parameter. Where complete performance verification cannot be accomplished during the environmental exposure because of limited test time, the most critical functions shall have priority. Tolerance bands or pass fail criteria shall be established for each parameter. Additionally any special tests necessary to verify the overall performance of the APDS shall be performed prior to environmental testing and following completion of all environmental testing.

4.2.4.1.3 Qualification Humidity Test

The APDS LRUs shall be subjected to a humidity test in accordance with the following:

4.2.4.1.3.1 Chamber

The chamber and accessories shall be constructed and arranged in such a manner as to avoid condensate dripping on the equipment. The chamber shall be trap-vented to the atmosphere to prevent the buildup of total pressure. Relative humidity shall be determined from the dry bulb-wet thermometer comparison method or an equivalent method approved by the Buyer. When readout charts are used, they shall be capable of being read with a resolution within 0.6 °C (1 °F). When the wet bulb control method is used, the wet bulb and tank shall be cleaned and a new wick installed at least every 30 days. The air velocity flowing across the wet bulb shall be not less than 900 feet per minute. Provisions shall be made for controlling the flow of air throughout the internal chamber test space where the velocity of air shall not exceed 150 feet per minute. Steam or distilled, demineralized, or deionized water having a pH value between 6.0 and 7.2 at 23 °C (73 °F) shall be used to obtain the specified humidity.

4.2.4.1.3.2 Procedure

Step 1 Conduct performance test per 4.2.4.1.2.

Step 2 Place equipment in test chamber per 4.1.2.3.1.

Step 3 Expose the equipment to a temperature of 68 to 77 °F (20 to 25 °C) at a relative humidity of 95 ± 3 % for 96 hours and conduct insulation resistance tests per 4.2.2.2.1 in the test chamber at the end of this exposure.

Step 4 Dry the equipment at 95 to 122 °F (35 to 50 °C) for 2 hours.

Step 5 Remove the equipment from the chamber.

Step 6 Inspect equipment to detect evidence of physical degradation (such as corrosion of metal parts, distortion, and insufficient lubrication of moving parts) and conduct performance tests per 4.2.4.1.2. At the Seller's option, these performance tests may be conducted at the end of the exposure with the equipment still in the test chamber.

4.2.4.1.4 Vibration

4.2.4.1.4.1 Qualification Acceptance Vibration Test (QAVT)

The APDS LRUs shall be subjected to the random vibration specified in 3.2.5.2.1.f, 3.2.5.2.2g, 3.2.5.2.3c, or 3.2.5.2.4c (depending on the location of the LRU) in each of three orthogonal axes. Vibration tolerances, test and procedures shall be in accordance with 4.1.2.2. Performance verification tests shall be identical to those conducted during AVT except that continuity checks shall be performed on selected circuits during vibration exposure. (Ref. 4.2.2.3)

4.2.4.1.5 Acceleration

4.2.4.1.5.1 Ultimate

The APDS LRUs shall be subjected to the acceleration specified by 3.2.5.2.1g and 3.2.5.2.2h for a minimum of five minutes in each direction along each of three orthogonal axes. If any axis(es) is (are) considered significant with respect to acceleration effects, it (they) shall be considered when establishing the orthogonal axes system. The equipment and its mounting attachments shall not break loose.

4.2.4.1.5.2 Crash Safety

The APDS LRUs shall be subjected to the acceleration specified by 3.2.5.2.1h for a minimum of 30 seconds. The equipment and its mounting attachments shall not break loose, create a hazard to personnel, or prevent egress from a crashed vehicle. Operating performance is not required after this environment.

4.2.4.1.6 Shock

4.2.4.1.6.1 Apparatus

4.2.4.1.6.1.1 Shock Machine

The shock machine shall be capable of producing the pulse shown on Figure 21. The shock machine may be of the free-fall, resilient-rebound, nonresilient, hydraulic, compressed-gas, or other activating types. Apparatus for other procedures is described in the individual procedure.

4.2.4.1.6.1.1.1 Shock Machine Calibration

The actual test item, a rejected item, or a rigid dummy mass shall be used to calibrate the shock machine for conformance with the specified wave shape. When a rigid dummy mass is used, it shall have the same center of gravity and the same mass as that intended for the test item and shall be installed in a manner similar to that of the test item. (When a rigid dummy mass or rejected item is used for calibration, the waveform during the actual test may be somewhat different from that observed during calibration.) The shock machine shall then be calibrated for conformance with the specified waveform. The consecutive shock applications to the calibration load shall produce waveforms which are all within the tolerance envelope given on Figure 21. The calibrating load shall then be removed and the shock test performed on the actual test item. Provided all conditions remain the same, other than the substitution of the test item for the calibrating load, the waveform shall be considered to meet the specified test requirement. The actual test waveform shall be recorded for later use should a failure analysis be required.

4.2.4.1.6.1.2 Instrumentation

The instrumentation used to measure the input shock pulse, in order to meet the tolerance requirements of the test procedure, shall have the characteristics specified in the following paragraphs:

4.2.4.1.6.1.2.1 Frequency Response

The frequency response of the complete measuring system, from the accelerometer through the readout instrument, shall be as shown on Figure 22. Particular care shall be exercised in the selection of each individual instrument of the shock measuring instrumentation system in order to assure compatibility with the prescribed frequency response tolerance.

4.2.4.1.6.1.2.2 Accelerometer, Piezoelectric

When a piezoelectric accelerometer is employed as the shock sensor, the fundamental resonant frequency of the accelerometer shall be greater than 14,000 Hz (resonant frequencies of 30,000 Hz or higher are recommended). For suitable low frequency response, the accelerometer and load (cathode follower, amplifier, or other load) shall have the following characteristics:

$RC > 0.2$

Where R = load resistance (ohms)
C = accelerometer capacitance plus shunt capacitance of cable and load (farads)

4.2.4.1.6.1.2.3 Accelerometer, Strain Gage

A strain gage accelerometer may be used, provided the undamped natural frequency is equal to or greater than 1,500 Hz with damping approximately 0.64 to 0.70 of critical.

4.2.4.1.6.1.2.4 Accelerometer calibration

The accelerometer shall be dynamically calibrated to the specified accuracy.

4.2.4.1.6.1.2.5 Accelerometer mounting

The monitoring accelerometer shall be rigidly attached to the test item support fixture at or near the attachment point(s) of the test item.

4.2.4.1.6.2 Test Setup

4.2.4.1.6.2.1 Shock Pulse

The shock pulses shall be as shown on Figure 21. All points of the acceleration wave form obtained shall lie within the area enclosed by the tolerance limit lines.

4.2.4.1.6.2.2 Mounting of Test Item

The test item shall be rigidly attached to the shock machine table. Wherever possible, the test load shall be distributed uniformly on the test platform in order to minimize the effects of unbalanced loads.

4.2.4.1.6.3 Basic Design Test

This procedure shall be used for shock testing of equipment assemblies (mechanical, electrical, hydraulic, electronics, etc.) of medium size, including items which mount on vibration isolators and equipment racks. Shocks in each direction shall be applied along three mutually perpendicular axes of the test item . If the test item is normally mounted on vibration isolators, the isolators shall be functional during the test. The shock pulse shape shall be in accordance with Figure 21, of amplitude and time duration a or b, as specified. At the conclusion of the test, the test item shall be operated and inspected and results obtained in accordance with 4.2.4.1.2.

4.2.4.1.6.4 Pyrotechnic Shock

The APDA shall be subjected to pyrotechnic shock as a result of actual initiation of the installed pyrotechnic devices.

4.2.4.1.7 Power Tests

Tests shall be performed to assure that the APDS meets performance requirements of 3.2.1 and power-consumption requirements of 3.3.3.2.1, with input power meeting the requirements of 3.1.2.1.

4.2.4.1.8 Deleted

4.2.4.1.9 Electromagnetic Compatibility Tests

EMC requirements which cannot be verified by analysis shall be verified by the Buyer's minimum susceptibility and emission test developed in accordance with 3.3.3.1.

4.2.4.1.10 Thermal Vacuum Test

The APDS LRUs shall be mounted to simulate usage conditions and exposed to a reduced pressure of 1.93 x 10^{-6} psia (10^{-4} mm Hg). During this exposure, the temperature shall be cycled to the maximum design temperature , to the minimum design temperature, to the maximum design temperature, five times. The thermal rate of change shall not exceed 10.8 °F (6 °C) per minute, nor be less than 1.0 °F (0.06 °C) per minute. Dwell at each thermal extreme shall be a minimum of 60 minutes after thermal stabilization of the test article. Selected performance tests shall be conducted at each thermal extreme and continuity of all circuits monitored during temperature ramping. All equipment shall be exposed to 200 hours of Vacuum while non-operating, except for the DCP and APDA. Rate of depressurization and repressurization shall be per 3.2.5.1.2a and 3.2.5.2.2a for Category II equipment. Full performance tests shall be conducted per 4.2.4.1.2 before and after this thermal Vacuum test.

4.2.4.1.11 Transportation Test

Certification of package performance shall be accomplished by analysis whenever possible. When certification cannot be accomplished by analysis, a Buyer-approved simulated dummy load or development assigned hardware shall be installed in its package and both subjected to the following transportation requirements:

A. Transportation (Shock)

Test equipment and setup shall be per 4.2.4.1.6. With a peak acceleration of 9 ± 1.8g's, apply pulses for 5 to 10 milliseconds at a frequency of less than 120 pulses per minute:

1. 2500 ± 125 pulses perpendicular to container cover
2. 1750 ± 90 pulses in two mutually perpendicular directions

Total number of pulses shall be 6000 ± 300.

4.2.4.1.12 Operating Life Test

Cycles and operating time accumulated on a single specimen during other qualification tests may be applied toward these requirements with the restriction that modifications or repairs would not invalidate previous testing.

A. APDA: The APDA shall be tested per 20.4.2.4.1.10.

B. Avionics: The APDS avionics LRU's shall be operated for 20 hours at defined worst-case environmental conditions. The remaining hours of 3.2.1.1.2 may be certified by analysis.

4.2.4.2 Certification by Analysis

Analytical certification shall be used as a supplement to and may be used in lieu of test for the following conditions:

A. When sufficient historical data or usage is available to fulfill certification requirements.

B. When specified conditions cannot be accurately or economically simulated on the ground. This includes environmental conditions as well as interaction effects under specified conditions.

4.2.4.2.1 Storage/Operating Life

Compliance with storage/operating life requirements of Section 3 shall be verified by analysis of the drawings and applicable test data.

4.2.4.2.2 Physical Characteristics

The capability of the APDS to meet the physical characteristics in accordance with 3.2.2 shall be verified by analysis of design drawings and test results.

4.2.4.2.3 Reliability

Compliance with the reliability requirements of 3.2.3 which cannot be verified by test or assessment shall be verified by analysis and evaluation of design drawings and test data, as applicable.

4.2.4.2.4 Salt Fog

Compliance with the requirements of 3.2.5 shall be verified by analysis of design drawings and test data. Buyer will perform this analysis under the conditions specified in 4.2.4.2.15.

4.2.4.2.5 Ozone

Compliance with the ozone requirements under 3.2.5 shall be verified by analysis of design drawings and test data. Buyer will perform this analysis under the conditions specified in 4.2.4.2.15.

4.2.4.2.6 Fungus

Compliance with the fungus requirements under 3.2.5 shall be verified by analysis of design drawings and material test data. Buyer will perform this analysis under the conditions specified in 4.2.4.2.15.

4.2.4.2.7 Materials and Processes

Compliance with the materials and processes requirements of 3.3.1.1 which cannot be verified by assessment or test shall be verified by analysis of design drawings and Process Specification.

4.2.4.2.8 Electromagnetic Compatibility

Compliance with the EMC requirements of 3.3.3.1 which cannot be verified by test shall be verified by analysis of design drawings and test data.

4.2.4.2.9 Electrical Design Requirements

Compliance with the electrical design requirements under 3.3.3.2 which cannot be verified by test or assessment shall be verified by analysis of design drawings and test data.

4.2.4.2.10 Safety

Compliance with the safety requirements of 3.3.9 shall be verified by analysis, review of implementation of hazard controls, and evaluation of design drawings and test data, as applicable.

4.2.4.2.11 Sand and Dust

Compliance with the requirements of 3.2.5 shall be verified by analysis of design drawings and test data. Buyer will perform this analysis under the conditions specified in 4.2.4.2.15.

4.2.4.2.12 Lightning

Compliance with the lightning requirements of 3.2.5 shall be verified by analysis of design drawings and test data.

4.2.4.2.13 Certification by Other Test Data

Test data generated from articles previously certified may be used as a certification method when it can be shown that the article is similar or identical to the article being certified. Features to be considered shall include design, performance, environmental duration and limits, manufacturing process, and quality control. Special effort shall be made to avoid duplication of previous tests from this or similar programs. Where certification by testing is required, data from other than qualification tests may be used to satisfy the requirements under the following conditions:

Predeclaration	The intent to use the test for certification is declared prior to test conduct.
Configuration	Production configuration or approval (where allowed) for differences.
Facilities	Certified
Inspection	Required
Test requirement/ procedure/pass-fail criteria	Formally approved by Buyer
Acceptance	Required
Functional test pre-, post- and during environment	Required (except for non-operating tests such as packaging tests)

Documentation — Configuration description, failure reports, and test results.

4.2.4.2.14 Mature Hardware (Off-the-Shelf)

A. Evaluate and document equipment capability utilizing a comparison matrix which includes considerations such as configuration, performance and environment versus specified requirements.

B. Where the environmental levels are more stringent than previous qualification levels, analyze or test to verify that the item can withstand the higher level design requirements.

C. For items that require minor modifications or have not been qualified to all environments, only the design modifications for the additional environments need to be certified, if cumulative and interaction effects do not exist. If cumulative and interaction effects do exist, complete qualification testing is required.

4.2.4.2.15 Certification Analysis by Buyer

For certain requirements as specified in 4.2.4.2 above, the Buyer will perform the certification analyses upon receipt of an approved materials list (per Appendix XV, MC02) from the Seller.

4.2.5 Verification Requirements Matrices

The Seller's verification program shall satisfy the performance and design verification requirements specified in Seller's approved certification/verification plan.

Table V. Performance and Design Verification Matrix

VERIFICATION METHOD

1. Analysis
2. Assessment
   a. Inspection
   b. Review of Design
3. Test
   a. Development
   b. Qualification
   c. Acceptance

N/A - Not Applicable

Section 3 and 5 Require-ment No.	Requirements	Verification Method							Related Section 4 Requirement No.
			1	2		3			
		N/A		a	b	a	b	c	
3	REQUIREMENTS	X							-
3.1	APDS Definition	X							
3.1.1	APDS Functional Diagram	X							
3.1.1.1	ISS Mission Configurations	X							
3.1.2	Interface Definition				X			X	4.2.2, 4.2.3
3.1.2.1	Electrical Characteristics	X							
3.1.2.1.1	Orbiter Main DC Power				X		X		4.2.4.1.9

Section 3 and 5 Require-ment No.	Requirements	Verification Method N/A	1	2 a	2 b	3 a	3 b	3 c	Related Section 4 Requirement No.
3.1.2.1.2	Orbiter Steady-State Limits						X		4.2.4.1.9
3.1.2.1.3	Orbiter Transient Voltage	X							
3.1.2.1.3.1	Surge				X		X		4.2.4.1.9
3.1.2.1.3.2	Spike				X		X		4.2.4.1.9
3.1.2.1.3.3	Ripple				X		X		4.2.4.1.9
3.1.2.1.4	Orbiter Primary Power Grounding System				X				4.2.3
3.1.2.1.5	Utilization of Orbiter Electrical Power	X							
3.1.2.1.5.1	Normal Electrical System Operation						X	X	4.2.2.2, 4.2.4.1.2
3.1.2.1.5.2	Abnormal Electrical System Operation						X		4.2.4.1.9
3.1.2.1.5.3	Emergency Electrical System Operation						X		4.2.4.1.9
3.1.2.1.5.4	Influence on Electrical Systems						X		4.2.4.1.9
3.1.2.1.5.5	Isolation of Power Source				X				4.2.3
3.1.2.1.5.6	Power Transfer				X				4.2.3
3.1.2.1.6	General Electric Equipment Requirements	X							
3.1.2.1.6.1	Separation of Redundant Equipment				X				4.2.3
3.1.2.1.6.2	Inadvertent Electrical Performance Due to Debris				X				4.2.3
3.1.2.1.6.3	System Checkout Provisions				X				4.2.3
3.1.2.1.6.4	Equipment Accessibility				X				4.2.3
3.1.2.1.6.5	Insulation Resistance						X	X	4.2.2.2.1, 4.2.4.1.2
3.1.2.1.6.6	Dielectric Withstanding Voltage						X	X	4.2.2.2.2, 4.2.4.1.2
3.1.2.1.6.7	Corona, High-Voltage Breakdown, Multipaction				X				4.2.3
3.1.2.1.7	Grounding and Bonding	X							
3.1.2.1.7.1	Equipment and Subsystem Returns and Grounding				X				4.2.3
3.1.2.1.8	Wiring	X							
3.1.2.1.8.1	Integral Leads				X		X		4.2.3
3.1.2.1.8.2	Circuit Protection				X				4.2.3
3.1.2.1.8.3	Strain Relief				X				4.2.3
3.1.2.1.8.4	Pyro Circuit Wiring				X		X		4.2.3, 4.2.4.1.9, 4.2.2.2.2
3.1.2.1.8.5	Wire Sizing				X				4.2.3
3.1.2.1.8.6	Circuit Separation				X				4.2.3
3.1.2.1.8.7	Wiring Identification			X					4.2.2.1
3.1.2.1.8.8	Wire Insulation Protection				X				4.2.3
3.1.2.1.8.9	Redundant Electrical Circuits				X				4.2.3
3.1.2.1.8.10	Wire Harness Protection				X				4.2.3
3.1.2.1.8.11	Visual Verification			X					4.2.2.1
3.1.2.1.8.12	Wire Bundling				X				4.2.3
3.1.2.2	Mechanical Interface			X					4.2.2.1

Section 3 and 5 Require-ment No.	Requirements	Verification Method N/A	1	2 a	2 b	3 a	3 b	3 c	Related Section 4 Requirement No.
3.1.2.2.1	Mounting			X					4.2.2.1
3.1.2.2.2	Connector Location and Pin Function Assignments			X	X				4.2.2.1, 4.2.3
3.1.2.3	Cooling		X			X			4.2.1, 4.2.2.4
3.1.2.4	Instrumentation							X	4.2.2.2
3 1.2.5	Field Support Equipment				X			X	4.2.3, 4.2.2.2
3.1.2.6	Electrical Resource Transfer	X							
3.1.2.6.1	Resources Transferred from Orbiter to ISS PMA-2, -3				X				4.2.3
3.1.2.6.1.1	Electrical Power						X	X	4.2.2.2, 4.2.4.1.2
3.1.2.6.2	Resources Transferred from Orbiter or ISS Node 1 to ISS FGB				X				4.2.3
3.1.3	Major Component Identification			X					4.2.3
3.2	Characteristics	X							
3.2.1	Performance Characteristics						X	X	4.2.2.2, 4.2.4.1.2
3.2.1.1	Life	X							
3.2.1.1.1	APDA	X							
3.2.1.1.1.1	Service Life		X				X		4.2.4.1.12, 4.2.4.2.1
3.2.1.1.1.2	Operating Life		X				X		4.2.4.1.12, 4.2.4.2.1
3.2.1.1.1.3	Shelf Life		X						4.2.4.2.1
3.2.1.1.2	Avionics		X				X		4.2.4.1.12, 4.2.4.2.1
3.2.1.1.3	Pyrotechnic Release Devices		X				X		4.2.4.1.12, 4.2.4.2.1
3.2.1.1.2.2	APDS Switching System		X				X		4.2.4.1.12, 4.2.4.2.1
3.2.1.2	Design Approach		X						4.2.4.2
3.2.1.3	Spacecraft Docking and Berthing		X			X	X		4.2.1, 4.2.4.1.2
3.2.1.3.1	Contact Conditions		X			X	X		4.2.1, 4.2.4.1.2
3.2.1.4	Mass Properties and Control Weights		X			X	X	X	4.2.1, 4.2.2.2
3.2.1.5	Contingency Operations	X							
3.2.1.5.1	Docking Operations Termination					X	X		4.2.4.1.2, 4.2.1
3.2.1.5.2	Time Critical Separation					X	X		4.2.4.1.2, 4.2.1
3.2.1.5.3	Extravehicular/Intravehicular Activity (EVA/IVA)				X		X		4.2.1, 4.2.3,4.2.4.1.2
3.2.1.6	Inhibits				X				4.2.3
3.2.1.6.1	Inhibit Control				X				4.2.3
3.2.1.7	Health Status				X				4.2.3
3.2.2	Physical Characteristics	X							
3.2.2.1	Envelope			X					4.2.2.1
3.2.2.2	Weight			X					4.2.2.1
3.2.2.3	Surface Wear			X					4.2.2.1
3.2.3	Reliability	X							
3.2.3.1	Redundancy				X		X	X	4.2.3, 4.2.2.2, 4.2.4.1.2
3.2.3.2	Failure Deterrent and Detection		X		X				4.2.3, 4.2.4.2.3

Section 3 and 5 Requirement No.	Requirements	Verification Method							Related Section 4 Requirement No.
			1	2		3			
		N/A		a	b	a	b	c	
3.2.3.3	Reliability Predictions	X							
3.2.3.4	Reliability Management	X							
3.2.3.4.1	Reliability Organization	X							
3.2.3.5	Reliability Progress Reporting	X							
3.2.3.6	Supplier Control	X							
3.2.3.7	Reliability Design Requirements	X							
3.2.3.7.1	Design Specification	X							
3.2.3.8	Failure Mode Effects Analysis (FMEA) and Single Failure Point Summary (SFPS)	X							
3.2.3.9	Design Review and Readiness Review	X							
3.2.3.10	Problem Reporting and Corrective Action System	X							
3.2.3.10.1	Problem Report Documentation	X							
3.2.3.10.2	Problem Analysis	X							
3.2.3.10.3	Corrective Action	X							
3.2.3.10.4	Problem Status	X							
3.2.3.10.5	Storage of Trend Hardware	X							
3.2.4	Maintainability	X							
3.2.4.1	Design Allocations	X							
3.2.4.2	Design Features			X					4.2.3
3.2.4.2.1	Maintenance			X					4.2.3
3.2.4.2.2	Installation			X					4.2.3
3.2.4.2.3	Accessibility			X					4.2.3
3.2.4.3	Test Provisions			X					4.2.3
3.2.4.3.1	Test and Monitoring Points			X					4.2.3
3.2.4.3.2	Line Replaceable Unit Peculiar Requirements			X					4.2.3
3.2.4.4	Maintainability Analysis	X							
3.2.4.4.1	Assessment	X							
3.2.4.4.2	Problem Reporting	X							
3.2.4.4.3	Design Reviews	X							
3.2.4.4.4	Design Changes	X							
3.2.5	Environments	X							
3.2.5.1	Operating		X			X	X		4.2.2, 4.2.4.1, 4.2.4.2
3.2.5.1.1	Crew Compartment		X			X	X		4.2.2, 4.2.4.1, 4.2.4.2
3.2.5.1.2	Airlock Floor		X			X	X		4.2.2, 4.2.4.1, 4.2.4.2
3.2.5.1.3	-6001 Orbiter Active APDA		X			X	X		4.2.2, 4.2.4.1, 4.2.4.2
3.2.5.1.4	-7001 ISS Active APDA and CSB		X			X	X		4.2.2, 4.2.4.1, 4.2.4.2
3.2.5.1.5	-8001 ISS Passive APDA		X			X	X		4.2.2, 4.2.4.1, 4.2.4.2
3.2.5.2	Non operating		X			X	X		4.2.2, 4.2.4.1, 4.2.4.2
3.2.5.2.1	Crew Compartment		X			X	X		4.2.2, 4.2.4.1, 4.2.4.2
3.2.5.2.2	Airlock Floor		X			X	X		4.2.2, 4.2.4.1, 4.2.4.2

Section 3 and 5 Require-ment No.	Requirements	Verification Method							Related Section 4
			1	2		3			
		N/A		a	b	a	b	c	Requirement No.
3.2.5.2.3	-6001 Orbiter Active APDA			X			X	X	4.2.2, 4.2.4.1, 4.2.4.2
3.2.5.2.4	-7001 ISS Active APDA and CSB			X			X	X	4.2.2, 4.2.4.1, 4.2.4.2
3.2.5.2.5	-8001 ISS Passive APDA			X			X	X	4.2.2, 4.2.4.1, 4.2.4.2
3.2.5.3	Transportation and Storage		X				X		4.2.4.1.11
3.2.6	Transportability				X		X		4.2.4.1.11, 4.2.3
3.2.6.1	Tiedown Capability				X				4.2.3
3.3	Design and Construction	X							
3.3.1	Materials, Processes, and Parts	X							
3.3.1.1	Materials and Processes	X							
3.3.1.1.1	Cleanliness	X							
3.3.1.1.1.1	Category I and II LRUs			X					4.2.2.1
3.3.1.1.1.2	Category II LRUs			X					4.2.2.1
3.3.1.1.2	Moisture and Fungus Resistance				X				4.2.3
3.3.1.2	Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Control	X							
3.3.1.2.1	General	X							
3.3.1.2.2	Parts Selection	X							
3.3.1.2.2.1	Parts Standardization	X							
3.3.1.2.3	Parts Specifications	X							
3.3.1.2.4	EEE Parts Qualification				X				4.2.3
3.3.1.2.4.1	Mechanical Parts				X				4.2.3
3.3.1.2.5	EEE Parts Where-Used List	X							
3.3.1.2.6	Parts Application Review	X							
3.3.1.2.7	Parts Problem Reporting and Corrective Action	X							
3.3.1.2.8	EEE Parts Control for Off-The-Shelf Equipment	X							
3.3.1.2.9	EEE Parts Handling	X							
3.3.1.2.10	EEE Parts Traceability	X							
3.3.1.2.11	Part Construction				X				4.2.3
3.3.1.2.12	Part Derating				X				4.2.3
3.3.1.2.13	Parts with Cavities				X				4.2.3
3.3.2	Selection of Specifications and Standards	X							
3.3.3	Electromagnetic Compatibility and Electrical Design		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1	Electromagnetic Compatibility		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.1	Limits		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.2	Limits for CE01 and CE02								
3.3.3.1.3	Limits for CE03 and CE04		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.4	Limit for CS01		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.4.1	Test Power Limit		X				X		4.2.4.1.9, 4.2.4.2.8

Section 3 and 5 Require-ment No.	Requirements	Verification Method N/A	1	2 a	2 b	3 a	3 b	3 c	Related Section 4 Requirement No.
3.3.3.1.5	Limit for CS02		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.5.1	Test Power Limit		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.6	Limit for CS06		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.7	Limits for RE02		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.7.1	Narrowband		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.7.2	Broadband		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.7.3	Polarization		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.8	Limit for RS02		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.9	Limit for RS03		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.1.10	Time Domain Transient and Ripple Test (TT01)		X				X		4.2.4.1.9, 4.2.4.2.8
3.3.3.2	Electrical Design Requirements	X							
3.3.3.2.1	Power Consumption						X		4.2.4.1.9
3.3.3.2.2	Metals and Metal Couples, Restriction on Use				X				4.2.3
3.3.3.2.3	Bonding				X		X		4.2.3, 4.2.4.1
3.3.4	Identification and Marking	X							
3.3.4.1	Identification of Parts			X					4.2.2.1
3.3.4.2	Identification of All Development/ Qualification Test Specimens			X					4.2.2.1
3.3.4.3	Nameplates			X	X				4.2.3.8
3.3.4.3.1	Marking Information			X	X				4.2.3.8
3.3.4.3.2	Methods of Applying Nameplates			X	X				4.2.3.8
3.3.4.3.3	Permanency and Legibility			X	X				4.2.3.8
3.3.4.3.4	Location			X	X				4.2.3.8
3.3.4.3.5	Modified Items			X	X				4.2.2.1
3.3.4.3.6	Type of Lettering			X	X				4.2.2.1
3.3.5	Interchangeability					X			4.2.3.3
3.3.6	Configuration Management (CM)	X							
3.3.6.1	General Requirements	X							
3.3.6.1.1	Management	X							
3.3.6.1.2	Procedures	X							
3.3.6.1.3	Management Review	X							
3.3.6.1.4	Baseline Management	X							
3.3.6.2	Detail Requirements	X							
3.3.6.2.1	Configuration Identification	X							
3.3.6.2.2	Specifications	X							
3.3.6.3	Engineering Drawings	X							
3.3.6.3.1	Preparation	X							
3.3.6.3.2	Retention of Design	X							
3.3.6.3.3	Identification of Parts	X							
3.3.6.3.4	Equipment Identification Marking	X							
3.3.6.3.5	Parts and Standards Marking	X							

Section 3 and 5 Require-ment No.	Requirements	Verification Method N/A	1	2 a	2 b	3 a	3 b	3 c	Related Section 4 Requirement No.
3.3.6.12	Engineering Drawings for Designated Development Items and Non-Flight Equipment Items	X							
3.3.6.13	Deviations and Waivers	X							
3.3.6.13.1	Deviation Definition	X							
3.3.6.13.2	Waiver Definition	X							
3.3.6.13.2.1	Request for Deviation or Waiver	X							
3.3.6.13.3	Accounting for Deviations or Waivers	X							
3.3.7	Documentation	X							
3.3.8	Logistics Support System	X							
3.3.8.1	Off-Line Maintenance	X							
3.3.8.1.1	Maintenance Engineering Analysis	X							
3.3.8.1.1.1	Scheduled Maintenance	X							
3.3.8.1.1.2	Tracking and Accounting	X							
3.3.8.1.2	Maintenance	X							
3.3.8.1.2.1	Maintenance Concept	X							
3.3.8.1.2.2	Logistics Engineering Analysis (LEA)	X							
3.3.8.1.2.3	Maintenance Data	X							
3.3.8.1.3	Limited Life Items	X							
3.3.8.1.4	Limited Operating Life Items	X							
3.3.8.1.5	Limited Shelf Life Items	X							
3.3.8.1.6	Work Unit Code (WUC) Documentation	X							
3.3.8.2	Supply Support Management	X							
3.3.8.2.1	Supply Support	X							
3.3.8.2.1.1	Spares Concept	X							
3.3.8.2.1.4	Spares Provisioning Data	X							
3.3.8.2.1.5	Cannibalization	X							
3.3.8.3	Transportation	X							
3.3.8.4	Training	X							
3.3.8.4.1	Authority	X							
3.3.8.4.2	Requirements	X							
3.3.8.4.2.1	Training and Certification Documentation	X							
3.3.9	Safety	X							
3.3.9.1	Hazards		X	X					4.2.3.7, 4.2.4.2.10
3.3.9.2	Hazard Reduction Precedence Sequence			X					4.2.3.7
3.3.9.3	Margin of Safety Testing			X					4.2.3.7
3.3.9.4	Sharp Edges			X					4.2.3.7
3.3.9.5	Protective Covers on Exposed Protrusions			X					4.2.3.7
3.3.9.6	Holes			X					4.2.3.7
3.3.9.7	Latches			X					4.2.3.7

Section 3 and 5 Require-ment No.	Requirements	Verification Method N/A	1	2 a	2 b	3 a	3 b	3 c	Related Section 4 Requirement No.
3.3.9.8	Screws and Bolts				X				4.2.3.7
3.3.9.9	Securing Pins				X				4.2.3.7
3.3.9.10	Levers, Cranks, Hooks, and Controls				X				4.2.3.7
3.3.9.11	Burrs				X				4.2.3.7
3.3.9.12	Deleted								
3.3.9.13	Factors of Safety for Pressurized Manned Compartments		X		X				4.2.3.7, 4.2.4.2.10
3.3.9.14	Pressure Vessels				X				4.2.3.7
3.3.9.15	Debris Prevention				X				4.2.3.7
3.3.9.16	Electrical Hazards Design				X				4.2.3.7
3.3.9.17	Chassis Leak Current				X			X	4.2.3.7, 4.2.2.1
3.3.9.18	Crew Member Protection				X				4.2.3.7
3.3.9.18.1	Grounding				X				4.2.3.7
3.3.9.18.2	Protective Covers				X				4.2.3.7
3.3.9.18.3	Interlocks				X				4.2.3.7
3.3.9.18.4	Warning Labels				X				4.2.3.7
3.3.9.18.5	Plugs and Receptacles				X				4.2.3.7
3.3.9.18.6	Insulation				X				4.2.3.7
3.3.9.18.7	FSE Power Cords				X				4.2.3.7
3.3.9.18.8	Spacing Between Connectors				X				4.2.3.7
3.3.9.18.9	Electrical Systems				X				4.2.3.7
3.3.9.18.10	Electrostatic Discharge				X				4.2.3.7
3.3.9.18.11	Wire Bundles - Protective Coating				X				4.2.3.7
3.3.9.19	Deleted								
3.3.9.20	Equipment Failure - Verification of Flight Readiness				X				4.2.3.7
3.3.9.21	Safety Precautions - Test and Operating Procedures				X				4.2.3.7
3.3.9.22	Field Support Equipment Protective Devices				X				4.2.3.7
3.3.9.23	Emergency Safing Electrical System				X				4.2.3.7
3.3.10	Human Performance/Human Engineering				X				4.2.3.6
3.4	Quality Assurance Program	X							
3.4.1	Management and Planning	X							
3.4.1.1	Planning	X							
3.4.1.2	Organization	X							
3.4.1.3	Quality Program Plan	X							
3.4.1.4	Management Assessment Data	X							
3.4.1.5	Deleted	X							
3.4.1.6	Milestone Reviews	X							
3.4.2	Design and Development Controls	X							
3.4.2.1	Technical Documents	X							

Section 3 and 5 Requirement No.	Requirements	Verification Method N/A	1	2 a	2 b	3 a	3 b	3 c	Related Section 4 Requirement No.
3.4.2.2	Change Control Verification	X							
3.4.2.3	Product/Process Development	X							
3.4.3	Identification and Data Retrieval	X							
3.4.3.1	General	X							
3.4.3.2	Retention of Records	X							
3.4.3.3	Record Retrieval	X							
3.4.4	Procurement	X							
3.4.4.1	Procurement Controls	X							
3.4.4.2	Quality Assurance Personnel at Supplier	X							
3.4.4.3	Receiving Inspection	X							
3.4.4.4	Supplier Data	X							
3.4.5	Fabrication Controls	X							
3.4.5.1	Fabrication Operations	X							
3.4.5.2	Article and Material Control	X							
3.4.5.3	Contamination Control and Cleanliness	X							
3.4.5.4	Process Controls	X							
3.4.5.5	Nondestructive Evaluation	X							
3.4.5.6	Workmanship	X							
3.4.5.7	Control of Temporary Installations and Removals	X							
3.4.5.8	Quality Assurance Designees	X							
3.4.5.9	Inspection Procedures	X							
3.4.6	Test Controls	X							
3.4.6.1	Verification	X							
3.4.6.2	Test Procedures	X							
3.4.6.3	Test Performance	X							
3.4.6.4	Inspection and Test Records and Data	X							
3.4.6.4.1	Records	X							
3.4.6.4.2	Acceptance Data Package (ADP)	X							
3.4.6.4.3	Acceptance Review (AR)	X							
3.4.7	Nonconforming Articles and Materials	X							
3.4.7.1	Nonconformance Control System	X							
3.4.7.2	Identification of Nonconformances	X							
3.4.7.3	Nonconformance Evaluation	X							
3.4.7.4	Nonconformance Dispositions	X							
3.4.7.4.1	Return to Supplier	X							
3.4.7.4.2	Return for Rework or Completion of Operations	X							
3.4.7.4.3	Recurrence Control	X							
3.4.8	Metrology	X							
3.4.8.1	Metrology Controls	X							
3.4.8.2	Calibration Records	X							

Section 3 and 5 Require-ment No.	Requirements	Verification Method N/A	1	2 a	2 b	3 a	3 b	3 c	Related Section 4 Requirement No.
3.4.8.3	Measurement Accuracy	X							
3.4.8.4	Calibration Controls	X							
3.4.8.4.1	Facility	X							
3.4.8.4.2	Traceability	X							
3.4.8.4.3	Handling, Storage, and Transportation	X							
3.4.8.4.4	Identification and Labeling	X							
3.4.8.4.5	Calibration Intervals	X							
3.4.8.4.6	Recall System	X							
3.4.8.4.7	Environmental Requirements	X							
3.4.8.5	Action and Recurrence Control	X							
3.4.9	Stamp Controls	X							
3.4.9.1	Stamp and Marking Materials	X							
3.4.9.2	Stamp Traceability	X							
3.4.9.3	Stamp Application	X							
3.4.9.4	Electronic Data Control	X							
3.4.9.5	Stamping and Marking Application	X							
3.4.9.6	Status Stamping	X							
3.4.9.7	Stamping Methods	X							
3.4.9.8	Stamp Significance	X							
3.4.9.9	Contractor Stamp Design	X							
3.4.10	Handling, Storage, Preservation, Marking, Labeling, Packaging, Packing, and Shipping	X							
3.4.10.1	Procedures and Instructions Control	X							
3.4.10.2	Handling, Hoisting, or Lifting	X							
3.4.10.3	Storage	X							
3.4.10.4	Preservation	X							
3.4.10.5	Packaging and Packing	X							
3.4.10.6	Marking and Labeling	X							
3.4.10.7	Shipping	X							
3.4.10.7.1	Control	X							
3.4.10.7.2	Unscheduled Removal	X							
3.4.11	Control of NASA Property	X							
3.4.11.1	Contractor Responsibility	X							
3.4.11.2	Unsuitable NASA Property	X							
5	Preparation for Delivery	X			X				
5.1	General Requirements	X			X				
5.2	Detailed Requirements	X			X				
5.2.1	Preservation and Packaging		X				X		4.2.4.1.11
5.2.2	Packing		X				X		4.2.4.1.11
5.2.3	Packaging of Precision Clean Items		X		X				4.2.3

Section 3 and 5 Require-ment No.	Requirements	Verification Method							Related Section 4 Requirement No.
			1	2		3			
		N/A		a	b	a	b	c	
5.2.4	Temporarily Installed Hardware Identification			X					4.2.2.1
5.2.5	Packaging and Labeling of Ordinance		X		X				4.2.2.1
5.2.6	Hazardous Materials Shipment	X							
5.2.7	Marking for Shipment				X				4.2.2.1
5.2.8	Documentation	X							

5. PREPARATION FOR DELIVERY

5.1 GENERAL REQUIREMENTS

The requirements specified herein govern the preparation for shipment and the transport of the subsystem to all Buyer and U.S. Government facilities. The methods of preservation, packaging and packing utilized for shipment together with necessary special control during transportation shall adequately protect the subsystem from damage or degradation of performance due to the natural and induced environments encountered during transportation and subsequent storage.

5.2 DETAILED REQUIREMENTS

Packaging, handling, and transportation shall be accomplished so as to assure safe delivery without degradation of reliability as supplemented by the following subparagraphs.

5.2.1 Preservation and Packaging

Preservation and packaging protection shall be accomplished to assure that relative humidity levels are maintained within acceptable levels to prevent contamination including corrosion. In addition, subsystem hardware shall be protected by packaging so designed as to protect the material against direct exposure to transportation environments that could cause possible damage or degradation of reliability. The packaging design shall consider but are not limited to:

A. Multiple handling during transportation and in transit storage from point of origin to the ultimate destination.

B. Shock, vibration and static loading during shipment.

C. Environmental exposure during shipment or during in transit operations where warehouse facilities are limited.

D. Static loads imposed by stacking

5.2.2 Packing

Exterior containers shall protect the item and any interior packs from damage and degradation from the natural and induced transportation environments during shipment to all Buyer and U.S. government facilities and short term (up to 6 months) storage. The exterior container and or an interior case liner or waterproof shroud shall protect the item from moisture damage or degradation. The item(s) packed shall be adequately protected with cushioning or dunnage as necessary. Consolidation of small containers shall be accomplished whenever practical. Containers exceeding a gross weight of 60 pounds shall be equipped with forklift handling capability.

5.2.3 Packaging of Precision Clean Items

Prior to packaging in accordance with the requirements of 5.2.1 and 5.2.2, items cleaned to the level of cleanliness specified in Section 3 shall first be pre-packaged to assure maintenance of the prescribed cleanliness level.

5.2.4 Temporarily Installed Hardware Identification

All temporarily installed devices such as caps, plugs, covers, support bracketry, protective plates, etc., shall be highly visible red in color or shall have attached highly visible red colored streamers to ensure that they are easily identified under casual observation. Reusable protective devices shall be labeled "REUSABLE ITEM, DO NOT DESTROY, RETAIN FOR REUSE."

5.2.5 Packaging and Labeling of Ordinance

Pyrotechnics and electro-explosive components shall be packaged in conductive materials to provide protection from static electric charges. Conductive materials shall have a maximum surface resistivity of 3E10 ohms maximum at all levels of relative humidity. Non conductive outer wrapping is acceptable for packaging if conductive inner wrap with a ground path through all non conductive exterior wrapping material is provided, and the non conductive material cannot contact the explosive device. This applies to packaging materials and containers and does not eliminate the need for other protective measures, such as shorting connectors and protection from high level RF energy. Packaging of ordnance for air shipment shall be accomplished in accordance with requirements of the Dangerous Goods Regulations of the International air transport association (IATA). A Competent Authority letter from the country of origin (Ministry of Civil Aviation, Leningradsky Prospekt 37, Moscow A-167) shall be submitted to the Associate Administrator for Hazardous Material Safety, Research and Special Programs Administration, US Department of Transportation, Washington D.C. 20590-0001, U.S.A. Prior approval by the appropriate authority of the US (Office of Hazardous Materials Exemptions and Approvals) shall be obtained to transport a pyrotechnic article to, from or through the United States of America.

5.2.6 Hazardous Materials Shipment

Hazardous materials shall be prepared for shipment and shipped in accordance with requirements of IATA for air shipment and code of federal regulations CFR-49 for highway shipment.

5.2.7 Marking for Shipment

Interior and exterior containers shall be marked and labeled with a non-fading, durable material capable of lasting throughout the distribution cycle of the container. Markings shall be clear and legible. Markings shall be accomplished through the utilization of labels, stamping, printing, stenciling, or tagging methods compatible with the style of the container. The size of container markings shall be commensurate with the size of the container, but not less than 1/4 inches in height. The color of the marking or label shall be contrast to the color of the container. The marking shall be located on one side of the container and shall not be disturbed by the opening or closing of the container. Containers too small for labeling on one side may have the label extended to an adjacent panel. All surfaces to be marked shall be free of any marks not applicable to the shipment.

Interior and exterior containers shall be marked with the following minimum information:

Name and address of the consignee and the consignor
Part number
Nomenclature
Manufacturers part number (if different from above)
Manufacturers name
Quantity and unit (ex: 1 kg each)
Number of packages (ex: 1 of 5, 2 of 5, etc. ...)
NASA Critical Item Label
Orientation label (up arrows)
Packing list envelope (contains copy of shipping papers)

In addition to the above requirements, hazardous material shipments shall be marked on 2 adjacent sides of each container with the following minimum information:

Proper Shipping Name/Description
Hazard Classification
Identification number
Hazardous labels
Net explosive quantity (weight) for pyrotechnics only
"UN" certified specification container symbol as approved by the country of origin

Packages with reuse capability shall be identified with the words "REUSABLE CONTAINER - DO NOT DESTROY - RETAIN FOR REUSE."

5.2.8 Documentation

Prior to air shipment of hazardous materials, a "Shipper's Declaration for Dangerous Goods" form and an air waybill must be completed in accordance with requirements of IATA section 8.

6.

NOTES

6.1 DEFINITIONS

Acceptance Tests. Inspection and tests to determine that a part, component, subsystem or system is capable of meeting design and performance requirements specified herein.

Abnormal Conditions. Transmission line or load-fault conditions.

Assessment. A verification method employing inspection and review of design techniques to verify design features not covered by verification of test and analysis such as finishes, tolerances, bonding, identification traceability, warning and servicing labels, Bill of Materials, etc. These methods may employ the orderly review and evaluation of design documentation or visual inspection techniques (e.g., mockup forms, fit checks, maintainability access, tolerances, etc.).

Capture. The initial physical connection between two spacecraft that provides little or no structural rigidity between the two vehicles.

Cable core. That group of conductors and associated shields which terminate at one equipment interface connector exclusive of any overall shield.

Certification. Certification consists of qualification testing, Major Ground Test, and other tests and analyses required to determine that the design hardware from the component through the subsystem level meets requirements.

A. Qualification Test. Rigorous demonstration by test that a production type item is capable of meeting design performance requirements, including design margin and life, under operating environmental conditions.

B. Certification by Analysis. Certification by analysis allows the use of appropriate engineering analyses including similarity to provide fulfillment of certification objectives.

Certification by Analysis. The use of appropriate engineering analyses including similarity to fulfill certification objectives.

Classification. N/A

Closed Test Bomb. A fixed volume chamber into which pressure cartridges are test fired to establish or verify the performance characteristics such as output pressure verses operating time.

Criticality. Categorization of the effect of loss of all redundancy for a given function. Functional criticality is based upon multiple failures which must occur to result in loss of the system or component function.

Critical Design Review (CDR). A formal technical review of the detailed design of a selected contract end item, or series of end items. This review is conducted when the detailed design is essentially complete (approximately the 90 to 95 percent design release point). The approved detailed design from this review serves as a basis for final production planning and often initial fabrication. The CDR determines whether the design is compatible with the specified requirements, and verifies that the design conforms to the requirements established at the PDR and updated to the time of the CDR. During the CDR, the integrity of the design is verified through review of analytical and test data. Following the CDR, the Configuration Item specifications and drawings are updated and placed under configuration control, and may be then released for fabrication.

The CDR is not considered formally complete until the contracting agency provides formal acknowledge indicating approval or contingent approval pending satisfactory completion of resultant action items.

Agenda - The appropriate items shall be addressed:

- Status of PDR action items
- Design requirements and specifications
- Interface requirements and specifications
- Design approach
- Assessment of hardware inheritance
- Test procedures
- Producibility demonstration results
- Scale model test results
- Design trades and alternatives considered
- Reliability, maintainability and operability considerations
- Spares list
- Conformance of the design to functional and user requirements
- Conformance to environmental design requirements
- Differences between the configuration item, system and subsystem performances in relation to the performances estimated at the PDR.
- Final hardware design verification plans
- Detailed mechanical (including electronic packaging, thermal, hydraulic and pneumatic) design
- Detailed electronic/electrical circuit design
- Interface details and agreements
- Mechanical and electronic parts stress analysis results
- Final reliability analyses, including single-point failure analyses against the reliability policy
- System safety analyses
- Electronics parts classification and screening specifications
- Non-electric parts, materials and processing list
- Materials and processing specifications
- Purchased devices list
- Manufacturing and fabrication plans
- Quality assurance plans and procedures
- Configuration control plans
- Qualification and acceptance test plans
- Calibration plan
- Data management flow and data reduction plan
- Support equipment and FSE requirements and plans
- Spares provisioning plan

- Ground operations plan
- Payload integration plan
- Flight operations plan
- Present status of items under review, including cost and technical developments
- Risk management activities

Major Documents

Drawings level 2 and 3 (production)
Interface Control Documents (ICD)
Informal Test Description/Test Procedures

Deliverables at CDR

Drawings level 2 and 3 (production)
Interface Control Documents (ICD)
Test Procedures
Spares list
Hardware Design Verification Plans
Detailed electronic/electrical circuit design
Mechanical and electronic parts stress analyses results
Final reliability analyses, including single-point failure analyses against the reliability policy
System Safety Analyses
Electronics parts classification and screening specifications
Non-electric parts, materials and processing list
Purchased devices list
Manufacturing and fabrication plans
Quality assurance plans and procedures
Configuration control plans
Qualification and acceptance test plans
Calibration plan
Data management flow and data reduction plan
Support equipment and FSE requirements and plans

Demate. To separate two vehicles rigidly joined by whatever means, methods and hardware systems available. (For the ODS, this includes termination of interfaces, undocking and final release.)

Development Tests. Those tests performed with minimum rigors and controls to verify a design approach.

Docking. The process of joining two spacecraft using alignment and translation maneuver to effect capture, attenuation and structural attachment.

Dual Failure Tolerant. The capability to sustain two failures and still retain the capability to complete the intended function/operation in a safe but possibly degraded mode. A subsequent component failure in the system could result in the inability to complete the function.

Dummy Load. For the purpose of shock tests, a dummy load is a duplicate of the shape, size, rigidity, mounting methods, weight, mass distribution and center-of-gravity of the Qualification unit. There is no requirement that it be a functioning device.

Dynamic Clearance. The clearance which remains between the items in question after accounting for each item's respective three sigma mechanical and dynamic envelope during ascent, on-orbit and descent.

Emergency Conditions. Conditions of power-source failure.

EVA Provisions. The EVA crew items attached to the Orbiter (including the APDS) required to accomplish EVA from the external airlock configured Orbiter.

Failure. The loss of ability of a system, subsystem, component, or part to perform its required function within specified limits, under specified conditions for a specified duration.

Fail-Operational. The ability to sustain a failure and retain full operational capability for safe mission continuation.

Fail-safe. The ability to sustain a failure and retain the capability to safely terminate the mission.

Field Support Equipment (FSE). Equipment to be supplied by the Seller as defined in paragraph 110.3.1.

Functional Path. A functional path is a serial set of one or more functional elements (e.g. LRUs) constrained by the following:

A. A physical means for accomplishing a given task. A redundant functional path has at least one functional duplicate; therefore failure of a redundant path will not necessarily result in system failure.

B. The point on a path at which several "downstream" paths originate must constitute the termination point of the "upstream" functional path and the starting point of each "downstream" functional path.

Hazard. The presence of a potential risk situation caused by an unsafe act or condition

Hazard Levels. A hazard whereby environment, personnel error, design characteristics, deficiencies, or subsystem malfunction may result in loss of personnel capability or loss of system shall be categorized as follows:

A. Catastrophic Hazard. Hazard could result in a mishap causing fatal injury to personnel and/or loss of one or more major elements of the flight vehicle or ground facility.

B. Critical Hazard. Hazard could result in serious injury to personnel and/or damage to flight or ground equipment which could cause mission abort or a significant program delay.

C. Marginal Hazard. Hazard could result in a mishap of minor nature inflicting first-aid injury to personnel and/or damage to flight or ground equipment which can be tolerated without abort or repaired without significant program delay.

Isolation. The separation of two or more entities (i.e. systems, functions, elements) into two or more paths or groups, by physically placing these entities in location or routes where no contact or cross talks can take place.

Interchangeability. An item which (1) processes such functional and physical characteristics as to be equivalent in performance, reliability and maintainability, to another item of similar or identical purpose and (2) is capable of being exchanged for other item (a) without selection for fit or performance and (b) without alteration of the items themselves or of adjoining items, except for adjustments is defined as being interchangeable.

Likelihood of Occurrence

A. Probable. Expected to happen in the life of the program.

B. Infrequent. Could happen in the life of the program. Controls have significant limitations or uncertainties.

C. Remote. Could happen in the life of the program, but not expected. Controls have minor limitations or uncertainties.

D. Improbable. Extremely remote probability that it will happen in the life of the program. Strong controls in place.

Line Replaceable Unit (LRU). A combination of components, units, parts, assemblies, subassemblies, etc., that are contained in one package or are so arranged that together the combination is common to one mounting; and in addition, provides a complete function(s) to the larger entity within which it operates.

In order to aid in the further definition on an individual basis, the following list of characteristics which can be attributed to a Line Replaceable Unit are provided:

A. It can be verified as ready for installation in an off-vehicle environment.

B. After installation readiness verification, it can be installed in any vehicle or GSE end item without regard to serial number.

C. The installation does not require manufacturing type tooling of dimensional or other similar nature.

D. It does not require engineering support during the installation or removal.

E. It does not require more time or involve more spares costs or other resources than its next assembly for installation or removal.

Load Interface. Load interface is defined as the point of power input to the subsystem/equipment/component being supplied for Shuttle use.

Mating. Bringing two vehicles together, in rigid combination, in space, by whatever means, methods and hardware systems available. (For the ODS, this includes capture, docking and the establishment of sustained physical interfaces.)

Mating/Demating System. Hardware/systems management software on the Orbiter side that are necessary to accomplish mating/demating of vehicles. The system(s) may be existing or yet to be provided hardware/software.

Maintenance

A. Organizational - Level Maintenance. Maintenance performed on vehicle subsystem and related support equipment in direct support of the turnaround flow. It includes scheduled and unscheduled servicing and maintenance action. It involves removal and replacement of LRUs, but does not include disposition, repair, service, calibration, and verification of the removed LRUs.

B. Intermediate-Level Maintenance. Maintenance that is performed in direct support of organizational-level maintenance and involves disposition, repair, service, calibration, and verification of items removed during organizational maintenance. It normally excludes activities requiring equipment, facilities, or skills which can be provided more economically at the depot level.

C. Depot-Level Maintenance. Maintenance that is performed by designated maintenance sources, e.g. manufacturers, USAF Air Material areas, NASA development centers, etc. It normally consists of maintenance that requires equipment, facilities, or skills that are not economically available at the intermediate level, e.g., repairing, modifying, overhauling, reclaiming, or rebuilding parts, assemblies, subassemblies, components, and end items; emergency manufacturing of unavailable parts; technical assistance for the organizational and intermediate maintenance levels.

D. Unscheduled Maintenance. The unscheduled actions performed, as a result of failure (including incipient failures), to restore an item to a specified condition.

E. Scheduled Maintenance. The attempt to retain an item in a specified condition through systematic inspection, detection, and servicing for the prevention of incipient failure.

Multipaction. A special coronal effect occurring when the condition of electron transit time is in resonance with applied ac voltage. Multipaction facilitates continuation of an arc which originates from corona.

Near-Real-Time Monitoring. Notification of changes in inhibit or safety status on a periodic basis (nominally once per orbit). Near-real-time monitoring may be accomplished via ground crew monitored telemetry data.

Operating Capability. The capability of an item to perform its intended function in accordance with its predetermined design/performance criteria.

Operating Cycles. The cumulative number of times an item completes a sequence of activation and return to its initial state; e.g., a switched-off sequence, a valve-opened/valve-closed sequence, a tank pressurized/depressurized, dewar cryogenic exposure/drain.

Operating Life. The specified operating time/cycles at defined worst case environmental conditions which an item can accrue before replacement or refurbishment without risk of degradation of performance beyond acceptable limits.

Operational Instrumentation. Operational Instrumentation provides the performance data necessary for crew to control, operate and assess the status of the Shuttle system and associated elements during the mission. The principle functions of operational measurements are to provide intelligence or normal subsystem management and for malfunction analysis to establish reconfiguration modes in the event of an inflight anomaly.

Preliminary Design Review (PDR). A formal technical review of the proposed design approach for a contract end item prior to or very early in the detailed design phase to assure that the engineering approach is acceptable, this shall represent approval to begin detail design (10% drawing release and 90% design complete). The review shall be held for each configuration item or aggregate of configuration items to (1) evaluate the progress, technical adequacy, and risk resolution (on a technical, cost, and schedule basis) of the selected design approach, (2) determine its compatibility with performance and engineering requirements of the development specification, (3) evaluate the degree of definition and assess the technical risk associated with the selected manufacturing methods/processes, and (4) establish the existence and compatibility of the physical and functional interfaces among the configuration item and other items of equipment, facilities, computer software, and personnel.

The PDR is not considered formally complete until the contracting agency provides formal acknowledgment indicating approval or contingent approval pending satisfactory completion of resultant action items.

The PDR establishes the "design-to" baseline and ensures that it meets the program, project, system, subsystem or specific baseline requirements. The PDR process will:

- Establish the ability of the selected design approach to meet the technical requirements
- Establish the compatibility of the interface relationships between the specific configuration item and other interfacing items
- Establish the integrity of the selected design approach
- Establish the operability of the selected design
- Assess compliance with quality assurance, reliability and system safety requirements
- Address status, schedule and inter-relationships
- Establish the feasibility of the approach

Agenda - The appropriate items shall be addressed:

- Technical justification that the design meets the performance specified
- Experiment performance analysis, including an analysis of instrument accuracy requirements
- Design parameters, restraints and constraints
- Environmental design requirements
- Interface design requirements

- Requirements traceability results
- Design and safety codes and standards to be applied
- Results of technical feasibility modeling and testing
- Design optimization analyses
- Discussion of block diagrams
- Compliance with functional requirements and specifications
- Suitability of inherited designs and hardware
- Lists of preliminary parts, materials and processes
- Spares requirements philosophy
- Preliminary data management flow and reduction plans
- Preliminary payload integration plan
- Preliminary ground operations plan
- Preliminary flight operations plan
- Requirements and plans for support equipment, including Field Support Equipment (FSE)
- Preliminary reliability analyses, including single-point failure mode policy
- Preliminary system safety analyses
- Quality Assurance Plan
- Hardware verification plans
- Hardware and software development plans and schedules (including verification tests or analyses to be performed)
- Present status of item under review, including cost and technical developments
- Risk management activities
- Mock-ups, Models, Breadboards and prototype hardware
- Developmental Test Data

Major Documents

Drawings level 1 and 2 (production prototype and limited production)
Preliminary Interface Design Document
Interface Control Drawings (ICDs)

During the PDR, special attention is directed toward interface documentation, high risk areas, long lead times, and system level trade studies that integrate preliminary design concepts.

Deliverables at PDR

Drawings level 1 and 2 (production prototype and limited production)

Preliminary Interface Design Document
Interface Control Drawings (ICDs)
Lists of preliminary parts, materials and processes
Block Diagrams
Quality Assurance Plan
Hardware Verification Plans
Mockups, Models, Breadboards and prototype hardware

Qualification. The demonstration of required performance under environmental conditions which is accomplished on individual units or subassemblies (LRUs) to substantiate the compliance of that particular design of hardware to the Orbiter environmental requirements and specified condition. Environmental qualification may consist of test or of comparative analyses and will establish the functional capabilities of each unit under Orbiter environmental conditions.

Redundancy. The use of more than one means of accomplishing a given function where more than one must fail before the article fails to perform.

Preflight Checkout. Verifies that the flight hardware functions within prescribed limits when the subsystems are operated alone, or together as an integrated vehicle.

Reliability. A capability of a system, or any element thereof, to perform satisfactorily its intended mission in a designated environment.

Real-Time Monitoring. Immediate notification to the crew. Real-time monitoring shall be accomplished via the use of Orbiter failure detection and annunciation system or by ground crew monitored telemetry data.

Release. The final separation of the physical connection of two vehicles such that each vehicle acts as a free-body.

Resource Transfer. Transfer of services or consumables, such as electrical power, water, command and data signal, communication signals etc., back and forth between two vehicles subsequent to mating and connection.

Risk. The chance (qualitative) of loss of personnel capability, loss of system, or damage to or loss of equipment or property.

Separation. The termination of physical contact between the two vehicles.

Single Fault Tolerant. The capability to sustain a single failure and still complete the intended function or operation in a safe but possibly degraded mode. A subsequent component failure in the system could result in an inability to complete the function.

Shelf Life. That period of time during which an item can remain in storage without having its operability affected. Preventive maintenance, servicing, and replacement of age-sensitive material parts shall be permitted on a scheduled basis during the storage period.

Sheltered. Pertaining to a warehouse-type facility, enclosed, and providing protection against environmental conditions.

Shop Replaceable Unit (SRU). An integral subassembly of an Line Replaceable Unit consisting of units and parts or a combination of parts so arranged that together the combination is common to one mounting; and in addition, provides a complete function(s) to the larger entity within which it operates.

Significant Surface. That surface area which contacts the service fluid(s) of the system.

Single Event Upset.

Single Failure Point. A hardware failure which, by itself, could result in a safety hazard or serious impairment (or loss) of functional capability.

Stress. For the purpose of interpretation of this section, the following definitions will apply:

A. Limit Load. The maximum load or maximum operating pressure expected on the structure during mission operations, including intact abort.

B. Ultimate Factor of Safety. The factor by which the limit load is multiplied to obtain the ultimate load.

C. Ultimate Load. The limit load multiplied by the ultimate factor of safety.

D. Allowable Load. The maximum load which the structure can withstand without rupture or collapse

E. Maximum Operating Pressure (Limit Load). The maximum pressure applied to a pressure vessel by the pressurizing system with the pressure regulators and relief valves at their upper limit and with the maximum regulator fluid flow rate.

F. Proof Pressure. The pressure to which pressurized manned compartments and production pressure vessels, including lines and components, are subjected to fulfill the acceptance requirements, in order to give evidence of satisfactory workmanship and material quality. Proof pressure is the maximum operating pressure times the proof factor which is determined by fracture mechanics analysis or 1.10, whichever is greater.

G. Burst Pressure. Burst pressure shall be the product of the maximum operating pressure and the ultimate factor of safety.

Structures.

A. Primary Structure. That structure that is the basis of framework to distribute and react external and internal loads resulting from all design flight and ground loads and their associated operational environments.

B. Secondary Structure. Those structures that interface with the primary structure for structural accommodations and attachment provisions for payloads, equipment, handling, other subsystem groups, and any item requiring structural interface with the Orbiter.

C. Secondary Structure Attach Points. Those load elements that secure secondary structures to primary structures. This includes all mechanical or physical bonding means (e.g., weld, rivet, threaded fasteners, etc.).

Structural Safe-Life. A design approach under which structural failure will not occur because of undetected flaws and/or fatigue damage during the specified service life of the article; also, the period of time for which the integrity of the structure can be ensured in the expected operating environments.

Torr. 1/760 of a standard atmosphere of 1,013,250/760 dynes per square centimeter. This is equivalent to defining the Torr as 1333.22 micro-bars, and differs by only one part in seven million from the International Standard millimeter of mercury.

Traceability. The ability to trace the history, application, use and location of an individual item or characteristic list of items through the systematic assignment, recording, and correlation of control identification numbers.

Transient Voltage:

A. Surge. A variation from the controlled steady-state level of a characteristic, resulting from the inherent regulation of the electric power supply system and the remedial action by the regulator.

B. Spike. A variation from the surge level or from the controlled steady-state level of a characteristic which reaches its greatest amplitude in a extremely short time. It results from very high frequency currents of complex wave form produced when loads are switched. Transient so generated usually consist of a train of spikes.

C. Ripple. The cyclic variation of voltage about the mean level of the dc voltage during steady-state dc electric system operation.

Undocking. The series of events which causes the separation of two joined vehicles such that they each operate as independent spacecraft.

Unsheltered. An open area, unprotected against environmental conditions.

Useful Life. The item's total life span including operating life and storage with normal preventive maintenance, servicing, repair, and replacement of parts before item is considered unacceptable for further usage. This life span may be equal to (throw-away), or greater than (repair, refurbishable) the value specified for "operating life".

Verification. The verification program is defined as the process by which the design of the systems and the implementation of that design is demonstrated by proof or positive evidence to meet the requirements established in the Procurement Specification. The elements leading to final verification include development tests, analyses, simulations, environmental qualification tests and/or analyses, and assessment.

Vestibule. The contiguous free space, when the Orbiter and ISSA are docked, between the APDS external airlock upper hatch and the ISSA entrance hatch.

Zero Failure Tolerant. No capability to sustain failures and continue the intended function in a safe or degraded mode.

6.2 ABBREVIATIONS AND ACRONYMS

Abbreviations and acronyms used in this specification are defined as follows:

A ampere
AC Alternating current
ACT active
ADP Acceptance Data Package
AL Active Latch
amp ampere
APDA Androgynous Peripheral Docking Assembly

APDS	Androgynous Peripheral Docking System
ATP	Acceptance Test Procedure
ATP	Authority to Proceed
ATT	Acceptance thermal tests
AVT	Acceptance vibration tests
BIT	Built-in test
BITE	Built-in test equipment
BTU	British thermal unit
CDR	Critical Design Review
CG	Center of Gravity
cm3	Cubic centimeter
CONN	connector
CSB	Connector Switch Box
Cu	Copper
DA	Double Amplitude
D/B	Docking Base
dB	decibel
DC	Direct current
DCP	Docking Control Panel
DCU	Data Collection Unit
DM	Docking Mechanism
DMCU	Docking Mechanism Control Unit
DNY	Downey
DPA	Destructive physical analysis
DSCU	Docking System Control Unit
E	Exempt from Traceability
EDCP	Engineering Design Change Proposal
EEE	Electrical, Electronic, and Electromechanical
EMC	Electromagnetic compatibility
EMU	Extravehicular Mobility Unit
ENG	Engineering
EPDC	Electrical Power Distribution & Control
ESD	Electrostatic Discharge
F	Fahrenheit
FGB	Functional Cargo Block
FSE	Field Support Equipment
F/T	Feedthrough
ft	Foot or feet
ft^2	Square foot or feet
ft^3	Cubic feet
g	Gravity
GC	Generally Clean
GFE	Government Furnished Equipment
Gnd	Ground
GSE	Ground Support Equipment
GSI	(U.S.) Government Source Inspection
He	Helium
Hg	Mercury
hr	Hour
Hyd	Hydraulic
Hz	Hertz (cycles per second)
I/F	Interface
in	Inch

I/O	Input/Output
ISS	International Space Station
k	Kilo
kgf	kilograms force
kHz	KiloHertz (kilocycles per second)
Km	Kilometers
KSC	Kennedy Space Center
KV	kilovolts
LACU	Latching Actuator Control Unit
lb	Pound
LISN	Line impedance stabilization network
LRU	Line replaceable unit
m	meter
ma	Milliampere
MAWP	Maximum allowable working pressure
max	maximum
MDM	Multiplexer/Demultiplexer
mg	Milligram
MHz	Mega Hertz (megacycles per second)
min	minimum
min	minutes
MIP	Mandatory Inspection Point
ml	Milliliter
mm	Millimeter
MOhm	Megohms, million ohms
MOP	Maximum operating pressure
MRB	Material Review Board
ms	Millisecond
mv	Millivolt
N/A	Not applicable
NASA	National Aeronautics and Space Administration
NDE	Non Destructive evaluation
N_2	Nitrogen
N_2O_4	Nitrogen Textroxide
Ni	Nickel
No.	Number
nsec	Nanosecond
NUM	number
NVR	Non-volatile Residue
O_2	Oxygen
ODM	Orbiter Docking Mechanism
ODS	Orbiter Docking System
OI	Operational instrumentation
OMS	Orbital Maneuvering System
~~PACU~~	~~Pressurization Actuator Control Unit~~
PAS	passive
Pb	Lead
pcw	Pulse Continuous Wave
PD	Pyrotechnic Device
PDR	Preliminary Design Review
PDRD	Procurement Data Requirement Description
PDRL	Procurement Data Requirements List
PHA	Pigtailed Harness Assembly
PHC	Permanent Human Capability
phm	Parts per hundred million

PIND Particle impact noise detection
PIW Pallet Interconnect Wiring
PL Passive Latch
PMA Pressurized Mating Adapter
Pnl Panel
P.O. Purchase order
POS Probability of Sufficiency
prot. protection
psi Pounds per square inch
psia Pounds per square inch absolute
psid Pounds per square inch differential
psig Pounds per square inch gauge
PSU Power Switching Unit
PTC Pyro Test Cable
Pwr Power

Q Magnification factor
QAR Quality Assurance Representative
QAVT Quality Acceptance Vibration Test

rf Radio frequency
R. H. Relative humidity
rms Root mean square
RTN Return

s second
SCBD Seller Configuration Baseline Document
SCC stress-corrosion cracking
SCI Seller Configuration Inspection
secsecond
SEISeller End Item
SIPStandard Interface Panel
SIW System Interconnect Wiring
SRP Standard Repair Procedure
SRU Shop replaceable unit
SS (APDS) switching system
STBD Starboard
std Standard
STE Special Test Equipment
SWSwitch
SWA Statement of Work Authorization

TBD To be determined by Buyer
TBS To be supplied by Seller
TL Lot Traceability
T/RTransmit/Receive
TS Serial Traceability

usec Microseconds

Vac Volts alternating current
Vdc Volts direct current

WUC Work Unit Code

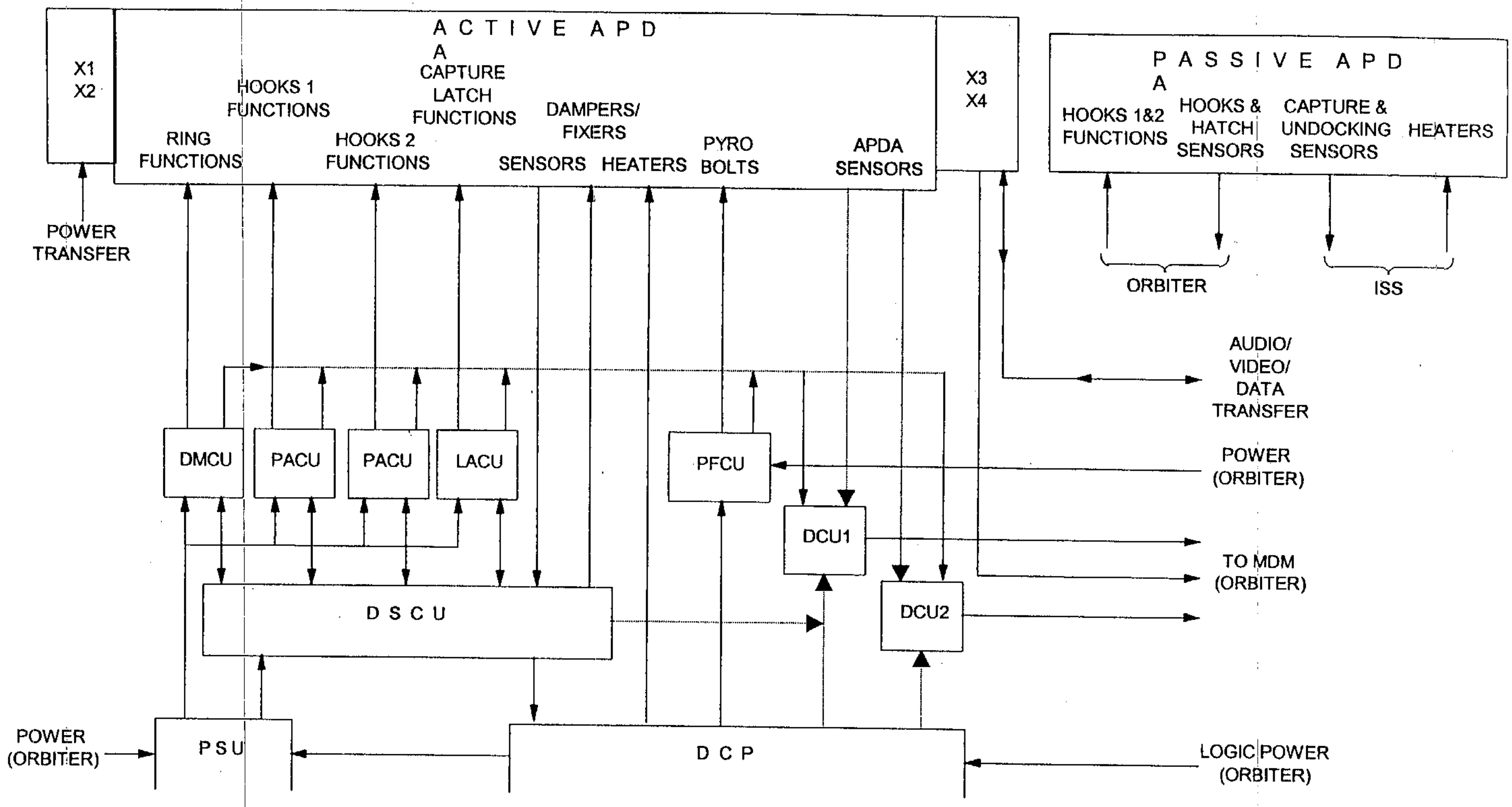


Figure 1. APDS functional diagram

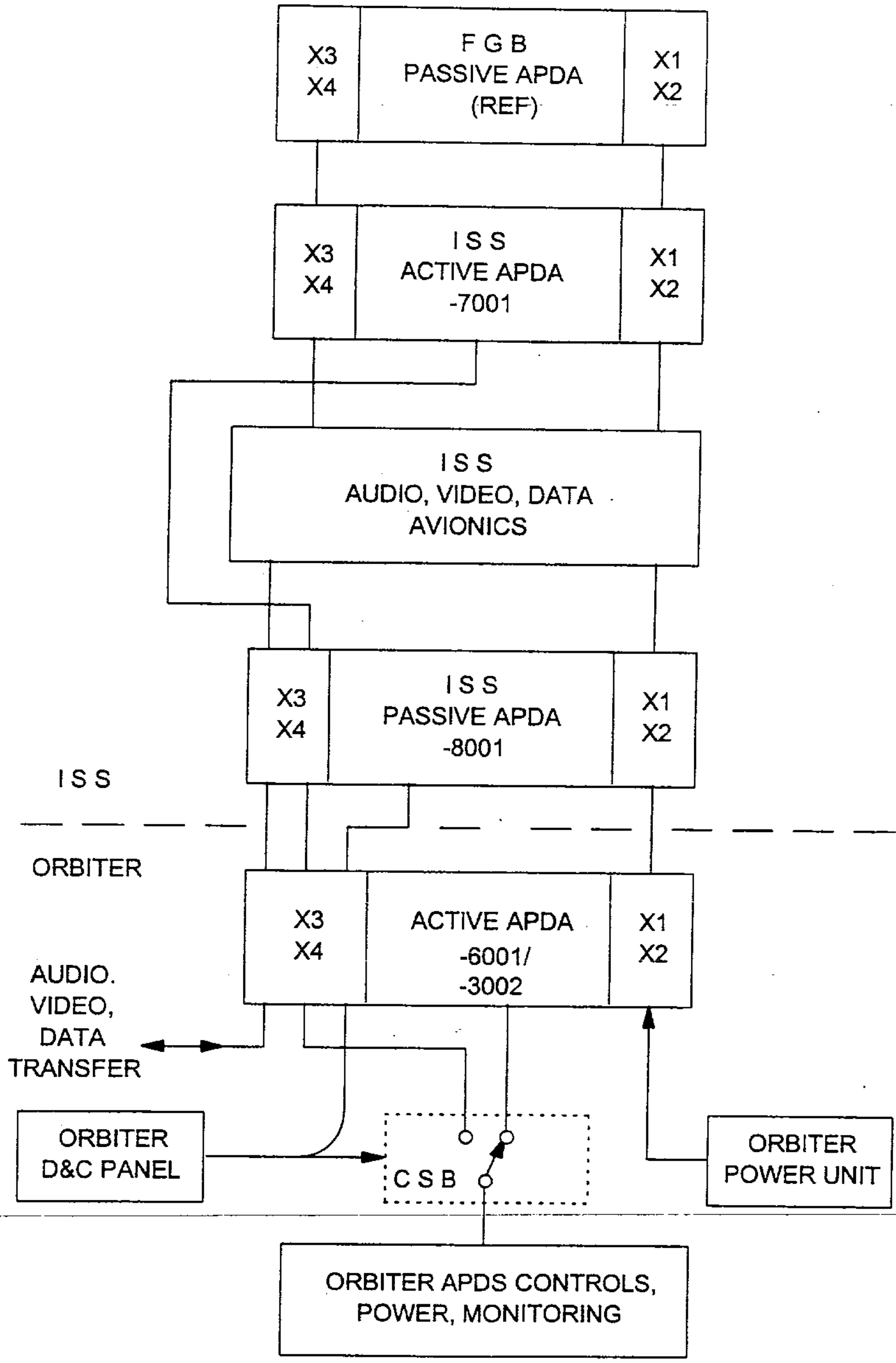
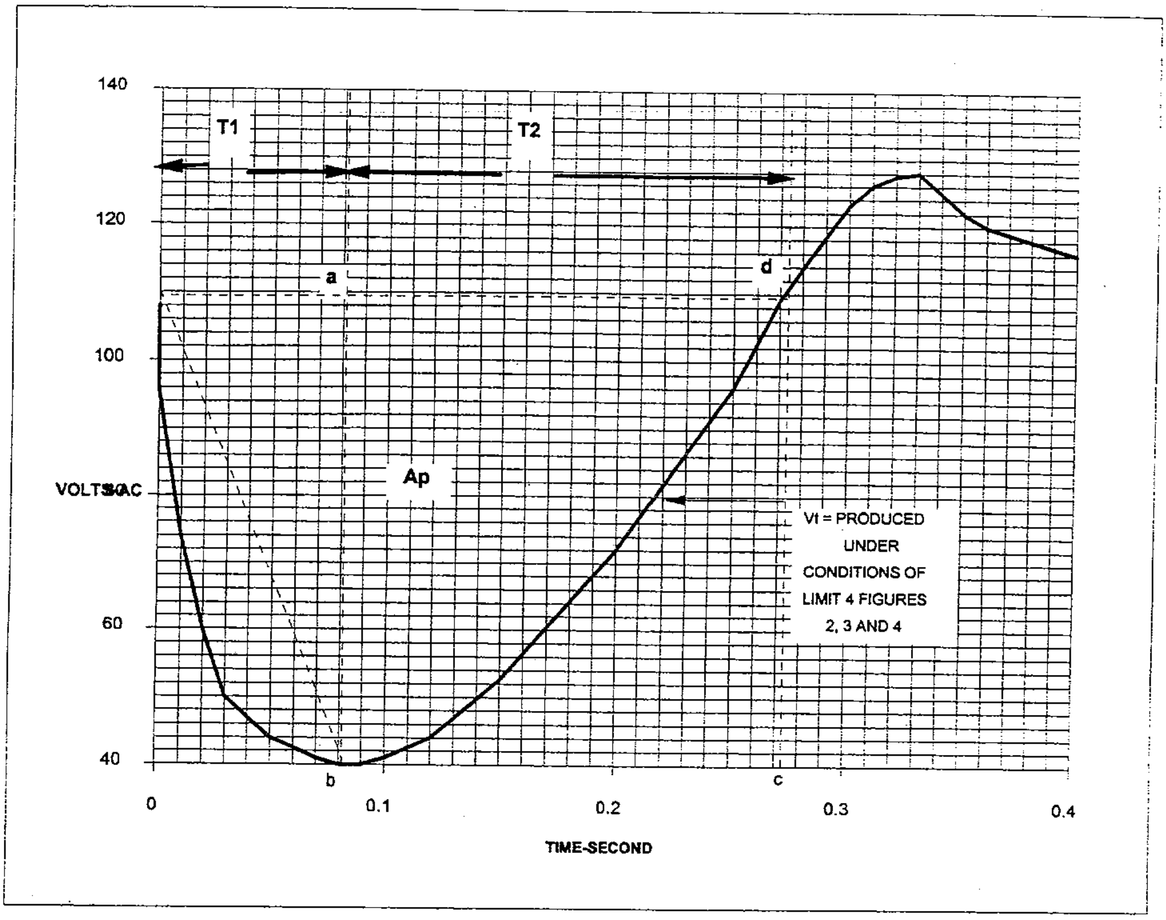


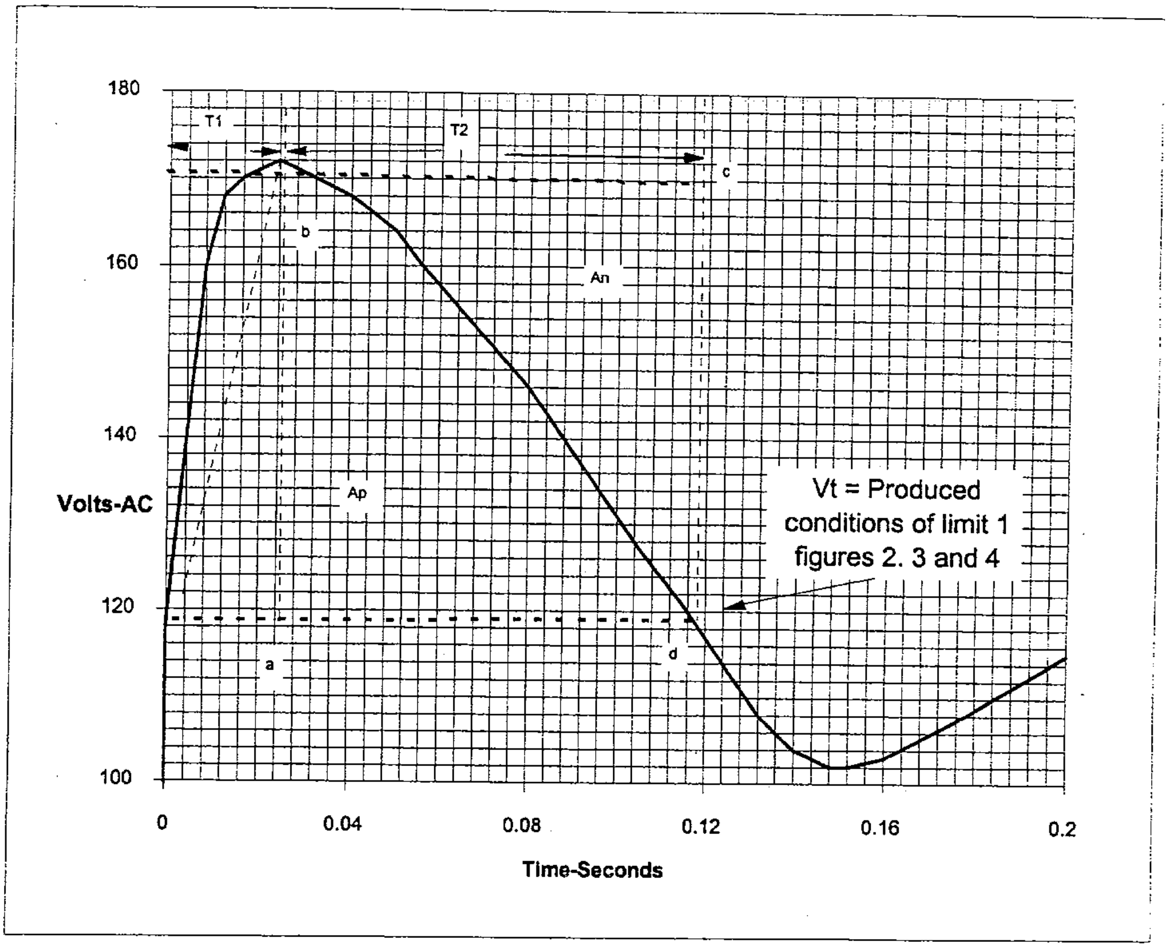
Figure 2. APDS interface diagram



Conversion is based on deficit Volt-Second under the normal Volt-Second Input

V1 = Voltage Transient Surge	T1 = 0.08 Second
T1 = Time to Reach Peak Voltage	T2 = 0.27 - 0.08 = 0.19 Second
T2 = Post-Peak Transient Time	Ap + An = 646 Squares
Ap = Area within abda	An = 218 Squares
An = Area within bcdb	Ap = 646 - 218 = 428 Squares
Tp = Equivalent Duration of Peak Voltage	Ts = T1/2 + Tp = T1/2 + T2(Ap/(ap+an)) = 0.8/2 + 0.19(428/646)
Ts = Duration of the Step Function at the peak voltage	= 0.04 + 0.19(.663) = 0.04 + 0.126 = 0.166 Seconds

Figure 3. Conversion of an undervoltage surge to its equivalent step function



Conversion is based on deficit Volt-Second over the normal Volt-Second Input

V1 = Voltage Transient Surge	T1 = 0.022 Second
T1 = Time to Reach Peak Voltage	T2 = 0.118 - 0.022 = 0.096 Second
T2 = Post-Peak Transient Time	Ap + An = 648 Squares
Ap = Area within abda	An = 259 Squares
An = Area within bcdb	Ap = 648 - 259 = 389 Squares
Tp = Equivalent Duration of Peak Voltage	Ts = T1/2 + Tp = T1/2 + T2 Ap/(Ap+An)
	= 0.022/2 + 0.096(389/648)
Ts = Duration of the Step Function at the Peak Voltage	= 0.011 + 0.096(.60)
	= 0.011 + 0.0575 = 0.0685 Seconds

Figure 4. Conversion of an overvoltage transient surge to its equivalent step function

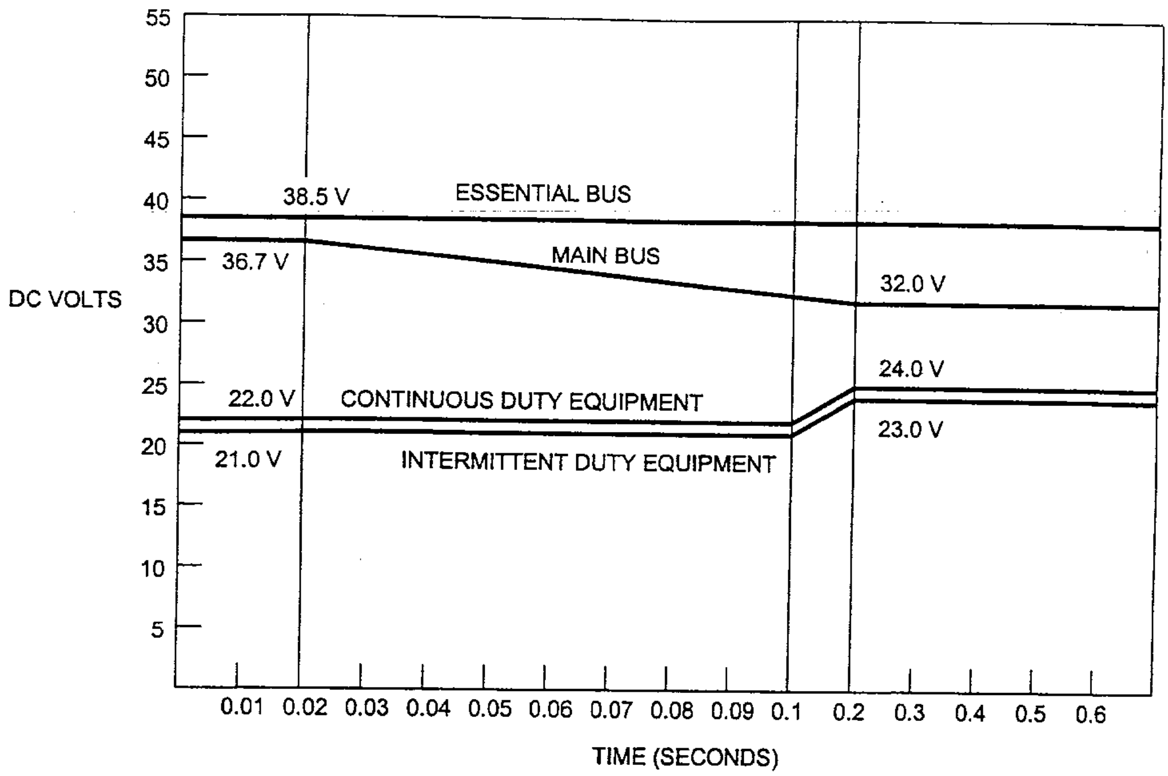


Figure 5. Transient surge of DC Voltage step function loci limits during normal equipment switching conditions

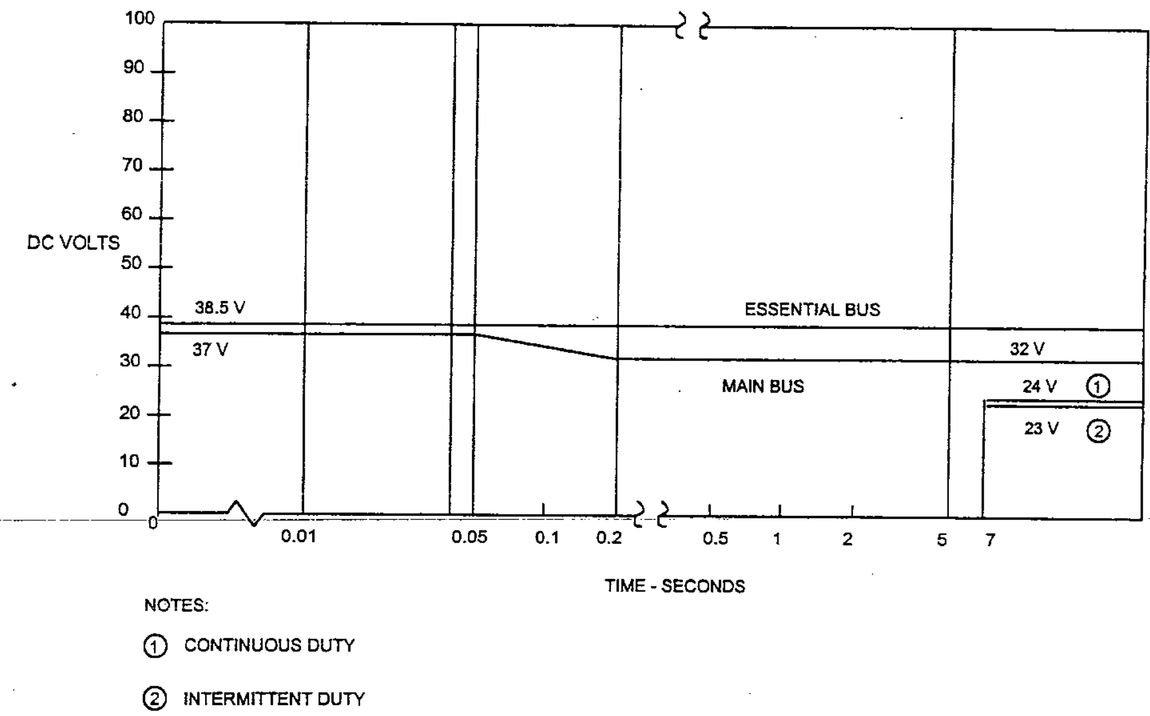
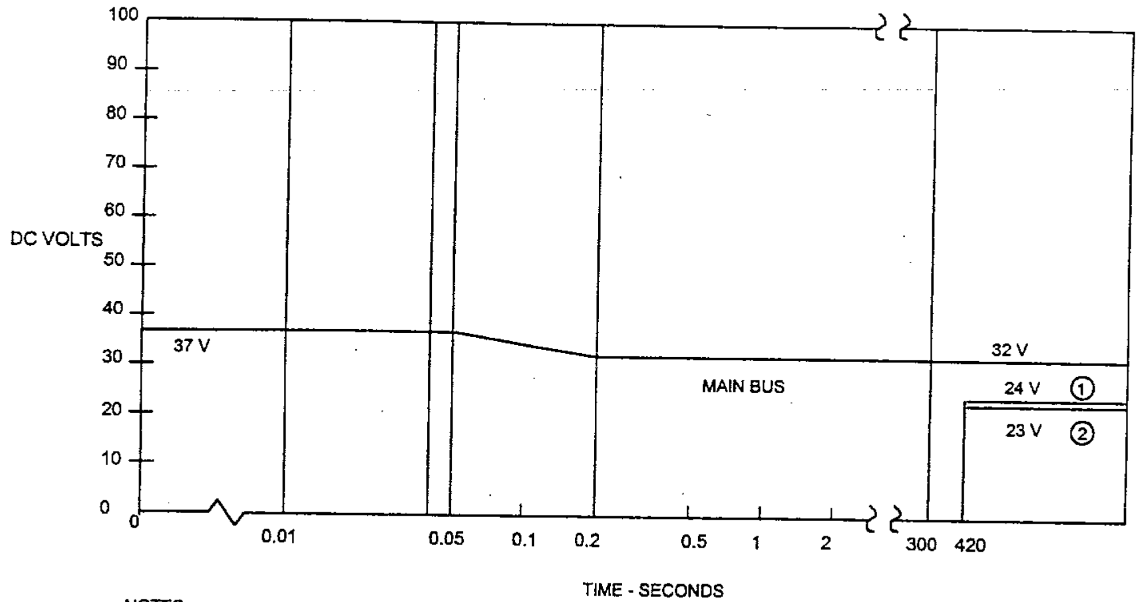


Figure 6. Transient surge of DC Voltage step function loci limits during abnormal switching conditions



NOTES:

① CONTINUOUS DUTY

② INTERMITTENT DUTY

Figure 7. Transient surge of DC voltage step function loci limits during emergency switching conditions

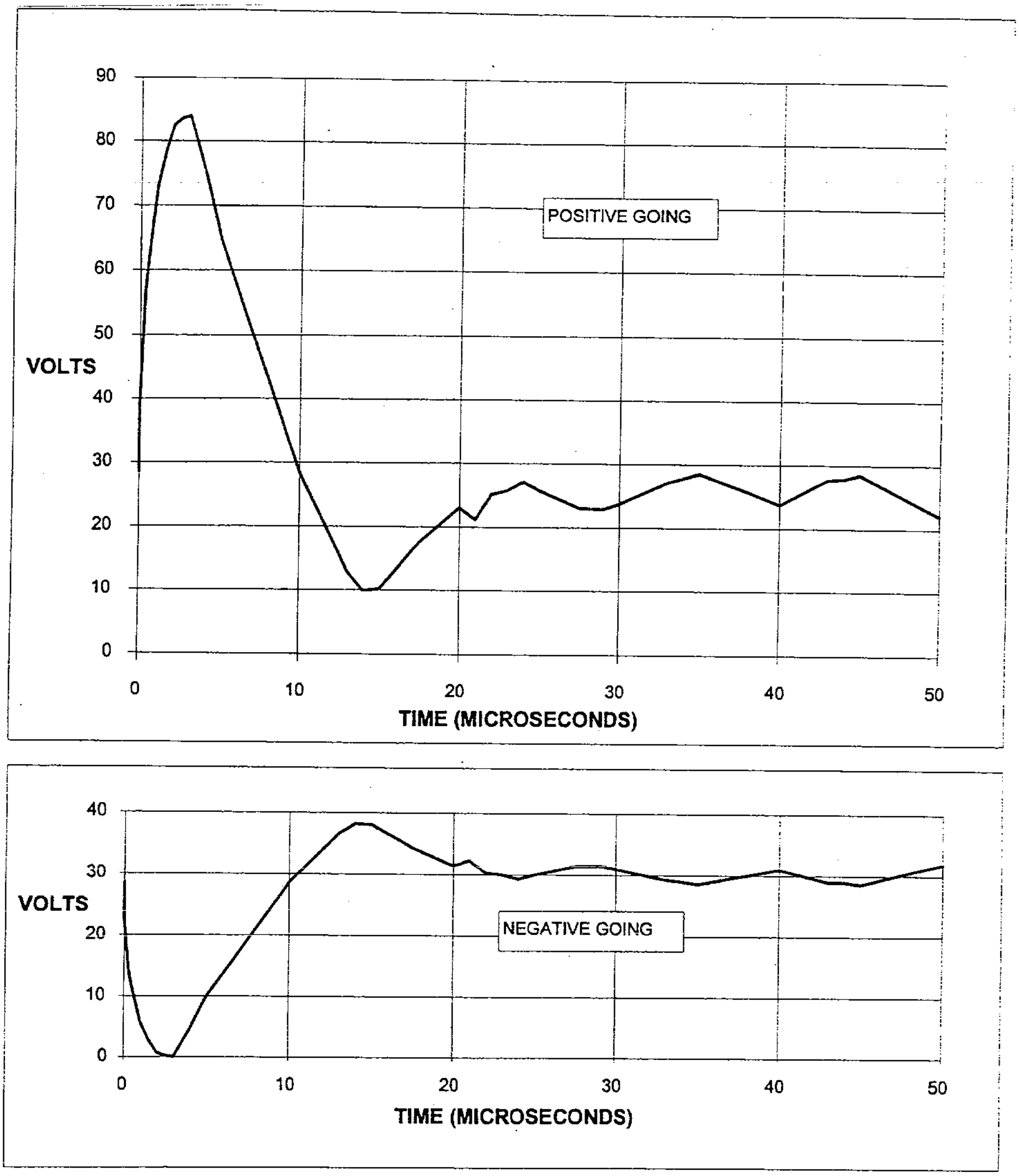


Figure 8. Transient spike voltage

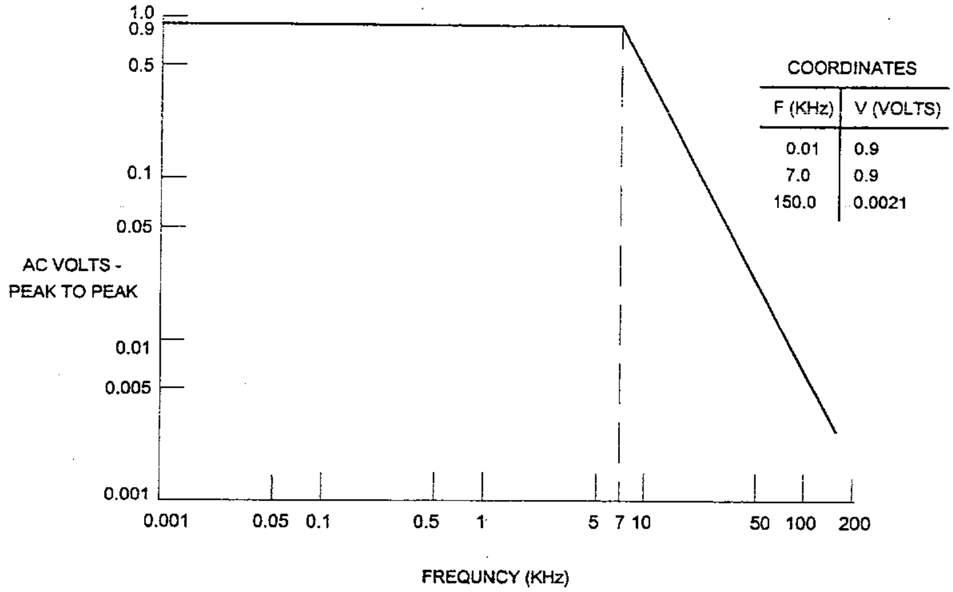


Figure 9. Frequency characteristics of ripple voltage in 28 Vdc electrical system

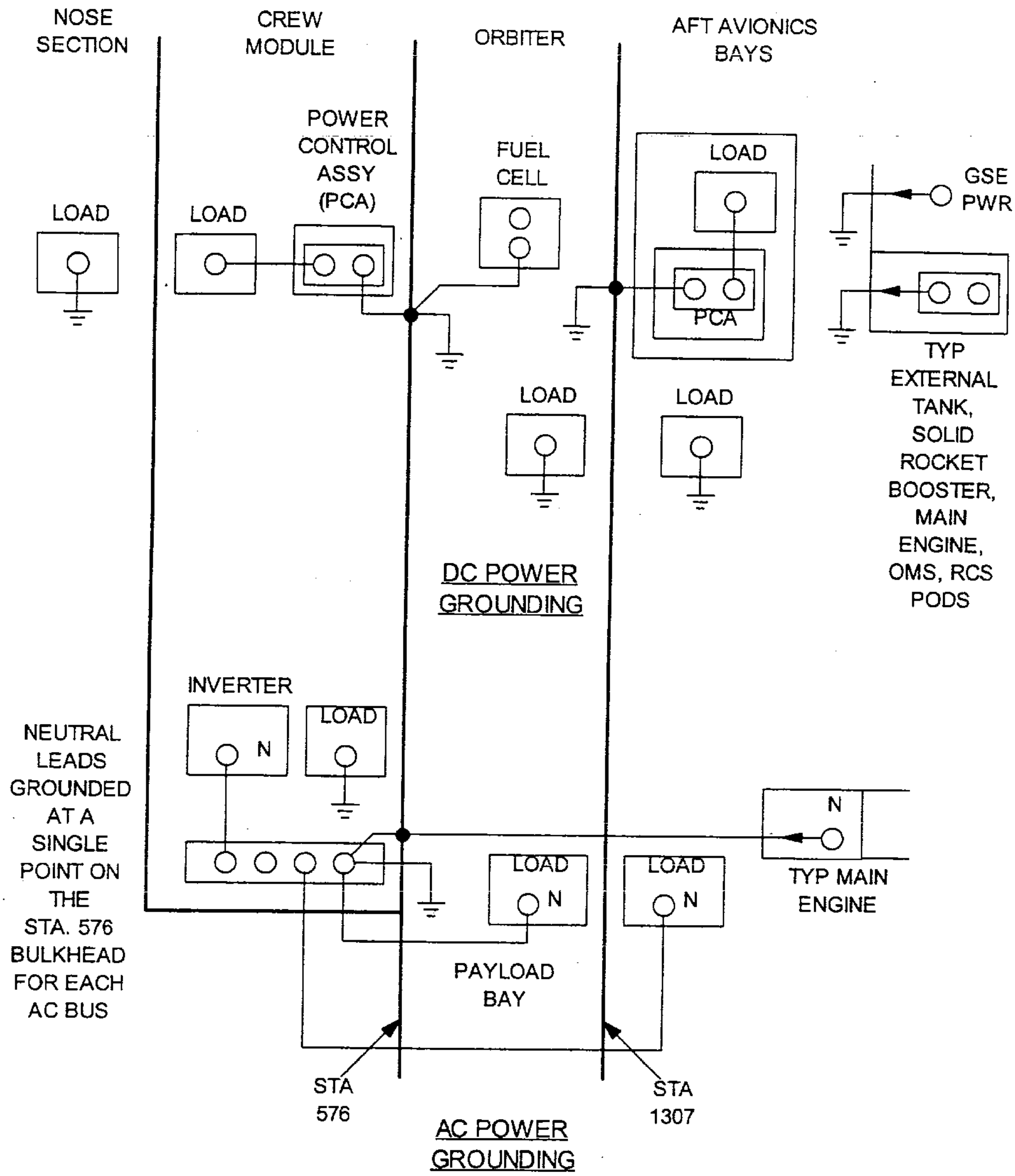


Figure 10. Space Shuttle primary grounding system

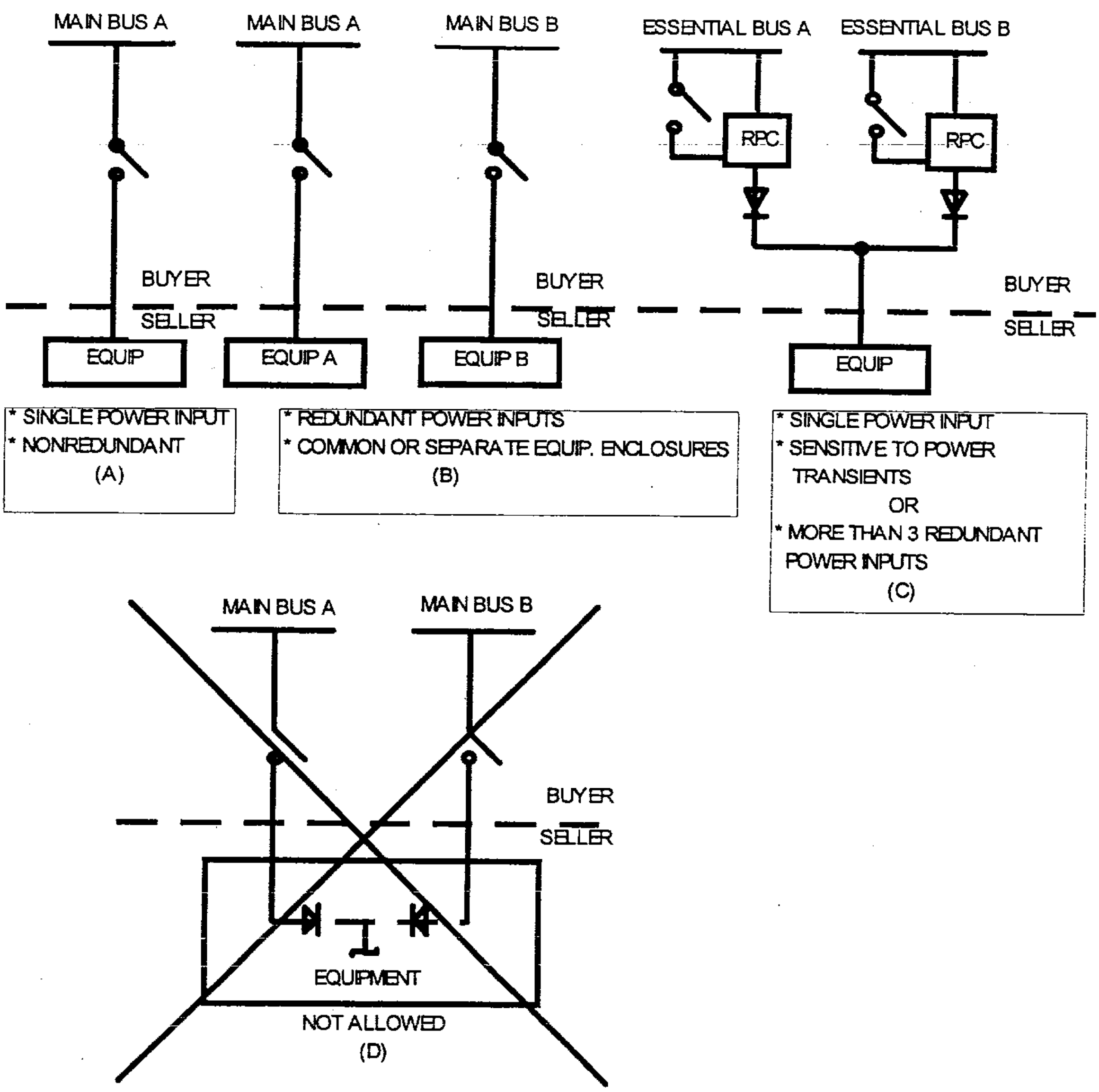


Figure 11. Isolation of power sources

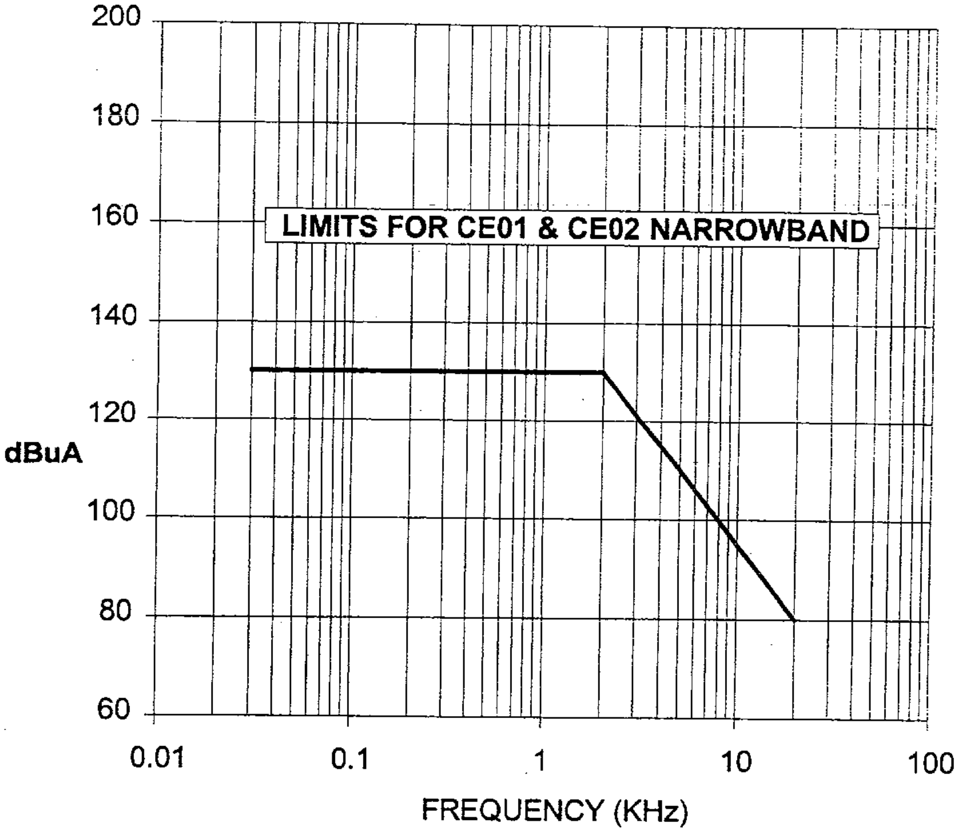


Figure 12. Limits for CE01 and CE02 narrowband emissions

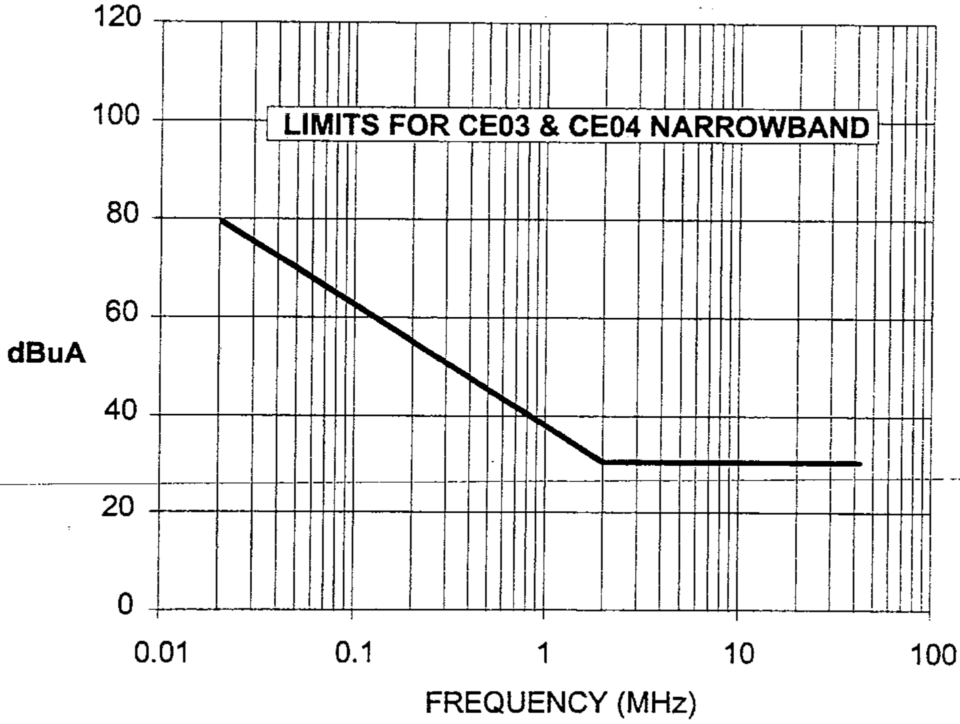


Figure 13. Limits for CE03 and CE04 narrowband emissions

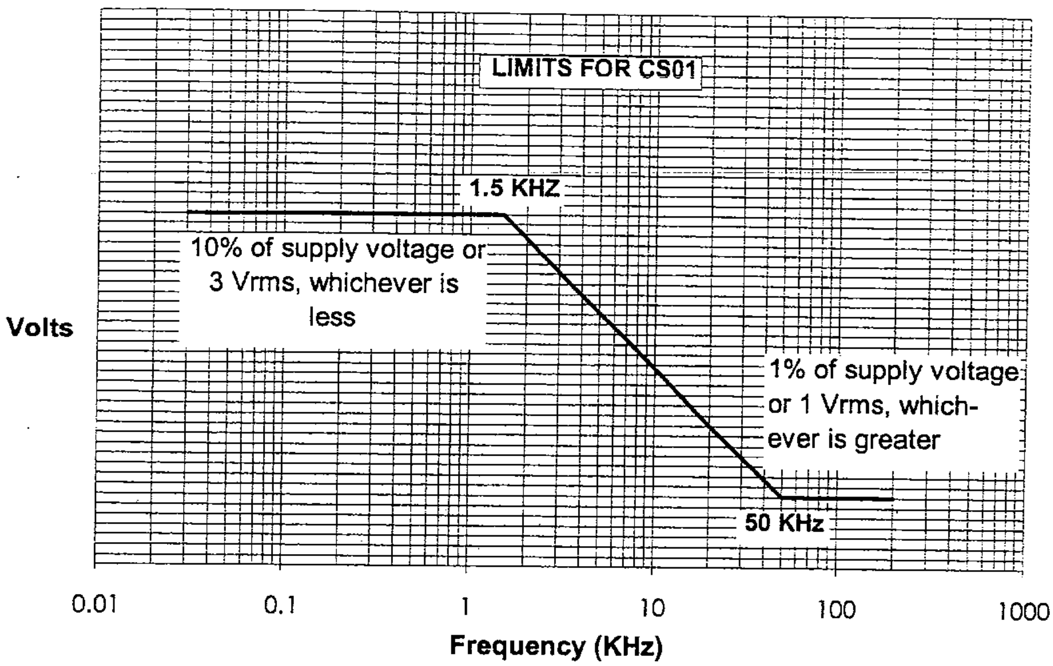


Figure 14. Limits for CS01

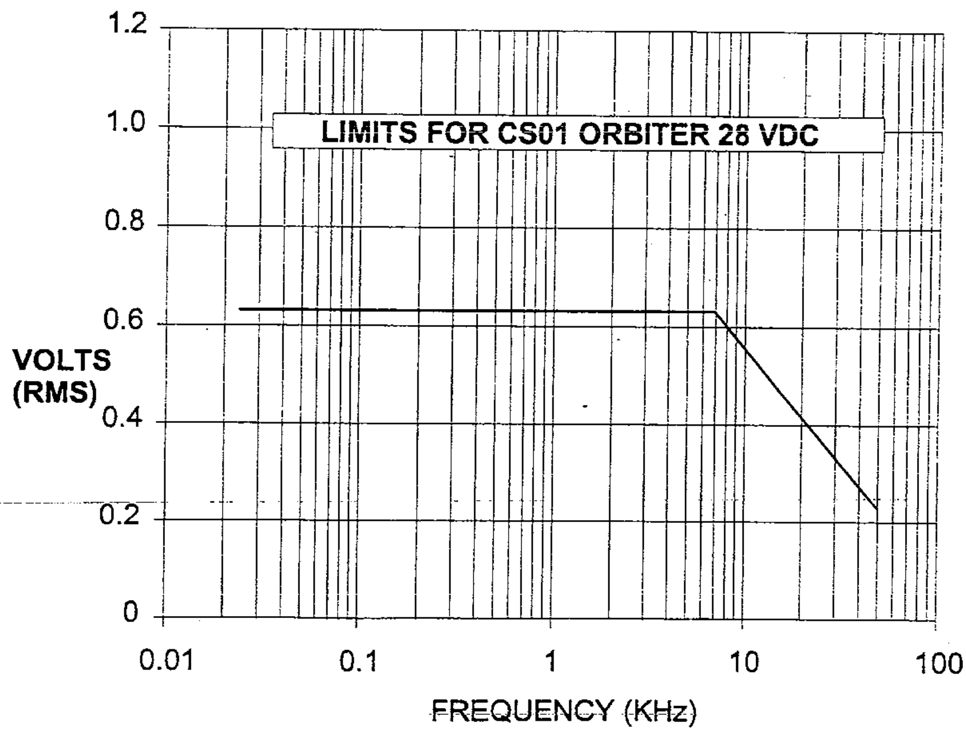


Figure 15. Limits for CS01 Orbiter 28 Vdc power

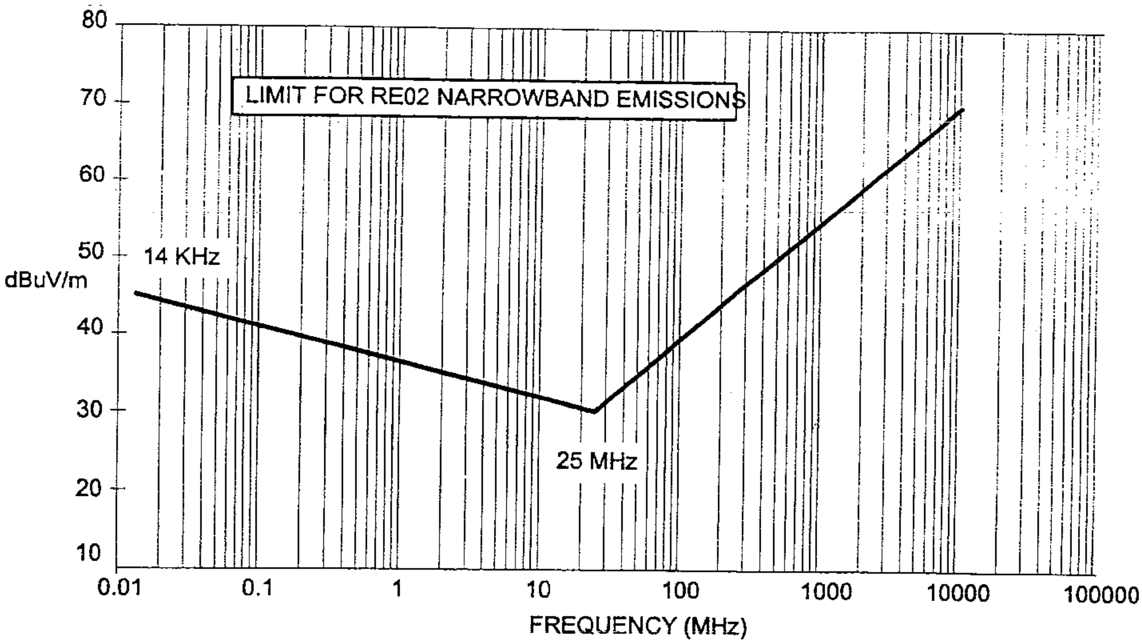


Figure 16. Limits for RE02 narrowband emissions

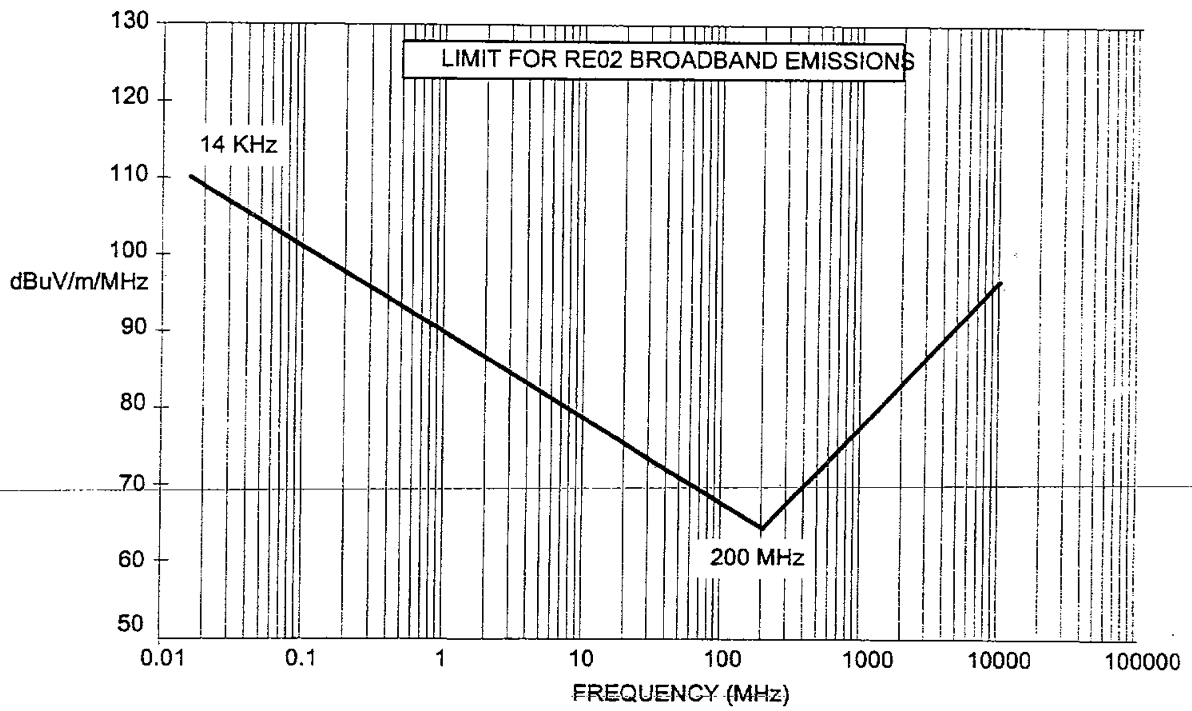


Figure 17. Limit for RE02 broadband emissions

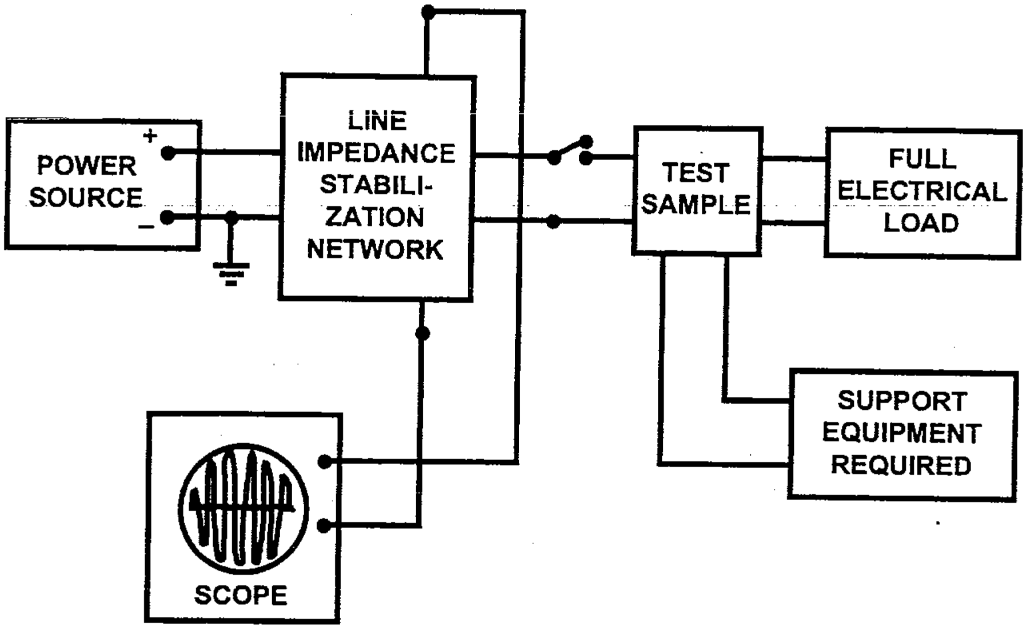
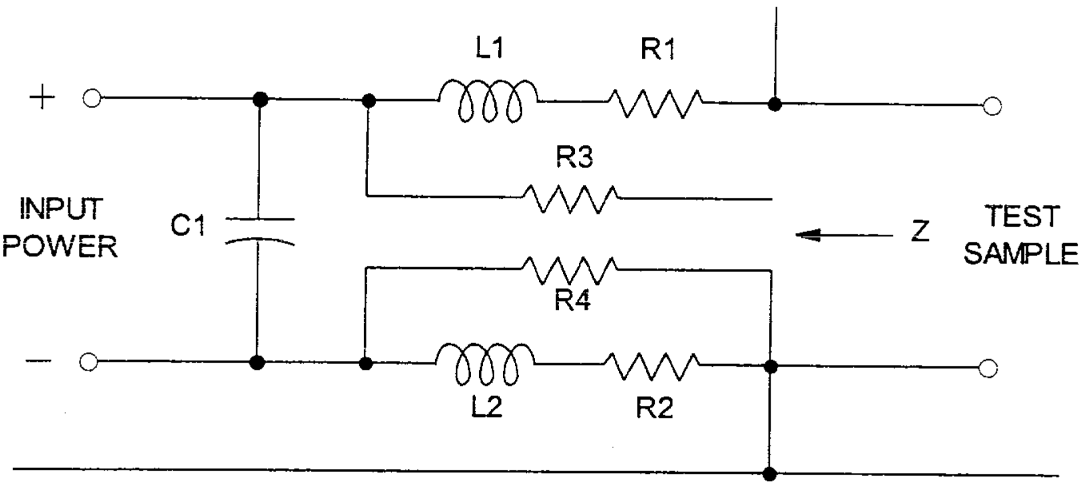


Figure 18. 28 Vdc power transient generation test set up (TT01)



R1, R2	=	0.25 OHM OR ACTUAL LINE RESISTANCE IF KNOWN
R3, R4	=	0.25 OHM
C1	=	19,000 uF 75 V ELECTROLYTIC
L1, L2	=	4 uH

Figure 19. 28 Vdc impedance stabilization network (LISN) schematic diagram

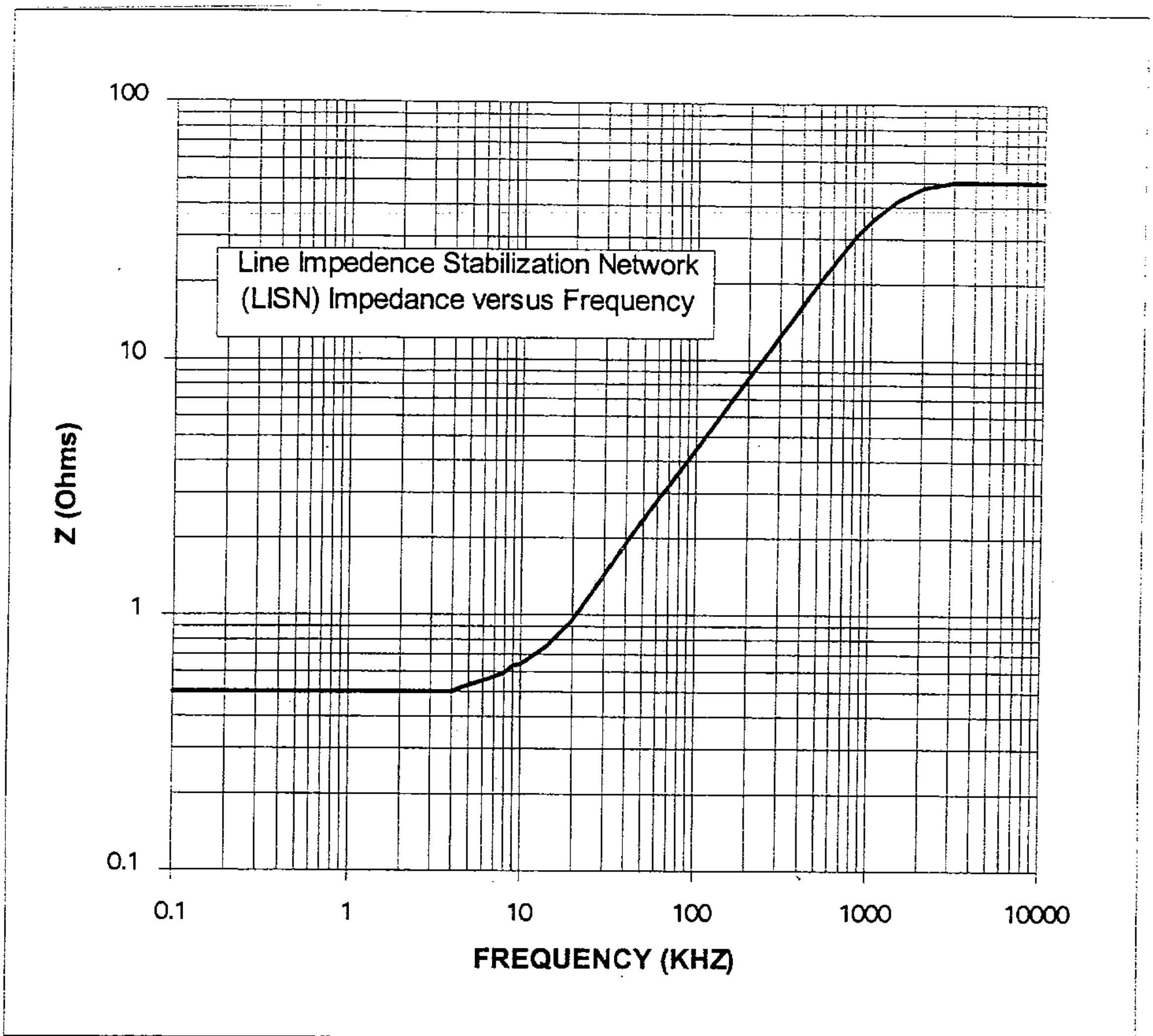
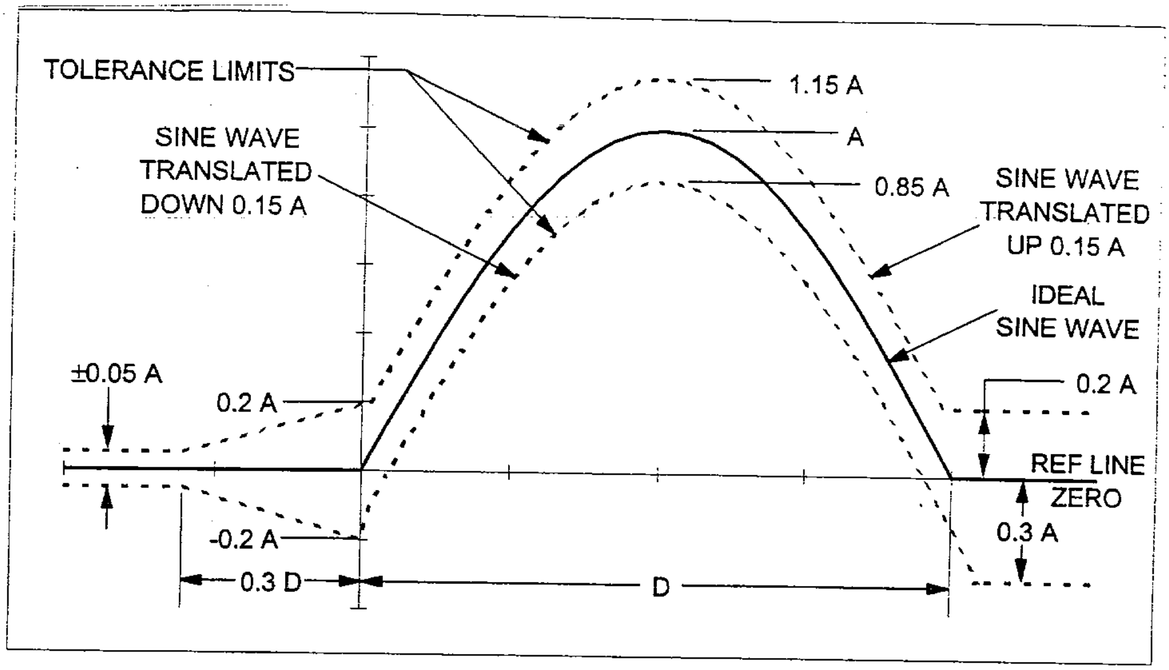


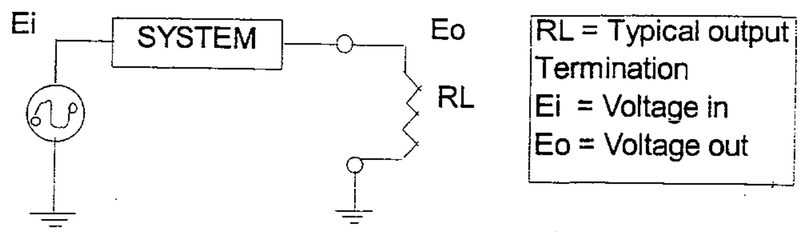
Figure 20. Line impedance stabilization network (LISN) frequency versus impedance



NOTES

1. The oscillogram shall include a time about 3D long with a pulse located approximately in the center. The acceleration amplitude of the ideal half-sine pulse is "A" and its duration is "D". The measured velocity change (which may be obtained by integration of the acceleration pulse) shall be within the limits Vi ± 0.1 Vi where Vi is the velocity change associated with the ideal pulse which equals 2 AD/π. The integration to determine velocity change shall extend from 0.4D before the pulse to 0.1D after the pulse.
2. Amplitudes "A" and durations "D": a) 100 g's, 1 to 3 milliseconds
   b) 40 g's, 3 to 5 milliseconds

Figure 21. Half sine shock pulse configuration and its tolerance limits



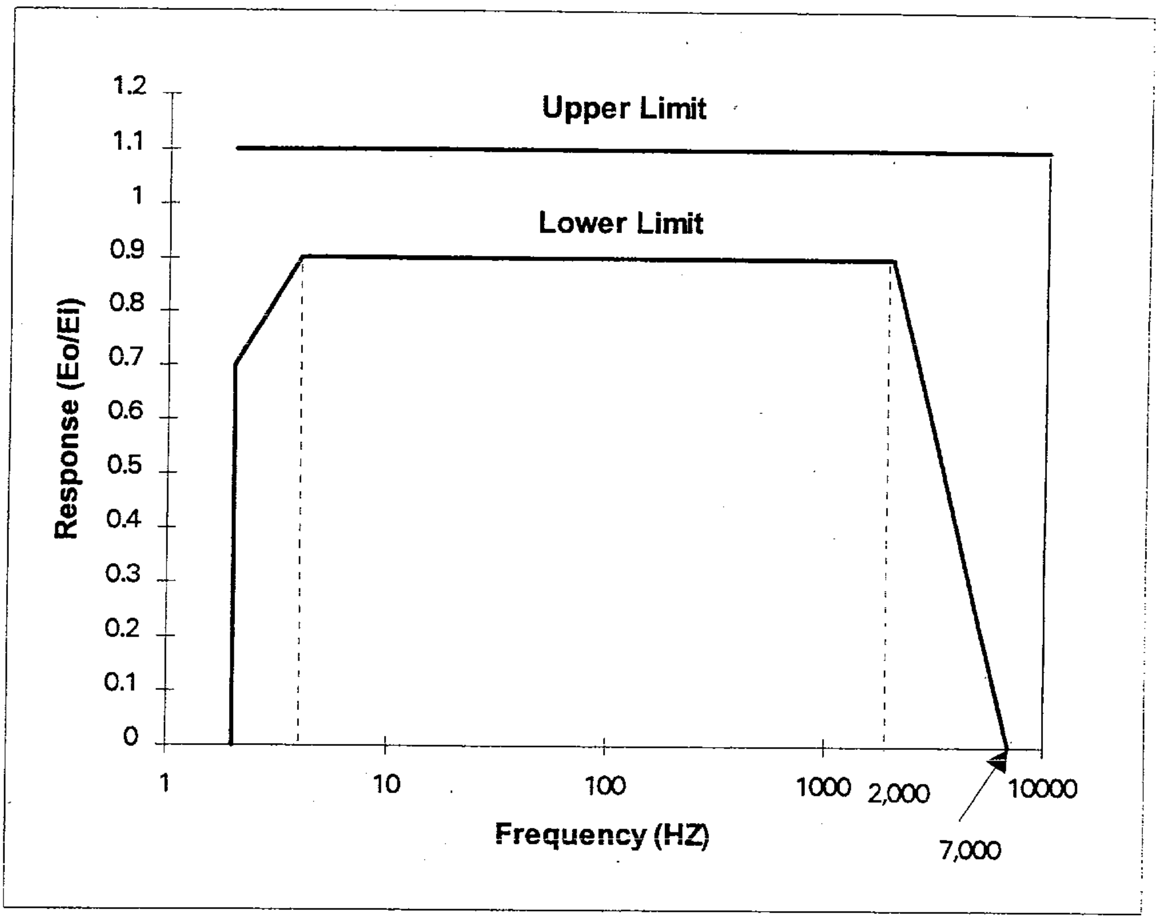


Figure 22. Shock measuring system frequency response

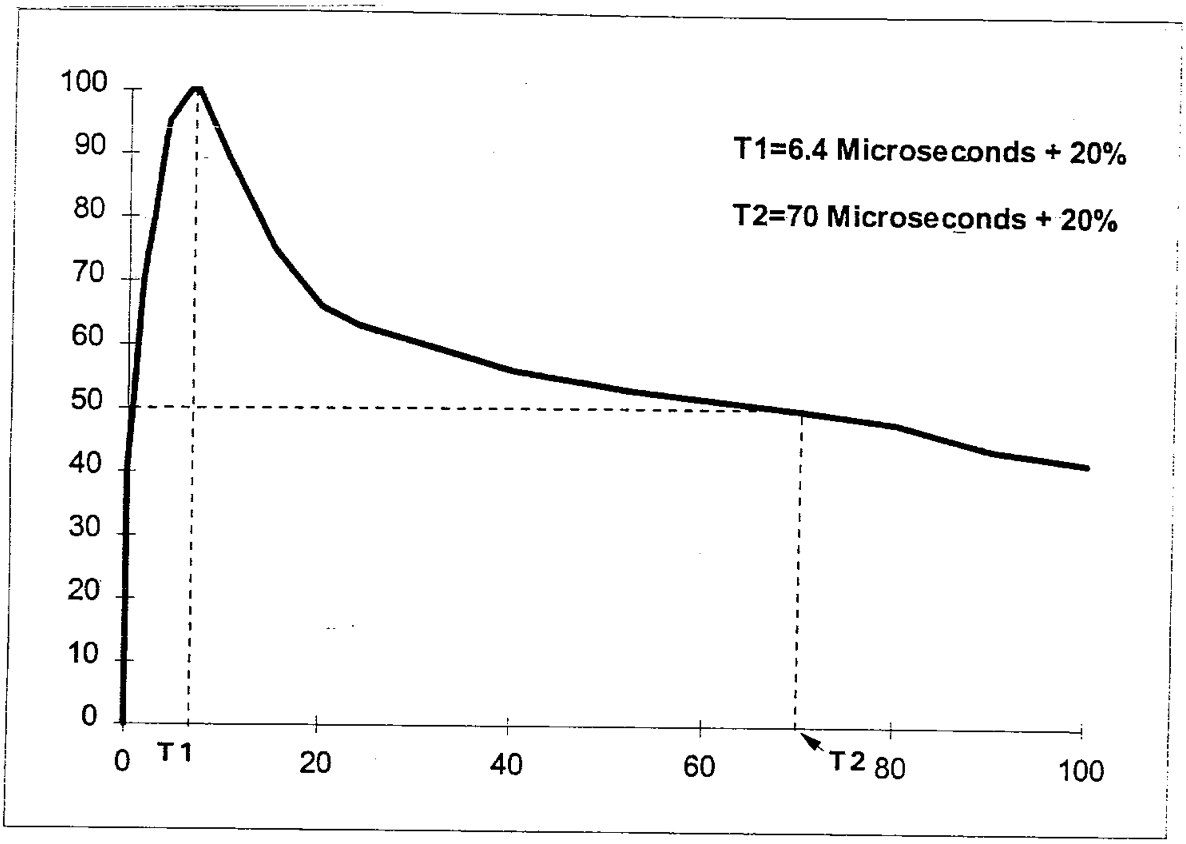


Figure 23. Double exponential voltage waveform

RISK MATRIX

(HAZARD SEVERITY AND LIKELIHOOD OF OCCURRENCE WITH CONTROLS IN PLACE)

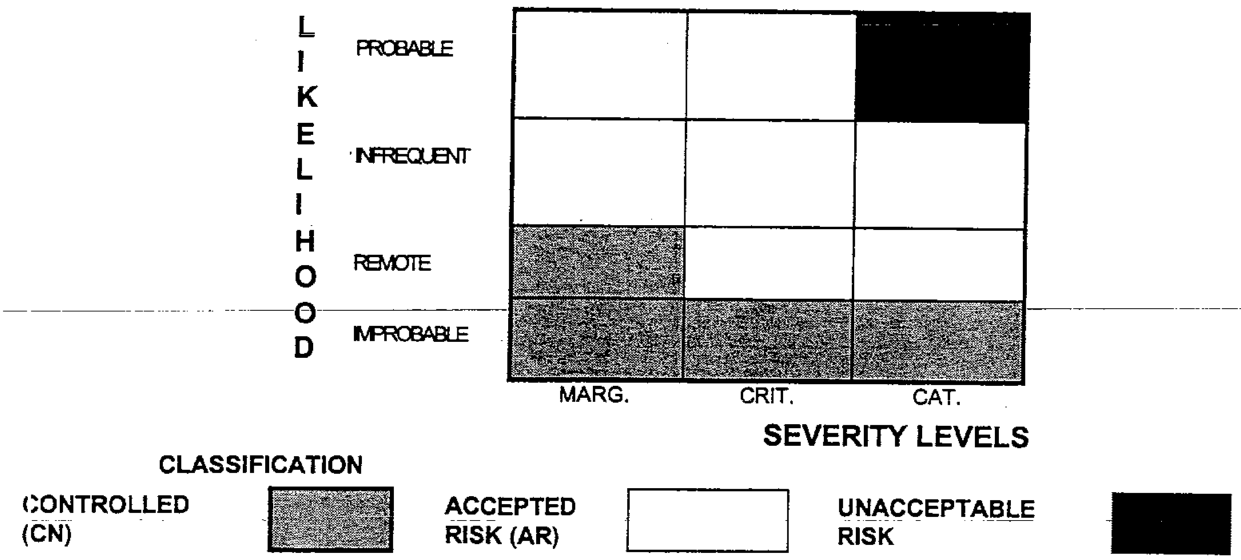


Figure 24. Risk matrix

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Appendix I

10. BRASSBOARD

10.1 SCOPE

This appendix establishes the performance, design development, and verification requirements for the Brassboard model of the APDS.

10.2 APPLICABLE DOCUMENTS

N/A

10.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

10.3.1 Item Definition

The Brassboard shall be a complete representation of the Energia Docking System in regard to form, fit, and function. The Brassboard shall demonstrate the capability to meet electrical and mechanical performance requirements for docking and undocking operations. The pyrotechnic release devices shall be replaced by inert devices which are electrically equivalent. The Brassboard need not be certified for flight must be of a quality sufficient to be operated with flight hardware and must match the flight configuration.

The Brassboard consists of the following subsystems;

A. Androgynous Peripheral Docking Assembly (-6001 configuration)

B. Docking System Control Unit

C. Power Switching Unit

D. Latch Actuator Control Unit

E. Docking Mechanism Control Unit

F. Pyro Firing Control Unit

G. Pressurization Actuator Control Unit (2 units)

H. Data Collection Unit (2 units)

I. Docking Control Panel

J. System Interconnecting Wiring

K. Pallet Interconnecting Wiring

L. Pigtailed Harness Assemblies

M. Switching System (Connector Switch Box and associated cables)

10.3.1.1 Functional Definition

The Brassboard shall use simulated Orbiter power and telemetry systems to demonstrate the following:

A. Ability to capture the ISS spacecraft at the Docking System Passive Capture Ring

B. Ability to perform a docking and undocking sequence (i.e. capture, retract, structural mate)

C. Ability to meet the APDS design performance requirements of the Avionics Units including power switching and controls, fault detection and annunciation, data collection, system redundancy, operation at all power levels, system inhibits and monitors, system grounding, and manual backup to automated sequences.

D. Ability to meet EMC qualification requirements. The qualification testing will be conducted by Buyer at Buyer's facility.

10.3.1.1.1 Item Diagram

A simplified functional block diagram of the Brassboard is illustrated in Figure 10-A.

10.3.1.2 Interface Definition

10.3.1.2.1 Electrical Power Characteristics

The requirements of 3.1.2.1 of the basic specification apply.

10.3.1.2.2 Mechanical Interface

The requirements of 3.1.2.2 of the basic specification apply except for the APDA: mounting provisions shall be provided for the APDA.

10.3.1.2.2.1 Connectors

The Brassboard shall have connector locations and pin assignments as shown in the applicable appendices of the items identified in 10.3.1.

10.3.1.2.3 Cooling

Cooling air shall not be required for the Avionics Units provided the Brassboard is not powered on continuously for longer than 4 hours with minimum 30-minute power-off intervals.

10.3.1.2.4 Instrumentation

The requirements of 3.1.2.4 of the basic specification apply.

10.3.1.3 Item Identification

The Brassboard shall be identified as follows:

Nomenclature	Buyer Part No.	Seller part No. Level	Maintenance
APDA	MC621-0087-9003	33U.6201.009-103	Line Replaceable Unit
DSCU	MC621-0087-2002	33U.5212.005-02	Line Replaceable Unit
PSU	MC621-0087-2003	33U.5114.007-02	Line Replaceable Unit
LACU	MC621-0087-2004	33U.5212.007-02	Line Replaceable Unit
DMCU	MC621-0087-0005	33U.5212.011	Line Replaceable Unit
PFCU	MC621-0087-0006	17KS.10Yu.2601A-0	Line Replaceable Unit
PACU	MC621-0087-0007	33U.5212.006	Line Replaceable Unit
DCU	MC621-0087-0008	TA 082	Line Replaceable Unit
DCP	MC621-0087-0009	SLIYu.468312.001	Line Replaceable Unit
Pigtail wire sets	N/A	SLIYu.374511.010	Line Replaceable Unit
		SLIYu.374511.011	Line Replaceable Unit
		SLIYu.374511.018	Line Replaceable Unit
		SLIYu.374511.019	Line Replaceable Unit
CSB	MC621-0087-0011	SLIYu.642522.001	Line Replaceable Unit

10.3.1.3.1 The APDA and all pallet Line Replaceable Units shall be permanently and obviously identified with the words "ENG TEST ONLY," in addition to the identification required by the Drawing or Specification to preclude use on production items. The letters shall be indelible and provide a distinctive and vivid contrast with the color of the specimen. The lettering size and identification location shall be clearly visible to the casual observer. Materials used for the identification shall be compatible with the test specimen and its operating environment. When the size or configuration of the test specimen is such that identification cannot appear on the specimen, other suitable means such as attached metal tags shall be used.

10.3.2 Characteristics

10.3.2.1 System Performance

10.3.2.1.1 Life

The APDS Brassboard shall be designed to provide the most cost effective life capability, considering minimum maintenance and refurbishment and its intended usage.

10.3.2.1.1.1 Operating Life

The APDS Brassboard shall be capable of performing all operations specified herein for a minimum of 500 docking/undocking simulation cycles for the mechanical components and 4,000 hours for the Avionics Units. Scheduled maintenance of time/cycle sensitive components shall be permitted as a means to meet this requirement.

10.3.2.1.1.2 Performance

The APDS Brassboard shall be capable of meeting all performance requirements specified in the applicable Line Replaceable Unit appendices II through X, XIII and XIV.

10.3.2.1.1.3 Useful Life

The APDS Brassboard shall have a useful life, with maintenance, of 4000 hours.

10.3.2.1.2 Design Approach

The requirements of 3.2.1.2 of the basic specification apply except that the system need not be certified for flight.

10.3.2.1.3 Docking Operations Termination

The requirements of 3.2.1.5.1 of the basic specification apply.

10.3.2.1.4 Time Critical Separation

The requirements of 3.2.1.5.2 of the basic specification apply.

10.3.2.1.5 Inhibit

The requirements of 3.2.1.6 of the basic specification apply.

10.3.2.1.6 Health Status

The requirements of 3.2.1.7 of the basic specification apply.

10.3.2.2 Physical Characteristics

The requirements of 3.2.2 of the basic specification apply except as follows:

10.3.2.2.1 Envelope

The envelope of the Brassboard shall be in accordance with Appendices II through X, XIII, and XIV.

10.3.2.2.2 Weight

The weight of the Brassboard shall be minimized wherever possible.

10.3.2.2.3 Insulation Resistance

The insulation resistance of all Brassboard LRUs shall be in accordance with 3.1.2.1.6.5 of the basic specification.

10.3.2.2.4 Dielectric Strength

The Brassboard LRUs shall be capable of withstanding voltage in accordance with 3.1.2.1.6.6 of the basic specification.

10.3.2.3 Reliability

The requirements of 3.2.3 of the basic specification apply, except for 3.2.3.3 and 3.2.3.8.

10.3.2.4 Environments

The Brassboard shall be capable of operating in the standard test environment specified in 4.1.2.1 of the basic specification.

10.3.2.5 Transportability

The requirements of 3.2.6 of the basic specification apply.

10.3.3 Design and Construction

The requirements of 3.3 of the basic specification apply.

10.4 QUALITY ASSURANCE PROVISIONS

10.4.1 General Requirements

The requirements of 4.1 of the basic specification apply except no environmental testing is required.

10.4.2 Quality Conformance

The requirements of 4.2 of the basic specification apply except as follows.

10.4.2.1 Acceptance

Acceptance tests and inspections shall be performed on all Brassboards units delivered to the Buyer. The Seller shall perform any other tests deemed necessary, subject to approval by the Buyer. These acceptance tests and inspections shall be performed to demonstrate that specified requirements have been met. Prior to delivery and as a condition of acceptance, the Seller shall conduct the acceptance inspections and tests on each Brassboard unit as specified for the corresponding flight units in the Appendices of this document.

10.4.2.2 Certification

The Brassboard elements must be of quality sufficient to be used with flight hardware.

10.5 PREPARATION FOR DELIVERY

The requirements of Section 5 of the basic specification apply.

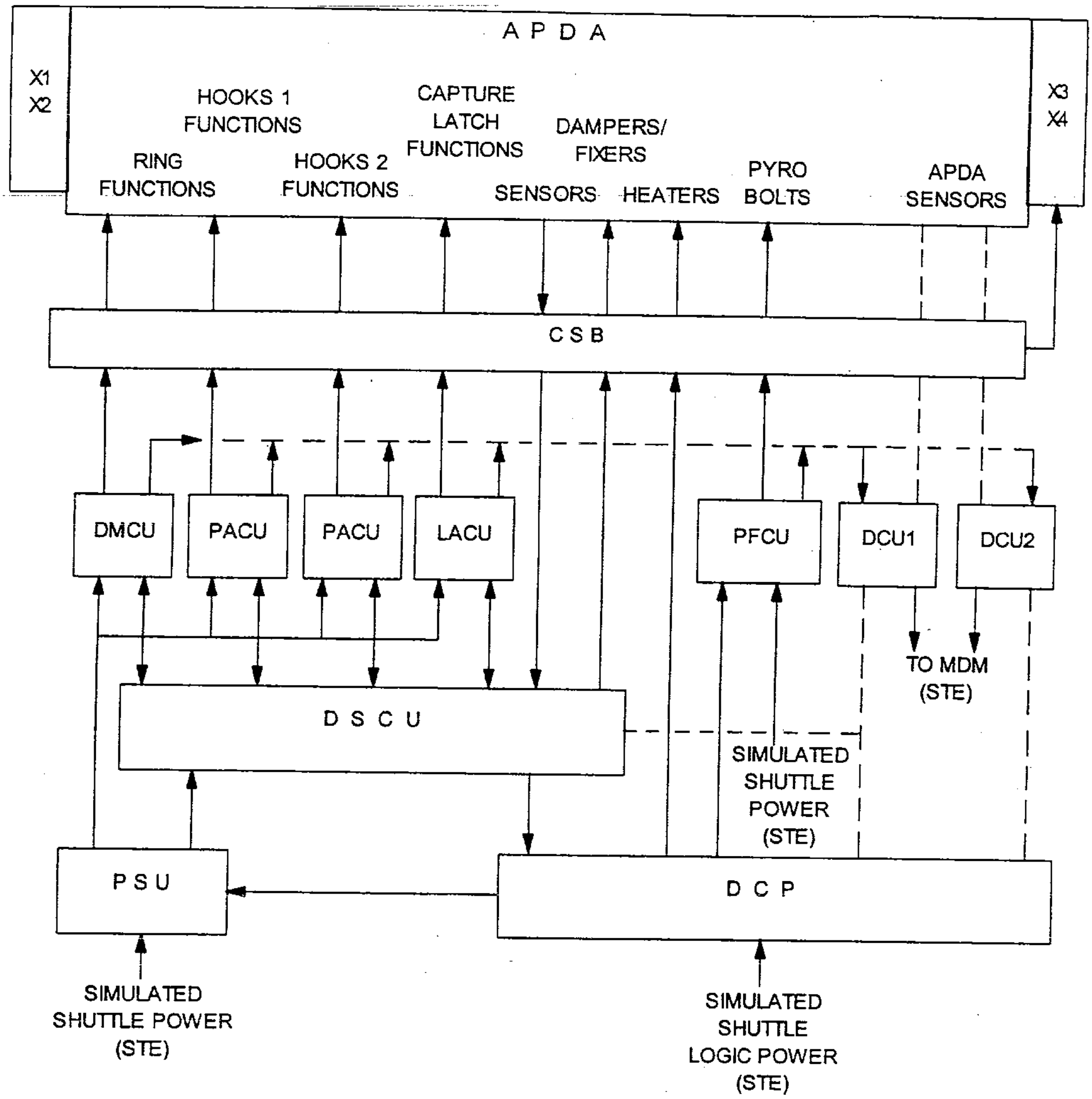


Figure 10-A. Brassboard item diagram

Appendix II

20. ISS ANDROGYNOUS PERIPHERAL DOCKING ASSEMBLIES (APDAs)

20.1 SCOPE

This appendix establishes the performance, design, development and verification requirements for the APDA active and passive APDA subassemblies.

20.2 APPLICABLE DOCUMENTS

The requirements of Section 2 of the basic specification apply.

20.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

20.3.1 Item Definition

The Passive and Active APDAs shall consist of the structure and mechanisms needed to capture, structurally attach and seal the active and passive docking halves. The mated systems shall provide for crew and equipment transfer and IVA between vehicles.

APDA-3002 (Orbiter Active - Mission 2A), APDA -6001 (Orbiter Active), and APDA -7001 (ISS Active) shall include the structure and guide ring and the capture latch, structural hook and extend/retract/attenuation mechanisms. The active APDAs shall be capable of providing compliance with 6 degrees of freedom. APDA -6001 shall have pyrotechnic release devices for the structural hooks. Except as specified otherwise in this Appendix, APDA-3002 (Orbiter Active - Mission 2A) shall be built in accordance with the requirements of JSC-26877. The other active APDSs shall be built in accordance with the requirements of this Appendix.

APDA -8001 (ISS Passive) shall include the structure and stationary guide ring, and the structural hook mechanism. The -8001 APDA shall not have pyrotechnic release devices for the structural hooks.

The axes of the docking system shall be referenced in this Appendix as X_T, Y_T and Z_T and correspond with Orbiter axes Zo, Yo and -Xo, respectively, as shown in Figures 20-A, B, C, and D. Figures 20-A, B, C, and D show the active and passive docking APDAs for the Orbiter and ISS.

20.3.1.1 Subsystem Definition

The APDA as shown in Figures 20-A, B, C, and D consists of the following subsystems;

I. APDA -6001 and -7001

   A. Structural Hook Mechanism
   B. Structure (Base, Guide Ring, and Seals)

C. Resource Electrical Connectors
D. Indicators
E. -Undocking Sensors, Temperature Sensors, Hook Status Sensors, Capture Sensors
F. Heaters
G. Pushers
H. Capture Latch Mechanism
I. Extend/Retract and Attenuation Mechanism
J. Pyrotechnic Release Device (-6001 only)
K. The pyrotechnic release device is addressed as a separate Line Replaceable Unit in Appendix XII.

II. APDA -8001
A. Structural Hook Mechanism
B. Structure (Base, Stationary Guide Ring, and Structural Seals)
C. Resource Electrical Connectors
D. Indicators
Undocking Sensors, Temperature Sensors, Hook Status Sensors, Capture Sensors, Hatch Sensors
E. Heaters
F. Pushers
G. Hatch Assembly with Docking Target
H. Laser Reflector
I. Pressure Equalization Valve
J. Data Buss Switch

20.3.1.1.1 Functional Definition

APDA -6001 and -7001 shall perform all primary functions. APDA -8001 shall have the capability to perform back-up structural latching and unlatching. The APDA shall:

. APDA -6001 and -7001

A. Capture the passive APDA body mounted capture latches.
B. Attenuate docking loads during capture and attenuation, and limit the relative vehicle motions.
C. Align, structurally attach and seal the active and passive APDAs.
D. Provide IVA passageway
E. Provide for the demating of the spacecraft.
F. Allow for termination of docking operations and separation of vehicles at any point in the docking process and shall not prevent the remating of the vehicles during the same mission.
G. Allow for resource transfer between vehicles

II. APDA -8001

A. Align and structurally attach the active and passive APDAs.
B. Provide IVA passageway
C. Provide for the demating of the spacecraft.
D. Allow for termination of docking operations and separation of vehicles at any point in the docking process and shall not prevent the remating of the vehicles during the same mission.

E. Allow for resource transfer between vehicles
F. Provide for pressurization equalization through the hatch
G. Provide capability to close the ISS data buss loop upon demating.

20.3.1.2 Interface Definition

20.3.1.2.1 Electrical Power Characteristics

The requirements of paragraph 3.1.2.1 of the basic specification apply except as follows:

20.3.1.2.1.1 Electrical Interface

The electrical interfaces of the Orbiter to the -3002 and -6001 APDAs shall be in accordance with Figures 20-A and B. The electrical interfaces of the ISS to the -7001 and -8001 APDAs shall be in accordance with Figures 20-C and D.

20.3.1.2.1.2 Electrical Interface Connectors

Electrical connections between the -3002 and -6001 APDAs and the Orbiter shall be located according to Figures 20-A and B. Electrical connections between the -7001 and -8001 APDAs and the ISS shall be located according to Figures 20-C and D. Connectors and pin assignments at these interfaces, for other than resource transfer, are shown in Tables 20-I, J, K, and L.

20.3.1.2.1.3 Resource Transfer Umbilicals

The four resource transfer umbilicals, referred to herein as X1 through X4, shall be mounted along the external surface of the APDA structure (base) per Figures 20-A, B, C, and D. The resource transfer pin assignments and functions for the -6001 and -8001 APDAs shall be per Tables 20-G-1 and -2. The resource transfer pin assignments for the -7001 APDA shall be as specified in Tables 20-G-3 and 20-G-4. The connectors shall be engaged and disengaged by operation of the mechanism. The pins shall be disengaged prior to completion of structural hook opening.

20.3.1.2.1.3.1 Umbilical Circuit Protection

For the power transfer circuit of the X1 and X2 umbilicals, circuit protection requirements may be met as shown in Figures 20-D and 20-E. Each individual wire of the power circuit (+, -, fault bond) shall be double insulated and each bundle of wires shall be wrapped double thickness.

20.3.1.2.2 Mounting

The mounting provisions of the APDAs shall be as shown in Figures 20-A, B, C, and D.

20.3.1.2.3 APDA/Orbiter Interface

The -3002 APDA/Orbiter interface and -6001 APDA/Orbiter interface shall be in accordance with Figures 20-A and B.

20.3.1.2.4 APDA/ISS Interface

The -7001 APDA/ISS interface and -8001 APDA/ISS interfaces shall be in accordance with Figures 20-C and D.

20.3.1.2.5 Active APDA/Passive APDA Interface

The active and passive APDAs shall be designed to mate under the loads, relative velocities, and relative misalignments of Table 20-A.

20.3.1.2.6 Pressure

20.3.1.2.6.1 Maximum Operating Pressure

The APDA structure shall be able to withstand and maintain a maximum operating pressure delta of 1.12 kg-force/cm^2 (16.0 psi) from the APDA interior to exterior.

20.3.1.2.6.2 Maximum Allowable Working Pressure

The APDA structure shall be able to withstand and maintain a maximum allowable working pressure delta of 1.05 kg-force/cm^2 (14.9 psid) from the APDA interior to exterior.

20.3.1.2.6.3 Minimum Allowable Working Pressure

The APDA structure shall be able to withstand and maintain a minimum operating pressure delta of 0 kg-force/cm^2 (0 psid) from the APDA interior to exterior.

20.3.1.2.6.4 Pressure Seal

20.3.1.2.6.4.1 Total Leak Rate

The total (combined) leak rate of a mated passive and active APDA blanked at each end (with passive APDA hatch open or closed) is not to exceed 0.045 kg-mass/day (0.1 lbs/day) at pressure of 1.03 ± 0.02 kg/cm^2 (14.7 ± 0.3 psid) internal to external.

20.3.1.2.6.4.2 Sealed Interfaces

Seals utilized in line installations or other sealing devices shall include back-up.

I. APDA -6001 and -7001
   - A. base installation interface seals
   - B. mating seals

II. APDA -8001
   - A. base installation interface seals
   - B. hatch seals

20.3.1.2.7 Seal Characteristics

-TBD

20.3.1.3 Item Identification

The APDA and pyrotechnic subassembly shall be identified as follows:

Nomenclature	Buyer Part No.	Seller Part No.	Maint. Level
Active APDA	MC621-0087-3002	33U.6201.008-05-005	LRU
Active APDA	MC621-0087-6001	33U.6201.008-09	LRU
Active APDA	MC621-0087-7001	33U.6201.008-05-004	N/A
Passive APDA	MC621-0087-8001	33U.6201.008-08	LRU
Pyrotechnic Release Device		(See Appendix XII)	

20.3.2 Characteristics

20.3.2.1 Performance Characteristics

The requirements of section 3.2.1 of the basic specification apply except as follows.

20.3.2.1.1 Life

The requirements of Section 3.2.1.1 shall apply, except that the pressure equalization valve of APDA -8001 need only meet the life requirements of 20.3.2.2.19, and the hatch mechanism of APDA-8001 need only meet the life requirements of 20.3.2.2.18.2.

20.3.2.1.2 CG and Moment of Inertia

The center of gravity (CG) of the mechanism shall be determined in three axes from a defined reference datum shown in Figures 20-A, B, C, and D. The moments of inertia shall be calculated about the CG of the APDA.

20.3.2.1.3 Forces, Moments and Dynamic Excursion Limit

The APDA shall limit the mating forces, moments and dynamic excursions at the interface to those defined in Table 20-A with the spacecraft mass properties defined in Tables 20-E and 20-F.

20.3.2.1.4 Vehicle Undocking

The four separation plungers (two on each system) shall induce an initial separation force of 250 kgf (551 lbs) minimum and 270 kgf (595 lbs) maximum. To demate, the work (energy) applied shall be between 4.0 kgf-m (28.9 ft-lbs) and 4.3 kgf-m (31.1 ft-lbs).

20.3.2.2 Physical Characteristics

The requirements of Section 3.2.2 of the basic specification apply except as follows:

20.3.2.2.1 Envelopes

20.3.2.2.1.1 APDA

The envelope of the APDAs shall not exceed the dimensions shown in Figures 20-A, B, C, and D. The APDA shall provide a minimum clear internal structural diameter of 29.5 inches.

20.3.2.2.1.2 Interface Hardware

20.3.2.2.1.2.1 Resource Transfer Umbilicals

The envelope of the resource transfer umbilicals shall not exceed the dimensions shown in Figures 20-A, B, C, and D.

20.3.2.2.1.2.2 Laser Reflector

The envelope of the -8001 APDA Laser Reflectors shall be as shown on Figure 20-D.

20.3.2.2.1.2.3 Docking Target

The envelope of the -8001 APDA Docking Target shall be as shown on Figure 20-D.

20.3.2.2.1.2.4 Data Bus Transfer Switches

The envelope of the data bus terminator switches on the -8001 APDA shall be as shown on Figure 20-D.

20.3.2.2.2 Weight

The weight of the resource transfer umbilicals, panels, and mounting hardware shall not exceed 9.1 kgf (20 lbs). The weight of the laser reflector shall not exceed 0.5 kgf (1.1 lbs). The weight of the APDAs, not including the resource transfer umbilicals and the laser reflector, shall not exceed the following:

A. -6001 300.0 kg

B. -8001: 210.0 kg

C. -7001: 300.0 kg

20.3.2.2.3 Strength

The APDA shall have adequate strength and stiffness at the design temperature to withstand limit loads and pressures without detrimental yielding and ultimate loads and pressures without failure. The load combinations are defined in Table 20-A. The APDA shall exhibit a minimum margin of safety equal to zero.

20.3.2.2.4 Factors of Safety

The requirements of Section 3.3.9.13 of the basic specification apply.

20.3.2.2.5 Fracture Control

In addition to the ultimate factors of safety, designs shall consider the presence of sharp cracks, crack-like flaws or other stress concentrations in determining the life of the structure for sustained loads and cyclic loads coupled with environmental effects. This is applicable to parts that if they fail would cause a catastrophic hazard.

20.3.2.2.6 Fatigue

Safe life design shall be adopted for all major load carrying structure. The structure shall be capable of surviving without failure a total number of mission cycles that is four times greater than the total number of mission cycles expected in service (shown by analysis or by test through a rationally derived cyclic loading and temperature spectrum). This does not preclude a fail-safe design approach.

20.3.2.2.7 Creep

The design shall preclude creep which could lead to rupture, detrimental deformation or creep buckling of compression members during their service life.

20.3.2.2.8 Insulation Resistance

The insulation resistance value between any isolated circuit and the case or enclosure shall be 20 megohms minimum using a potential of 100 Vdc under normal conditions. The insulation resistance shall be measured between mutually insulated parts with all power sources and loads disconnected.

20.3.2.2.9 Dielectric Strength

The APDA shall be capable of withstanding 200 Vac for 1 second. There shall be no arc-over or leakage greater than 100 milliamperes. The Seller's installation drawing and other applicable documents shall include any necessary caution notes regarding dielectric or other test voltages with regard to connected terminals, terminals across capacitors, integrated circuits, semiconductors and other polarity sensitive devices. Buyer must approve any variation with this requirement.

20.3.2.2.10 Exterior Surface Finish

Interacting surfaces shall be sufficiently smooth and wear resistant such that particle generation will not preclude the normal functioning of the item as specified herein.

20.3.2.2.11 Cycle Definition

For purposes of life certification, as defined in 20.3.2.1.1, one APDA cycle is defined to include one capture latch operational cycle (per 20.3.2.2.12.1.6), one structural hook operational cycle (per 20.3.2.2.12.2.8), and one attenuation mechanism operational cycle (per 20.3.2.2.12.3.12).

20.3.2.2.12 Subsystem Requirements

The following sections describe the requirements of each mechanical subsystem as an installed subsystem of the APDA.

20.3.2.2.12.1 Capture Latch Mechanism

APDA -6001 and -7001 shall be equipped with capture latches. The capture latch mechanism consists of two roller/latch assemblies on each of three guides. Each latch pair is driven by a single motor to the initial and released positions. APDA -8001 shall be equipped with body mounted latches.

20.3.2.2.12.1.1 Load/Stroke

A. The combined compression force required to depress the three capture latch roller pairs in the capture position and three capture latch sensors shall not exceed 16 kg.

B. With the capture latches in the released position, the axial load to disengage (separate) shall not exceed 12 kgf.

C. The capture latches and body latches shall engage with 2.0 +/- 0.1 mm clearance between the guide rings.

D. When captured, displacement of the rings along the Y_T and Z_T axes shall be 3 mm max.

E. The gap between the guide rings shall be from 0 to 3 mm at aligned rings with no load, and 4 mm max with 150 +/- 20 kgf applied in tension along X_T axis.

F. Capture latches shall unlock with total axial force of 2100 ± 100 kgf applied in tension and 23 Vdc applied to the motor.

20.3.2.2.12.1.2 Limit Load

With the mechanism in the initial position, the capture latches and the body latches while engaged shall be able to withstand a 500 kgf-m moment and a 2200 kgf. axial load independently applied without release or degradation of performance capability.

20.3.2.2.12.1.3 Ultimate Load

With the mechanism in the initial position, the capture latches and the body latches while engaged shall be able to withstand a 700 kgf-m moment and a 3000 kgf axial load independently applied without release or degradation of performance capability.

20.3.2.2.12.1.4 Load Application Angle

The angle of load application required to trip the capture latches to release shall be 0° (parallel to the guide surface) to 5° minimum.

20.3.2.2.12.1.5 Speed/Rate

The time to operate from the release to the latch position, or from the latch to the release position shall be 10 seconds max under any operating condition. Motor current operating with no load not to exceed 0.13 A per motor.

20.3.2.2.12.1.6 Operational Cycle

An operational cycle is defined as operating the latch to the capture position, capturing, withstanding attenuation and retraction loads and operating to the release position.

20.3.2.2.12.1.7 Stall/Max Load

The maximum output torque of the motor shall not exceed the limit load of the mechanism.

20.3.2.2.12.1.8 Aiding Load

An aiding limit load on the capture latch shall not cause overspeeding resulting in motor damage.

20.3.2.2.12.1.9 Irreversibility

The capture latch shall be irreversible to the limit load.

20.3.2.2.12.1.10 Manual Release

The capture latch mechanism shall provide means for manual release as an intravehicular activity (IVA) by a shirtsleeve or EMU-suited crew member using special tools. When the capture latches are manually released, three initial position sensors must activate upon separation.

20.3.2.2.12.2 Structural Hook Mechanism

The structural hook mechanism shall consist of twelve hooks driven in two sets of six hooks comprising alternate hooks. Each set is driven with an actuator with redundant motors powered through a pulley and cable system to the hooks. Each actuator shall consist of redundant motors driving the output through a reduction unit. The redundant motors shall operate concurrently and failure of either motor shall not affect the output torque or the operation of the remaining motor, but the actuator rate may be reduced by 50%. Each of 12 hook locations shall have a passive and an active hook. APDA -6001 only shall have the capability to release both active and passive hooks pyrotechnically (Reference Appendix XII). Each active hook shall be equipped with a micro switch capable of indicating the closed position of the hook. Orbiter electric power to active hooks on APDA-8001 shall automatically shut off 1 second after receipt of function inhibit signal.

20.3.2.2.12.2.1 Load/Stroke

A. The 12 structural hooks on the APDA shall be capable of sealing the active and passive APDA with 40500 to 57000 kgf load.

B. Clearance between the hook and the interface plane while the hooks are in the intermediate position shall be 4.8 mm.

C. When the structural hooks are latched with no delta pressure, the clearance between the seal interfaces shall be 0.2 mm max on the whole perimeter of the inner side and 0.8 mm max on the whole perimeter of the outer surface.

D. Maximum seal interface deflection shall be less than 0.5 mm at the outer diameter of the interface surface with a delta pressure of 1.12 kg/cm^2 combined with mated loads on Table 20-A-2.

20.3.2.2.12.2.2 Limit Load

The structural hooks shall be capable of operating to latch and release as well as maintaining a structural and pressure seal under the mated loads specified in Table 20-A-2.

20.3.2.2.12.2.3 Ultimate Load

The structural hooks shall be capable of withstanding a maximum opposing load of 1.5 x the limit load when in the "latched" position without failure.

20.3.2.2.12.2.4 Stall/Maximum Load

The maximum output torque of the actuator shall not exceed the limit load of the mechanism.

20.3.2.2.12.2.5 Aiding Loads

An aiding limit load on the structural hook shall not cause overspeeding or increase the stopping direction during operation.

20.3.2.2.12.2.6 Irreversibility

The structural hooks shall be irreversible to the limit load.

20.3.2.2.12.2.7 Speed/Rate

The operating time of the structural hooks at 27 +7/-4 Vdc shall be as follows:

Ambient temperature, No Load

Function	Dual Motor		Single Motor	
	time, s	current, A	time, s	current, A
latch to unlatch	280	.54	500	.27
unlatch to latch	280	.54	500	.27

Operating Temperature, Operating Load

Function	Dual Motor		Single Motor	
	time, s	current, A	time, s	current, A
latch to unlatch	320	.8	500	0.45
unlatch to latch	360	1.3	600	0.65

20.3.2.2.12.2.8 Operational Cycles

An operational cycle is defined as operating from the release position to the latch position and back to the release position. All specified times and currents shall be met.

20.3.2.2.12.2.9 Mechanical Stops

The mechanism shall include mechanical stops for end of travel limits. The mechanism shall be able to withstand 10 cycles into mechanical stops with both motors operating.

20.3.2.2.12.2.10 Pyrodevices

APDA -6001 shall be equipped with pyrodevices. Pyrodevices shall assure emergency undocking for all 12 active and 12 passive hooks. Reference requirements of Appendix XII.

20.3.2.2.12.3 Extend/Retract and Attenuation Mechanism

APDA -6001 and -7001 shall have extend/retract and attenuation mechanisms. The extend/retract and attenuation mechanism provides capability to extend and retract the guide ring as well as attenuate mating loads while the guide ring is in the initial position. The mechanism consists of a guide ring supported by three sets (six total) of ball screws which in turn are supported on the base assembly. The ball screws are attached by universal joints on each end. Adjacent ball screw sets are interconnected by means of a gearing between the universal joints. One screw in each set has a left hand helix thread with the other screw having a right hand helix to provide translational capability. The three output shafts of the ball screw sets are summed through three interconnected differentials into a single output which drives a spring assembly, friction brake (attenuator), and gearbox/motor/brake assembly. Three electronically operated locks (fixers) hold the ball screws in a synchronized condition during extend and retract. The ring is driven with an actuator that consists of redundant motors driving the output through a reduction unit. The redundant motors shall operate concurrently and failure of either motor shall not affect the output torque or operation of the remaining motor, but the actuator rate may be reduced by 50%. APDA -6001 and -7001 shall have different attenuation systems as specified in the following paragraphs.

20.3.2.2.12.3.1 System Stiffness and Damping Characteristics

The system level preload, stiffness, damping, slip limits, and stroke limits for three translational and three rotational axes in compression and tension shall be sufficient to meet the performance requirements in Table 20-A.

20.3.2.2.12.3.1.1 Axial Slip Clutch

A. APDA -6001
The clutch shall limit the axial load to 300 ±50 kgf excluding the effect of reflective inertia. The device shall be symmetrical with 300 ±50 kgf in both tension and compression. The device shall also be able to limit the axial load during retraction to 1900 +300, - 200 kgf.

B. APDA -7001
The clutch shall limit the axial load to 1000 ±200 kgf excluding the effect of reflective inertia. The device shall be asymmetrical with 1900 +300, - 200 kgf in tension and 1000 ±200 kgf in compression.

20.3.2.2.12.3.1.2 Shock Spring

For the -6001 APDA and -7001 APDA, the shock spring characteristics shall be as shown below with tolerance of ±10%.

TBD

20.3.2.2.12.3.1.3 Ball Screw Length

A. -6001 APDA
The length of each ball screw shall be TBD +55 mm.

B. -7001 APDA
The length of each ball screw shall be TBD.

20.3.2.2.12.3.1.4 Initial Position

The initial position of the -6001 and -7001 APDAs shall meet the requirements of Figures 20-B and C.

20.3.2.2.12.3.1.5 Guide Ring Dampers

A. -6001 APDA
The three dampers shall be electro-mechanically capable of being activated at 5 sec. after capture. The damping coefficient at the ball screw shaft shall be 2 kgf-cm/rad. The devices shall be able to remain energized throughout the attenuation phase until the ring-aligned signal is received and throughout ring extension to the forward position.

B. -7001 APDA
The damping coefficient at the ball screw shaft shall be TBD.

20.3.2.2.12.3.1.6 Guide Ring Centering Spring

A. -6001 APDA
The centering spring stiffness at the ball screw shaft shall be 2 kgf-cm/rad.

B. -7001 APDA
The centering spring stiffness at the ball screw shaft shall be 4.3 kgf-cm/rad.

20.3.2.2.12.3.1.7 High Energy Dampers

A. -6001 APDA
The high energy dampers shall be activated at 5 sec after capture and remain energized throughout the attenuation phase until the ring-aligned signal is received and throughout ring extension to the forward position.

B. -7001 APDA
The high energy dampers shall be activated at 5 sec after capture and remain energized for approximately 30 sec.

20.3.2.2.12.3.2 Load/Stroke

The mechanism shall operate from the final position (stowed) to the initial position (capture) to the forward position (extended), to the interface sealed position and back to the final position (stowed) under nominal operating loads as shown in Table 20-A.

20.3.2.2.12.3.3 Maximum Angle of Rotation

Maximum angle of rotation of the free guide ring (extended with the fixers unlocked) from the initial position to the mechanical stop shall be:

APDA	-6001	-7001
relative to X_T	17±2° at 300 kgf-m	10°±1° at 300 kgf-m
relative to Y_T	14±2° at 500 kgf-m	14°±2° at 500 kgf-m
relative to Z_T	14±2° at 500 kgf-m	14°±2° at 500 kgf-m

20.3.2.2.12.3.4 Rotational Applied Contact and Return Moments

Contact and return moments at rotation of the free guide ring shall be:

A. APDA -6001

Guide Ring Rotation	About X_T axis		About Y_T axis		About Z_T axis	
	Applied Contact Moment kgf-m	Return Moment kgf-m	Applied Contact Moment kgf-m	Return Moment kgf-m	Applied Contact Moment kgf-m	Return Moment kgf-m
Prior to Sensor Initiation *	40±20	35±20	30±15	25±15	25±15	20±10
2°±6'	70±20	60±15	35±15	30±15	30±15	25±10
10°±12'	100±25	90±20	40±15	35±15	40±15	35±15
14°±30'	140±25	130±25	MS	MS	MS	MS
17°±2°	180±35	140±35	MS	MS	MS	MS

Note: a) * At least one sensor shall be initiated within 1°18' maximum
b) Mechanical Stop (MS)

B. APDA -7001

Guide Ring Rotation	About X_T axis		About Y_T axis		About Z_T axis	
	Applied Contact Moment kgf-m	Return Moment kgf-m	Applied Contact Moment kgf-m	Return Moment kgf-m	Applied Contact Moment kgf-m	Return Moment kgf-m
Prior to Sensor Initiation *	45±20	40±20	30±15	25±15	25±15	20±10
2°±6'	85±20	70±15	35±15	30±15	30±15	25±10
8°±30'	120±25	110±25	---	---	---	---
10°±30'	MS	MS	40±15	35±15	40±15	35±15
14°	---	---	MS	MS	MS	MS

Note: a) * At least one sensor shall be initiated within 1°18' maximum
b) Mechanical Stop (MS)

20.3.2.2.12.3.5 Parallel Applied Contact and Return Forces

Contact and return forces parallel to the interface surfaces shall be:

A. APDA -6001

Guide Ring Displacement	Direction of Y_T axis		Direction of Z_T axis	
	Applied Contact Force kgf	Return Force kgf	Applied Contact Force kgf	Return Force kgf
Prior to Sensor Initiation *	50±25	45±15	50±15	45±15
50 mm	100±30	80±25	100±30	80±25
100 mm	140±50	110±50	120±50	90±40
150 mm	180±50	150±50	140±50	120±40
180±20 mm	200±50	170±50	160±50	130±50

* Note: Sensor initiation to be at 8 mm maximum

B. APDA -7001

Guide Ring Displacement	Direction of Y_T axis		Direction of Z_T axis	
	Applied Contact Force kgf	Return Force kgf	Applied Contact Force kgf	Return Force kgf
Prior to Sensor Initiation *	55±25	50±15	55±15	50±15
50 mm	110±30	90±25	110±30	90±25
100 mm	190±40	160±40	180±40	160±30

* Note: Sensor initiation to be at 8 mm maximum

20.3.2.2.12.3.6 Limit Load

The mechanism shall be capable of withstanding and attenuating the capture loads at the velocities and misalignments specified in Table 20-A-1. The mechanism shall be capable of retracting with 1700-2200 kgf after capture.

20.3.2.2.12.3.7 Ultimate Load

The mechanism shall be capable of withstanding ultimate loads equal to 1.4 x the limit loads.

20.3.2.2.12.3.8 Stall/Maximum Load

The maximum output torque of the actuator shall not exceed the limit load of the mechanism.

20.3.2.2.12.3.9 Aiding Loads

An aiding limit load on the mechanism shall not cause overspeeding or increase the stopping distance during operation.

20.3.2.2.12.3.10 Irreversibility

The mechanism shall be irreversible to the limit load in each operating position.

20.3.2.2.12.3.11 Speed/Rate

A. APDA -6001, Ambient Temperature, No-Load

Function	Dual Motor		Single Motor	
	time, s	current, A	time, s	current, A
final to initial	340	1.0	680	0.5
initial to forward	160	1.0	320	0.5
forward to final	500	1.0	1000	0.5

Operating Temperature, Operating Load

Function	Dual Motor		Single Motor	
	time, s	current, A	time, s	current, A
initial to ready to hook	400	3.2	800	1.6
ready to hook to final	85	3.2	170	1.6

B. APDA -7001, Ambient Temperature, No-Load

Function	Dual Motor		Single Motor	
	time, s	current, A	time, s	current, A
final to initial	220	1.0	440	0.5
initial to forward	110	1.0	220	0.5
forward to i/f sensor	280	1.0	560	0.5
i/f sensor to final	50	1.0	100	0.5

Operating Temperature, Operating Load

Function	Dual Motor		Single Motor	
	time, s	current, A	time, s	current, A
final to initial	220	3.2	440	1.6
initial to forward	110	3.2	220	1.6
forward to i/f sensor	270	3.2	540	1.6
i/f sensor to final	60	3.2	120	1.6

20.3.2.2.12.3.12 Operational Cycles

An operational cycle is defined as operating from the final (stowed) position to the initial (docking) position, exposure to capture and attenuation loads, to the forward (extended) position and back to the final (stowed) position according to the requirements of the automatic sequence under nominal operating loads.

20.3.2.2.12.3.13 Mechanical Stops

The extend/retract mechanism shall include mechanical stops for end of travel limits with both motors operating. Current of each motor not to exceed 2.5 A.

A. The ball screw mechanical stop shall be capable of resisting 500 kgf limit load applied along the ball screw longitudinal axis.

B. The shock spring mechanical stop shall be able to react the maximum guide ring actuator output in retraction through the slip clutch.

C. The hardstops shall be capable of resisting 500 kgf in interface translation.

D. Mechanical stops restraining the ring movement relative to the Y_T and Z_T axes should be capable of resisting torque loads of 500 kgf-m and about the X_T axis, 300 kgf-m maximum.

20.3.2.2.12.3.14 Ring Rotation Moment

20.3.2.2.12.3.14.1 Ring Rotation Moment about Y_T and Z_T axes (-6001 and -7001). The moment which occurs at ring rotation about Y_T & Z_T axes with velocity 0.2±0.05°/sec after engagement of three High Energy Dampers shall be as shown. Current of each High Energy Damper shall not exceed 3 A at any operating condition.

APDA -6001	APDA -7001
350±80 kgf-m	350±80 kgf-m

20.3.2.2.12.3.14.2 Ring Rotation Moment about X_T axis (-6001 only). The moment which occurs at ring rotation about X_T axis with velocity TBD°/sec after engagement of the three ring dampers shall be TBD.

20.3.2.2.12.3.15 Fixers

Five fixers shall be capable of stabilizing guide ring movement during extension and retraction.

20.3.2.2.12.3.15.1 With fixers on and the docking ring in the initial position, deflection of the guide ring in any lateral direction (the Y_T-Z_T plane) shall not be greater than 10 mm with a force of 150 kgf. At least one misalignment sensor shall activate.

20.3.2.2.12.3.15.2 With fixers on and the docking ring in the initial position, rotation of the guide ring with a moment of 100 kgf-m shall not be greater than 2°40' in the Y_T and Z_T axis and ·°12 about the X_T axes. At least one misalignment sensor shall activate.

20.3.2.2.12.3.15.3 Fixers that resist deflection shall resist up to 500 kgf in any direction parallel to seal interface

20.3.2.2.12.3.15.4 Fixers that resist rotation shall resist up to 350 kgf-m torque in any direction, about any axis.

20.3.2.2.12.3.15.5 The initiation current of each fixer at 27 +7/-4 V shall be 1.1 A max. for less than 0.5 seconds and 0.3 A maximum during operation

20.3.2.2.13 Commands

The APDA shall be designed to respond to commands listed in Table 20-B. Any additional commands required to operate the APDA shall be provided by the Seller.

20.3.2.2.14 Indications

Any additional indications required to operate the APDA shall be provided by the Seller

A. The active APDA shall be designed to provide the position indications listed in Table 20-B.

B. The passive mechanism shall provide capture, undocking complete, hatch closed status, structural hook gang open and closed indications and individual hook closed position indications to the Orbiter. Moding switches on the passive mechanism shall provide capture and undocking indications to the ISS. Four temperature measurements on the passive mechanism shall also be provided to the ISS. Indications are shown in Table 20-B.

Table 20-B. Command and Indication Requirements

COMMAND	EVENT	APDA -6001	APDA -7001	APDA -8001
Ring Out	Extend capture ring to initial position or final position	x	x	
Ring In	Retract capture ring to final position	x	x	
Open Hooks	Open structural hooks (System 1 & 2)	x	x	x
Close Hooks	Latch structural hooks (System 1 & 2)	x	x	x
Open Latches	Open capture latches to release position	x	x	
Close Latches	Latch capture latches to ready-to-capture position	x	x	
Fixer Off	Unlock fixers (5 ball screws and nut differentials)	x	x	
Undocking	Initiates undocking sequence	x	x	
Active Hooks Fire	Initiates pyros for 12 active hooks	x		
Passive Hooks Fire	Initiates pyros for 12 passive hooks	x		
Ring Initial Position	Capture ring ready to dock	x	x	

Table 20-B. (Continued)

INDICATION	EVENT	APDA -6001	APDA -7001	APDA -8001
Ring Final Position	Capture ring retracted. Final position sensors shall initiate if interface surface of ring is 4.5 + 3 mm lower than seal interface of assembly.	x	x	
Ring Aligned	Capture ring centered (5 sensors aligned) An 8 mm deflection or 1°18' rotation of the guide ring from the initial position, fixers off, parallel to the seal interface in any direction shall actuate one of the misalignment sensors.	x	x	
Ring Forward Position	Capture ring extended	x	x	
Hooks 1 Open	Structural hooks open (System 1, 6 hooks)	x	x	x
Hooks 1 Closed	Structural hooks closed (System 1, 6 hooks)	x	x	x
Hooks 2 Open	Structural hooks open (System 2, 6 hooks)	x	x	x
Hooks 2 Closed	Structural hooks closed (System 2, 6 hooks)	x	x	x
Hook Closed Position Indicator	Verifies closure of each active structural hook	x	x	x
Latches Closed	Capture latches ready to capture (3 latches)	x	x	
Latches Open	Capture latches released (3 latches)	x	x	
Latches Open (Manual)	Capture latches manually released	x	x	
Fixer Off	Fixers (5 ball screws & nut differentials) unlocked	x	x	
Ready - To - Latch	Seal interface within reach of structural hooks	x	x	
Undocking Complete		x	x	x
Interface Sealed	Structural seal compressed	x	x	
Initial Contact	Signal from any one of 5 alignment sensors	x	x	
Capture	Contact sensors on ring actuated	x	x	x
Linear Translation	Linear translation of guide ring	x	x	
Hatch Position	Verifies closed position of hatch			x
Temperature Sensors	Monitor temperature of various components			x

20.3.2.2.16 Optical Properties

The exposed surfaces of mechanism components shall have solar absorbitivities (α) and emissivities (ε) within ranges as follows:

Component	α	ε
Docking Mechanism Structure	$0.25 < \alpha < 0.45$	$0.60 < \varepsilon < 0.85$
Guide Ring and Petals	$0.25 < \alpha < 0.45$	$0.60 < \varepsilon < 0.85$
Capture Latch Mechanism (-6001 and -7001 only)	$0.25 < \alpha < 0.45$	$0.60 < \varepsilon < 0.85$
Capture Latches (-6001 and -7001 only)	n/a	$0.75 < \varepsilon < 0.90$
Ball Screws (-6001 and -7001 only)	n/a	n/a
Fiberglass fabric	$0.75 < \alpha < 0.90$	$0.80 < \varepsilon < 0.95$
Fluorocarbon and/or Beta Cloth	$0.20 < \alpha < 0.45$	$0.70 < \varepsilon < 0.90$
Antifriction surfaces	$0.80 < \alpha < 0.95$	$0.70 < \varepsilon < 0.85$

20.3.2.2.17 Capture Latch Heaters

For the -7001 and -6001 mechanisms, heater thermostats shall activate and deactivate heaters at temperatures ranging from 0 °C to 35 °C to maintain the thermal environment specified for APDAs in 3.2.5. Heater current at 27 +7/-4 V shall be 0.5 A max.

20.3.2.2.18 Hatch Assembly

The -8001 APDA shall include a hatch assembly capable of holding pressure as defined in Section 20.3.1.2.5. The hatch shall have mechanical latch mechanism and shall be capable of being manually closed or opened from each side. The hatch shall be installed such that pressure from the mounting interface will hold the hatch closed and sealed. The hatch will be installed so that the hinge is adjacent to petal guide number 3. A contingency pressurization equalization valve shall be mounted on the hatch. The hatch assembly shall have thermal insulation covering its exposed external (space-facing) surface.

20.3.2.2.18.1 Docking Target

The -8001 APDA hatch assembly shall include provisions for mounting a buyer supplied docking target on the external side of the hatch such that the target is in the center of the mechanism. Mounting interface shall be as shown on Figure 20- D. The Seller shall provide the target mounting fasteners. The fastener heads shall have a bead blast process performed to dull the finish and reduce glare.

20.3.2.2.18.2 Hatch Cycle Life

The -8001 APDA hatch assembly shall have an operational life of 107 cycles. A hatch cycle is defined as one opening and one reclosing and resealing.

20.3.2.2.19 Pressure Equalization Valve

The -8001 APDA shall include a pressure equalization valve mounted on the hatch that can be operated manually from the Orbiter side. This pressure equalization valve shall have an effective orifice size of 20 mm and shall be capable of holding pressure seal until the second docking mission.

20.3.2.2.20 Laser Reflector

The -8001 APDA shall include provisions for mounting three buyer supplied planar laser reflectors on the APDA structural flange. The laser reflectors shall be mounted on the APDA so that the center of the laser reflector is as shown on Figure 20- D.

20.3.2.2.21 Data Bus Transfer Switches

The -8001 APDA shall include provisions for mounting four Buyer-supplied data buss transfer switches, located per Figure 20-D. Wiring connections shall be per Table 20-K.

20.3.2.3 Reliability

The requirements of Section 3.2.3 of the basic specification apply.

20.3.2.4 Maintainability

The requirements of Section 3.2.4 of the basic specification apply.

20.3.2.5 Environments

APDA requirements of Section 3.2.5 of the basic specification apply.

20.3.2.6 Transportability

The requirements of Section 3.2.6 of the basic specification apply.

20.3.3 Design and Construction

The requirements of Section 3.3 of the basic specification apply.

20.4 QUALITY ASSURANCE PROVISIONS

20.4.1 General Requirements

The requirements of Section 4.1 of the basic specification apply.

20.4.2 Quality Conformance

The requirements of Section 4.2 of the basic specification apply.

20.4.2.1 Development

The requirements of Section 4.2.1 of the basic specification apply. Development tests shall be performed to verify the mechanical modifications made to the attenuation system of APDA -6001.

20.4.2.2 Acceptance

Acceptance tests and inspections shall be performed on all APDAs to be employed in qualification test programs and on all APDAs delivered to the Buyer. The seller shall perform any other tests deemed necessary, subject to approval by the buyer. These acceptance tests and inspections shall be performed to demonstrate that specified requirements have been met. Final acceptance tests and inspections shall be performed in a manner and under conditions which simulate end-use to the highest degree practicable without damage to the APDA. The degree, duration and number of tests shall be sufficient to verify that the quality required is present. Prior to delivery and as a condition of acceptance, the seller shall conduct the acceptance inspections and tests shown in Table 20-C on each APDA.

Table 20-C. Acceptance Requirements

Inspection and Test	Sequence	APDA	
		-6001/-7001	-8001
Examination of Product	20.4.2.2.1	x	x
Electrical Circuit Verification Test	20.4.2.2.2	x	x
Insulation Electrical Resistance Test	20.4.2.2.3	x	x
Dielectric Strength Test	20.4.2.2.4	x	x
Functional Performance Tests			
Guide Ring Test	20.4.2.2.5.1	x	
Fixer Test	20.4.2.2.5.2	x	
Interface Sensor Test	20.4.2.2.5.3	x	x
Structural Hook Test	20.4.2.2.5.4	x	x
Capture Latch Test	20.4.2.2.5.5	x	
Heater Test	20.4.2.2.5.6	x	x
High Energy Damper Test	20.4.2.2.5.7	x	
Instrumentation Calibration Test	20.4.2.2.5.8	x	x
Acceptance Vibration Tests	20.4.2.2.6	x	x
Loads Tests			
Axial Stiffness in Initial Position Test	20.4.2.2.7.1	x	
Retraction Force Test	20.4.2.2.7.2	x	
Restraining Force Test	20.4.2.2.7.3	x	
Body Latch Load Test	20.4.2.2.7.4		x
Capture Latch Force Test	20.4.2.2.7.5	x	
Capture Latch Unlatch Force Test	20.4.2.2.7.6	x	
Translation Capability Test-Y_T&Z_T axes	20.4.2.2.7.7	x	
Rotational Capability Test-Y_T&Z_T axes	20.4.2.2.7.8	x	
Rotational Capability Test-X_T axis	20.4.2.2.7.9	x	
Acceptance Thermal Vacuum Test	20.4.2.2.8	x	x
Hatch Function Test	20.4.2.2.9		x
Hatch and APDA Body Component Proof Pressure Test	20.4.2.2.10	x	x
Optical Properties Test	20.4.2.2.13	x	x
Weight Measurement	20.4.2.2.14	x	x

20.4.2.2.1 Examination of Product

Each APDA (and each APDA pyrobolt) shall be carefully examined to determine conformance to the requirements of this specification. Particular attention shall be given to weight, workmanship, finish, dimensions, construction, cleanliness, identification marking, level and that certified materials and processes have been used.

20.4.2.2.2 Electrical Circuit Verification Test

Verify that the resistance between contacts of electrical circuits and components is per the requirements of the electrical schematics.

20.4.2.2.3 Insulation Electrical Resistance Test

Measure insulation resistance to the case or enclosure and between mutually insulated parts using potential of 100 Vdc. Resistance to be equal to or greater 20 megohms.

20.4.2.2.4 Dielectric Strength Test

Test each electromechanical device at the component level (subassembly level testing is acceptable) to 200 Vac for 1 second. Verify no arc over or leakage greater than 100 milliamperes.

20.4.2.2.5 Functional Performance Tests

20.4.2.2.5.1 Guide Ring Test (APDA -6001 and -7001)

The APDA shall be cycled with both motors, no load, at 23 Vdc and 34 Vdc as follows:

-7001

Extend to Initial position
Actuate High Energy Dampers for 30 seconds
Extend to Forward Position with High Energy Dampers off
Retract to Final Position

-6001

Extend to Initial position
Actuate High Energy Dampers
Extend to Forward Position with High Energy Dampers on
Retract to Final Position with High Energy Dampers off

Time, travel limits, operating currents, command, instrumentation and indication requirements shall all be met.

20.4.2.2.5.1.1 No Back Functional

Perform a single motor operations at the actuator subassembly level to verify proper operation. Time, travel limits, operating currents, and indication requirements shall all be met.

20.4.2.2.5.2 Fixer Test (APDA -6001 and -7001)

Measure the current of each of 5 fixers operating individually at 23 Vdc and 34 Vdc. Checkout simultaneous operation of all 5 fixers. Initial current not to exceed 1.1 A for up to 0.5 sec, operating current not to exceed 0.3 A for each fixer.

20.4.2.2.5.3 Interface Sensor Test

A. APDA -6001 and -7001

Manually depress the Capture Sensors (3) to both the long and short positions. Also, depress the Ready to Latch Sensors (4), Interface Sealed Sensors (3), and Undocking Sensors (2). Verify proper operation and correct panel indications

B. APDA -8001

Manually depress the Capture Sensors (3) to both the long and short positions. Also, depress the Undocking Sensors (2), Hatch Sensors (3), Interface sealed sensors (3), and Data Bus Transfer Switches (4). Verify proper operation and correct panel indications

20.4.2.2.5.4 Structural Hook Test

Cycle both sets of the structural hook mechanism with both motors, no load at 23 V and 34 V to the open and closed positions. Time, travel limits, operating currents, command, instrumentation and indication requirements shall all be met. Requirements of paragraph 20.3.2.2.12.2.7 shall be met.

20.4.2.2.5.4.1 No Back Functional

Perform a single motor operation at the actuator subassembly level to verify proper operation. Time, travel limits, operating currents, and indication requirements shall all be met.

20.4.2.2.5.5 Capture Latch Test (APDA -6001 and -7001)

Cycle the capture latch mechanism with no load at 23 V and 34 V as follows:

A. Open and close each set of redundant hook

B. Open and close all three sets of latches simultaneously.

Time, travel limits, operating currents, command, instrumentation and indication requirements shall all be met.

20.4.2.2.5.6 Heater Test

Verify operation of all heaters and thermostat settings at 27 Vdc. Operating currents, command, instrumentation and indication requirements shall all be met.

20.4.2.2.5.7 Damper Tests

20.4.2.2.5.7.1 High Energy Damper Test (APDA -6001 and -7001)

Mount the APDA on the static stand with guide ring in the initial position. Rotate about Y_T and Z_T axes and measure the moment with and without dampers engaged. Verify that ring returns to the initial position with the dampers off and that the ring does not return to the initial position with the dampers on. Requirements of paragraph 20.3.2.2.12.3.14.1 shall be met

20.4.2.2.5.7.2 Ringer Damper Test (-6001 only)

Mount the APDA on the static stand with the guide ring in the initial position. Rotate the ring about the X_T axis and measure the moment with and without the dampers engaged. Requirements of paragraph 20.3.2.2.12.3.14.2 shall be met.

20.4.2.2.5.8 Instrumentation Calibration Tests

A calibration test shall be performed on all sensors by applying an input stimulus of known value and representative of the expected operation levels. The output shall be recorded on data sheets. Measurements shall have a minimum of six steps up from zero to full-scale input, and five steps down from full-scale to zero input. All calibrations performed on instrumentation signals shall be documented including those performed by the subcontractor's subtier suppliers, and submitted to NASA in accordance with Procurement Data Requirements List (PDRL).

20.4.2.2.6 Acceptance Vibration Tests

Subject the APDA to random vibration for a minimum of one minute duration in each of three orthogonal axes as follows:

20 to 80 Hz	Increasing at 3 dB/Octave
80 to 350 Hz	Constant at 0.04 g^2/Hz
350 to 2000 Hz	Decreasing at 3 dB/Octave

Verify no degradation and that the guide ring remains seated. Perform visual inspection, electrical circuit verification, insulation resistance, and a functional (no load, 27 V) after test. Time, travel limits, operating currents, command and indication requirements shall all be met before and after test.

20.4.2.2.7 Loads Tests

20.4.2.2.7.1 Axial Stiffness in Initial Position Test (APDA -6001 and -7001)

With the ring in the initial position, fixers off, and (for -6001 only) the low torque slip clutch engaged, mate with the Docking Simulator to activate Capture Latches and apply an incremental axial load to deflect the ring. Verify proper operation of actuator spring and shaft cartridge spring assemblies. Verify stiffness meets the requirements as follows:

Deflection	APDA -6001	-7001
1 -3 mm	150-250 kgf	150-250 kgf
8 - 10 mm	300±50 kgf	600-800 kgf
14 - 60 mm	300±50 kgf	800-1200 kgf

For -6001 only, verify that slipping of the low torque slip clutch occurs in both the $+X_T$ and $-X_T$ directions at 300 ± 50 kgf.

20.4.2.2.7.2 Retraction Force Test (APDA -6001 and -7001)

Retract the ring to 20-40 mm from the final position stop. Dock with Docking Simulator until Capture Latches are engaged. With the fixers on, retract the ring in the direction of the final position stop. Allow the load limiting clutch to operate for 10 seconds max. Operating current not to exceed limit. Force developed by the mechanism to be 1900 +300, - 200 kgf. Capture Latches must remain latched.

20.4.2.2.7.3 Restraining Force Test (APDA -6001 and -7001)

With the capture latches engaged to the Docking Simulator, raise the simulator to apply 1700 +100/-0 kgf in the extend direction. Verify the guide ring does not move. Verify no damage or degradation to the capture latches or body latches. Verify Capture Latches remain latched.

20.4.2.2.7.4 Body Latch Load Test (APDA -8001 only)

With the Docking Simulator Capture Latches latched to the APDA Body latches, apply an axial force of 2100 +100/-0 kgf in the extend direction. Verify the Body Latches maintain Capture Latch engagement.

20.4.2.2.7.5 Capture Latch Latching Force Test (APDA -6001 and -7001)

With the Capture Latches closed, measure the force required to trip the Capture Latches using a counterbalanced test ring to simulate docking. The force to trip all three latches and long and short capture sensors is not to exceed 16 kgf. Capture Latches and Body Latches are to engage with 1.4 mm gap minimum between them.

20.4.2.2.7.6 Capture Latch Unlatching Force Test (APDA -6001 and -7001)

With the Capture Latches open, measure the force required to release the Capture Latches using a counterbalanced test ring to simulate undocking. Force to release open latches not to exceed 12 kgf.

~~20.4.2.2.7.7 Translation Capability Test (Y_T & Z_T axes) (APDA -6001 and -7001)~~

With APDA in initial position, fixers off,

I. APDA -6001

A. Apply a force in direction of +YT axis to activate one misalignment sensor. Measure displacement and force required. Decrease force and measure displacement and force when sensor de-activates.

B. Displace ring to the mechanical stop at 10 mm intervals, measure force and return force at each position.
C. Apply 100 to 500 kgf at 100 kgf intervals, measure displacement and return force at initial and final position.
D. With fixers on, apply 150 kgf in same direction. Measure deflection.
E. Repeat in +ZT, -YT and -ZT directions.

II. APDA -7001

A. Apply a force in direction of +YT axis activate one misalignment sensor. Measure displacement and force required. Decrease force and measure displacement and force when sensor de-activates.
B. Displace ring 100 mm at 10 mm intervals, measure force and return force at each position.
C. Apply 100 to 500 kgf at 100 kgf intervals, measure displacement and return force at initial and final position.
D. With fixers on, apply 150 kgf in same direction. Measure deflection.
E. Repeat in +ZT, -YT and -ZT directions.

Verify misalignment sensors (1,2,3), misalignment potentiometers (1,2,3), ball screw centering springs and fixers (1,2,3) operate properly. Verify ring returns to initial position when load relieved. Verify displacement and forces meet requirements of paragraph 20.3.2.2.12.3.5.

20.4.2.2.7.8 Rotational Capability Test (Y_T & Z_T axes) (APDA -6001 and -7001)

With the APDA in the initial position, fixers off.

I. APDA -6001

A. Rotate clockwise about the YT axis until one of the misalignment sensors indicates. Measure moment and return moment required.
B. Rotate ring from 2° to the mechanical stop at 2° intervals. Measure moment at each interval. Measure return moment from the mechanical stop.
C. Apply a moment of 50, 100, 200, 300, 400 and 500 kgf-m. Measure angle of rotation. Remove load and verify ring returns to initial position.
D. With fixers on, apply 100 ± 10 kgf-m moment. Measure rotation.
E. Repeat clockwise about the ZT axis, and counterclockwise about YT and ZT axes.

II. APDA -7001

A. Rotate clockwise about the YT axis until one of the misalignment sensors indicates. Measure moment and return moment required.
B. Rotate ring from 2° to 10° at 2° intervals. Measure moment at each interval. Measure return moment at 10°.
C. Apply a moment of 50, 100, 200, 300, 400 and 500 kgf-m. Measure angle of rotation. Remove load and verify ring returns to initial position.
D. With fixers on, apply 100 ± 10 kgf-m moment. Measure rotation.
E. Repeat clockwise about the ZT axis, and counterclockwise about YT and ZT axes.

Verify misalignment sensors (4,5), misalignment potentiometers (4,5,6) and fixers (4,5) operate properly. Verify that the ring returns to the initial position when the load is relieved. Verify displacements and moments meet the requirements of paragraph 20.3.2.2.12.3.4.

20.4.2.2.7.9 Rotational Capability Test about X_T axis (APDA -6001 and -7001)

With the APDA in the initial position, fixers off,

I. APDA -6001

A. Rotate clockwise about the XT axis until one of the misalignment sensors indicates. Measure moment and return moment required.
B. Rotate ring from 2° to the mechanical stop at 2° intervals. Measure moment at each interval. Measure return moment from the mechanical stop.
C. Apply a moment of 50, 100, 200, 300, 350 kgf m. Measure angle of rotation. Remove load and verify ring returns to initial position.
D. With fixers on, apply 100 ± 10 kgf moment. Measure rotation.
E. Repeat counterclockwise about XT axis.

II. APDA -7001

A. Rotate clockwise about the XT axis until one of the misalignment sensors indicates. Measure moment and return moment required.
B. Rotate ring from 2° to 10° at 2° intervals. Measure moment at each interval. Measure return moment at 10°.
C. Apply a moment of 50, 100, 200, 300, 350 kgf-m. Measure angle of rotation. Remove load and verify ring returns to initial position.
D. With fixers on, apply 100 ± 10 kgf moment. Measure rotation.
E. Repeat counterclockwise about XT axis.

Verify misalignment sensors (1,2,3), misalignment potentiometers (1,2,3) and fixers (1,2,3) operate properly. Verify ring returns to initial position when load relieved. Verify displacement meets the requirements of 20.3.2.2.12.3.4.

20.4.2.2.8 Acceptance Thermal Vacuum Test

Thermally cycle as described below in a vacuum at 10^{-4} to 10^{-5} Torr. Dwell at each temperature and between operations at each temperature shall be a minimum of 60 minutes after stabilization. Perform functionals at each temperature dwell as follows:

Simulate 4° pitch and 4° roll. Dock at speed of .15 m/sec. Measure the settling force of the ring. Verify proper mate with minimum load and no evidence of binding or damage. Verify correct sensor operation. Operate high energy dampers with 30 second delay. Extend ring to the forward position. Retract ring and close structural hooks. Verify the interface seal when structurally latched. Test pressure to be 1.23 kg/cm^2 for 5 minutes minimum. A leak test shall be performed after the pressure test with delta pressure test at 1.03 ± 0.02 kg/cm^2 (14. 7 ± 0.3 psi). Verify operating parameters are met. Leak rate not to exceed 0.045 kg-mass/day (0.1 lbs/day).

Part Number	Thermal Cycle
-6001, -7001, -8001	+20°C to -50°C to +50°C to +20°C

20.4.2.2.9 Hatch Function Test

A mechanical function test and sensor checkout shall performed on each hatch. Proper operation shall be verified.

20.4.2.2.10 Hatch and APDA Body Component Proof Pressure Test

Ultimate pressure tests (to 1.68 kgf/m^2) shall be performed on docking mechanism pressure vessel components (APDA body and hatch) in order to demonstrate a factor of safety of at least 1.5.

20.4.2.2.13 Optical Properties Test

Measurements shall be provided for the components specified in paragraph 20.3.2.2.16. Required optical properties shall be verified.

20.4.2.2.14 Weight Measurement

APDA to be weighed with an accuracy of ± 500 g. The requirements of paragraph 20.3.2.2.2 shall be met.

20.4.2.3 Assessment

The requirements of section 4.2.3 of the basic specification apply.

20.4.2.4 Certification

MC621-0087-3001 mechanism qualification test results will be used where applicable to certify by similarity.

20.4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements specified in the performance and design verification matrix (Table V of the main specification) shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in Table 20-D in the sequence shown. Qualification test hardware shall be of the same configuration as APDA -6001 and -8001 flight hardware.

Table 20-D. Qualification Requirements

Inspection and Test	Sequence	APDA -6001	APDA -7001	APDA -8001
Acceptance Test	20.4.2.2	x	S	x
Examination of Product	20.4.2.4.1.1	x	S	x
Transportation Strength Test	20.4.2.4.1.2	x	S	x
Qualification Vibration Test	20.4.2.4.1.3	x	S	x
Shock-Basic Design Test	20.4.2.4.1.4	x	S	x
Acoustic Noise Test	20.4.2.4.1.5	x	S	x
Qualification Thermal Vacuum Test	20.4.2.4.1.7	x	S	x

Table 20-D (Continued)

Inspection and Test	Sequence	APDA -6001	APDA -7001	APDA -8001
Six Degree of Freedom Test	20.4.2.4.1.9	x	S	
Service Life Test	20.4.2.4.1.10	x	S	x
Loads Tests	20.4.2.4.1.11			
Extend/Retract Mechanism Limit Load Test	20.4.2.4.1.11.1	x	S	
Extend/Retract Mechanism Ultimate Load Test	20.4.2.4.1.11.2	x	S	
Capture and Body Latch Ultimate Load Test	20.4.2.4.1.11.3	x	S	x
Simultaneous Loads Test	20.4.2.4.1.11.4	x	S	x
Structural Hook Component Loads Test	20.4.2.4.1.11.5	x	S	x
Ultimate Translational Load Test	20.4.2.4.1.11.6	x	S	
Ultimate Rotational Load Test	20.4.2.4.1.11.7	x	S	
Fixer Limit Load Test	20.4.2.4.1.11.8	x	S	
Fixer Ultimate Load Test	20.4.2.4.1.11.9	x	S	
Pyrotechnic Shock Test	20.4.2.4.1.12	x		
Hatch Test	20.4.2.4.1.13			x
Disassembly Inspection	20.4.2.4.1.14	x	S	x

Note: S = Requirement applies, but certification will be by similarity with the -6001 mechanism.

20.4.2.4.1.1 Examination of Product

Each APDA shall be carefully examined to determine conformance to the requirements of this specification. Particular attention shall be given to weight, workmanship, finish, dimensions, construction, cleanliness, identification marking, level and that certified materials and processes have been used.

20.4.2.4.1.2 Transportation Strength Test

Subject to spectral densities as follows. After test, perform technical inspection, electric circuit verification, insulation resistance, operational capability (dual at 27 V) and seal integrity test. Verify no damage or degradation. Time, travel limits, operating currents, command and indication requirements shall all be met.

Vibration Acceler-ation Direction	Vibration Acceler-ation Ampli-tude, g's	Frequency Subrange, Hz					Total Test Time	
		5 - 7	7 - 15	15 - 30	30 - 40	40 - 60	hours	min
		Test time, minutes						
Longitudinal (Along X_T axis)	1.4 1.2	- 76	4 93	- 32	- 61	- 39	- 5	4 7
Lateral (Along Y_T axis)	1.1 1.0	- 13	4 16	- 7	- 10	- 7	- -	4 53
Lateral (Along Z_T axis)	1.1 1.0	- 32	4 40	- 16	- 26	- 16	- 2	4 10

20.4.2.4.1.3 Qualification Vibration Test

Subject to random vibration in each of three orthogonal axes as follows:

Vibration Level	-6001	-7001/-8001
Increasing at 3 dB/Octave	20 to 80 Hz	20 to 80 Hz
Constant at 0.067 g^2/Hz	80 to 350 Hz	80 to 350 Hz
Decreasing at 3 dB/Octave	350 to 2000 Hz	350 to 2000 Hz
Duration, seconds	1020	380

There shall be no signs of degradation. After test, perform technical inspection, electric circuit verification, insulation resistance, operational capability (dual at 27 V) and seal integrity test. Time, travel limits, operating currents, command and indication requirements shall all be met after test. Verify guide ring remains seated. These tests may be performed at intervals not less than 5 minutes.

20.4.2.4.1.4 Shock-Basic Design Test

The APDAs shall be mounted in the final position to the shock stand table. Apply 20 g terminal sawtooth shock pulses in each axis, three pulses in each direction for a total of six pulses/axis. After completion, perform technical inspection, insulation resistance, electric circuit, operational capability and pressure integrity tests. There shall be no signs of degradation. Time, travel limits, operating currents, command and indication requirements shall all be met after test. There shall be no breakdown or loosening of fasteners.

20.4.2.4.1.5 Acoustic Noise Test

Subject assembly to spectral density as follows. After test, perform technical inspection, electric circuit verification, insulation resistance, operational capability (dual at 27 V) and seal integrity test. There shall be no signs of degradation. Time, travel limits, operating currents, command and indication requirements shall all be met after test.

Frequency Subrange, (Hz)	63	125	250	500	1000	2000	4000
Acoustic Pressure Spectral Density, (dB/Hz)	132	135	137	137	133	126	119

Total Level: 142 dB
Duration of effect: APDA –6001 is 60 sec, APDA -8001 is 60 sec.

20.4.2.4.1.6 Deleted.

20.4.2.4.1.7 Qualification Thermal Vacuum Test - Complete APDA

Thermally cycle as follows at vacuum of 10^{-4} to 10^{-5} Torr. Dwell at each temperature and between operations at each temperature shall be a minimum of 60 minutes after stabilization. With APDA mounted on a moving dynamic stand, perform functionals and verify pressure integrity at each temperature dwell as follows. During the course of this test, perform a total of 5 cycles against the guide ring extend and final position mechanical stops for 10 seconds each. Perform 5 cycles against the structural hook forward and back mechanical stops for 10 seconds each. After test, perform technical inspection, electric circuit verification, insulation resistance, operational capability (dual at 27 V). Time, travel limits, operating currents, command and indication requirements shall all be met. Verify proper mate with minimum load and no evidence of binding or damage. Verify no degradation at seal interface. Leak rate not to exceed 0.045 kg-mass/day (0.1 lbs/day). Perform proof test of APDA body and hatch at 1.23 kgf/cm^2 (factor of 1.1 of MOP). Temperature tolerance for ambient (25°C) shall be ± 10°C and for dwell temperatures ± 5°C.

QUALIFICATION THERMAL-VACUUM TEST

	Temperature (°C)	Docking Rate (m/sec)	Simulator Rotation Angle		Voltage (V)	Comments
			Pitch (deg)	Roll (deg)		
1	+25±10	0.10	0	0	23	SH & Capture
2	+85±5	0.10	0	4	34	
3	+85±5	0.12	4	4	27	
4	+85±5					
5	+60±5	0.10	4	0	27	SH & Capture
6	-65±5					
7	-50±5	0.10	4	0	27	SH & Capture
8	+85±5					
9	+50±5	0.10	0	4	23	SH & Capture
10	-65±5					
11	-50±5	0.10	0	4	23	SH & Capture
12	+85±5					
13	+50±5	0.12	4	4	34	SH & Capture
14	-65±5					
15	-50±5	0.12	4	4	34	SH & Capture
16	+85±5					
17	+50±5	0.10	4	0	27	SH & Capture
18	-65±5					
19	-50±5	0.10	0	4	27	SH & Capture
20	+85±5					
21	+50±5	0.10	0	4	27	SH & Capture
22	-65±5					
23	-60±5	0.12	4	4	27	SH & Capture
24	+25±10	0.12	4	4	23	SH & Capture

Note: Pressure Integrity Checkout to be performed at steps 1, 5, 7, 11, 23, 24.
SH indicates Structural Hook Mechanism Cycle

20.4.2.4.1.8 Qualification Thermal Tests-Capture Sensor

Without being activated, capture sensor qualification units are to be exposed to the temperature extremes of paragraph 3.2.5.2.5 plus a margin of ±18°F (±10°C) while in a vacuum of 10^{-5} to 10^{-6} Torr. During this exposure the units are also to be operated and conductivity measurements taken at the temperature extremes of paragraph 3.2.5.1.5 plus a margin of ±18°F (±10°C).

20.4.2.4.1.9 Six Degree of Freedom Test

Perform 19 docking cycles using simulator 3Y571-045 on 6 DOF test stand per displacements, velocities, ISS configurations, and temperatures as follows. After test, perform technical inspection, electric circuit verification, insulation resistance, operational capability (dual at 27 V). Time, travel limits, operating currents, command and indication requirements shall all be met. Verify proper operation, no damage or degradation.

SIX-DEGREE-OF-FREEDOM TEST
APDA -6001

	Relative linear mis-align-ments, mm		Relative angular misalignments, degrees			Relative linear velocities, mm/sec			Relative angular velocities, deg/sec			Tem pera-ture, ° C	Com-ments	ISS Con-figu-ration
	Y_T	Z_T	X_T	Y_T	Z_T	v_X	v_Y	v_Z	ω_X	ω_Y	ω_Z			
1		-100				30.5						25±10	PCT1	4A
2			2.0			30.5						25±10	PCT1	4A
3			3.0			30.5						25±10	PCT1	4A
4				4.0		30.5						25±10	PCT1	4A
5						120						+50		19A
6		-100				30.5						+50	PCT2	19A
7			4.0			30.5						+50	PCT2	19A
8			2.0	-2.83	-2.83	30.5						+50	PCT2	19A
9		-100		4.0		30.5				0.2		+50	PCT2	19A
10				4.0		30.5						+50	PCT2	19A
11				-4.0		30.5				-0.2		+50	*PCT2	19A
12			2.0			30.5	15.0		0.2			+50	*PCT2	19A
13						120						-30		19A
14		-100				30.5						-30	PCT2	19A
15			2.0			30.5						-30	PCT2	19A
16			2.0	-2.83	-2.83	30.5						-30	PCT2	19A
17				4.0		30.5						-30	PCT2	19A
18				-4.0		30.5				-0.2		-30	*PCT2	19A
19			2.0			30.5	15.0		0.2			-30	*PCT2	19A

* Alignment with ring extension to the forward position

Six-Degree-of-Freedom Test
APDA -7001

	Relative linear mis-alignments, mm		Relative angular misalignments, degrees			Relative linear velocities, mm/sec			Relative angular velocities, deg/sec			Tem-pera-ture, C
	Y_T	Z_T	X_T	Y_T	Z_T	n_X	n_Y	n_Z	w_X	w_Y	w_Z	
1						150.						25±10
2		-100				30.5						25±10
3			4.00			30.5						25±10
4			4.00	-2.83	-2.83	30.5						25±10
5	70	-70	2.00	-2.00	-2.00	30.5	28.0	-28.0	0.15	-0.15	0.15	25±10
6		-100	2.00	-2.83	-2.83	30.5		15.0	0.20	-0.20	-0.20	25±10
7		100		4.00		30.5		15.0		0.20		25±10
8		-100				30.5						50
9			4.00			30.5						50
10			4.00	-2.83	-2.83	30.5						50
11	70	-70	2.00	-2.00	-2.00	30.5	28.0	-28.0	0.15	-0.15	-0.15	50
12		-100	2.00	-2.83	-2.83	30.5		15.0	0.20	-0.20	-0.20	50
13		-100				30.5						-30
14			4.00			30.5						-30
15			4.00	-2.83	-2.83	30.5						-30
16	70	-70	2.00	-2.00	-2.00	30.5	28.0	-28.0	0.15	-0.15	-0.15	-30
17		-100	2.00	-2.83	-2.83	30.5		15.0	0.20	-0.20	-0.20	-30

20.4.2.4.1.10 Service Life Test

Cycle the APDA and all subsystems to simulate on-orbit docking. The active and passive APDAs shall be cycled as follows in addition to the cycles accumulated during acceptance testing: Reference paragraph 3.2.1.1.1.1c for -8001 Class I and Class II definitions.

POST-ATP CYCLES

	-6001	-7001	-8001 Class I	-8001 Class II
Vacuum/Load Cycles	80	4	214	20
Load Cycles	14	4	4	4
No-Load Cycles	576	18	18	18

One third of cycles shall be performed at 23 Vdc, 27 Vdc and 34 Vdc respectively. If a component fails during the vacuum cycle testing, the testing shall be stopped, the failed component replaced, and the remaining vacuum cycles added to the "Load" cycle category. After test, perform technical inspection, electric circuit, insulation resistance, and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.11 Loads Tests

20.4.2.4.1.11.1 Extend/Retract Mechanism Limit Load Test (APDA -6001 and -7001)

With the mechanism in the initial position and with the capture latches engaged to the Docking Simulator, raise the simulator to apply 2100 ±100 kgf in the extend direction. Verify guide ring does not move. Verify no damage or degradation to extend/retract mechanisms. Verify no damage or degradation to capture latches or body latches. Verify Capture Latches remain latched. After test, perform technical inspection, and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.11.2 Extend/Retract Mechanism Ultimate Load Test (APDA -6001 and -7001)

With the mechanism in the initial position and with the capture latches engaged to the Docking Simulator, raise the simulator to apply 3000 ±100 kgf in the extend direction. Verify guide ring does not move. Verify no damage or degradation to extend/retract mechanisms. Verify no damage or degradation to capture latches or body latches. Verify Capture Latches remain latched. After test, perform technical inspection, and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.11.3 Capture and Body Latch Load Tests

20.4.2.4.1.11.3.1 Limit and Ultimate Loads Test

With the mechanism in the initial position and with the capture latches latched to the body latches of the passive system, apply a bending moment of 500 kgf-m to the APDA. Remove moment. Repeat with 700 kgf-m moment. Verify no damage or degradation to capture latches or body latches. Verify Capture Latches remain latched. After test, perform technical inspection, and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.11.3.2 Capture Latch Simultaneous Loads Test

With the mechanism in the initial position and with the capture latches latched to the body latches of the passive system, apply a lateral of 500 kgf and a bending moment of 500 kgf-m to the APDA. Verify no damage or degradation to capture latches or body latches. Verify Capture Latches remain latched.

20.4.2.4.1.11.4 Structural Hook Simultaneous Fatigue and Ultimate Loads Tests.

20.4.2.4.1.11.4.1 Limit Loading.

With the APDA mated and structural hooks latched as follows, perform pressure integrity checkout. Apply the following limit loads simultaneously:

	APDS -6001, -8001 (12 Hooks)		APDS -7001 (24 Hooks)	
	Case 1a	Case 1b	Max. Bending	Max. Torsion
Bending (1)	4000 kgf-m	6650 kgf-m	7930 kgf-m	5090 kgf-m
Torsion	6650 kgf-m	4000 kgf-m	4330 kgf-m	7630 kgf-m
Axial	500 kgf	500 kgf	590 kgf	590 kgf
Shear (1)	500 kgf	500 kgf	600 kgf	600 kgf
Delta Pressure	1.12 kg/cm^2	1.12 kg/cm^2	1.12 kg/cm^2	1.12 kg/cm^2

Relieve the load. Verify hooks remain latched. Verify seal integrity. Verify no damage or degradation. After test, perform technical inspection and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.11.4.2 Fatigue Loading.

Apply the limit loads of each case of 20.4.2.4.1.11.4.1 simultaneously to the corresponding cycle spectrum specified in Table 20-H-1. Pressure may remain constant during load cycles.

Relieve the load. Verify hooks remain latched. Verify seal integrity. Verify no damage or degradation. After test, perform technical inspection and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.11.4.3 Ultimate Loading.

With structural hooks latched as follows, apply the following ultimate loads simultaneously:

	APDS -6001, -8001 (12 Hooks)		APDS -7001 (24 Hooks)	
	Case 1a	Case 1b	Max. Bending	Max. Torsion
Bending (1)	6000 kgf-m	9975 kgf-m	11900 kgf-m	7635 kgf-m
Torsion	9975 kgf-m	6000 kgf-m	6500 kgf-m	11450 kgf-m
Axial	750 kgf	750 kgf	890 kgf	890 kgf
Shear (1)	750 kgf	750 kgf	900 kgf	900 kgf
Delta Pressure	1.23 kg/cm^2	1.23 kg/cm^2	1.23 kg/cm^2	1.23 kg/cm^2

Notes: (1) Indicates vector sum
(2) Cases are defined in Table 20-A-2
(3) All testing of 20.4.2.4.1.11.4 may be run to the acceptable test plan as specified in Table 20-H-2. Any change to Table 20-H-2 must meet the requirements of 20.4.2.4.1.11.4.

Relieve the load. Verify hooks remain latched. Verify seal integrity. Verify no damage or degradation. After test, perform technical inspection and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.11.5 Structural Hook Component Loads Test

Load an active and passive hook pair to 5000 kgf in increments of 1000 kgf. Relieve load. Load to 7500 kgf in increments of 1000 kgf. Verify no damage or degradation.

20.4.2.4.1.11.6 Extend/Retract Mechanism Ultimate Translational Load Test (APDA -6001 and -7001)

With the guide ring in the initial position, fixers off, apply a load parallel to the seal interface of 700 kgf. Verify no damage or degradation. After test, perform technical inspection, and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.11.7 Extend/Retract Mechanism Ultimate Rotational Load Test (APDA -6001 and -7001)

With the guide ring in the initial position, fixers off, apply a moment about the Y_T axis of 700 kgf-m. Repeat about the Z_T axis. Apply a moment about the X_T axis of 420 kgf-m. Verify no damage or degradation. After test, perform technical inspection, and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.11.8 Extend/Retract Mechanism Fixer Limit Load Test (APDA -6001 and -7001)

With the fixers engaged, apply a load parallel to the seal interface of 500 kgf. Relieve the load and then apply a moment about the X_T axis of 350 kgf-m. Relieve the X_T moment and repeat moment application about the Y_T and Z_T axes independently. Verify no damage or degradation. After test, perform technical inspection and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.11.9 Extend/Retract Mechanism Fixer Ultimate Load Test (APDA -6001 and -7001)

With the fixers engaged, apply a load parallel to the seal interface of 700 kgf . Relieve the load and then apply a moment about the X_T axis of 500 kgf-m. Relieve the X_T moment and repeat moment application about the Y_T and Z_T axes independently. Verify no damage or degradation. After test, perform technical inspection, and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.12 Pyrotechnic Shock Test (APDA -6001 only)

With assembly mounted on the moveable docking stand, dock with simulator 3Y571-045 0270-0 with -6001 only. Fire the 12 active and 12 passive hooks to simulate emergency separation. Verify successful separation. Perform technical inspection to verify no structural degradation at the APDA/ base assembly interface. After test, perform technical inspection, and operational capability tests. Time, travel limits, operating currents, command and indication requirements shall all be met.

20.4.2.4.1.13 Hatch Function Test. (APDA -8001 only)

A mechanical function test and sensor checkout shall be performed on each hatch. Proper operation shall be verified.

20.4.2.4.1.14 Disassembly Inspection

Perform technical inspection. Disassemble and check component level characteristics. Record and submit all results.

20.4.2.4.2 Certification by Analysis

The requirements of section 4.2.4.2 of the basic specification apply, except as stated below.

20.4.2.4.2.1 Thermal Certification for Specific APDA Components

APDA guide rings and petals, protective shrouds, and capture latches shall be certified for the operational and non-operational temperature limits of sections 3.2.5.1.5 and 3.2.5.2.5, plus a margin of ±18°F (±10°C). This certification must be accomplished for all APDA units.

20.5 PREPARATION FOR DELIVERY

The requirements of Section 5 of the basic specification apply.

20.6 NOTES

The requirements of Section 6 of the basic specification apply.

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	E	REVISED 08/03/98 BY C. KATAKIA		R.AJEMIAN

NOTES:

1. DIMENSIONS SHOWN XXX ARE IN US STANDARD (INCHES)
   (XXX) ARE IN METRIC (MM)

(1) 2. U.S.A. SHALL PROVIDE 2 GROUNDING STRAPS BETWEEN DOCKING MECHANISM AND BASE AND 2 ATTACH LOCATIONS AS SHOWN ON SHEET 4. RSC-E SHALL PROVIDE 2 GROUNDING LOCATIONS AS SHOWN ON SHEET 4 AND 2 BOLTS.

3. FOR APDA INTERCONNECTING ELECTRICAL CABLES SEE APPENDIX XIII OF THIS SPECIFICATION.

(2) 4. LOCKING INSERT: KNML10X1.5 SP (TRIDAIR INDUSTRIES)
   MATERIAL: 303 CRES
   FINISH: SILVER PLATE

(3) 5. SEAL : MATERIAL 51-1567 TY38-40595-72
   SHORE HARDNESS 50-65
   COMPRESS LOAD 28.54 - 39.95 LB/INCH (5-7 N/mm)

(4) 6. BOLT: M10-8g: MATERIAL: STAINLESS 07Ch16N6
   FINISH: PASSIVATE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	166.9(1150)	137.9(950)	9
AXIAL	174.2(1200)	145.1(1000)	12
RADIAL	152.4(1050)	130.6(900)	6

(5) 7. NASA/RI BASE MATERIAL: AL ALLOY 2219-T852
   FINISH: ANODIZE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	60.0(413.4)	48.0(330.7)	6
AXIAL	56.0(385.8)	44.0(303.1)	4
RADIAL	56.0(385.8)	44.0(303.1)	3

(6) 8. RSC-E BASE MATERIAL: AL ALLOY AMr6.M
   FINISH: CHEM FILM ANODIZE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	42.1(290)	17.4(120)	11
AXIAL	42.1(290)	17.4(120)	11
RADIAL	42.1(290)	17.4(120)	11

(7) 9. ALIGNMENT PIN MATERIAL: TITANIUM BT-14
   FINISH: NONE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	137.9(950)	123.4(850)	10
AXIAL	137.9(950)	123.4(850)	10
RADIAL	137.9(950)	123.4(850)	10

(8) 10. LEAKAGE OF SEALS ACROSS EACH INTERFACE CODED (8) SHALL NOT EXCEED 0.02 LBS/DAY(9g/DAY) WHEN INTERIOR IS PRESSURIZED TO 14.7±0.2 PSI(760 ±10 mmHG) IN THE DOCKED OR MATED MODE

(9) 11. THESE BOLTS TO BE TORQUED TO 364.0±9.0 IN-LBS (4.0±0.1 KGF M) AFTER APPLICATION OF LUBRICANT ON THE THREADS OF THE BOLTS. LOCKWIRE BOLTS IN PAIRS USING .020 DIA LOCKWIRE.

(10) 12. FACILITY GROUND STUD: FACILITY GROUNDING CABLE MUST BE ATTACHED AT THIS LOCATION AT ALL TIMES UNTIL THE DOCKING MECHANISM AND ITS SUPPORTING BASE ARE FIRMLY SECURED TO THE AIRLOCK

(11) 13. PROVIDED BY RSC-E

(12) 14. THESE CONNECTORS WILL BE FURNISHED WITH SHORTING PLUGS

(13) 15. CONNECTOR KEYWAYS AS SHOWN

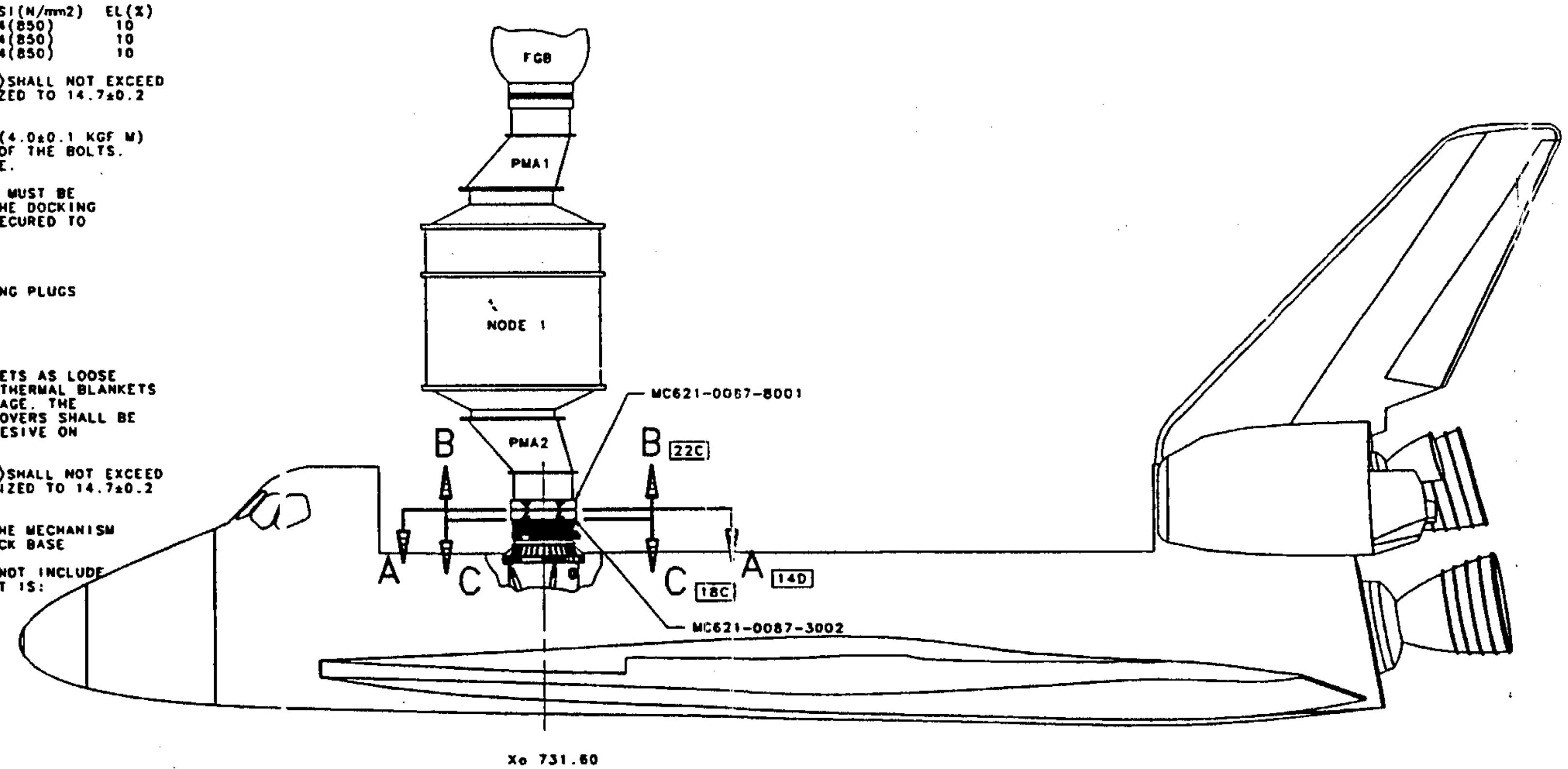
16. X1, Y1, Z1 DENOTE MECHANISM TEST AXIS

17. RSC-E SHALL DELIVER THE EXTERNAL THERMAL BLANKETS AS LOOSE EQUIPMENT AND RSC-E SHALL DESIGN THE EXTERNAL THERMAL BLANKETS TO BE REMOVABLE AND RE-INSTALLABLE WITHOUT DAMAGE. THE X1 THRU X4 CONNECTORS AND THE EXTERNAL METAL COVERS SHALL BE INSTALLED ON THE MECHANISM WITHOUT LOCKING ADHESIVE ON FASTENERS.

(14) 10. LEAKAGE OF SEALS ACROSS EACH INTERFACE CODED (14) SHALL NOT EXCEED 0.08 LBS/DAY(36g/DAY) WHEN INTERIOR IS PRESSURIZED TO 14.7±0.2 PSI(760 ±10 mmHG) IN THE DOCKED OR MATED MODE

(15) 11. U.S.A WILL PROVIDE AND INSTALL BUSHINGS INTO THE MECHANISM STRUCTURE PRIOR TO ITS MOUNTING ONTO THE AIRLOCK BASE

(16) 12. ALL ENVELOPE DIMENSIONS, WHERE APPLICABLE, DO NOT INCLUDE THERMAL BLANKET THICKNESS. THICKNESS OF BLANKET IS:
   .19-.40(5-10 MM)- ON THE GROUND
   .78(20 MM) MAX, UNRESTRICTED- ON ORBIT



FLIGHT 2A CONFIGURATION

SCALE: NONE

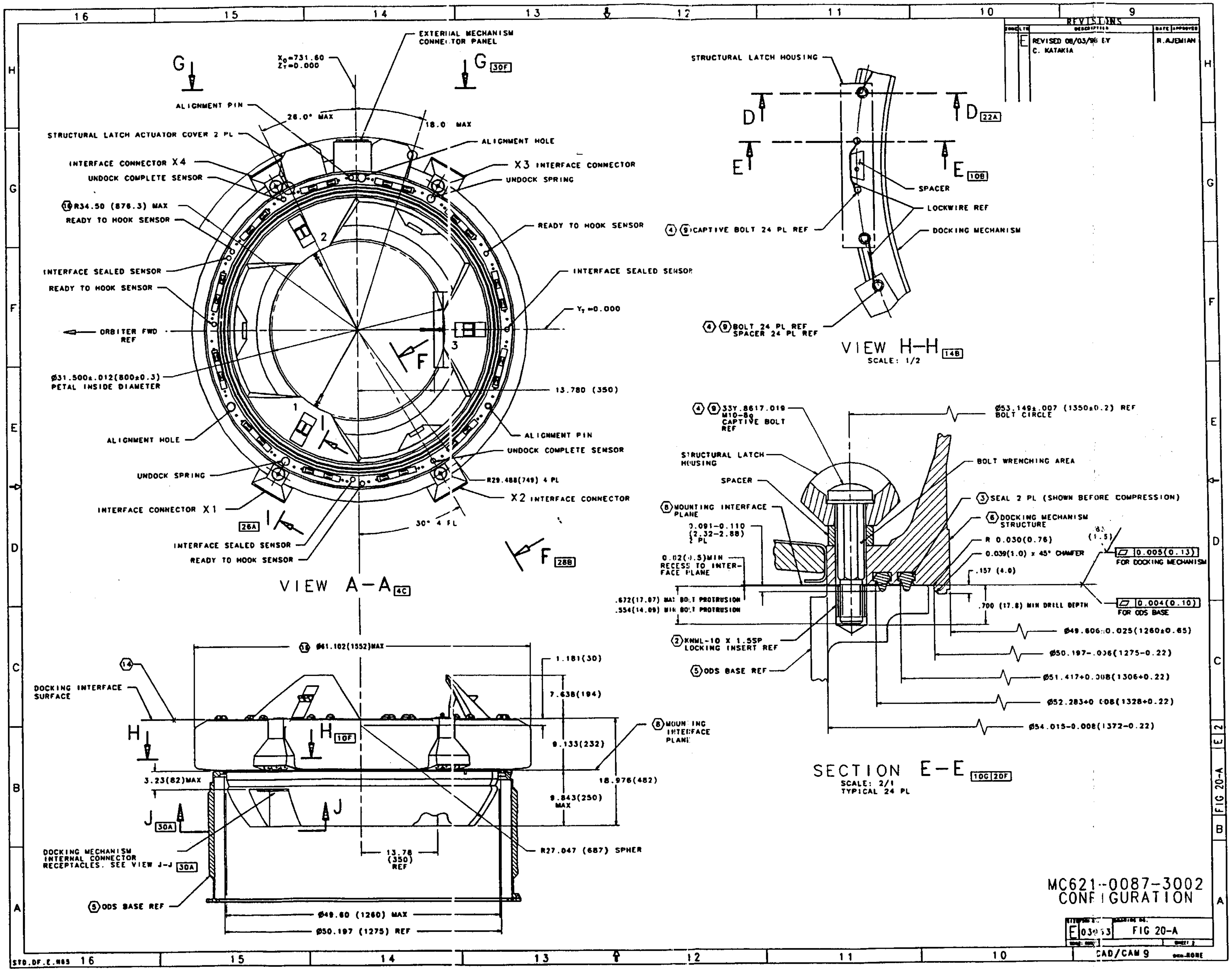
MC621-0087-3002 CONFIGURATION
(33Y.6201.008-05-005)
MAKE FROM MC621-0087-3001

SPEC CONTROL DRAWING - ISSA, DOCKING MECHANISM INTERFACE REQUIREMENTS

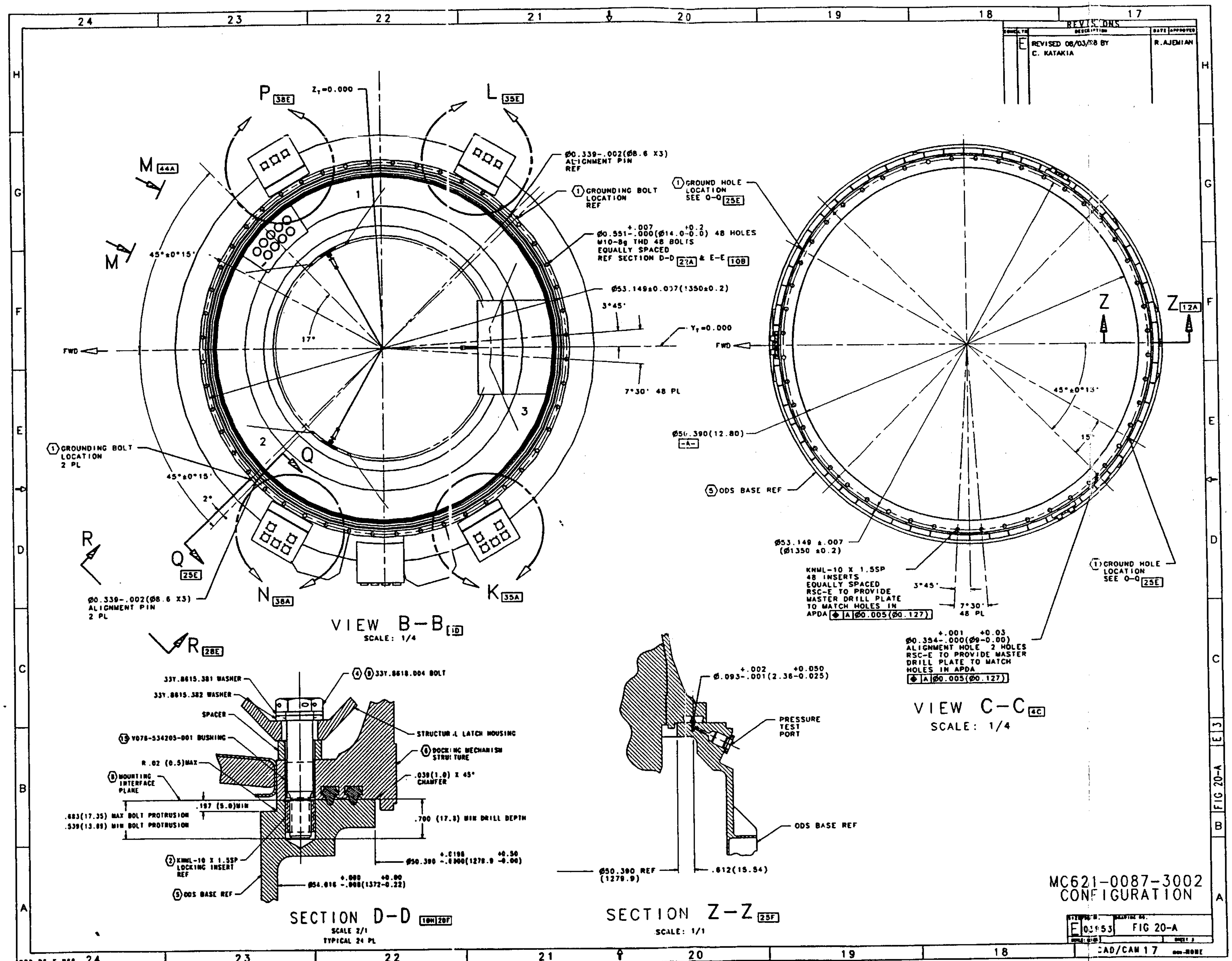
E 03953 FIG 20-A

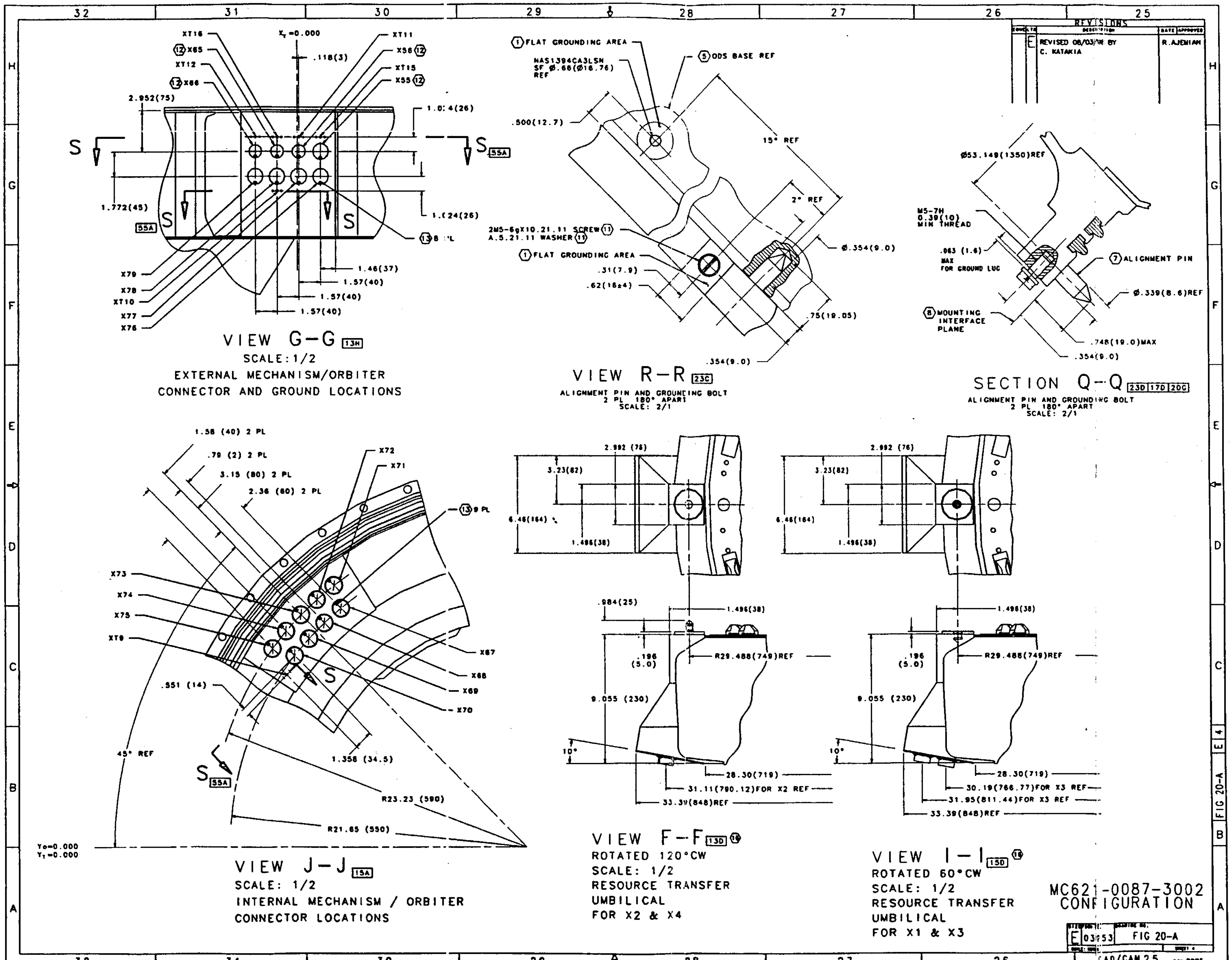
CAD/CAM 1

STD.DF.E.H87

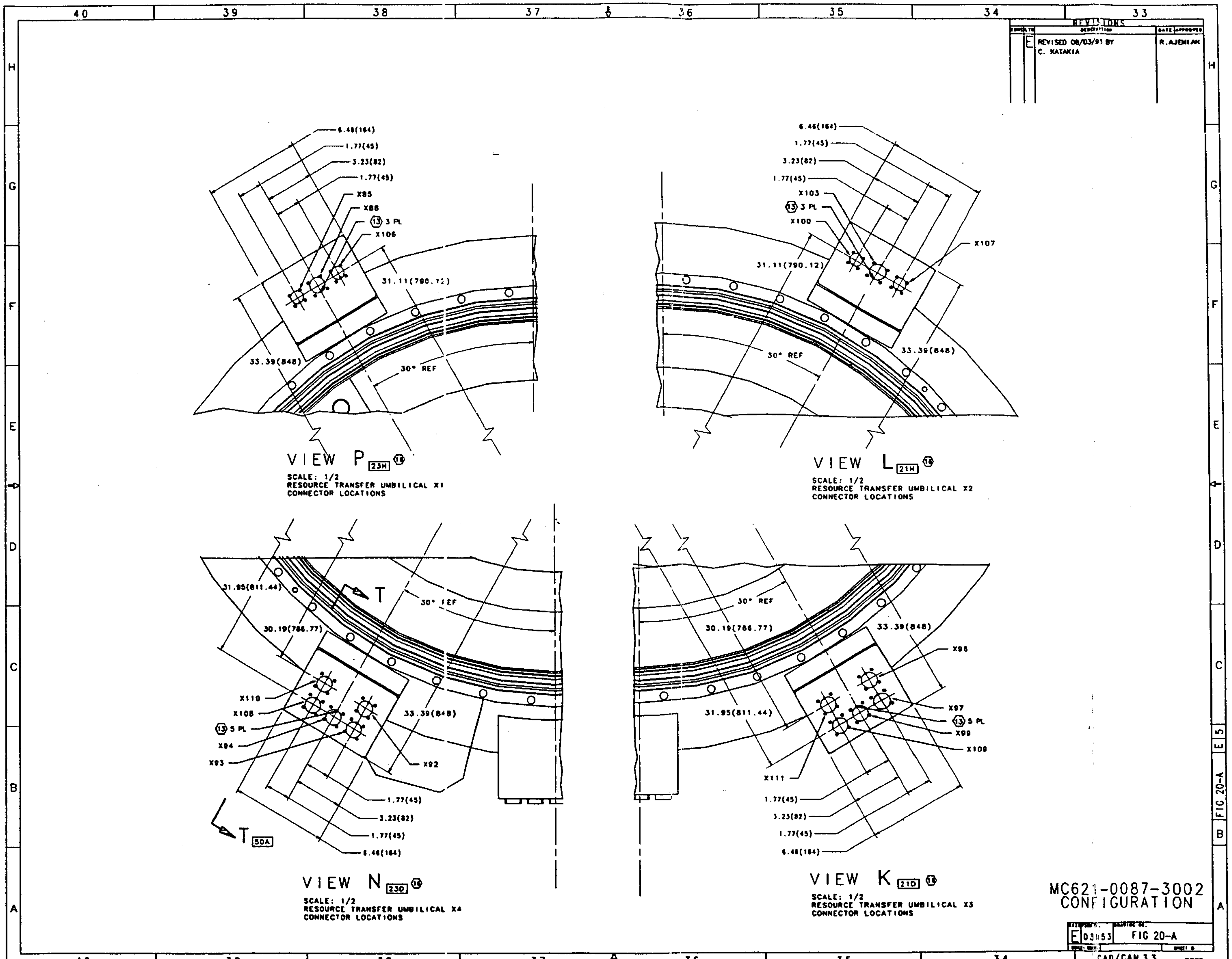

REVISIONS
REVISED 08/03/96 BY C. KATAKIA
R. AJEMIAN
EXTERNAL MECHANISM CONNECTOR PANEL
X_0=731.60 Z_T=0.000
ALIGNMENT PIN
26.0° MAX
18.0° MAX
STRUCTURAL LATCH ACTUATOR COVER 2 PL
ALIGNMENT HOLE
INTERFACE CONNECTOR X4
X3 INTERFACE CONNECTOR
UNDOCK COMPLETE SENSOR
UNDOCK SPRING
R34.50 (876.3) MAX
READY TO HOOK SENSOR
INTERFACE SEALED SENSOR
Y_T=0.000
ORBITER FWD REF
Ø31.500±.012(800±0.3) PETAL INSIDE DIAMETER
13.780 (350)
ALIGNMENT PIN
UNDOCK COMPLETE SENSOR
R29.488(749) 4 PL
X2 INTERFACE CONNECTOR
INTERFACE CONNECTOR X1
30° 4 PL
VIEW A-A 4C
STRUCTURAL LATCH HOUSING
SPACER
LOCKWIRE REF
CAPTIVE BOLT 24 PL REF
DOCKING MECHANISM
BOLT 24 PL REF
SPACER 24 PL REF
VIEW H-H 14B
SCALE: 1/2
33Y.8617.019 M10-8g CAPTIVE BOLT REF
Ø53.149±.007 (1350±0.2) REF BOLT CIRCLE
STRUCTURAL LATCH HOUSING
BOLT WRENCHING AREA
SEAL 2 PL (SHOWN BEFORE COMPRESSION)
MOUNTING INTERFACE PLANE
DOCKING MECHANISM STRUCTURE
R 0.030(0.76)
0.039(1.0) x 45° CHAMFER
.157 (4.0)
0.005(0.13) FOR DOCKING MECHANISM
0.004(0.10) FOR ODS BASE
.672(17.07) MAX BOLT PROTRUSION
.554(14.09) MIN BOLT PROTRUSION
.700 (17.8) MIN DRILL DEPTH
KNML-10 X 1.5SP LOCKING INSERT REF
ODS BASE REF
Ø49.606±0.025(1260±0.65)
Ø50.197-.036(1275-0.22)
Ø51.417+0.008(1306+0.22)
Ø52.283+0.008(1328+0.22)
Ø54.015-0.008(1372-0.22)
SECTION E-E 10C 20F
SCALE: 2/1
TYPICAL 24 PL
Ø61.102(1552)MAX
DOCKING INTERFACE SURFACE
1.181(30)
7.638(194)
9.133(232)
18.976(482)
9.843(250) MAX
3.23(82)MAX
MOUNTING INTERFACE PLANE
DOCKING MECHANISM INTERNAL CONNECTOR RECEPTACLES. SEE VIEW J-J 30A
13.78 (350) REF
R27.047 (687) SPHER
ODS BASE REF
Ø49.60 (1260) MAX
Ø50.197 (1275) REF
MC621-0087-3002
CONFIGURATION
FIG 20-A
CAD/CAM 9

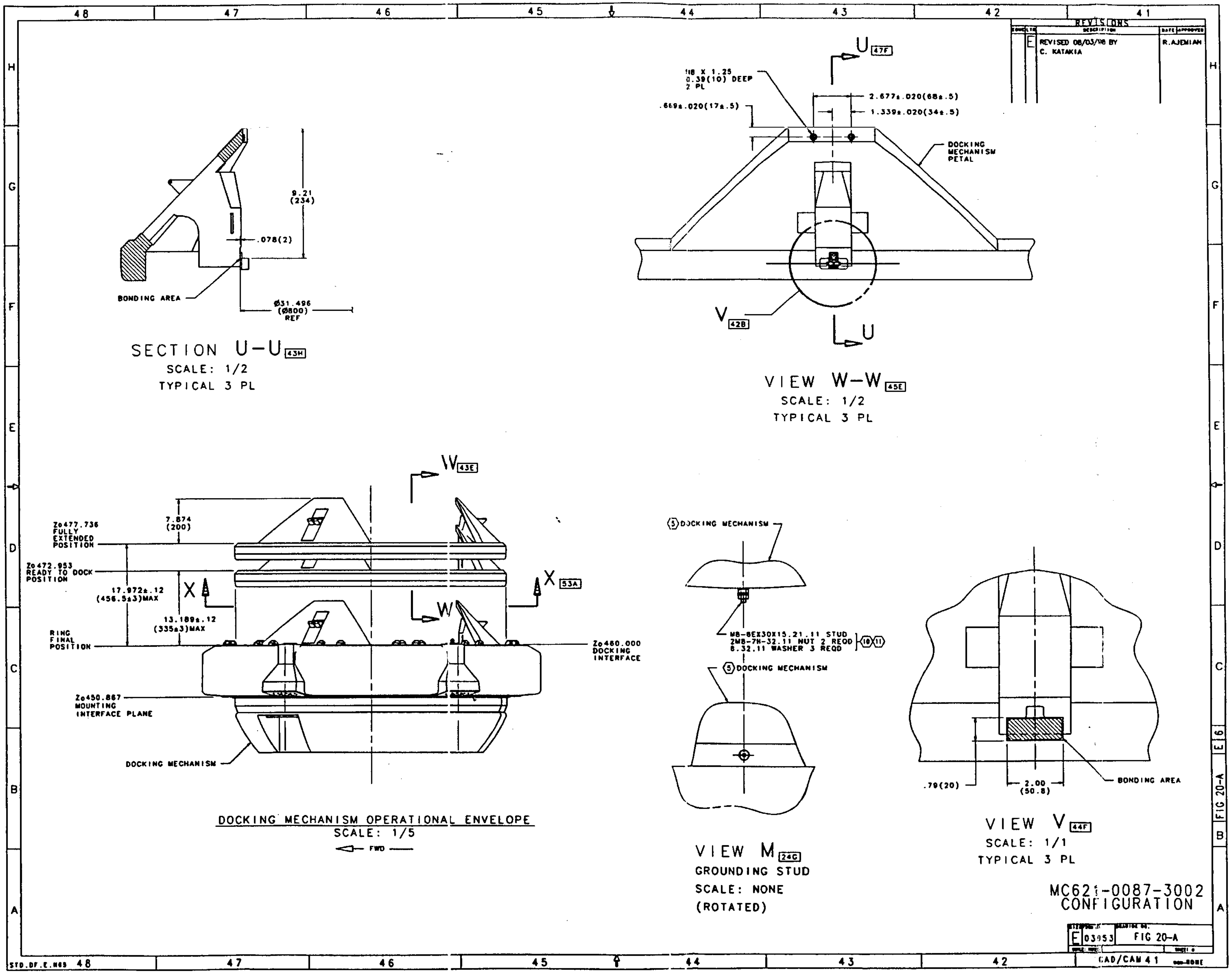
glMon Aug 10 08:52:56 PDT 1998

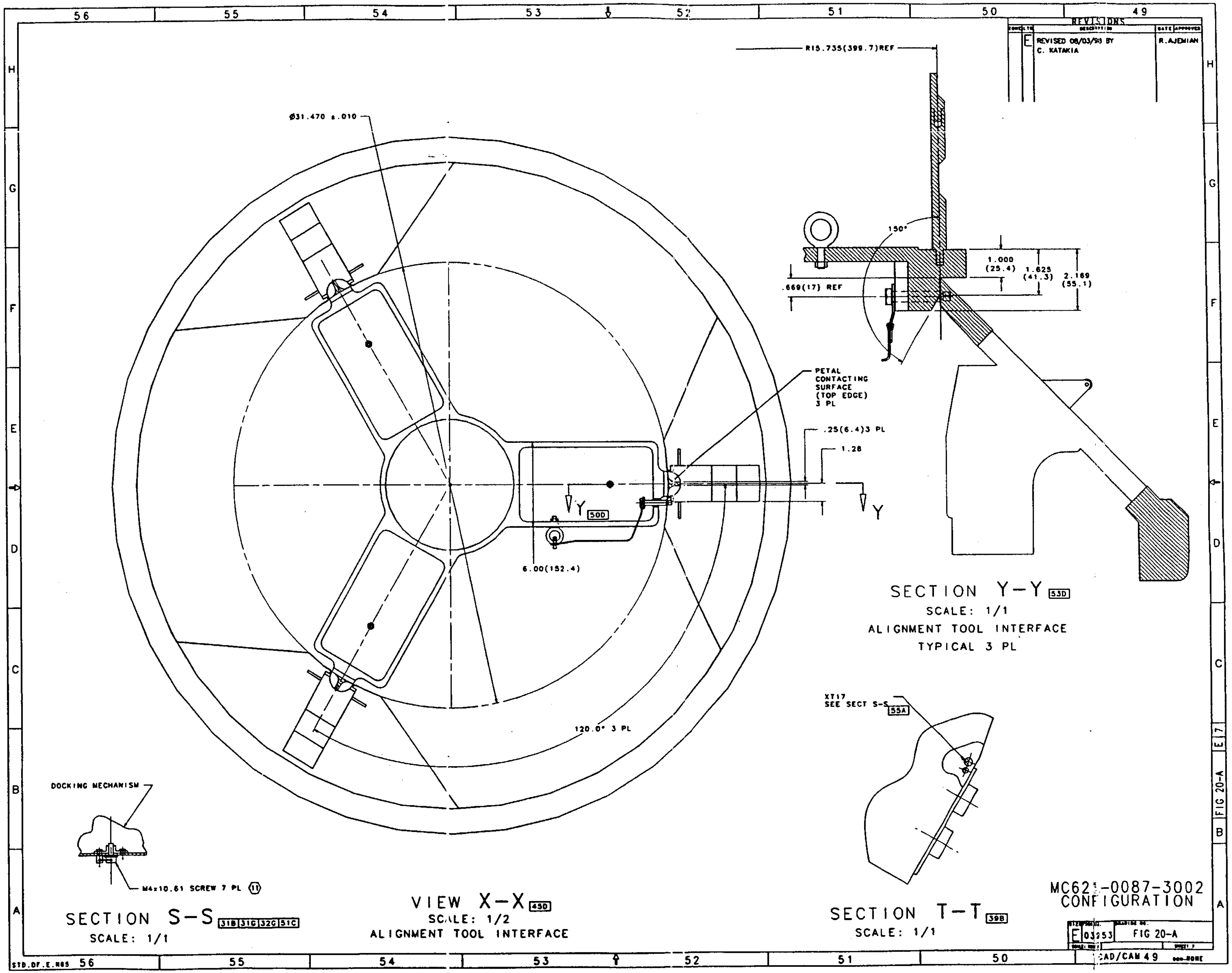



REVISIONS
E REVISED 08/03/98 BY C. KATAKIA
R.AJEMIAN
VIEW G-G 13H
SCALE:1/2
EXTERNAL MECHANISM/ORBITER
CONNECTOR AND GROUND LOCATIONS
VIEW R-R 23C
ALIGNMENT PIN AND GROUNDING BOLT
2 PL 180° APART
SCALE: 2/1
FLAT GROUNDING AREA
ODS BASE REF
15° REF
2° REF
SECTION Q-Q 23D 17D 20G
ALIGNMENT PIN AND GROUNDING BOLT
2 PL 180° APART
SCALE: 2/1
ALIGNMENT PIN
MOUNTING INTERFACE PLANE
VIEW J-J 15A
SCALE: 1/2
INTERNAL MECHANISM / ORBITER
CONNECTOR LOCATIONS
VIEW F-F 13D
ROTATED 120°CW
SCALE: 1/2
RESOURCE TRANSFER
UMBILICAL
FOR X2 & X4
VIEW I-I 15D
ROTATED 60°CW
SCALE: 1/2
RESOURCE TRANSFER
UMBILICAL
FOR X1 & X3
MC621-0087-3002
CONFIGURATION
FIG 20-A
CAD/CAM 25

192


REVISIONS
E REVISED 08/03/93 BY C. KATAKIA
R.AJEMIAN
6.46(164)
1.77(45)
3.23(82)
X85
X88
13 3 PL
X106
31.11(790.12)
33.39(848)
30° REF
VIEW P 23H 16
SCALE: 1/2
RESOURCE TRANSFER UMBILICAL X1
CONNECTOR LOCATIONS
X103
X100
X107
VIEW L 21H 16
SCALE: 1/2
RESOURCE TRANSFER UMBILICAL X2
CONNECTOR LOCATIONS
31.95(811.44)
30.19(766.77)
T
X110
X108
13 5 PL
X94
X93
X92
T 50A
VIEW N 23D 16
SCALE: 1/2
RESOURCE TRANSFER UMBILICAL X4
CONNECTOR LOCATIONS
X96
X97
X99
X109
X111
VIEW K 21D 16
SCALE: 1/2
RESOURCE TRANSFER UMBILICAL X3
CONNECTOR LOCATIONS
MC621-0087-3002
CONFIGURATION
E 03953 FIG 20-A
CAD/CAM
FIG 20-A E 5
STD.DF.E.HBS


REVISIONS
E REVISED 08/03/98 BY C. KATAKIA R.AJEMIAN
SECTION U-U 43H
SCALE: 1/2
TYPICAL 3 PL
9.21 (234)
.078(2)
BONDING AREA
Ø31.496 (Ø800) REF
VIEW W-W 45E
SCALE: 1/2
TYPICAL 3 PL
M8 X 1.25 0.39(10) DEEP 2 PL
2.677±.020(68±.5)
1.339±.020(34±.5)
.669±.020(17±.5)
DOCKING MECHANISM PETAL
U 47F
V 42B
DOCKING MECHANISM OPERATIONAL ENVELOPE
SCALE: 1/5
FWD
W 43E
X 53A
Zo477.736 FULLY EXTENDED POSITION
7.874 (200)
Zo472.953 READY TO DOCK POSITION
17.972±.12 (456.5±3)MAX
13.189±.12 (335±3)MAX
RING FINAL POSITION
Zo460.000 DOCKING INTERFACE
Zo450.887 MOUNTING INTERFACE PLANE
DOCKING MECHANISM
5 DOCKING MECHANISM
M8-6EX30X15.21.11 STUD
2M8-7H-32.11 NUT 2 REQD
8.32.11 WASHER 3 REQD
VIEW M 24G
GROUNDING STUD
SCALE: NONE
(ROTATED)
.79(20)
2.00 (50.8)
BONDING AREA
VIEW V 44F
SCALE: 1/1
TYPICAL 3 PL
MC621-0087-3002
CONFIGURATION
E 03953 FIG 20-A
CAD/CAM 41
STD.DF.E.H65



Mon Aug 10 08:56:27 PDT 1998

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED
D	REVISED 06/03/16 BY C. KATAKIA		R.AJEMIAN

NOTES:

1. DIMENSIONS SHOWN XXX ARE IN US STANDARD (INCHES) (XXX) ARE IN METRIC (MM)
2. (1) U.S.A. SHALL PROVIDE 2 GROUNDING STRAPS BETWEEN DOCKING MECHANISM AND BASE AND 2 ATTACH LOCATIONS AS SHOWN ON SHEET 5 RSC-E SHALL PROVIDE 2 GROUNDING LOCATIONS AS SHOWN ON SHEET 5 AND 2 BOLTS.
3. FOR APDA INTERCONNECTING ELECTRICAL CABLES SEE APPENDIX XIII AND XIV OF THIS SPECIFICATION.
4. (2) SEAL : MATERIAL 51-1567 TY38-40595-72
   SHORE HARDNESS 50-65
   COMPRESS LOAD 28.54 - 39.95 LB/INCH (5-7 N/mm)
5. (3) BOLT: M10-8g: MATERIAL: STAINLESS 07Ch16N6
   FINISH: PASSIVATE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	166.9(1150)	137.9(950)	9
AXIAL	174.2(1200)	145.1(1000)	12
RADIAL	152.4(1050)	130.6(900)	6

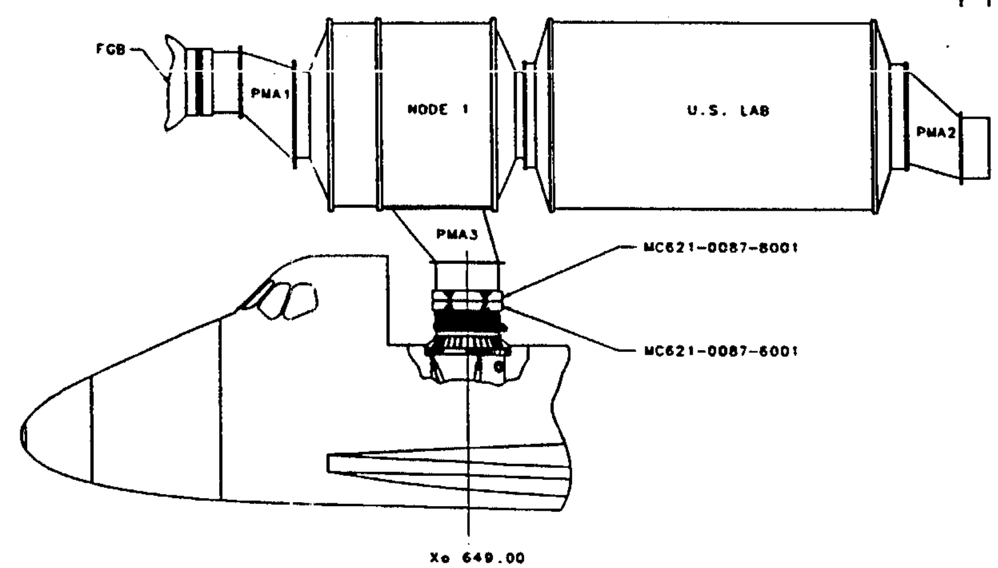
6. (4) RSC-E BASE MATERIAL: AL ALLOY AMr6.M
   FINISH: CHEM FILM ANODIZE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	42.1(290)	17.4(120)	11
AXIAL	42.1(290)	17.4(120)	11
RADIAL	42.1(290)	17.4(120)	11

7. (5) ALIGNMENT PIN MATERIAL: TITANIUM BT-14
   FINISH: NONE

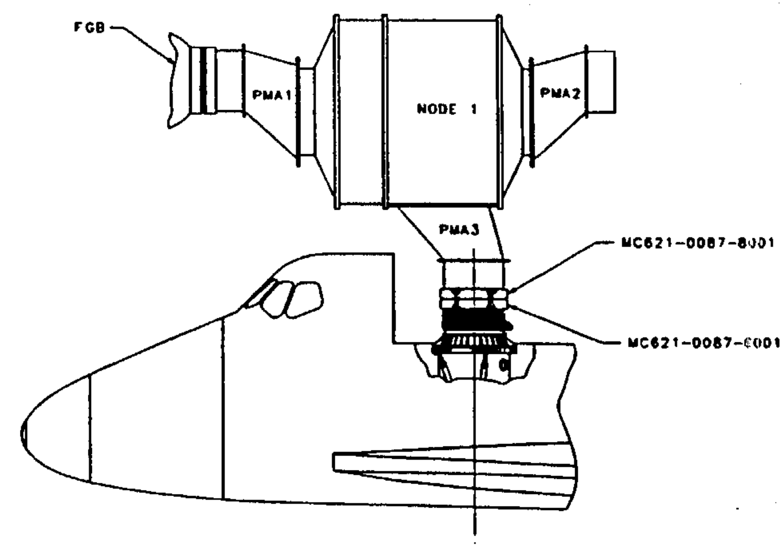
MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	137.9(950)	123.4(850)	10
AXIAL	137.9(950)	123.4(850)	10
RADIAL	137.9(950)	123.4(850)	10

8. (6) LEAKAGE OF SEALS ACROSS EACH INTERFACE CODED (6) SHALL NOT EXCEED 0.02 LBS/DAY(9g/DAY) WHEN INTERIOR IS PRESSURIZED TO 14.7±0.2 PSI(760 ±10 mmHG) IN THE DOCKED OR MATED MODE
9. (7) THESE BOLTS TO BE TORQUED TO 384.0±9.0 IN-LBS (4.0±0.1 KGF M) AFTER APPLICATION OF LUBRICANT ON THE THREADS OF THE BOLTS. LOCKWIRE BOLTS IN PAIRS USING .020 DIA LOCKWIRE.
10. (8) FACILITY GROUND STUD: FACILITY GROUNDING CABLE MUST BE ATTACHED AT THIS LOCATION AT ALL TIMES UNTIL THE DOCKING MECHANISM AND ITS SUPPORTING BASE ARE FIRMLY SECURED TO THE AIRLOCK
11. (9) PROVIDED BY RSC-E
12. (10) THESE CONNECTORS WILL BE FURNISHED WITH SHORTING PLUGS
13. (11) CONNECTOR KEYWAYS AS SHOWN
14. Xt, Yt, Zt DENOTE MECHANISM TEST AXIS
15. RSC-E SHALL DESIGN THE INTERNAL AND EXTERNAL THERMAL BLANKETS TO BE REMOVABLE AND RE-INSTALLABLE WITHOUT DAMAGE. RSC-E SHALL DELIVER THE EXTERNAL THERMAL BLANKET AS LOOSE EQUIPMENT. THE X1 THRU X4 CONNECTORS AND THE EXTERNAL METAL COVERS SHALL BE TEMPORARILY INSTALLED ON THE MECHANISM WITHOUT LOCKWIRE OR TORQUING OF FASTENERS. ONLY HAND TIGHT.
16. COMPONENTS THAT ARE DETERMINED TO BE PERIODICALLY MAINTAINABLE AND NEED TO BE REMOVED AND OR REPLACED SHALL HAVE FASTENING PROVISIONS WHICH CONTAIN LOCKING INSERTS WITHOUT THE NEED OF LOCKWIRE OR ADHESIVE.
17. (12) LEAKAGE OF SEALS ACROSS EACH INTERFACE CODED (12) SHALL NOT EXCEED 0.08 LBS/DAY(36g/DAY) WHEN INTERIOR IS PRESSURIZED TO 14.7±0.2 PSI(760 ±10 mmHG) IN THE DOCKED OR MATED MODE
18. (13) U.S.A WILL PROVIDE AND INSTALL BUSHINGS INTO THE MECHANISM STRUCTURE PRIOR TO ITS MOUNTING ONTO THE AIRLOCK BASE
19. (14) ALL ENVELOPE DIMENSIONS, WHERE APPLICABLE, DO NOT INCLUDE THERMAL BLANKET THICKNESS. THICKNESS OF BLANKET IS:
   .19-.40(5-10 MM)- ON THE GROUND
   .78(20 MM) MAX, UNRESTRICTED- ON ORBIT



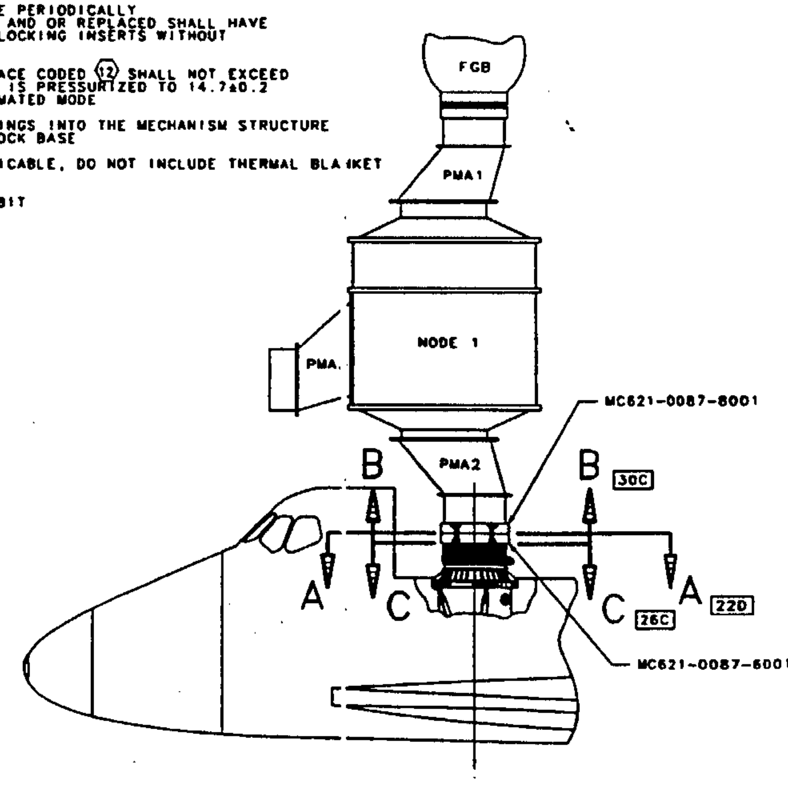
FLIGHT 5A CONFIGURATION REF

SCALE: NONE



FLIGHT 4A CONFIGURATION REF

SCALE: NONE



FLIGHT 3A CONFIGURATION

SCALE: NONE

MC621-0087-6001 CONFIGURATION (33Y.6201.008-09)

SPEC CONTROL DRAWING - ISSA DOCKING MECHANISM INTERFACE REQUIREMENTS

E 03953 FIG 20-8

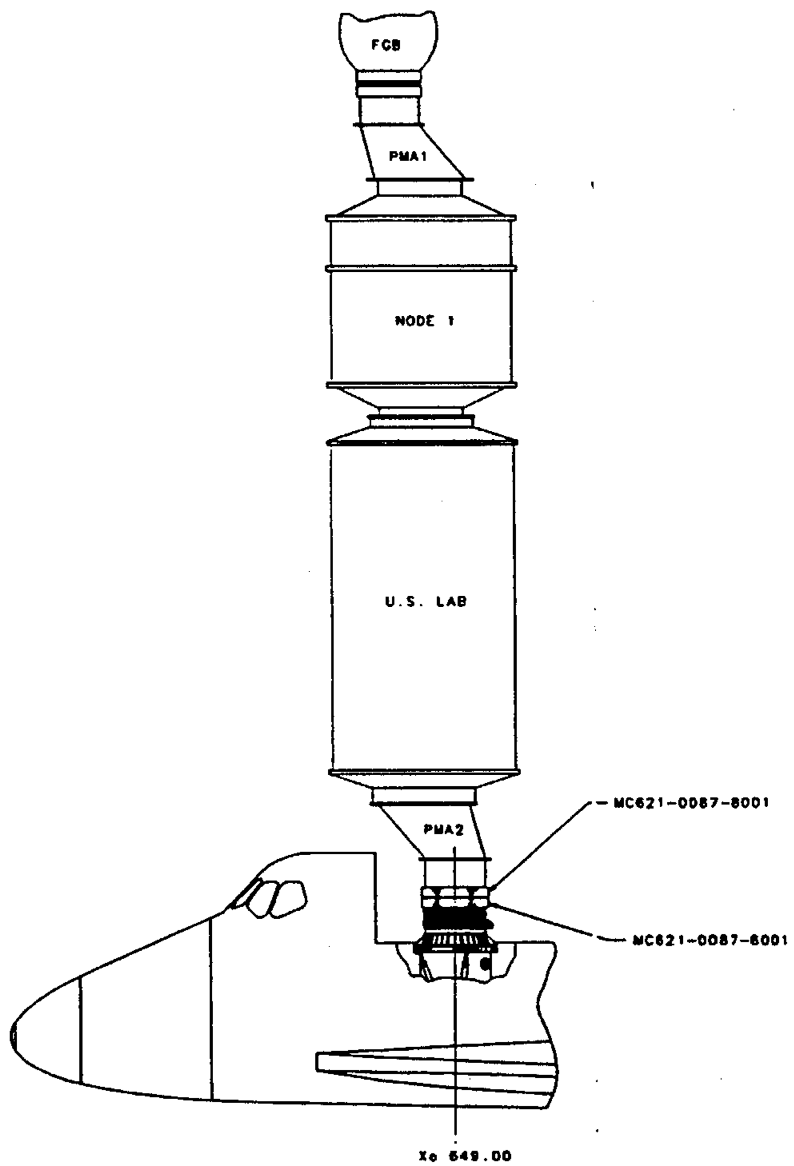
CAD/CAM 1

STD.DF.E.N67

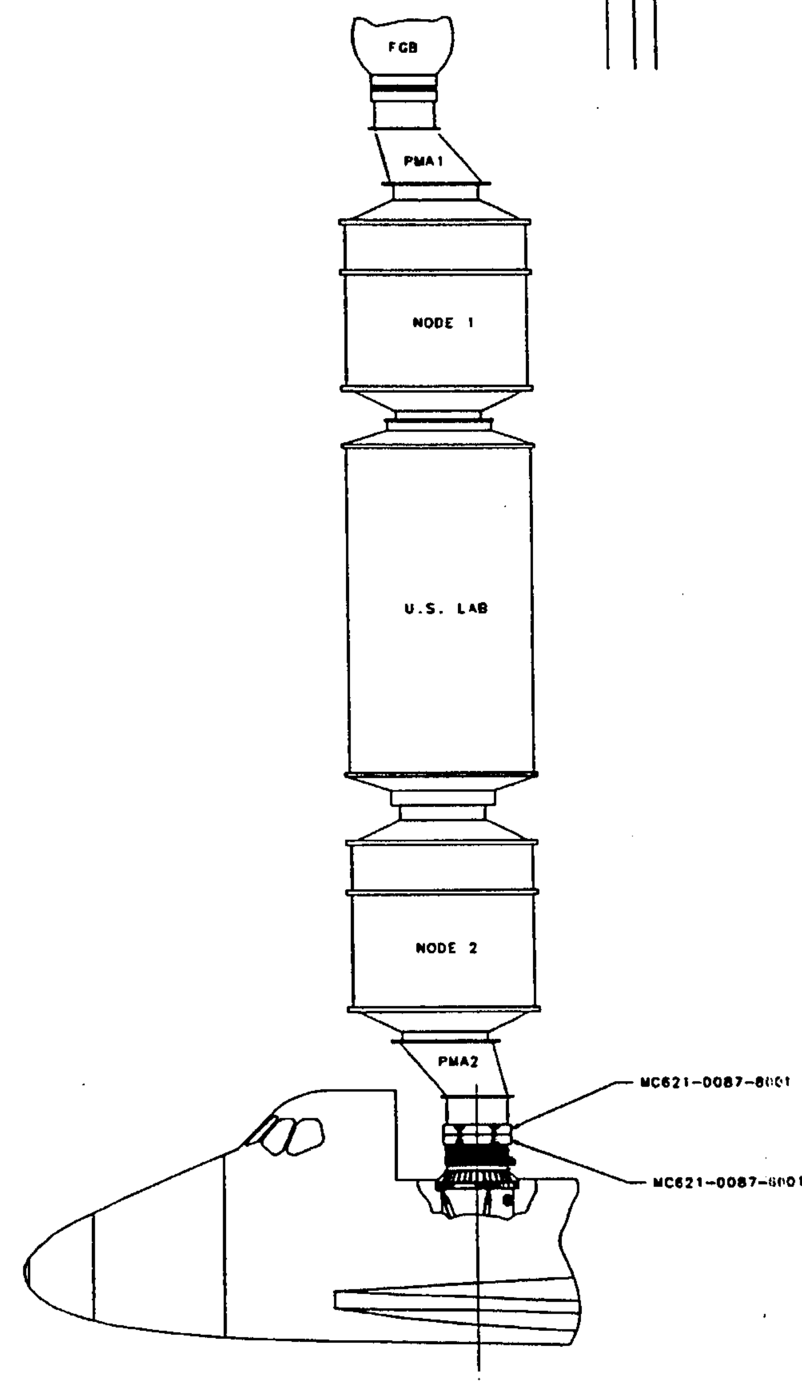
Tue Aug 11 09:22:16 PDT 1998

REVISIONS

D REVISED 08/03/98 BY C. KATAKIA R.AJEMIAN



FLIGHT 6A CONFIGURATION REF
SCALE: NONE

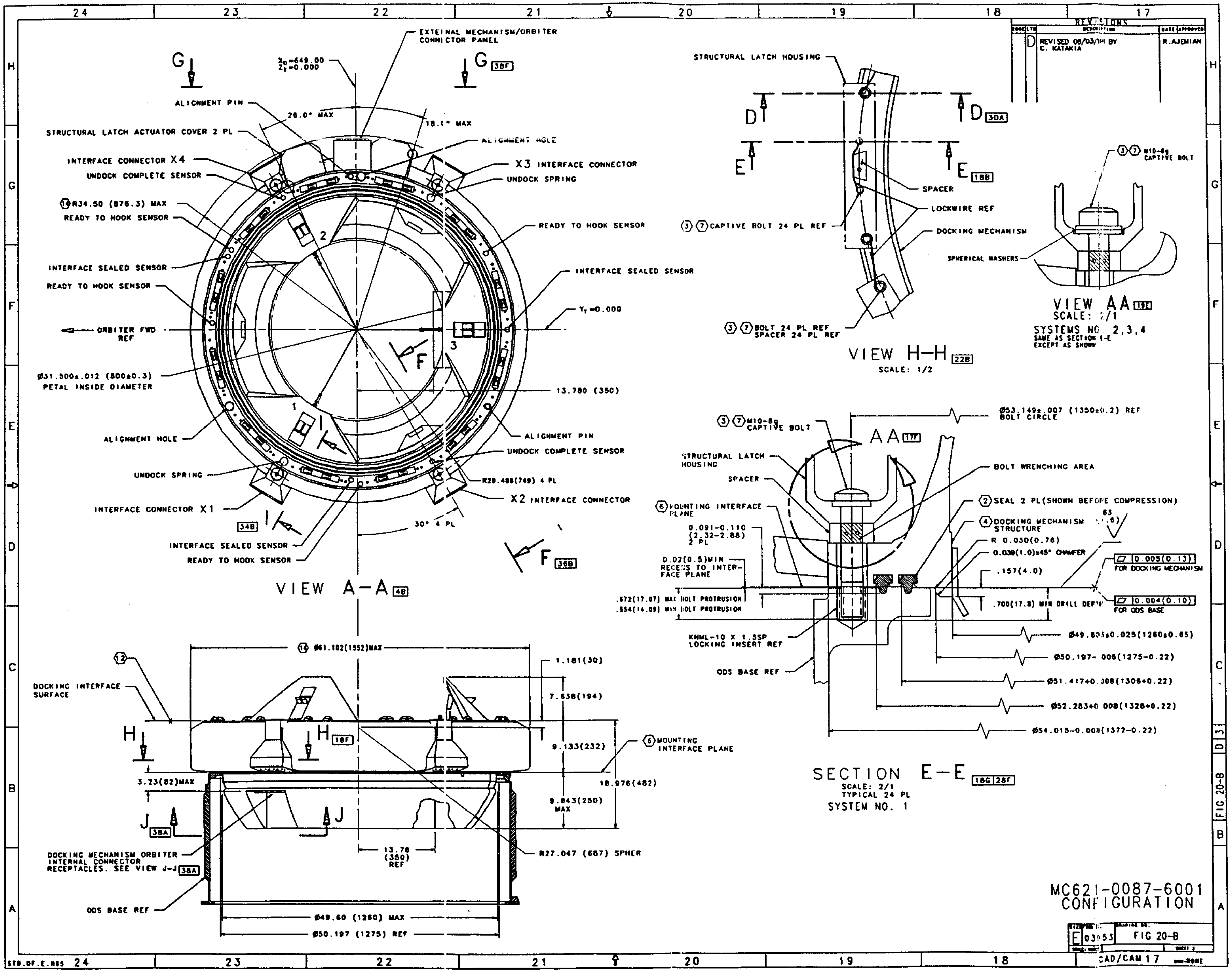


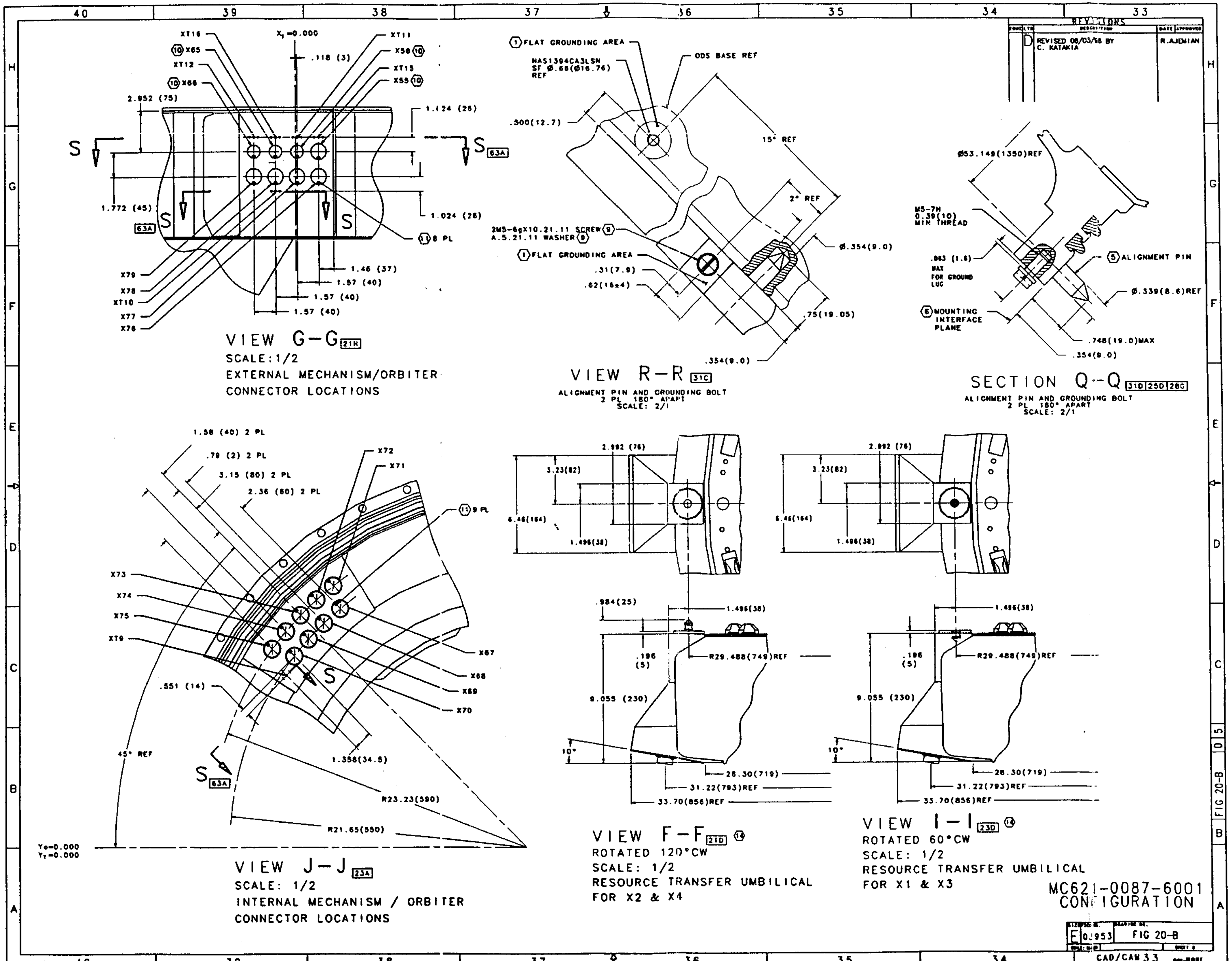
FLIGHT FINAL CONFIGURATION REF
SCALE: NONE

MC621-0087-6001
CONFIGURATION

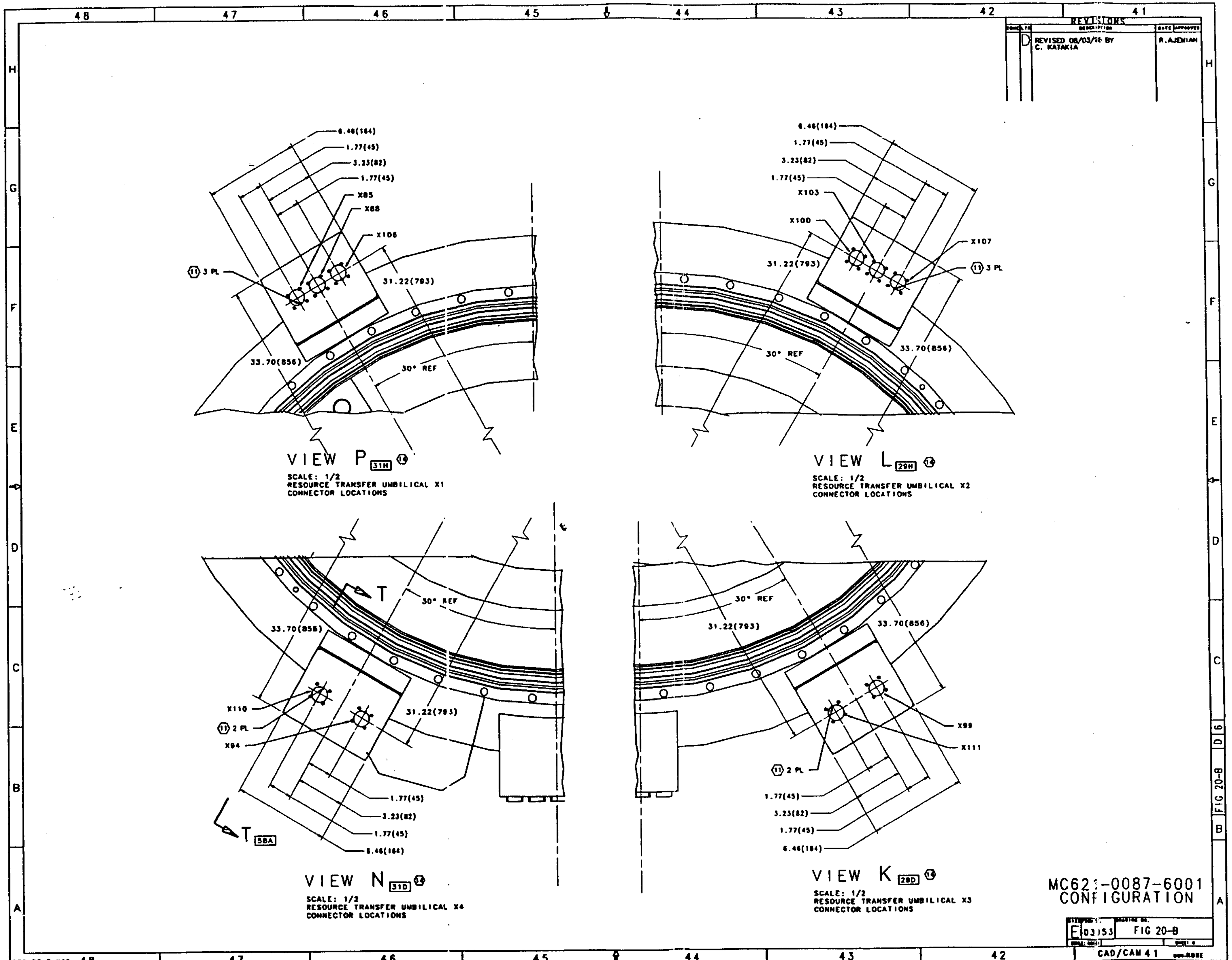
E 03953 FIG 20-B

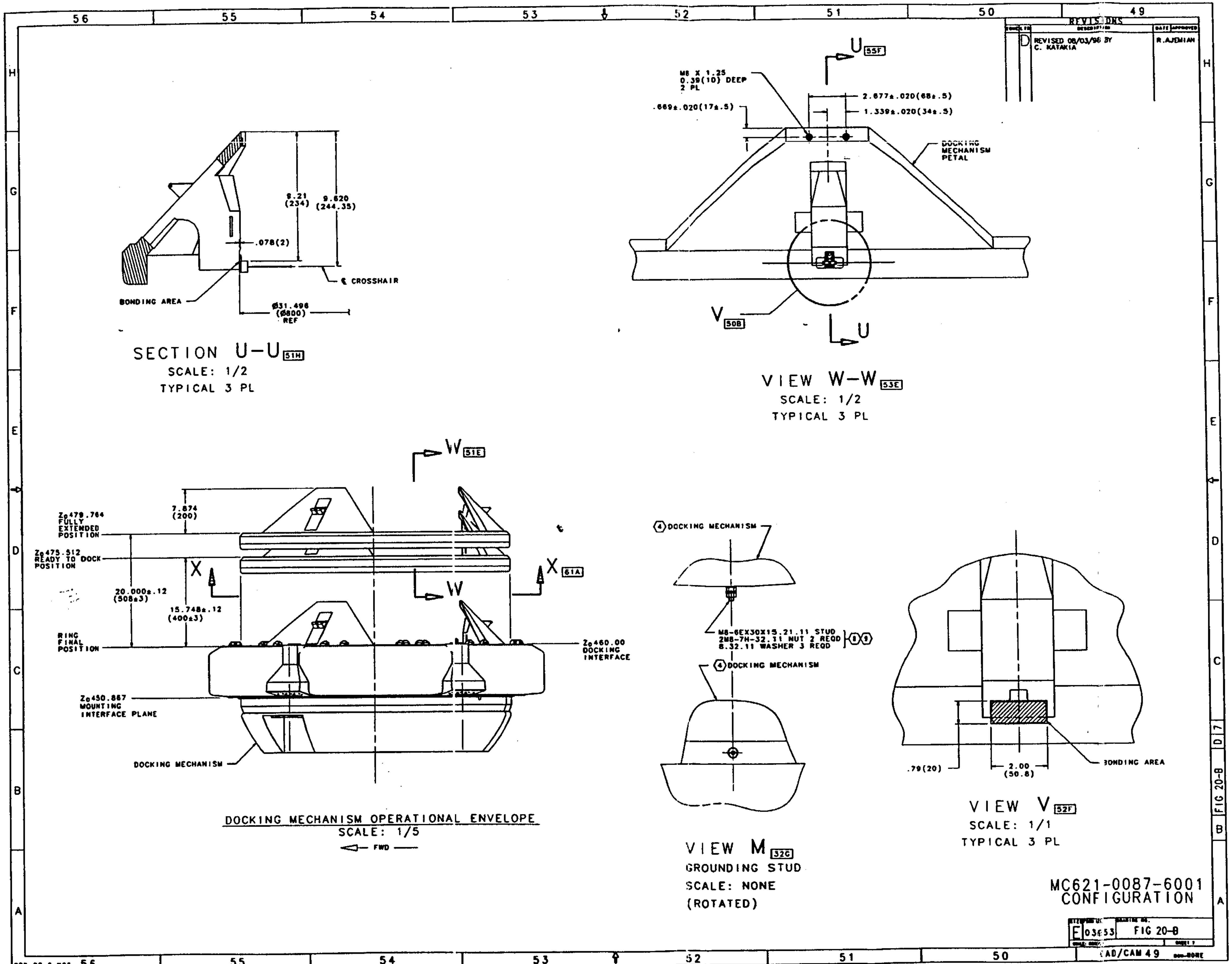
CAD/CAM 9


EXTERNAL MECHANISM/ORBITER CONNECTOR PANEL
ALIGNMENT PIN
STRUCTURAL LATCH ACTUATOR COVER 2 PL
INTERFACE CONNECTOR X4
UNDOCK COMPLETE SENSOR
READY TO HOOK SENSOR
INTERFACE SEALED SENSOR
ORBITER FWD REF
Ø31.500±.012 (800±0.3) PETAL INSIDE DIAMETER
ALIGNMENT HOLE
UNDOCK SPRING
INTERFACE CONNECTOR X1
X3 INTERFACE CONNECTOR
X2 INTERFACE CONNECTOR
13.780 (350)
30° 4 PL
VIEW A-A
DOCKING INTERFACE SURFACE
MOUNTING INTERFACE PLANE
DOCKING MECHANISM ORBITER INTERNAL CONNECTOR RECEPTACLES. SEE VIEW J-J
ODS BASE REF
Ø49.60 (1260) MAX
Ø50.197 (1275) REF
R27.047 (687) SPHER
STRUCTURAL LATCH HOUSING
SPACER
LOCKWIRE REF
DOCKING MECHANISM
CAPTIVE BOLT 24 PL REF
BOLT 24 PL REF SPACER 24 PL REF
VIEW H-H
SCALE: 1/2
M10-8g CAPTIVE BOLT
SPHERICAL WASHERS
VIEW AA
SYSTEMS NO. 2,3,4
BOLT WRENCHING AREA
SEAL 2 PL (SHOWN BEFORE COMPRESSION)
DOCKING MECHANISM STRUCTURE
KNML-10 X 1.5SP LOCKING INSERT REF
SECTION E-E
SCALE: 2/1
TYPICAL 24 PL
SYSTEM NO. 1
REVISIONS
REVISED 08/03/98 BY C. KATAKIA
R. AJEMIAN
MC621-0087-6001 CONFIGURATION
FIG 20-B
CAD/CAM 17


REVISIONS
D REVISED 08/03/98 BY C. KATAKIA
R.AJEMIAN
XT16
X65
XT12
X66
X_T =0.000
.118 (3)
XT11
X56
XT15
X55
2.952 (75)
1.124 (26)
1.772 (45)
1.024 (26)
8 PL
1.46 (37)
1.57 (40)
1.57 (40)
1.57 (40)
X79
X78
XT10
X77
X76
VIEW G-G 21H
SCALE:1/2
EXTERNAL MECHANISM/ORBITER CONNECTOR LOCATIONS
FLAT GROUNDING AREA
NAS1394CA3LSN SF Ø.66(Ø16.76) REF
ODS BASE REF
.500(12.7)
15° REF
2° REF
2M5-6gX10.21.11 SCREW
A.5.21.11 WASHER
FLAT GROUNDING AREA
.31(7.9)
.62(16±4)
Ø.354(9.0)
.75(19.05)
.354(9.0)
VIEW R-R 31C
ALIGNMENT PIN AND GROUNDING BOLT
2 PL 180° APART
SCALE: 2/1
Ø53.149(1350)REF
M5-7H 0.39(10) MIN THREAD
.063 (1.6) MAX FOR GROUND LUG
ALIGNMENT PIN
Ø.339(8.6)REF
MOUNTING INTERFACE PLANE
.748(19.0)MAX
.354(9.0)
SECTION Q-Q 31D 25D 28G
ALIGNMENT PIN AND GROUNDING BOLT
2 PL 180° APART
SCALE: 2/1
1.58 (40) 2 PL
.79 (2) 2 PL
3.15 (80) 2 PL
2.36 (60) 2 PL
X72
X71
9 PL
X73
X74
X75
XT9
X67
X68
X69
X70
.551 (14)
45° REF
1.358(34.5)
R23.23(590)
R21.65(550)
Y_O=0.000
Y_T=0.000
VIEW J-J 23A
SCALE: 1/2
INTERNAL MECHANISM / ORBITER CONNECTOR LOCATIONS
2.992 (76)
3.23(82)
6.46(164)
1.496(38)
.984(25)
1.496(38)
.196 (5)
R29.488(749)REF
9.055 (230)
10°
28.30(719)
31.22(793)REF
33.70(856)REF
VIEW F-F 21D
ROTATED 120°CW
SCALE: 1/2
RESOURCE TRANSFER UMBILICAL FOR X2 & X4
VIEW I-I 23D
ROTATED 60°CW
SCALE: 1/2
RESOURCE TRANSFER UMBILICAL FOR X1 & X3
MC621-0087-6001
CONFIGURATION
E 02953 FIG 20-B
CAD/CAM 33
FIG 20-B

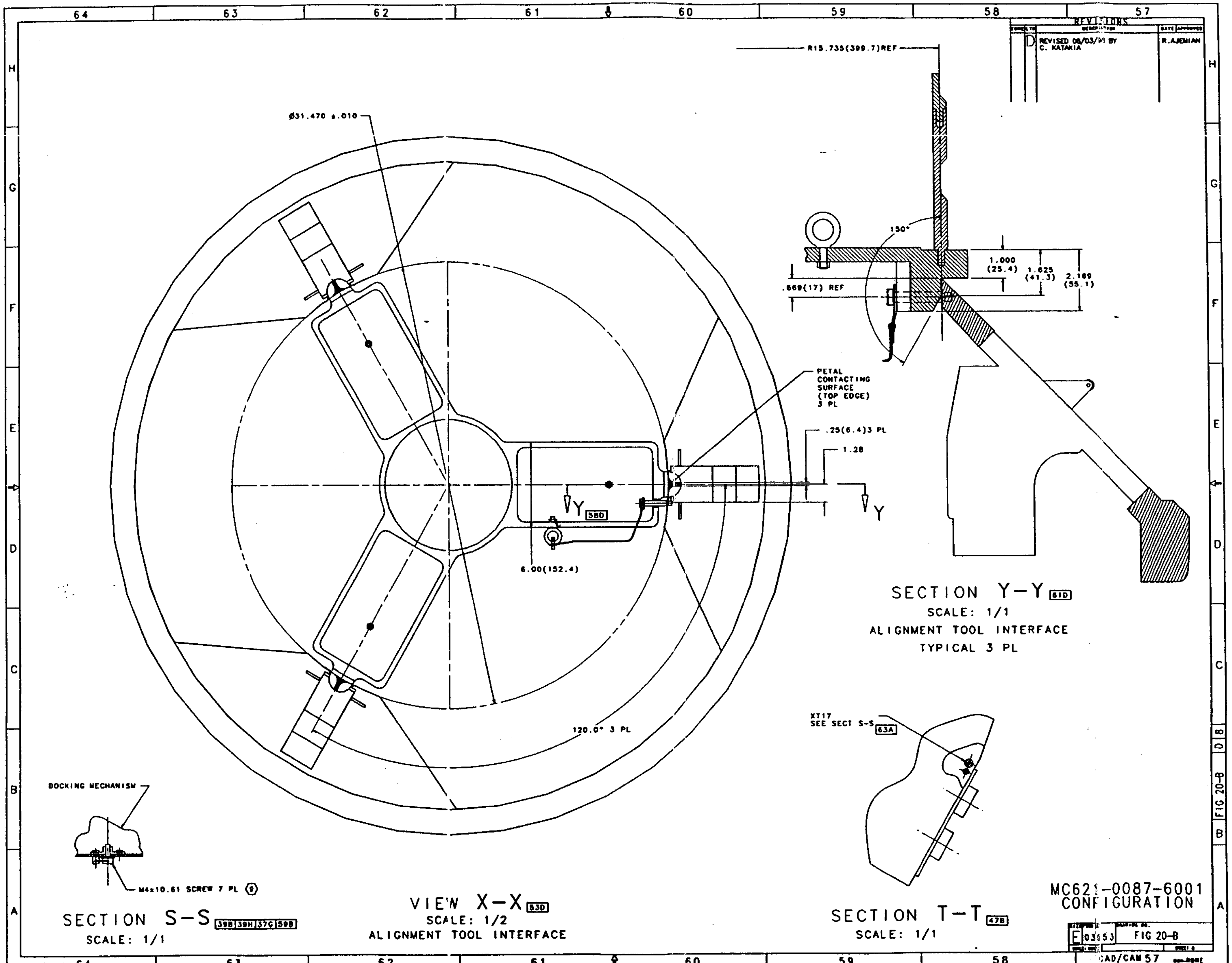
Tue Aug 11 09:28:34 PDT 1998





REVISIONS
REVISED 08/03/98 BY C. KATAKIA
R. AJEMIAN
SECTION U-U 51H
SCALE: 1/2
TYPICAL 3 PL
9.21 (234)
9.620 (244.35)
.078(2)
℄ CROSSHAIR
BONDING AREA
Ø31.496 (Ø800) REF
M8 X 1.25 0.39(10) DEEP 2 PL
2.677±.020(68±.5)
1.339±.020(34±.5)
.669±.020(17±.5)
DOCKING MECHANISM PETAL
VIEW W-W 53E
SCALE: 1/2
TYPICAL 3 PL
Zo479.764 FULLY EXTENDED POSITION
7.874 (200)
Zo475.912 READY TO DOCK POSITION
20.000±.12 (508±3)
15.748±.12 (400±3)
RING FINAL POSITION
Zo460.00 DOCKING INTERFACE
Zo450.887 MOUNTING INTERFACE PLANE
DOCKING MECHANISM
DOCKING MECHANISM OPERATIONAL ENVELOPE
SCALE: 1/5
FWD
4 DOCKING MECHANISM
M8-6EX30X15.21.11 STUD
2M8-7H-32.11 NUT 2 REQD
8.32.11 WASHER 3 REQD
VIEW M 32C
GROUNDING STUD
SCALE: NONE
(ROTATED)
.79(20)
2.00 (50.8)
BONDING AREA
VIEW V 52F
SCALE: 1/1
TYPICAL 3 PL
MC621-0087-6001
CONFIGURATION
FIG 20-8
CAD/CAM 49

Tue Aug 11 09:35:07 PDT 1998



Sat Aug 8 12:45:19 PDT 1998

REV	DESCRIPTION	DATE	APPROVED
E	REVISED 08/03/98 BY C. KATAKIA		R. AJEMIAN

NOTES:

1. DIMENSIONS SHOWN XXX ARE IN US STANDARD (INCHES)
   (XXX) ARE IN METRIC (MM)

(1) 2. U.S.A. SHALL PROVIDE 2 GROUNDING STRAPS BETWEEN DOCKING MECHANISM AND PMA.
RSC-E SHALL PROVIDE 2 GROUNDING LOCATIONS AS SHOWN ON SHEET 4 AND 2 BOLTS.

3. ~~FOR APDA INTERCONNECTING ELECTRICAL CABLES SEE APPENDIX XIII AND~~ XIV OF THIS SPECIFICATION.

(2) 4. SEAL : MATERIAL 51-1567 TY38-40595-72
SHORE HARDNESS 50-65
COMPRESS LOAD 28.54 - 39.95 LB/INCH (5-7 N/mm)

(3) 5. BOLT: M10-8g: MATERIAL: STAINLESS 07Ch16N6
FINISH : PASSIVATE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	166.9(1150)	137.9(950)	9
AXIAL	174.2(1200)	145.1(1000)	12
RADIAL	152.4(1050)	130.6(900)	6

(4) 6. RSC-E BASE MATERIAL: AL ALLOY AMr6.M
FINISH : CHEM FILM ANODIZE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	42.1(290)	17.4(120)	11
AXIAL	42.1(290)	17.4(120)	11
RADIAL	42.1(290)	17.4(120)	11

(5) 7. ALIGNMENT PIN MATERIAL: TITANIUM BT-14
FINISH: NONE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	137.9(950)	123.4(850)	10%
AXIAL	137.9(950)	123.4(850)	10%
RADIAL	137.9(950)	123.4(850)	10%

(6) 8. THESE BOLTS TO BE TORQUED TO 364.0±9.0 IN-LBS (4.0±0.1 KGF M) AFTER APPLICATION OF LUBRICANT ON THE THREADS OF THE BOLTS. LOCKWIRE BOLTS IN PAIRS USING .020 DIA LOCKWIRE.

(7) 9. FACILITY GROUND STUD . FACILITY GROUNDING CABLE MUST BE ATTACHED AT THIS LOCATION AT ALL TIME

(8) 10. PROVIDED BY RSC-E

(9) 11. CONNECTOR KEYWAYS AS SHOWN

(10) 12. Xt, Yt, Zt DENOTE MECHANISM TEST AXIS

13. INTERNAL THERMAL BLANKETS SHALL BE CAPABLE OF BEING REMOVED IN FLIGHT

14. PMA:
MATERIAL: ALUMINUM ALLOY 2219-T851
FINISH: CHEM FILM PER MIL-C-5541, CLASS 3

(11) 15. THESE CONNECTORS ARE CAPPED

(12) 16. SURFACES CODED SHALL SUPPORT AN ELECTRICAL BOND WITH THE "FGB" PASSIVE APDA OF RESISTANCE NO MORE THAN 100mΩ AT 1 MHZ

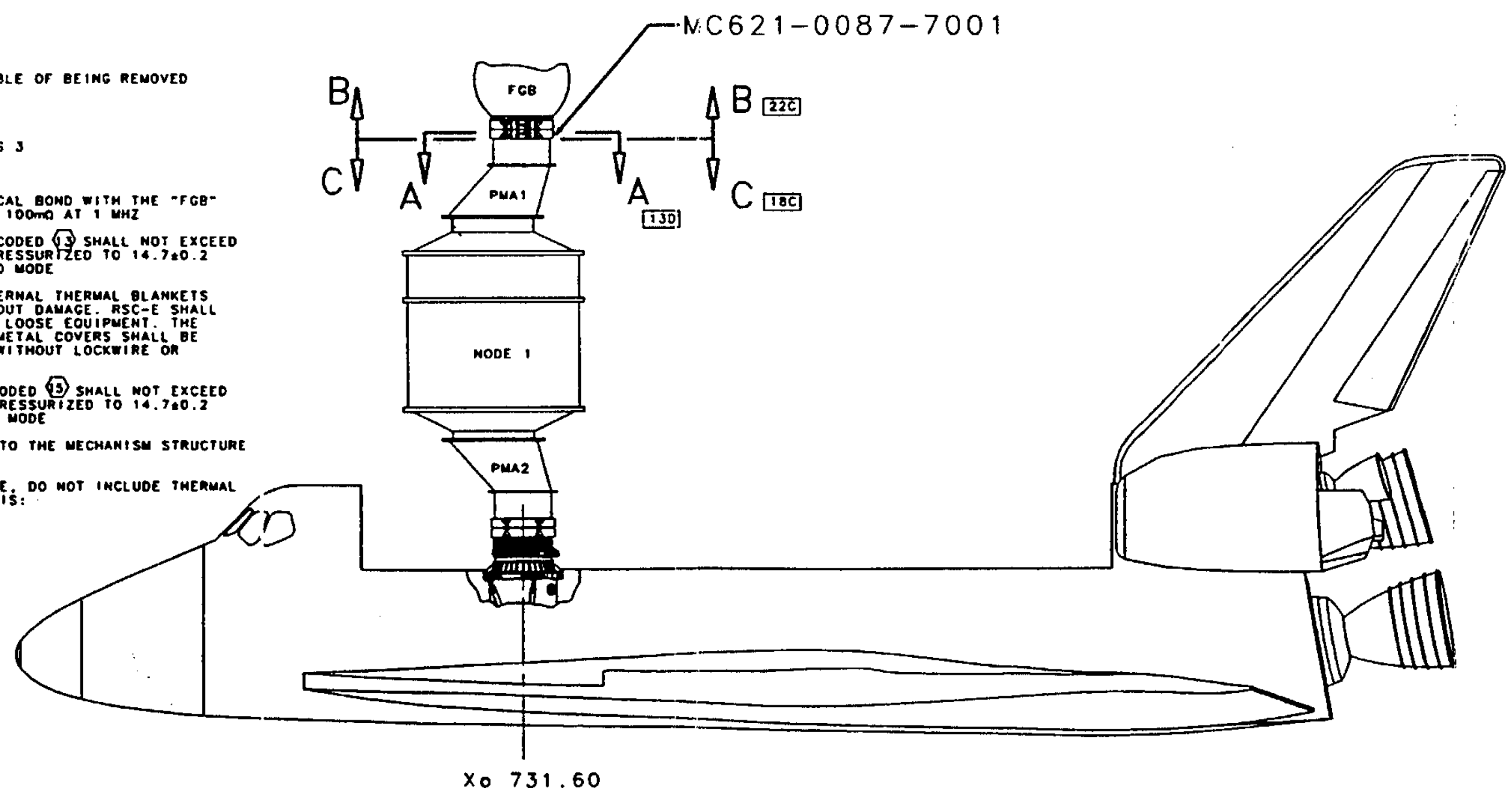
(13) 17. LEAKAGE OF SEALS ACROSS EACH INTERFACE CODED (13) SHALL NOT EXCEED 0.02 LBS/DAY(9g/DAY) WHEN INTERIOR IS PRESSURIZED TO 14.7±0.2 PSI(760 ±10 mmHG) IN THE DOCKED OR MATED MODE

(14) 15. RSC-E SHALL DESIGN THE INTERNAL AND EXTERNAL THERMAL BLANKETS TO BE REMOVABLE AND RE-INSTALLABLE WITHOUT DAMAGE. RSC-E SHALL DELIVER THE EXTERNAL THERMAL BLANKET AS LOOSE EQUIPMENT. THE X1 THRU X4 CONNECTORS AND THE EXTERNAL METAL COVERS SHALL BE TEMPORARILY INSTALLED ON THE MECHANISM WITHOUT LOCKWIRE OR TORQUING OF FASTENERS. ONLY HAND TIGHT.

(15) 16. LEAKAGE OF SEALS ACROSS EACH INTERFACE CODED (15) SHALL NOT EXCEED 0.08 LBS/DAY(36g/DAY) WHEN INTERIOR IS PRESSURIZED TO 14.7±0.2 PSI(760 ±10 mmHG) IN THE DOCKED OR MATED MODE

(16) 17. USA WILL PROVIDE AND INSTALL BUSHINGS INTO THE MECHANISM STRUCTURE PRIOR TO ITS MOUNTING ONTO THE PMA.

(17) 18. ALL ENVELOPE DIMENSIONS, WHERE APPLICABLE, DO NOT INCLUDE THERMAL BLANKET THICKNESS. THICKNESS OF BLANKET IS:
.19-.40(5-10 MM)- ON THE GROUND
.78(20 MM)MAX, UNRESTRICTED- ON ORBIT



FLIGHT 2A CONFIGURATION

SCALE: NONE

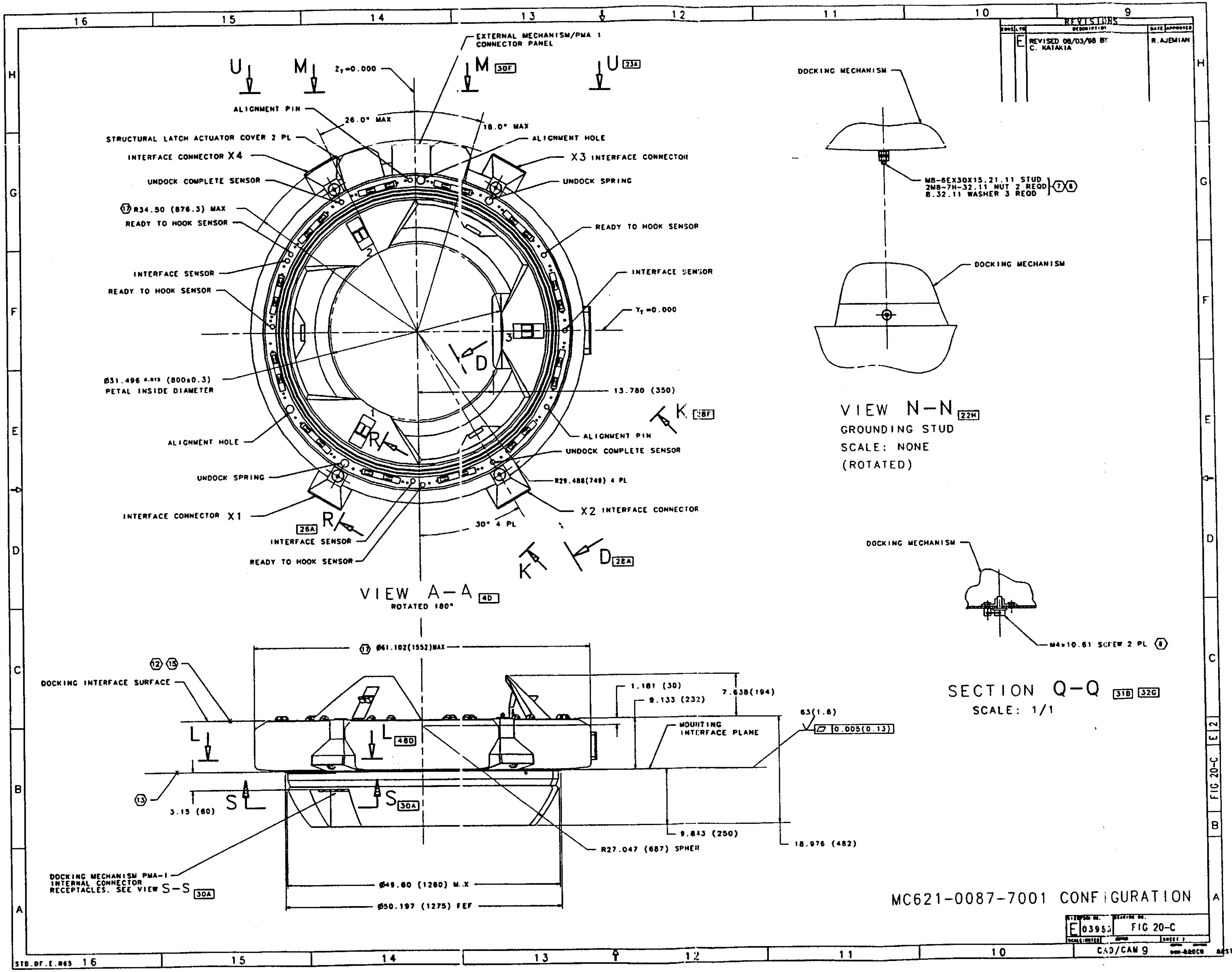
MC621-0087-7001 CONFIGURATION
(33Y.6201.008-05-004)

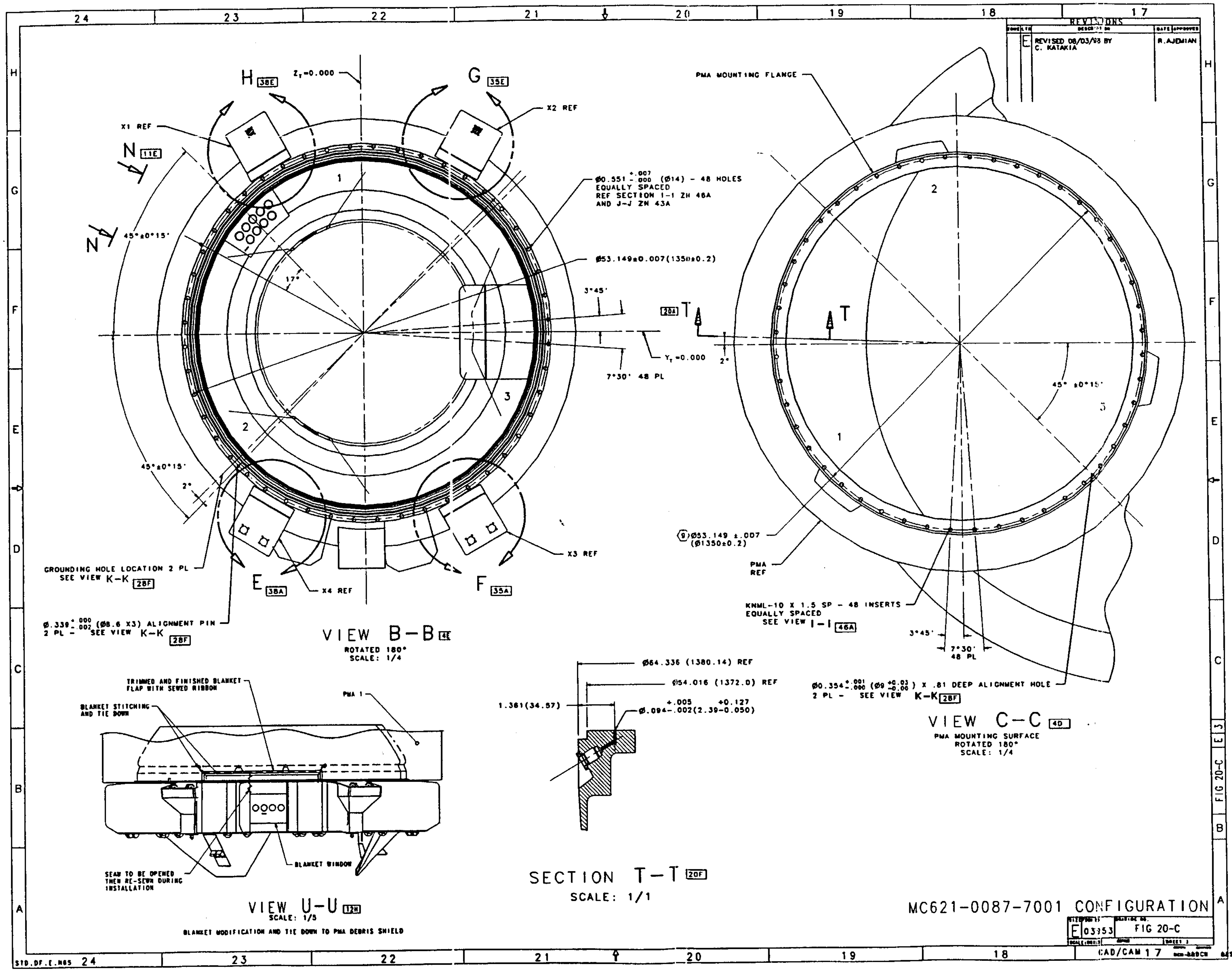
SPEC CONTROL DRAWING - ISSA, DOCKING MECHANISM INTERFACE REQUIREMENTS

E 03153 FIG 20-C

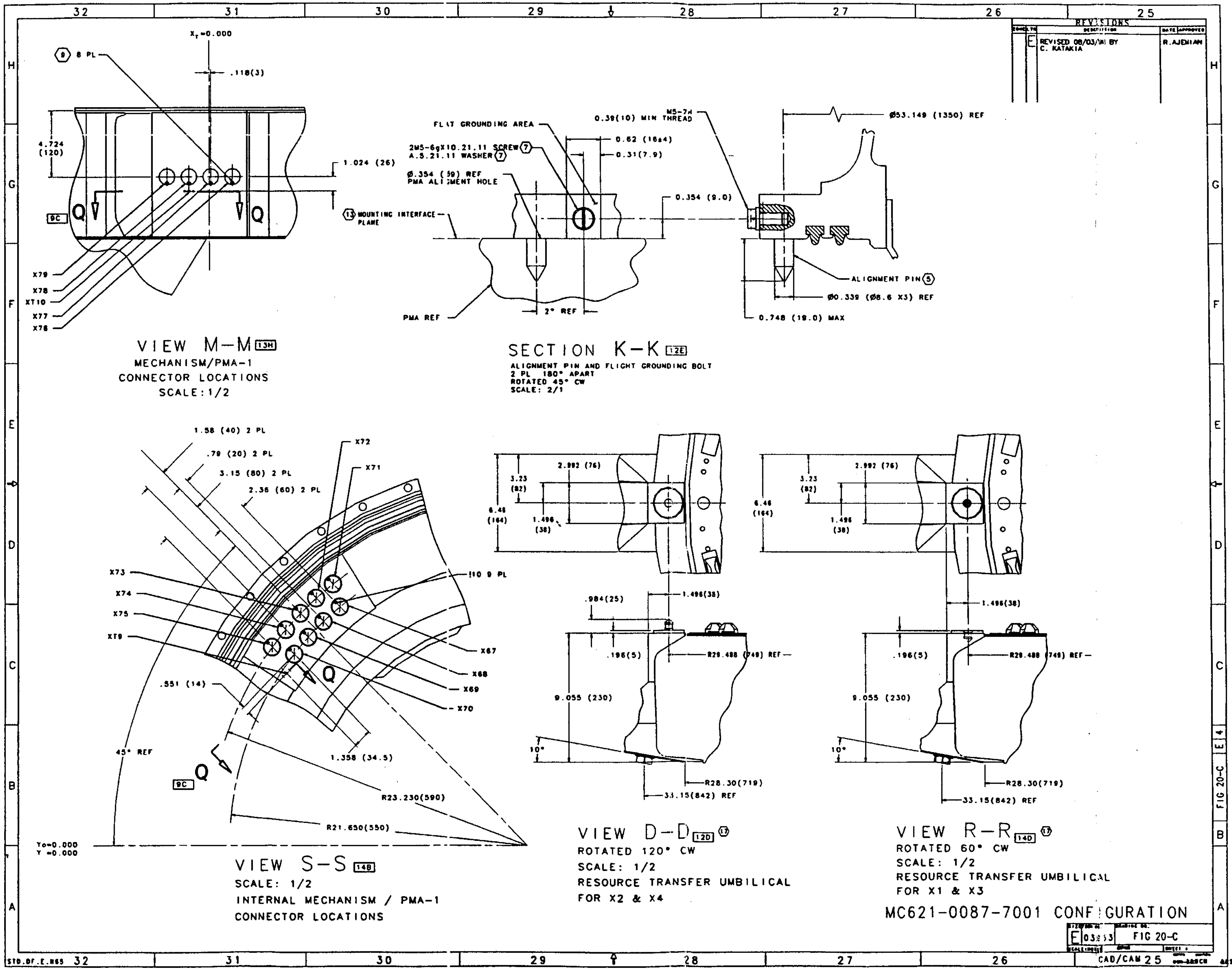
CAD/CAM 1

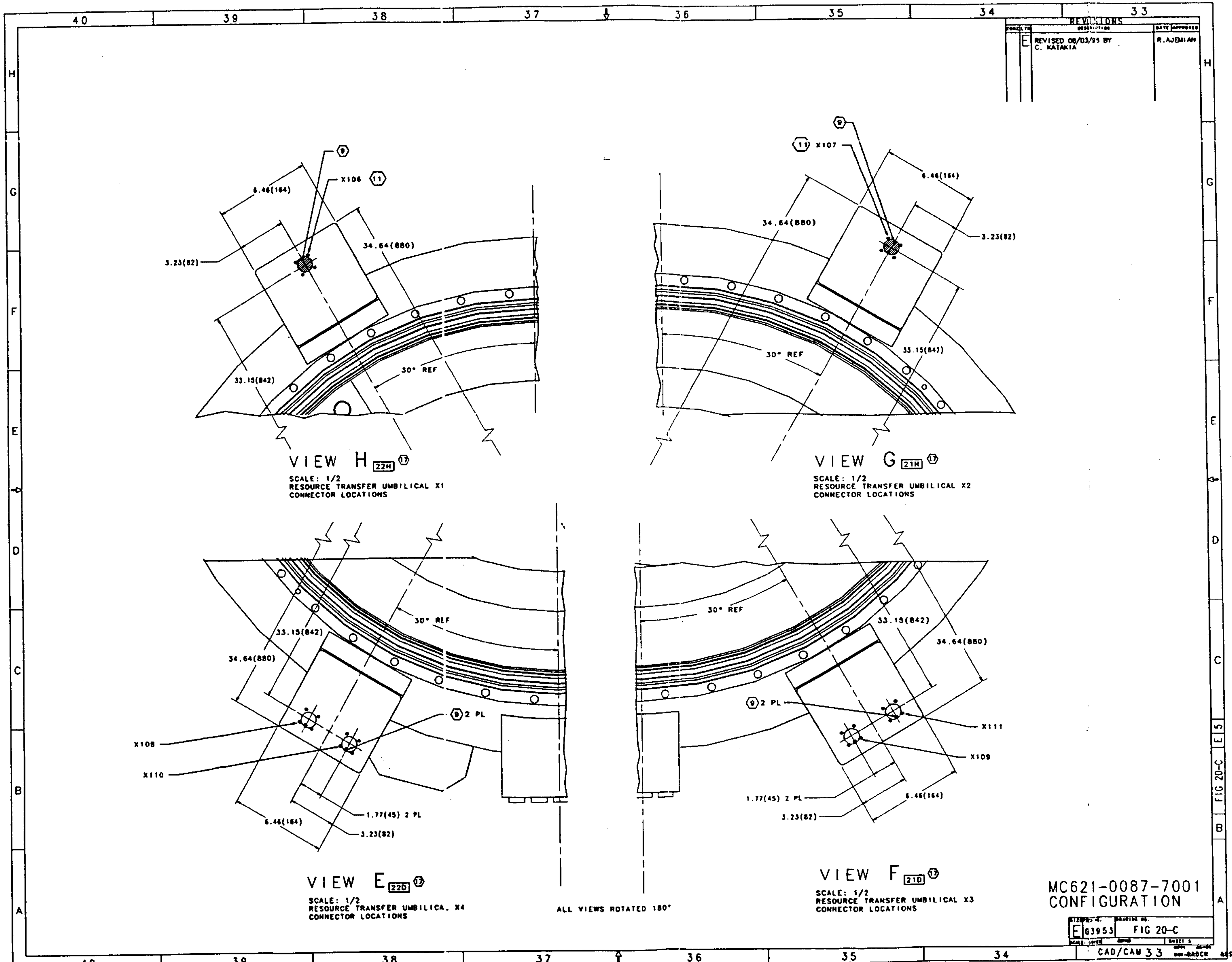
STD.OF.E.R67


REVISIONS
E REVISED 06/03/98 BY C. KATAKIA
R. AJEMIAN
EXTERNAL MECHANISM/PMA 1 CONNECTOR PANEL
ALIGNMENT PIN
STRUCTURAL LATCH ACTUATOR COVER 2 PL
INTERFACE CONNECTOR X4
UNDOCK COMPLETE SENSOR
R34.50 (876.3) MAX
READY TO HOOK SENSOR
INTERFACE SENSOR
READY TO HOOK SENSOR
Ø31.496 (800±0.3) PETAL INSIDE DIAMETER
ALIGNMENT HOLE
UNDOCK SPRING
INTERFACE CONNECTOR X1
INTERFACE SENSOR
READY TO HOOK SENSOR
26.0° MAX
18.0° MAX
ALIGNMENT HOLE
X3 INTERFACE CONNECTOR
UNDOCK SPRING
READY TO HOOK SENSOR
INTERFACE SENSOR
13.780 (350)
ALIGNMENT PIN
UNDOCK COMPLETE SENSOR
R29.488(749) 4 PL
X2 INTERFACE CONNECTOR
30° 4 PL
VIEW A-A 4D
ROTATED 180°
Ø61.102(1552)MAX
DOCKING INTERFACE SURFACE
1.181 (30)
9.133 (232)
7.638(194)
MOUNTING INTERFACE PLANE
63(1.6)
0.005(0.13)
3.15 (80)
9.843 (250)
18.976 (482)
R27.047 (687) SPHER
DOCKING MECHANISM PMA-1 INTERNAL CONNECTOR RECEPTACLES. SEE VIEW S-S 30A
Ø49.60 (1260) MAX
Ø50.197 (1275) REF
DOCKING MECHANISM
M8-6EX30X15.21.11 STUD
2M8-7H-32.11 NUT 2 REQD
8.32.11 WASHER 3 REQD
DOCKING MECHANISM
VIEW N-N 22H
GROUNDING STUD
SCALE: NONE
(ROTATED)
DOCKING MECHANISM
M4x10.61 SCREW 2 PL
SECTION Q-Q 31B 32G
SCALE: 1/1
MC621-0087-7001 CONFIGURATION
E 03953 FIG 20-C
CAD/CAM 9


REVISIONS
E REVISED 08/03/98 BY C. KATAKIA R.AJEMIAN
H 38E
G 35E
Z_T=0.000
X1 REF
X2 REF
N 11E
PMA MOUNTING FLANGE
Ø0.551 +.007 -.000 (Ø14) - 48 HOLES EQUALLY SPACED REF SECTION I-I ZN 46A AND J-J ZN 43A
45°±0°15'
Ø53.149±0.007(1350±0.2)
17°
3°45'
20A T
T
Y_T=0.000
2°
7°30' 48 PL
45° ±0°15'
45°±0°15'
2°
Ø53.149 ±.007 (Ø1350±0.2)
PMA REF
X3 REF
GROUNDING HOLE LOCATION 2 PL SEE VIEW K-K 28F
E 38A
X4 REF
F 35A
KNML-10 X 1.5 SP - 48 INSERTS EQUALLY SPACED SEE VIEW I-I 46A
Ø.339 +.000 -.002 (Ø8.6 X3) ALIGNMENT PIN 2 PL - SEE VIEW K-K 28F
VIEW B-B 4E
ROTATED 180°
SCALE: 1/4
3°45'
7°30' 48 PL
Ø64.336 (1380.14) REF
Ø54.016 (1372.0) REF
1.361(34.57)
Ø.094 +.005 -.002(2.39 +0.127 -0.050)
Ø0.354 +.001 -.000 (Ø9 +0.03 -0.00) X .81 DEEP ALIGNMENT HOLE 2 PL - SEE VIEW K-K 28F
VIEW C-C 4D
PMA MOUNTING SURFACE
ROTATED 180°
SCALE: 1/4
TRIMMED AND FINISHED BLANKET FLAP WITH SEWED RIBBON
PMA 1
BLANKET STITCHING AND TIE DOWN
SEAM TO BE OPENED THEN RE-SEWN DURING INSTALLATION
BLANKET WINDOW
VIEW U-U 12H
SCALE: 1/5
BLANKET MODIFICATION AND TIE DOWN TO PMA DEBRIS SHIELD
SECTION T-T 20F
SCALE: 1/1
MC621-0087-7001 CONFIGURATION
E 03353 FIG 20-C
CAD/CAM
FIG 20-C
STD.DF.E.NOS

Tue Aug 11 08:45:47 PDT 1998




REVISIONS
E REVISED 08/03/95 BY C. KATAKIA
R.AJEMIAN
9
X106 11
6.46(164)
3.23(82)
34.64(880)
33.15(842)
30° REF
VIEW H 22H 17
SCALE: 1/2
RESOURCE TRANSFER UMBILICAL X1
CONNECTOR LOCATIONS
9
11 X107
6.46(164)
34.64(880)
3.23(82)
30° REF
33.15(842)
VIEW G 21H 17
SCALE: 1/2
RESOURCE TRANSFER UMBILICAL X2
CONNECTOR LOCATIONS
30° REF
33.15(842)
34.64(880)
X108
X110
9 2 PL
1.77(45) 2 PL
6.46(164)
3.23(82)
VIEW E 22D 17
SCALE: 1/2
RESOURCE TRANSFER UMBILICA. X4
CONNECTOR LOCATIONS
ALL VIEWS ROTATED 180°
30° REF
33.15(842)
34.64(880)
9 2 PL
X111
X109
1.77(45) 2 PL
3.23(82)
6.46(164)
VIEW F 21D 17
SCALE: 1/2
RESOURCE TRANSFER UMBILICAL X3
CONNECTOR LOCATIONS
MC621-0087-7001
CONFIGURATION
E 03953 FIG 20-C
CAD/CAM
FIG 20-C E 5
STD.DF.E.N05

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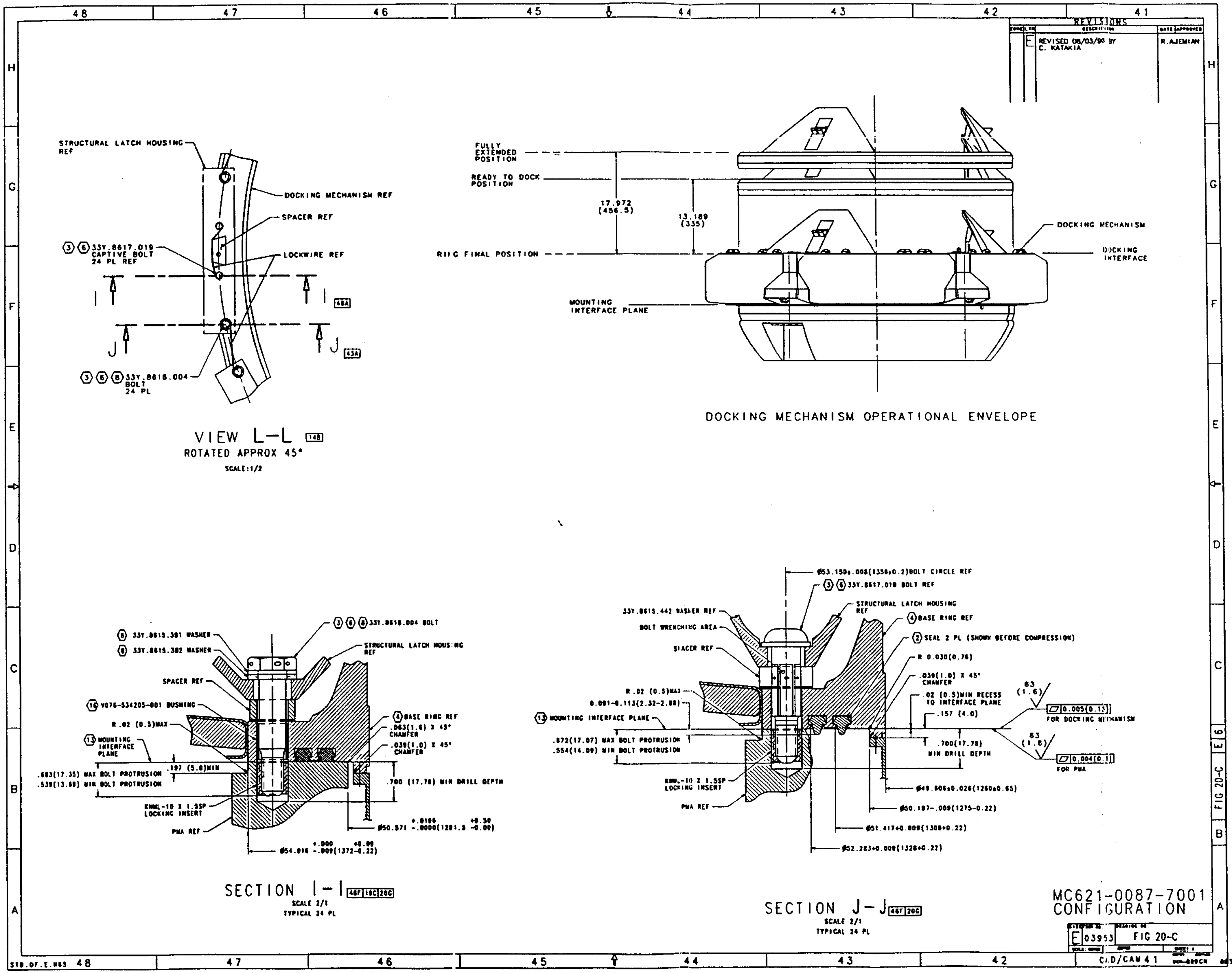
Mon Aug 10 11:16:37 PDT 1998



Mon Aug 10 10:59:54 PDT 1998

NOTES:

1. DIMENSIONS SHOWN XXX ARE IN US STANDARD (INCHES)
   (XXX) ARE IN METRIC (MM)
2. ⟨1⟩ USA PROVIDES 2 GROUNDING STRAPS BETWEEN DOCKING MECHANISM AND THE PMA RSC-E PROVIDES 2 GROUNDING LOCATIONS AS SHOWN ON SHEET 4 AND 2 BOLTS
3. FOR APDA INTERCONNECTING ELECTRICAL CABLES SEE APPENDIX XIII OF THIS SPECIFICATION.
4. ⟨2⟩ SEAL : MATERIAL 51-1567 TY38-40595-72
   SHORE HARDNESS 50-65
   COMPRESS LOAD 28.54 - 39.95 LB/INCH (5-7 N/mm)
5. ⟨3⟩ BOLT: M10-8g: MATERIAL: STAINLESS 07Ch16N6
   FINISH : PASSIVATE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	166.9(1150)	137.9(950)	9
AXIAL	174.2(1200)	145.1(1000)	12
RADIAL	152.4(1050)	130.6(900)	6

6. ⟨4⟩ RSC-E BASE MATERIAL: AL ALLOY AMr6.M
   FINISH : CHEM FILM ANODIZE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	42.1(290)	17.4(120)	11
AXIAL	42.1(290)	17.4(120)	11
RADIAL	42.1(290)	17.4(120)	11

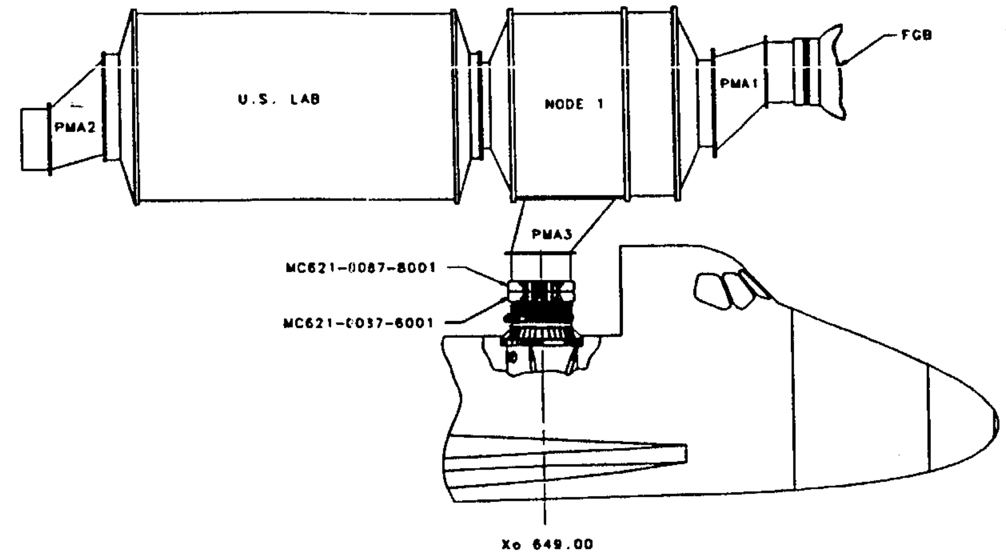
7. ⟨5⟩ ALIGNMENT PIN MATERIAL: TITANIUM BT-14
   FINISH: NONE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	137.9(950)	123.4(850)	10%
AXIAL	137.9(950)	123.4(850)	10%
RADIAL	137.9(950)	123.4(850)	10%

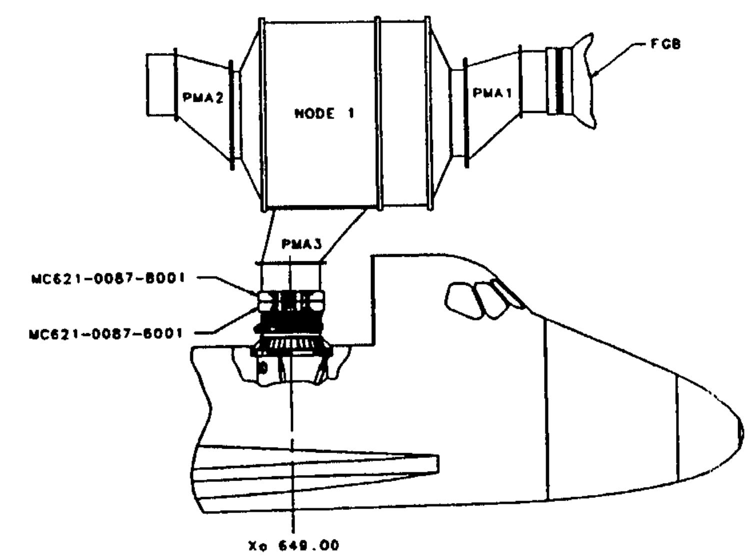
8. ⟨6⟩ THESE BOLTS TO BE TORQUED TO 364.0±9.0 IN-LBS (4.0±0.1 KGF M) AFTER APPLICATION OF LUBRICANT ON THE THREADS OF THE BOLTS. LOCKWIRE BOLTS IN PAIRS USING .020 DIA LOCKWIRE.
9. ⟨7⟩ PROVIDED BY RSC-E
10. ⟨8⟩ CONNECTOR KEYWAYS AS SHOWN
11. X1, Y1, Z1 DENOTE MECHANISM TEST AXIS
12. BTS1, BTS2, BTS3 & BTS4 ARE DATA BUS SWITCHES
13. INTERNAL THERMAL BLANKETS SHALL BE CAPABLE OF BEING REMOVED IN FLIGHT.
14. PMA:
    MATERIAL: ALUMINUM ALLOY 2219-T851
    FINISH: CHEM FILM PER MIL-C-5541, CLASS 3
15. ⟨9⟩ DRILL PLATE PROVIDED BY RSC-E
16. THIS MECHANISM INTERFACES WITH MC621-0087-6001 MECHANISM ON THE ORBITER
17. ⟨10⟩ THESE BOLT HEADS MUST HAVE NON-GLARE SURFACES. TORQUE THESE BOLTS TO 125±5 IN/LBS(1.43±.06 KGF-M)
18. ⟨11⟩ THESE CONNECTORS ARE CAPPED
19. ⟨12⟩ HATCH MAY BE OPENED WITH OR WITHOUT THE TARGET
20. ⟨13⟩ LEAKAGE OF SEALS ACROSS EACH INTERFACE CODED ⟨13⟩ SHALL NOT EXCEED 0.02 LBS/DAY(9g/DAY) WHEN INTERIOR IS PRESSURIZED TO 14.7±0.2 (760±10mmHg) IN THE DOCKED OR MATED MODE
21. ⟨14⟩ A: DURING THE DOCKING OF MECHANISM, WHEN CONTACTS 1-15, 2-16, 11-26, 12-27 ARE CLOSED AND CONTACTS 1-5, 2-6, 11-18, 12-19 ARE OPEN WITH THE GAP C BEING EQUAL TO 2.5±0.1mm
    B: DURING THE UNDOCKING OF MECHANISM, WHEN CONTACTS 1-5, 2-6, 11-18, 12-19 ARE CLOSED AND CONTACTS 1-15, 2-16, 11-26, 12-27 ARE OPEN WITH THE GAP C BEING EQUAL TO 3.0±0.1mm
22. RSC-E SHALL DESIGN THE EXTERNAL THERMAL BLANKET TO BE REMOVABLE AND RE-INSTALLABLE WITHOUT DAMAGE.
    RSC-E SHALL DELIVER THE EXTERNAL THERMAL BLANKET AS LOOSE EQUIPMENT. THE X1 THRU X4 CONNECTORS AND THE EXTERNAL METAL COVERS SHALL BE TEMPORARILY INSTALLED ON THE MECHANISM WITHOUT LOCKWIRING OR TORQUEING OF FASTENERS. ONLY HAND TIGHT.
    RSC-E SHALL PROVIDE WITH EACH MECHANISM A HATCH FSE HANDLE.
23. ⟨15⟩ LEAKAGE OF SEALS ACROSS EACH INTERFACE CODED ⟨15⟩ SHALL NOT EXCEED 0.08 LBS/DAY(36g/DAY) WHEN INTERIOR IS PRESSURIZED TO 14.7±0.2 (760±10mmHg) IN THE DOCKED OR MATED MODE
24. ⟨16⟩ RESOURCE TRANSFER BUNDLE SUPPORT BRACKET TO BE INSTALLED PRIOR TO LIFT-OFF.
25. ⟨17⟩ U.S.A TO PROVIDE AND INSTALL BUSHINGS INTO THE MECHANISM STRUCTURE PRIOR TO ITS MOUNTING ONTO THE PMA2 AND PMA3
26. ⟨18⟩ ALL ENVELOPE DIMENSIONS, WHERE APPLICABLE, DO NOT INCLUDE THERMAL BLANKET THICKNESS. THICKNESS OF BLANKET IS:
    .19-.40(5-10 MM)- ON THE GROUND
    .78(20 MM)MAX, UNRESTRICTED- ON ORBIT

REVISIONS

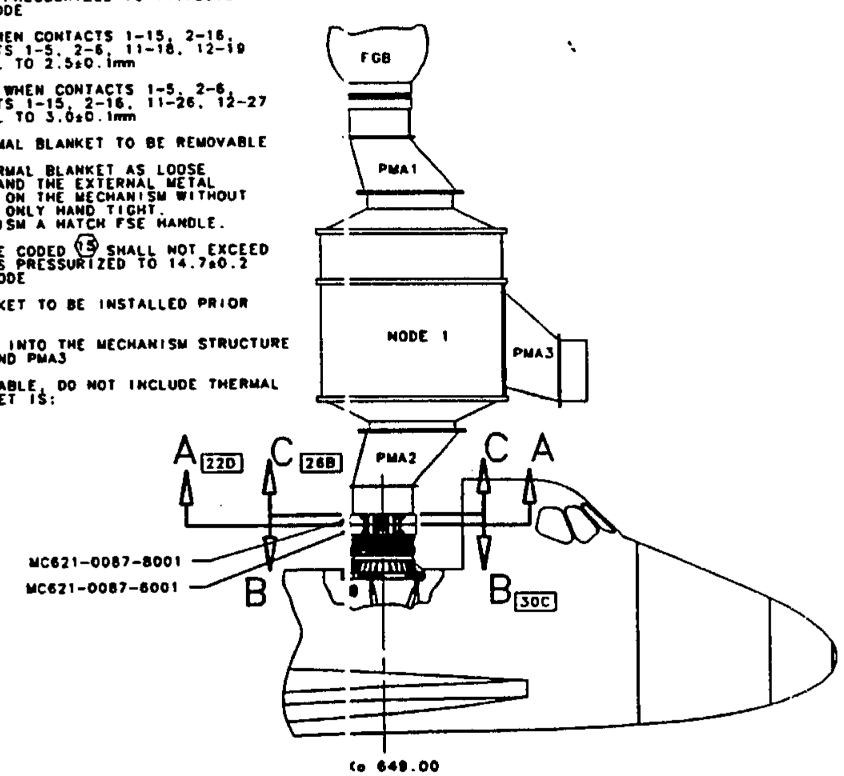
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	E	REVISED 06/03/18 BY C. KATAKIA		R.AJEMIAN



FLIGHT 5A CONFIGURATION REF



FLIGHT 4A CONFIGURATION REF



FLIGHT 3A CONFIGURATION

MC621-0087-8001 CONFIGURATION
(33y.6201.008-08)

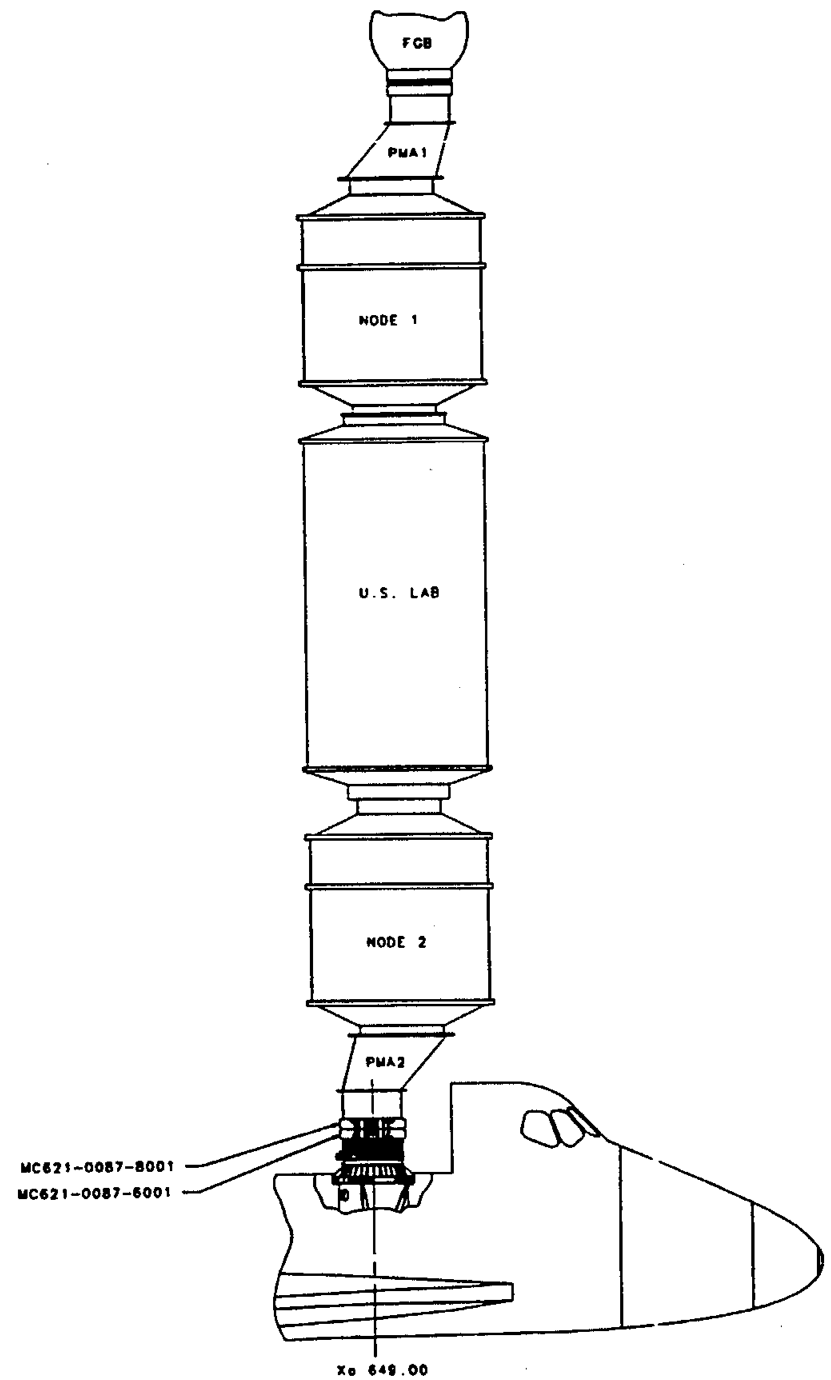
SPEC CONTROL DRAWING - ISSA, DOCKING MECHANISM INTERFACE REQUIREMENTS

SIZE E 03953 FIG 20-D

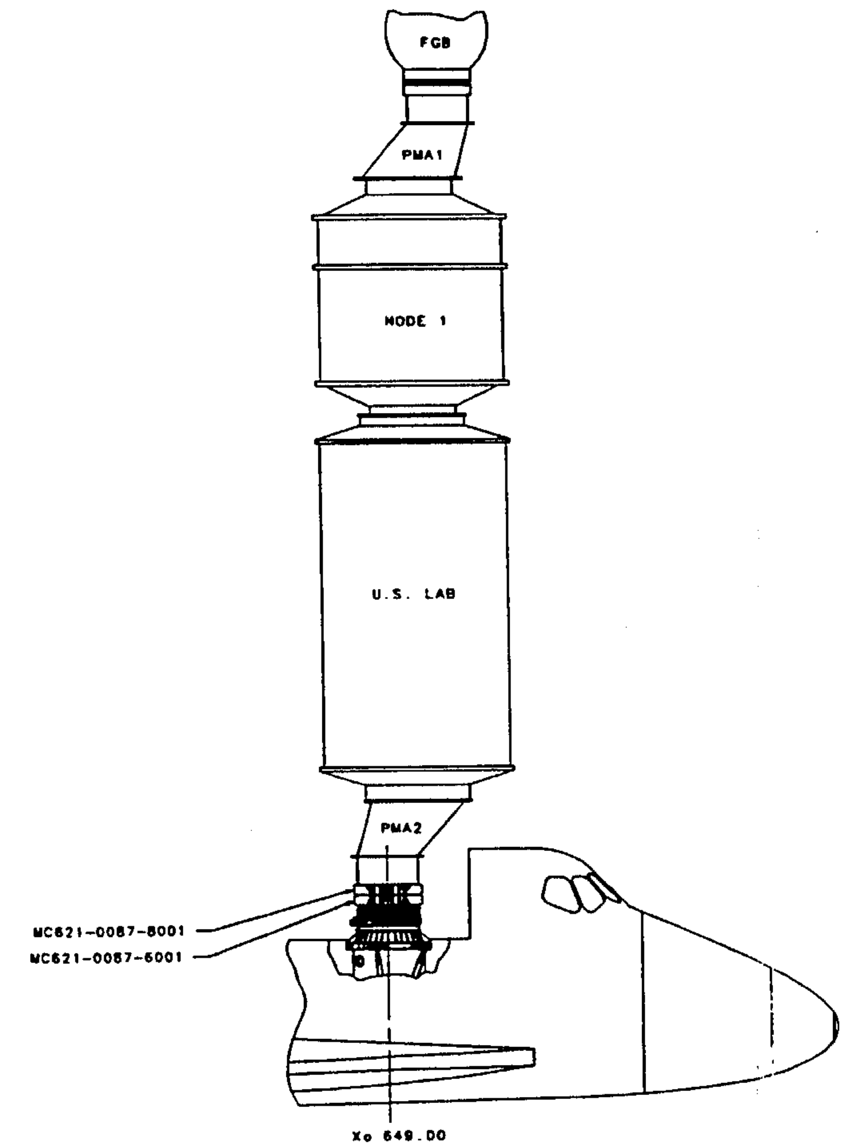
CAD/CAM 1

STD.DF.E.N67

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
E	REVISED 06/03/98 BY C. KATAKIA		R.AJEMIAN



FLIGHT FINAL CONFIGURATION REF



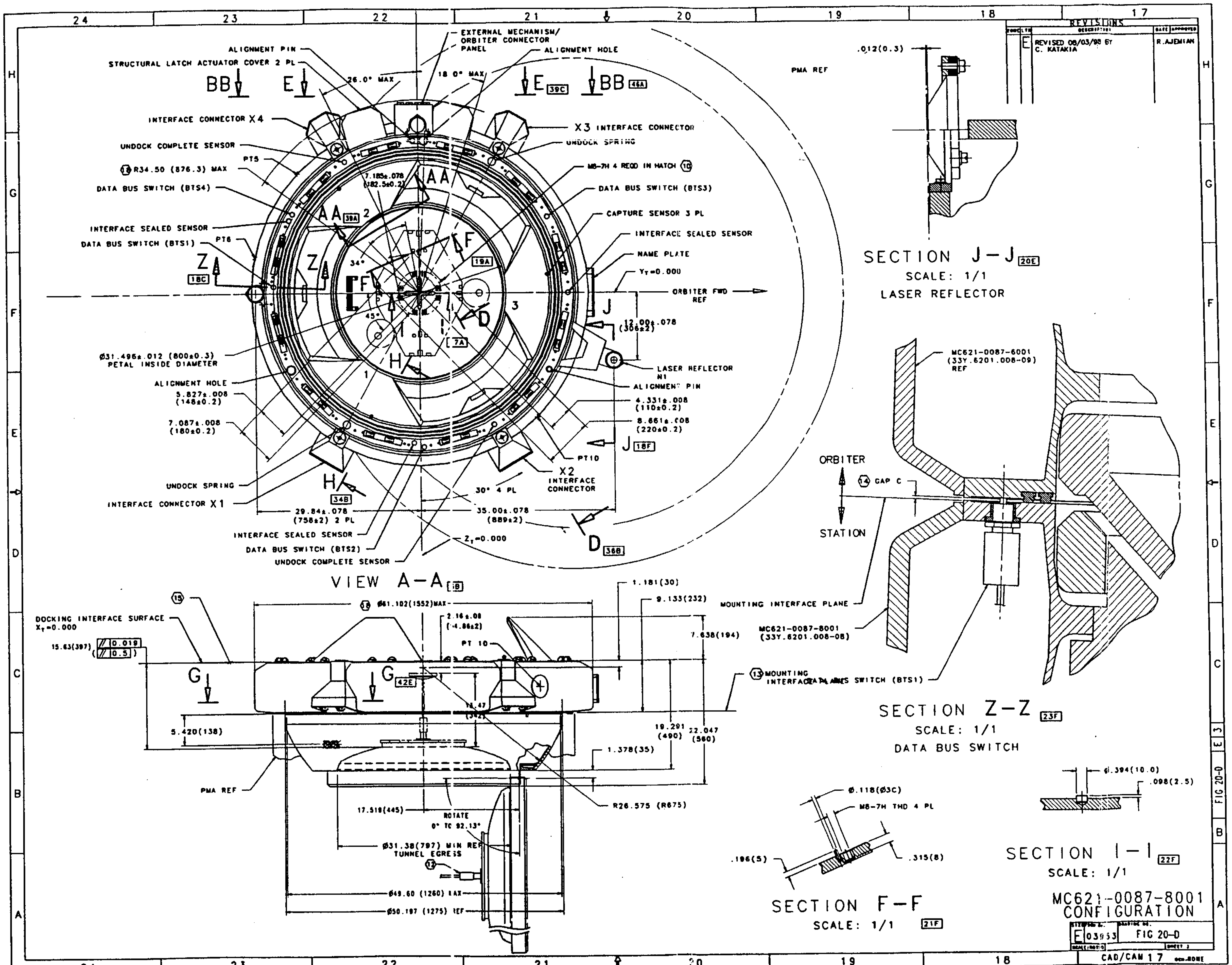
FLIGHT 6A CONFIGURATION REF

MC621-0087-8001
CONFIGURATION

E 03353 FIG 20-D

CAD/CAM 9

FIG 20-D E 2


REVISIONS
E REVISED 08/03/98 BY C. KATAKIA R.AJEMIAN
EXTERNAL MECHANISM/ORBITER CONNECTOR PANEL
ALIGNMENT PIN
STRUCTURAL LATCH ACTUATOR COVER 2 PL
ALIGNMENT HOLE
INTERFACE CONNECTOR X4
X3 INTERFACE CONNECTOR
UNDOCK COMPLETE SENSOR
UNDOCK SPRING
R34.50 (876.3) MAX
M6-7H 4 REQD IN HATCH
DATA BUS SWITCH (BTS4)
DATA BUS SWITCH (BTS3)
CAPTURE SENSOR 3 PL
INTERFACE SEALED SENSOR
DATA BUS SWITCH (BTS1)
NAME PLATE
Y_T=0.000
ORBITER FWD REF
Ø31.496±.012 (800±0.3) PETAL INSIDE DIAMETER
LASER REFLECTOR N1
ALIGNMENT PIN
INTERFACE CONNECTOR X1
X2 INTERFACE CONNECTOR
INTERFACE SEALED SENSOR
DATA BUS SWITCH (BTS2)
UNDOCK COMPLETE SENSOR
Z_T=0.000
VIEW A-A
PMA REF
SECTION J-J
SCALE: 1/1
LASER REFLECTOR
MC621-0087-6001 (33Y.6201.008-09) REF
ORBITER
STATION
CAP C
MOUNTING INTERFACE PLANE
MC621-0087-8001 (33Y.6201.008-08)
DATA BUS SWITCH (BTS1)
SECTION Z-Z
SCALE: 1/1
DATA BUS SWITCH
DOCKING INTERFACE SURFACE X_T=0.000
MOUNTING INTERFACE PLANE
Ø61.102(1552)MAX
ROTATE 0° TO 92.13°
Ø31.38(797) MIN REF TUNNEL EGRESS
Ø49.60 (1260) MAX
Ø50.197 (1275) REF
R26.575 (R675)
SECTION F-F
SCALE: 1/1
M6-7H THD 4 PL
SECTION I-I
SCALE: 1/1
MC621-0087-8001 CONFIGURATION
FIG 20-D
CAD/CAM 17

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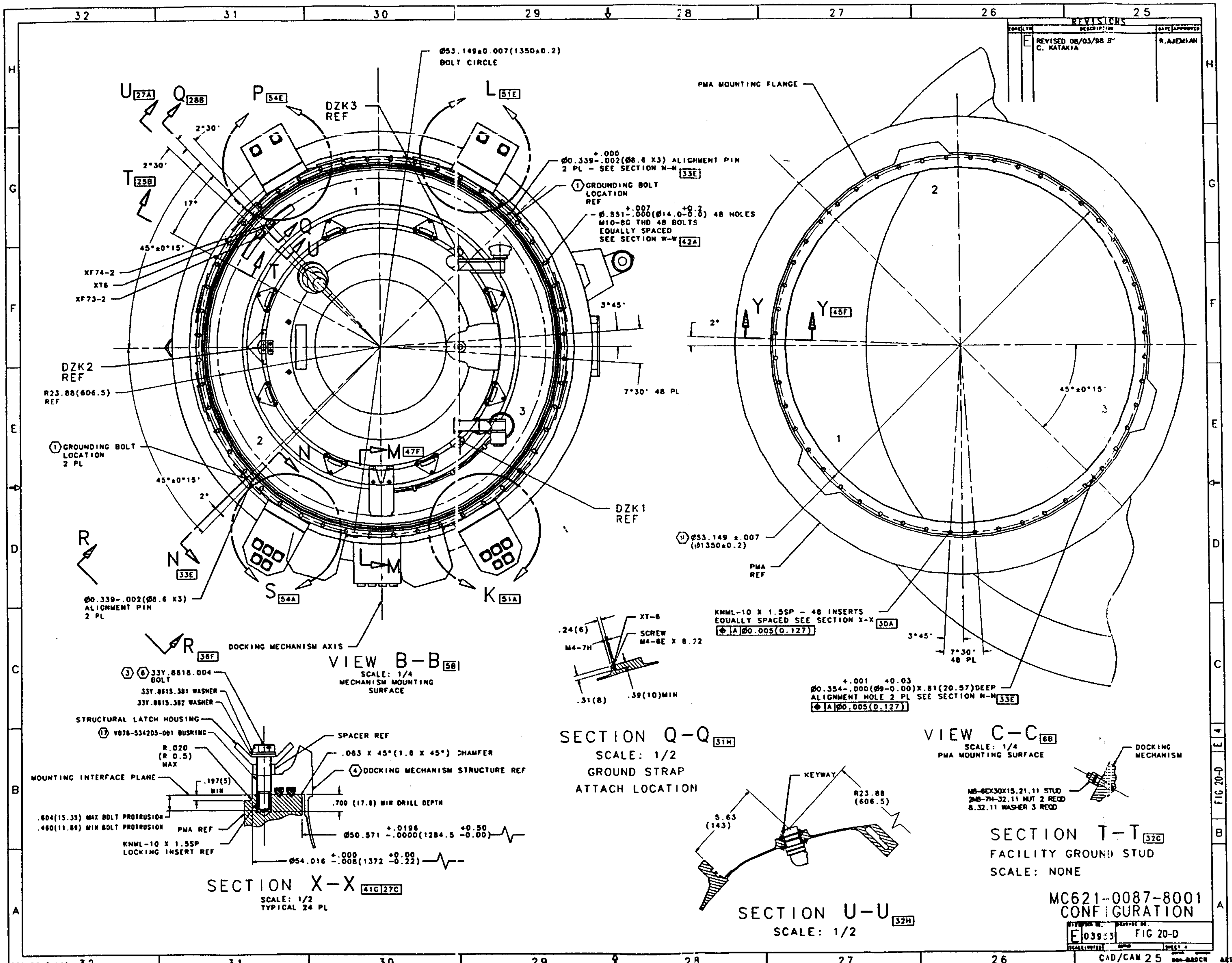
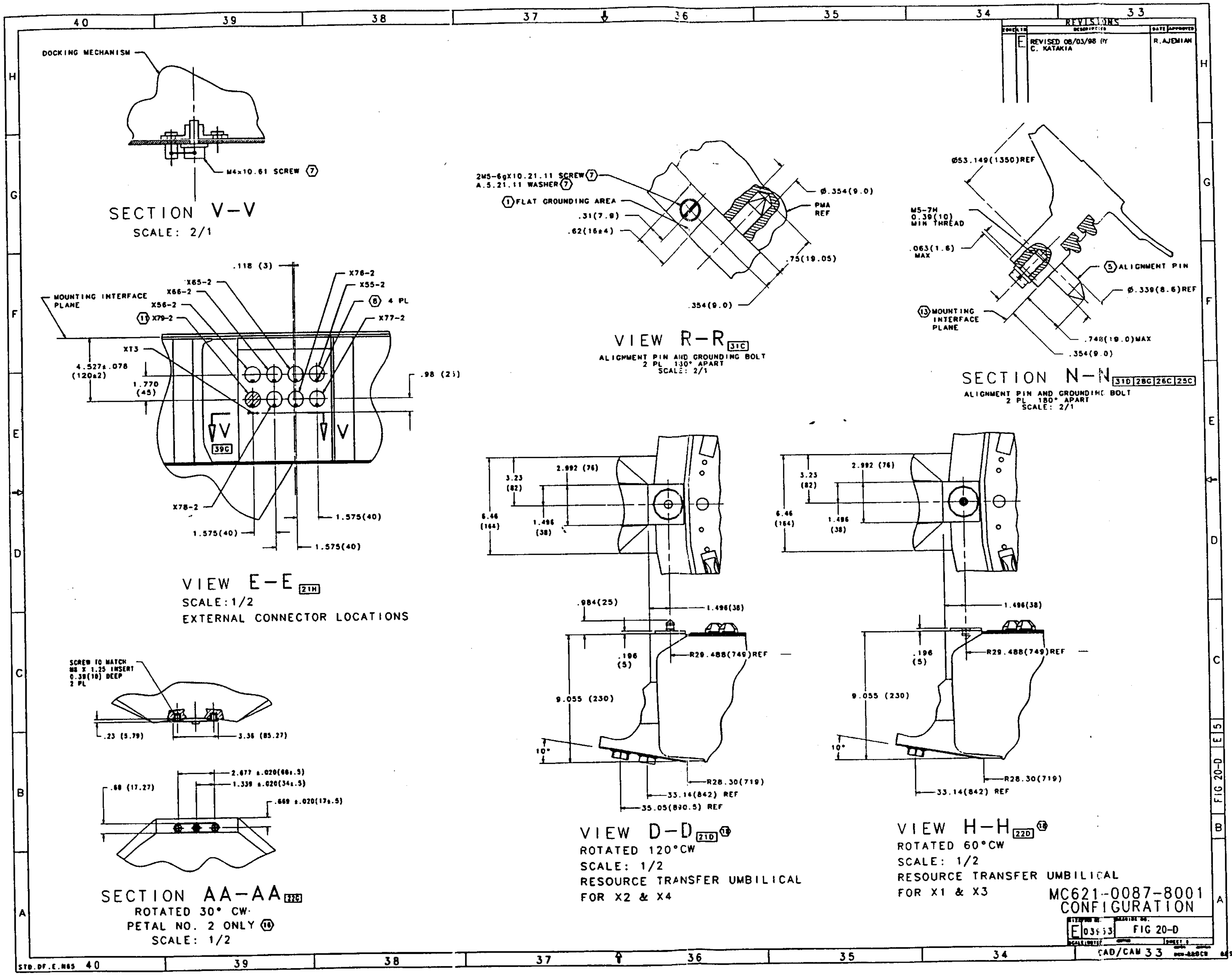
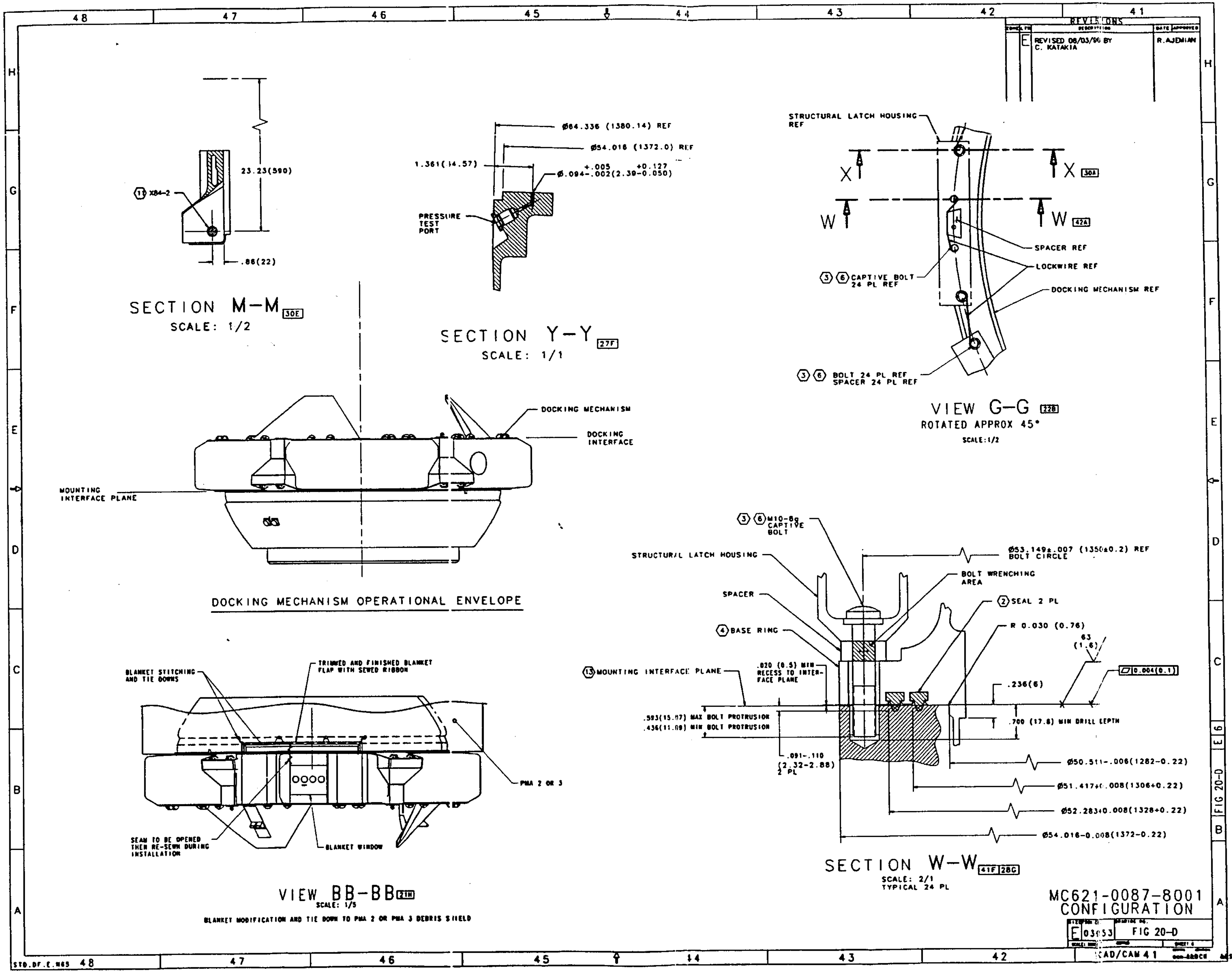
Sat Aug 8 12:59:23 PDT 1998



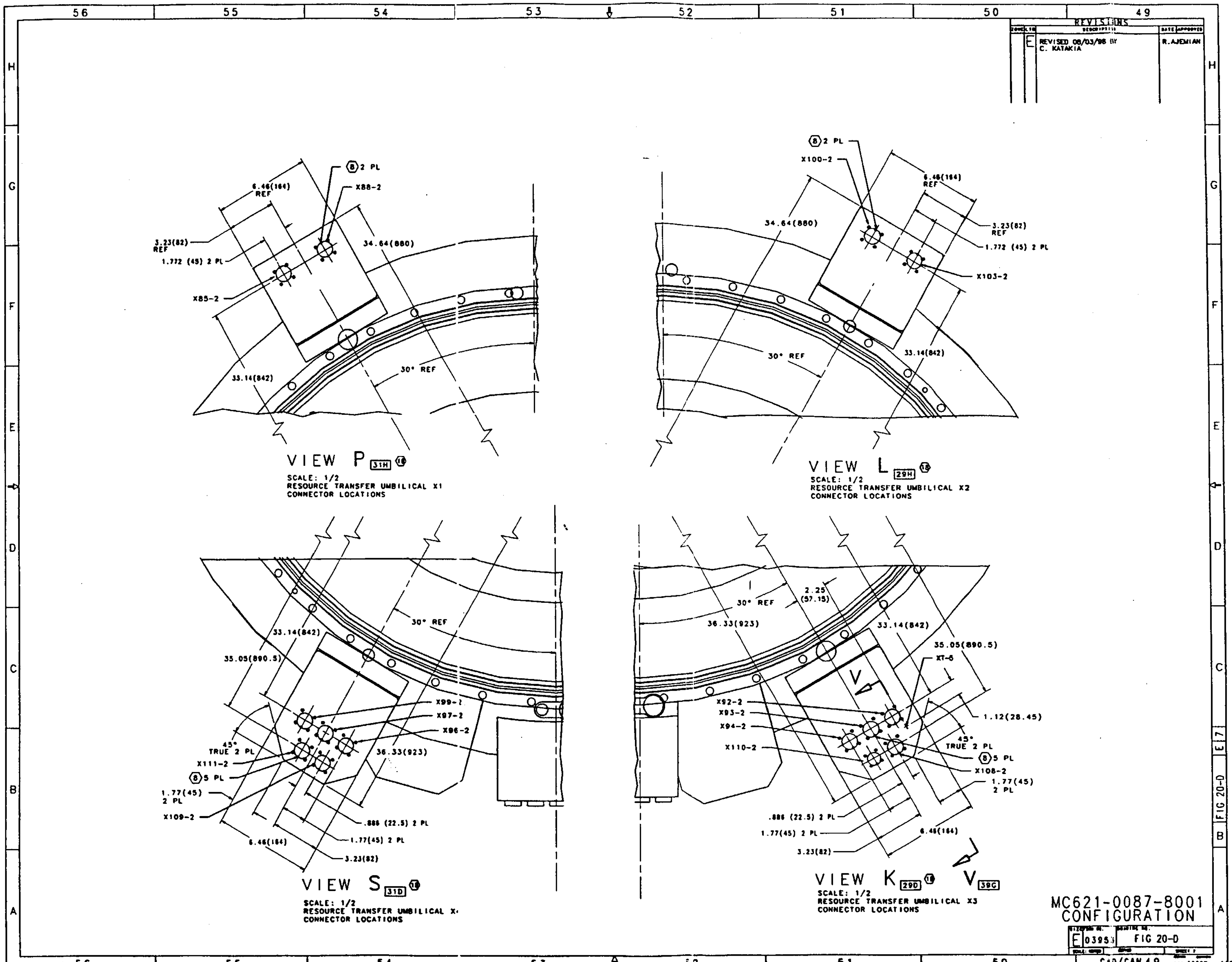
gISat Aug 8 12:59:53 PDT 1998




REVISIONS
E REVISED 08/03/98 BY C. KATAKIA
R. AJEMIAN
SECTION M-M 30E
SCALE: 1/2
23.23(590)
X84-2
.86(22)
SECTION Y-Y 27F
SCALE: 1/1
Ø64.336 (1380.14) REF
Ø54.016 (1372.0) REF
1.361(34.57)
PRESSURE TEST PORT
STRUCTURAL LATCH HOUSING REF
SPACER REF
LOCKWIRE REF
DOCKING MECHANISM REF
CAPTIVE BOLT 24 PL REF
BOLT 24 PL REF
SPACER 24 PL REF
VIEW G-G 22B
ROTATED APPROX 45°
SCALE: 1/2
DOCKING MECHANISM
DOCKING INTERFACE
MOUNTING INTERFACE PLANE
DOCKING MECHANISM OPERATIONAL ENVELOPE
M10-6g CAPTIVE BOLT
STRUCTURAL LATCH HOUSING
SPACER
BASE RING
MOUNTING INTERFACE PLANE
Ø53.149±.007 (1350±0.2) REF BOLT CIRCLE
BOLT WRENCHING AREA
SEAL 2 PL
R 0.030 (0.76)
.236(6)
.700 (17.8) MIN DRILL DEPTH
.593(15.07) MAX BOLT PROTRUSION
.436(11.08) MIN BOLT PROTRUSION
.020 (0.5) MIN RECESS TO INTERFACE PLANE
.091-.110 (2.32-2.88) 2 PL
Ø50.511-.008(1282-0.22)
Ø51.417+.008(1306+0.22)
Ø52.283+0.008(1328+0.22)
Ø54.016-0.008(1372-0.22)
SECTION W-W 41F 28G
SCALE: 2/1
TYPICAL 24 PL
BLANKET STITCHING AND TIE DOWNS
TRIMMED AND FINISHED BLANKET FLAP WITH SEWED RIBBON
PMA 2 OR 3
SEAM TO BE OPENED THEN RE-SEWN DURING INSTALLATION
BLANKET WINDOW
VIEW BB-BB 21H
SCALE: 1/5
BLANKET MODIFICATION AND TIE DOWN TO PMA 2 OR PMA 3 DEBRIS SHIELD
MC621-0087-8001
CONFIGURATION
E 03953 FIG 20-D
CAD/CAM

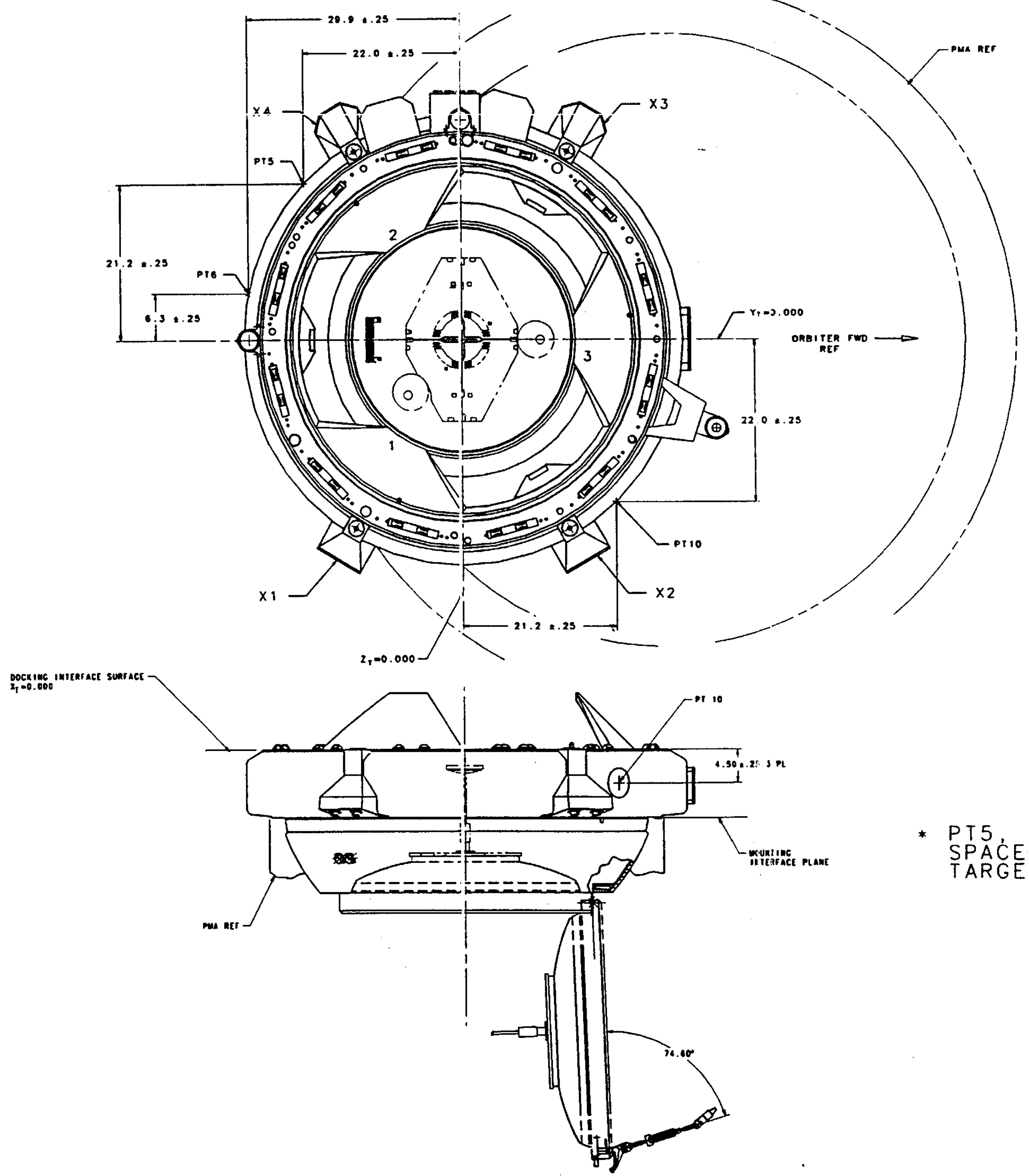
315

Sat Aug 8 13:01:34 PDT 1998



Mon Aug 10 10:51:53 PDT 1998

REVISIONS			
		DESCRIPTION	DATE APPROVED
	E	REVISED 08/03/98 BY C. KATAKIA	R. AJEMIAN



* PT5, PT6 AND PT10 REPRESENT SPACE VISION SYSTEM (SVS) TARGET LOCATIONS.

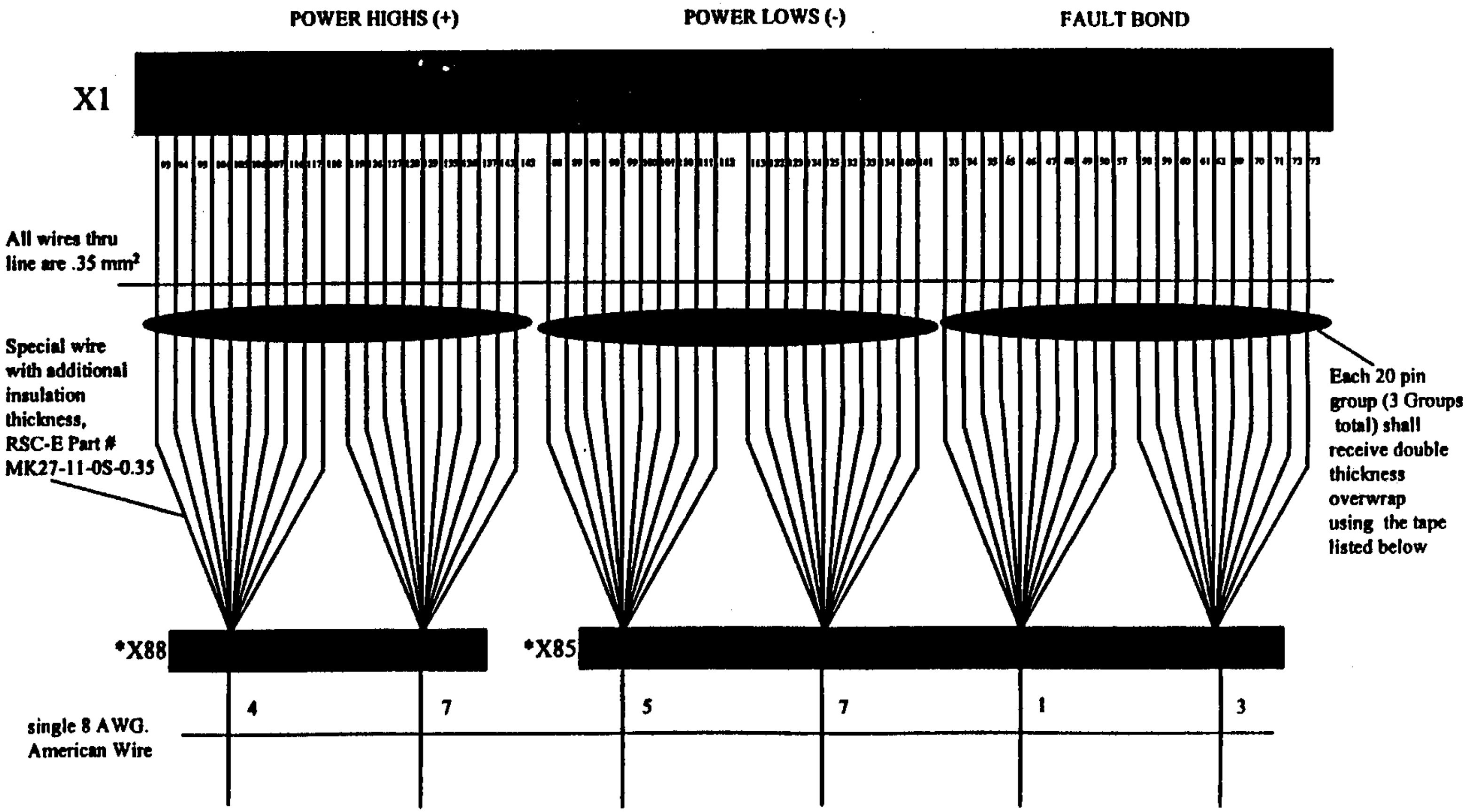
MC621-0087-8001 CONFIGURATION

E 03953 FIG 20-D

CAD/CAM

FIG 20-D E 8

POWER TRANSFER CABLE DEFINITION

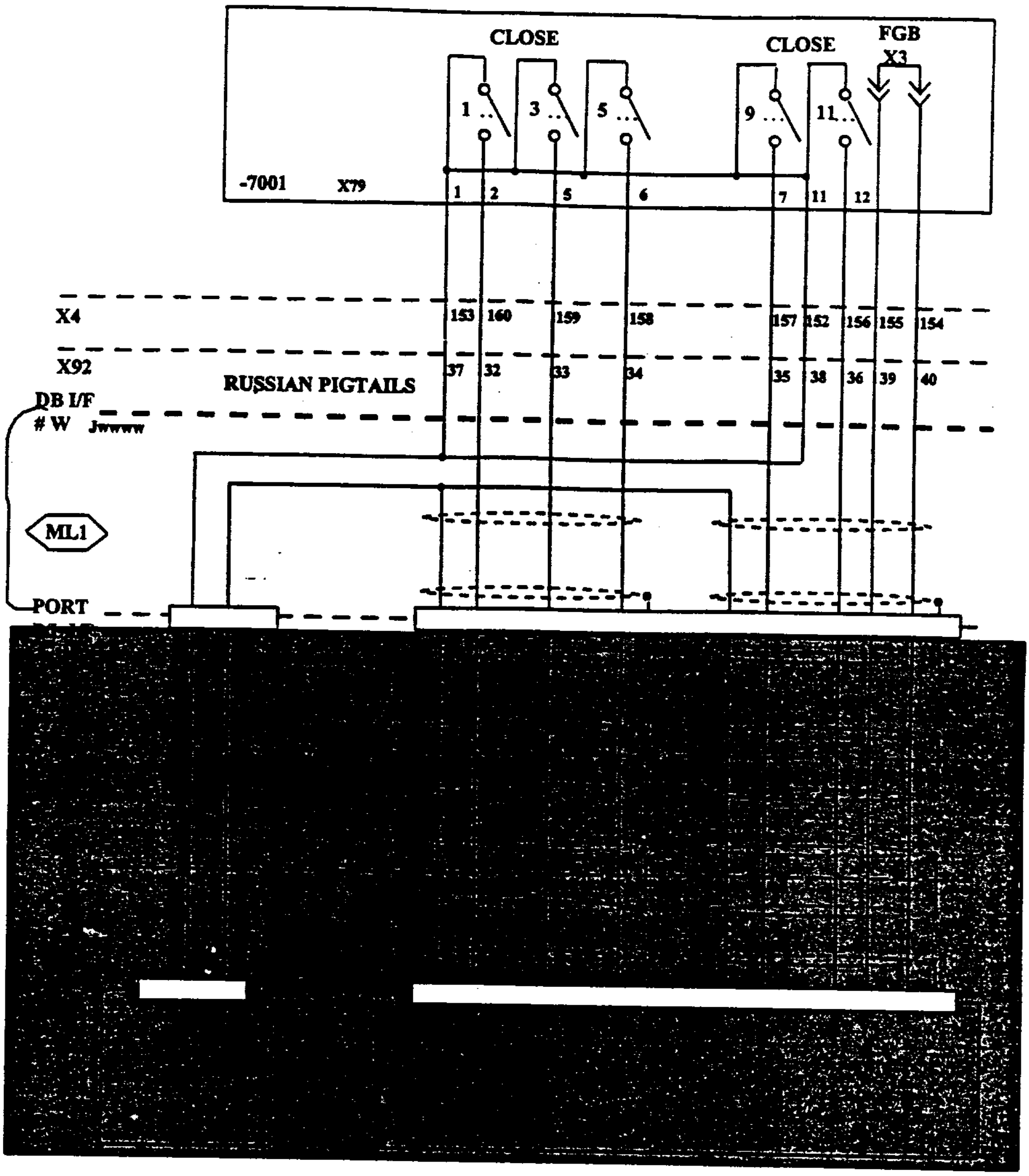


*note: 7 Pin connector same as utilized for STS74 Power Feed to Docking Module

* Orbiter side illustrated. PMA 2/3 identical.

* Wrap harnesses using fluoroplast tape, RSC-E Part # F-4EOL-A1

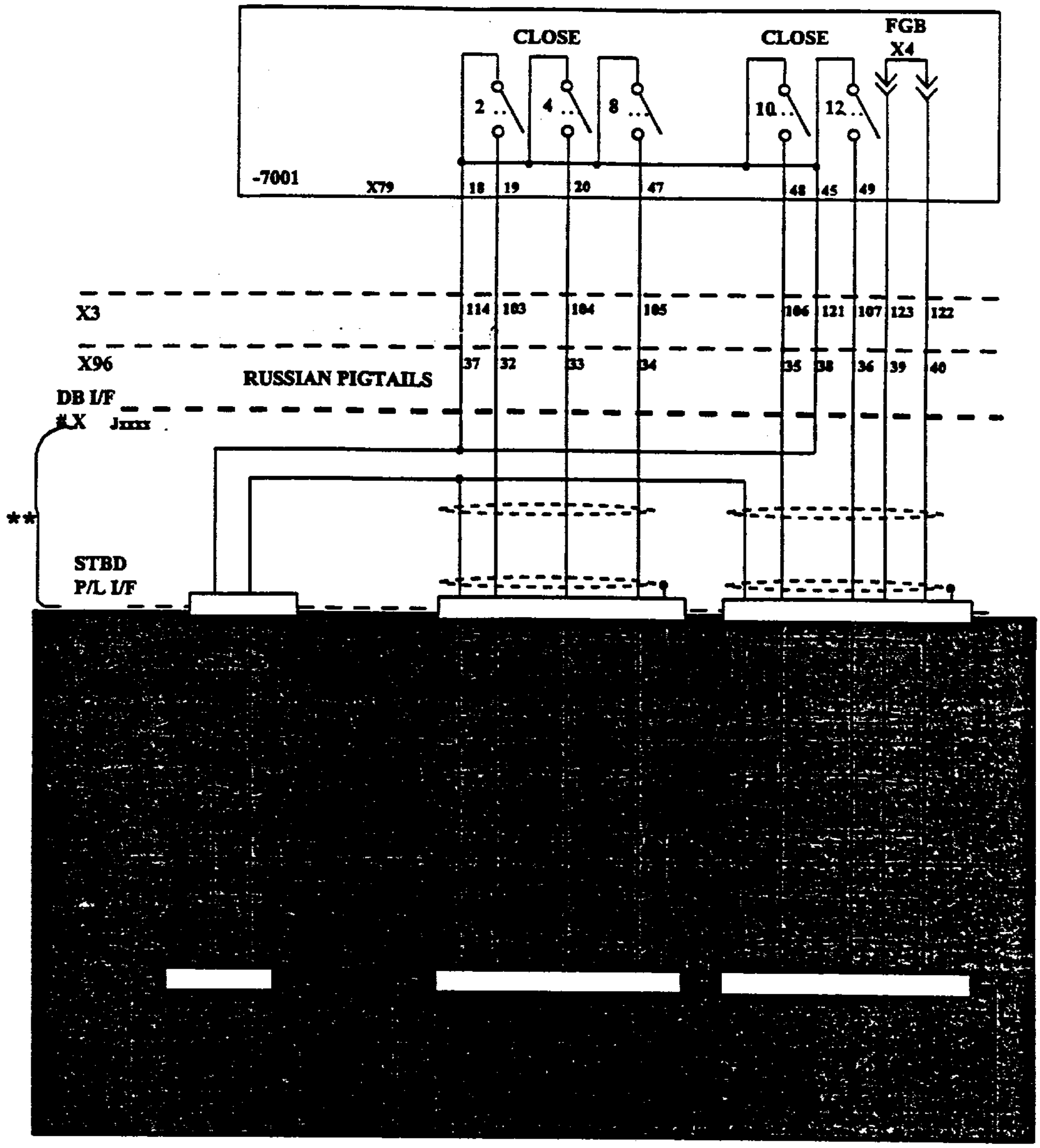
Figure 20-E. Power transfer cable definition



** REQUIRED FOR FLIGHT 2A ONLY.
SHADED AREA PROVIDED BY PAYLOAD SERVICES- REQ'D FOR FLT 2A ONLY -

Figure 20-G. ISS PMA1 MECHANISM
(Sheet 1 of 2)

FLT 2A ONLY- *SYSTEM 1 HOOKS INSTRUMENTATION*



** REQUIRED FOR FLIGHT 2A ONLY.
SHADED AREA PROVIDED BY PAYLOAD SERVICES- REQ'D FOR FLT 2A ONLY -

FIGURE 20-G, ISS PMA1 MECHANISM
(Sheet 2 of 2)
FLT 2A ONLY- SYSTEM 2 HOOKS INSTRUMENTATION

Table 20-A-1. Forces, Moments and Dynamic Excursion Limits

APDA PERFORMANCE REQUIREMENTS

APDA -6001 and -7001

a. Capture and attenuate with the following mass properties

Orbiter see Table 20-E — ISS see Table 20-F

b. Contact Condition Limits (10)

APDA	-6001 (1)	-7001
Axial Velocity	0.0 to 0.2 ft/sec (0.0 to 70.0 mm/sec)	0.0 to 0.2 ft/sec (0.0 to 70.0 mm/sec)
Lateral Velocity	0.15 ft/sec (radial)	0.15 ft/sec (radial)
Angular Velocity	±0.20 deg/sec/axis	±0.20 deg/sec/axis
Lateral Misalignment (8)	4.2 in (radial)	4.2 in (radial)
Angular Misalignment	Z_T: ±4.0 deg Y_T: ±4.0 deg	±4.0 deg/axis(2)
Rotational	X_T: ±4.0 deg	±4.0 deg

c. APDA Mating and Demating Forces and Moments

	Docking			Extension at Mechanical Stop			Retraction at Mechanical Stop		
Load	-6001	-7001	-8001	-6001	-7001	-8001	-6001	-7001	-8001
Tension	300±50 kgf	1000 kgf	300±50 kgf	n/a	n/a	n/a	2200 kgf *	2200 kgf *	2200 kgf *
Compression (Static)	300±50 kgf	1000 kgf	300±50 kgf	1000 kgf *	1000 kgf *	n/a	n/a	n/a	n/a
Compression (Dynamic - < 0.1 sec.)	850 kfg	1900 kgf	850 kgf	n/a	n/a	n/a	n/a	n/a	n/a
Shear (7)	±500 kgf	±500 kgf	±500 kgf	n/a	n/a	n/a	n/a	n/a	n/a
Bending (7)	±500 kgf-m	±500 kgf-m	±500 kgf-m	±500 kgf-m	±500 kgf-m	±500 kgf-m	n/a	n/a	n/a
Torsion	±300 kgf-m	±300 kgf-m	±300 kgf-m	±300 kgf-m	±300 kgf-m	±300 kgf-m	n/a	n/a	n/a

* = APDA internal loads not transmitted to ISS

d. Vehicle Relative Dynamic Rotation Limits During Mating (6)

$\theta_{x,y}$ 13°
θ_z 13°

e. Undocking Separation Conditions (3) e

In accordance with 20.3.2.1.4

Table 20-A-2. Forces, Moments and Dynamic Excursion Limits

MATED DESIGN LIMIT LOADS (4) (5)

APDA -6001/-8001

(12 Structural Hooks Engaged)

	CASE 1a	CASE 1b	CASE 2	CASE 3
Axial	±500 kgf (1100 lb)	±500 kgf (1100 lb)	±1800 kgf (3970 lb)	±1400 kgf (3080 lb)
Shear (7)	±500 kgf (1100 lb)	± 500 kgf (1100 lb)	±1500 kgf (3310 lb)	±1700 kgf (3740 lb)
Bending (7)	±4000 kgf-m (28,900 ft-lb)	±6650 kgf-m (48,100 ft-lb)	±4000 kgf-m (28,900 ft-lb)	±7000 kgf-m (50,630 ft-lb)
Torsion	±6650 kgf-m (48,100 ft-lb)	±4000 kgf-m (28,900 ft-lb)	±4000 kgf-m (28,900 ft-lb)	±3500 kgf-m (25,320 ft-lb)

APDA -7001

(24 Structural Hooks Engaged)

LOAD CASE	RSS BENDING MOMENT	RSS SHEAR	TORSION	AXIAL
Maximum Bending	± 688,000 in-lb (± 7,930 kg-m)	± 1,330 lb (± 600 kg)	± 376,000 in-lb (± 4,330 kg-m)	± 1,300 lb (± 590 kg)
Maximum Torsion	± 442,000 in-lb (± 5,090 kg-m)	± 1,330 lb (± 600 kg)	± 662,000 in-lb (± 7,630 kg-m)	± 1,300 lb (± 590 kg)
Maximum Axial & Shear	± 434,000 in-lb (± 5,000 kg-m)	± 3,000 lb (± 1,360 kg)	± 434,000 in-lb (± 5,000 kg-m)	± 4,410 lb (± 2,000 kg)

APDA –3002 (9)

(12 Structural Hooks Engaged)

	CASE 1	CASE 2
Axial	±1800 kgf (3970 lb)	±2000 kgf (4410 lb)
Shear (7)	±1500 kgf (3310 lb)	±1700 kgf (3740 lb)
Bending (7)	±4000 kgf-m (28,900 ft-lb)	±3500 kgf-m (25,320 ft-lb)
Torsion	±4000 kgf-m (28,900 ft-lb)	±7000 kgf-m (50,630 ft-lb)

Notes for Tables 20-A-1 and 20-A-2.

(1) These values are 3s maxima and shall be applied simultaneously in a statistically appropriate manner, provided that the reach capability of the internal petals is not exceeded

(2) 4 deg. about any axis within the Orbiter x-y (Y_T - Z_T) plane.

(3) Impulse shall be applied at the center of the docking interface and along the mechanism X_T axis.

(4) For design purposes, the loads and moments shall apply simultaneously. Loads shall be applied at the center of the docking interface.

(5) These are maximum case-consistent loads.

(6) These can be simultaneous dynamic rotations.

(7) Value is a vector sum

(8) Lateral misalignment is defined as the minimum distance between the center of the active ring of the APDA and the longitudinal axis of the capture ring of the passive APDA at the moment of first contact between the guide petals.

(9) Provided that additional tests won't be performed.

(10) Orbiter RCS jets will be used during docking to assist capture dynamics. Two nose, F1D and F2D, and two tail, L3D and R3D, jets will be operated from first contact to capture. A 1.0 second pilot reaction time, starting from first contact, is assumed before the PRCS jets are activated. Post Contact Thrusting 1 (PCT1) shall consists of three 80 millisecond nose and tail jet firings with 160 millisecond delay between them, a 1.0 second wait, and finally four 160 millisecond nose and tail firings with 80 millisecond delay between them. PCT2 is the same as PCT1 except that in the second phase of firing it will have only three pulses. Each RCS pulse for docking operation, has a ramp-up time of 0.01 seconds to the maximum forces or moments shown in Table 20-A-3. Forces/Moments stay at the specified levels for 0.070 seconds for the first phase of firing, and for 0.150 seconds for the second phase of firing. The ramp-down time from the maximum value to zero is also 0.010 seconds.

Table 20-A-3. RCS Forces and Moments

Fxo	=	-152.28	kg
Fyo	=	0	
Fzo	=	1113.85	kg
Mxo	=	16.933	kg-m
Myo	=	5026.63	kg-m
Mzo	=	2.31	kg-m

Table 20-E. Orbiter Mass Properties

Weight (kg)	98029
MOMENT OF INERTIA (kg-m^2) I_{XX} I_{YY} I_{ZZ}	 1296162.01 9938145.94 10358449.52
PRODUCT OF INERTIA (kg-m^2) P_{XY} P_{YZ} P_{XZ}	 -10588.94 595.2 -379629.04
C.G. offset from docking I/F (m) X Y Z	 11.533 -0.015 -2.588

Table 20-F. ISS Mass Properties

	Flight 4A Arrival	Flight 19A Departure
Weight (kg)	85238	405140
Moment of Inertia (kg-m^2) Ixx Iyy Izz	 560515 15572699 15481042	 191818640 99274520 121412888
Products of Inertia (kg-m^2) Ixy Iyz Ixz	 -16483 -7955 -278780	 937686 -555301 -6859398
c.g. offset from docking I/F (m) X Y Z	 -18.696 0.01 4.968	 -1.63 -0.46 21.157
RELATIVE ALIGNMENT IN ORBITER STRUCTURAL AXIS	SPACE STATION AXIS OF ALIGNMENT	
X Y Z	Positive X Negative Y Negative Z	Positive Z Positive Y Negative X

Table 20-G1. Orbiter/PMA - 2/3 Interfaces - X1 and X2

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL					
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN				
X88	4	X1	93	X2	93	X103-2	4	EO1	8 GA*	8	TRANSFER POWER HI (140V)
		X1	94	X2	94						
		X1	95	X2	95						
		X1	104	X2	104						
		X1	105	X2	105						
		X1	106	X2	106						
		X1	107	X2	107						
		X1	116	X2	116						
		X1	117	X2	117						
		X1	118	X2	118						
X88	7	X1	119	X2	119	X103-2	7	EO1	8 GA*	8	TRANSFER POWER HI (140V)
		X1	126	X2	126						
		X1	127	X2	127						
		X1	128	X2	128						
		X1	129	X2	129						
		X1	135	X2	135						
		X1	136	X2	136						
		X1	137	X2	137						
		X1	142	X2	142						
		X1	143	X2	143						
X103	4	X2	93	X1	93	X88-2	4	EO2	8 GA*	8	TRANSFER POWER HI (140V)
		X2	94	X1	94						
		X2	95	X1	95						
		X2	104	X1	104						
		X2	105	X1	105						
		X2	106	X1	106						
		X2	107	X1	107						
		X2	116	X1	116						
		X2	117	X1	117						
		X2	118	X1	118						

Table 20-G1. Orbiter/PMA - 2/3 Interfaces - X1 and X2 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-6001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL					
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN				
X103	7	X2	119	X1	119	X88-2	7	EO2	8 GA*	8	TRANSFER POWER HI (140V)
		X2	126	X1	126						
		X2	127	X1	127						
		X2	128	X1	128						
		X2	129	X1	129						
		X2	135	X1	135						
		X2	136	X1	136						
		X2	137	X1	137						
		X2	142	X1	142						
		X2	143	X1	143						
X85	5	X1	88	X2	88	X100-2	5	EO1	8 GA*	8	TRANSFER POWER LO
		X1	89	X2	89						
		X1	90	X2	90						
		X1	98	X2	98						
		X1	99	X2	99						
		X1	100	X2	100						
		X1	101	X2	101						
		X1	110	X2	110						
		X1	111	X2	111						
		X1	112	X2	112						
X85	7	X1	113	X2	113	X100-2	7	EO1	8 GA*	8	TRANSFER POWER LO
		X1	122	X2	122						
		X1	123	X2	123						
		X1	124	X2	124						
		X1	125	X2	125						
		X1	132	X2	132						
		X1	133	X2	133						
		X1	134	X2	134						
		X1	140	X2	140						
		X1	141	X2	141						

Table 20-G1. Orbiter/PMA - 2/3 Interfaces - X1 and X2 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL					
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN				
X100	5	X2	88	X1	88	X85-2	5	EO2	8 GA*	8	TRANSFER POWER LO
		X2	89	X1	89						
		X2	90	X1	90						
		X2	98	X1	98						
		X2	99	X1	99						
		X2	100	X1	100						
		X2	101	X1	101						
		X2	110	X1	110						
		X2	111	X1	111						
		X2	112	X1	112						
X100	7	X2	113	X1	113	X85-2	7	EO2	8 GA*	8	TRANSFER POWER LO
		X2	122	X1	122						
		X2	123	X1	123						
		X2	124	X1	124						
		X2	125	X1	125						
		X2	132	X1	132						
		X2	133	X1	133						
		X2	134	X1	134						
		X2	140	X1	140						
		X2	141	X1	141						
X85	1	X1	33	X2	33	X100-2	1	EO1	8 GA*	8	TRANSFER POWER FAULT BOND
		X1	34	X2	34						
		X1	35	X2	35						
		X1	45	X2	45						
		X1	46	X2	46						
		X1	47	X2	47						
		X1	48	X2	48						
		X1	49	X2	49						
		X1	50	X2	50						
		X1	57	X2	57						

Table 20-G1. Orbiter/PMA - 2/3 Interfaces - X1 and X2 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL					
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN				
		X1	58	X2	58						
		X1	59	X2	59						
		X1	60	X2	60						
		X1	61	X2	61						
X85	3	X1	62	X2	62	X100-2	3	EO1	8 GA*	8	TRANSFER POWER FAULT BOND
		X1	69	X2	69						
		X1	70	X2	70						
		X1	71	X2	71						
		X1	72	X2	72						
		X1	73	X2	73						
		X2	33	X1	33						
		X2	34	X1	34						
		X2	35	X1	35						
		X2	45	X1	45						
X100	1	X2	46	X1	46	X85-2	1	EO2	8 GA*	8	TRANSFER POWER FAULT BOND
		X2	47	X1	47						
		X2	48	X1	48						
		X2	49	X1	49						
		X2	50	X1	50						
		X2	57	X1	57						
		X2	58	X1	58						
		X2	59	X1	59						
		X2	60	X1	60						
		X2	61	X1	61						
X100	3	X2	62	X1	62	X85-2	3	EO2	8 GA*	8	TRANSFER POWER FAULT BOND
		X2	69	X1	69						
		X2	70	X1	70						
		X2	71	X1	71						
		X2	72	X1	72						
		X2	73	X1	73						

Table 20-G1. Orbiter/PMA - 2/3 Interfaces - X1 and X2 (concluded)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL					
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN				
X106	4	X1	26	X2	26	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TM/SIG)
X106	5	X1	27	X2	27	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TM/PWR)
X106	6	X1	28	X2	28	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TM/SIG)
X106	7	X1	29	X2	29	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TM/PWR)
X106	17	X1	4	X2	4	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TEST)
X106	19	X1	149	X2	149	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TEST)
						n/a	n/a				
X107	4	X2	26	X1	26	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TM/SIG)
X107	5	X2	27	X1	27	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TM/PWR)
X107	6	X2	28	X1	28	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TM/SIG)
X107	7	X2	29	X1	29	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TM/PWR)
X107	17	X2	4	X1	4	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TEST)
X107	19	X2	149	X1	149	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TEST)

NOTES: 8 GA* = RUSSIAN SIDE TO USE AMERICAN 8 GA WIRE FOR POWER TRANSFER
(8 GA WIRE TO BE PROVIDED TO RUSSIA BY U.S.)
A = NO RUSSIAN PIGTAILS REQUIRED FOR ORB X1/X2 CONNECTOR MATES ON PMA-2/3 SIDE OF INTERFACE
(LOOP BACK WITHIN RUSSIAN CONNECTOR)
B = NO RUSSIAN PIGTAILS REQUIRED FOR ORB X1/X2 CONNECTOR MATES ON EITHER SIDE OF INTERFACE
n/a = NOT APPLICABLE; NO PINS AT I/F PANEL; CONNECTOR MATE FUNCTIONS JUMPERED AT UMBILICAL INTERFACE

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X92	32	X4	160	X3	160	X92-2	32	ML1	0.35	22	PMA-1 HOOKS 1 CLOSED IND	C
X92	33	X4	159	X3	159	X92-2	33	ML1	0.35	22	PMA-1 HOOKS 3 CLOSED IND	C
X92	34	X4	158	X3	158	X92-2	34	ML1	0.35	22	PMA-1 HOOKS 5 CLOSED IND	C
X92	35	X4	157	X3	157	X92-2	35	ML1	0.35	22	PMA-1 HOOKS 9 CLOSED IND	C
X92	36	X4	156	X3	156	X92-2	36	ML1	0.35	22	PMA-1 HOOKS 11 CLOSED IND	C
X92	37	X4	153	X3	153	X92-2	37	ML1	0.35	22	PMA-1 HOOKS 1,3,5,9,11 CLOS IND SOURCE (1)	C
X92	38	X4	152	X3	152	X92-2	38	ML1	0.35	22	PMA-1 HOOKS 1,3,5,9,11 CLOS IND SOURCE (2)	C
X96	32	X3	103	X4	103	X96-2	32	ML2	0.35	22	PMA-1 HOOKS 2 CLOSED IND	C
X96	33	X3	104	X4	104	X96-2	33	ML2	0.35	22	PMA-1 HOOKS 4 CLOSED IND	C
X96	34	X3	105	X4	105	X96-2	34	ML2	0.35	22	PMA-1 HOOKS 8 CLOSED IND	C
X96	35	X3	106	X4	106	X96-2	35	ML2	0.35	22	PMA-1 HOOKS 10 CLOSED IND	C
X96	36	X3	107	X4	107	X96-2	36	ML2	0.35	22	PMA-1 HOOKS 12 CLOSED IND	C
X96	37	X3	114	X4	114	X96-2	37	ML2	0.35	22	PMA-1 HOOKS 2,4,8,10,12 CLOS IND SOURCE (1)	C
X96	38	X3	121	X4	121	X96-2	38	ML2	0.35	22	PMA-1 HOOKS 2,4,8,10,12 CLOS IND SOURCE (2)	C
X96	40	X3	122	X4	122	X96-2	40	ML2	0.35	22	PMA-1 X3 CONN MATE (TM/SIG)	C
X96	39	X3	123	X4	123	X96-2	39	ML2	0.35	22	PMA-1 X3 CONN MATE (TM/PWR)	C
X92	40	X4	154	X3	154	X92-2	40	ML1	0.35	22	PMA-1 X4 CONN MATE (TM/SIG)	C
X92	39	X4	155	X3	155	X92-2	39	ML1	0.35	22	PMA-1 X4 CONN MATE (TM/PWR)	C
X111	31	X3	176	X4	176	X97-2	44	ML2	0.35	22	ORB X3 CONN MATE (TM/SIG)	A
X111	32	X3	177	X4	177	X97-2	45	ML2	0.35	22	ORB X3 CONN MATE (TM/PWR)	A
X110	31	X4	176	X3	176	X93-2	44	ML1	0.35	22	ORB X4 CONN MATE (TM/SIG)	A
X110	32	X4	177	X3	177	X93-2	45	ML1	0.35	22	ORB X4 CONN MATE (TM/PWR)	A

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X94	1	X4	4	X3	4	X94-2	1	ML	0.35	22	ICOM A IN HI - TALK (ORB TO STAT)	2S-1
X94	5	X4	10	X3	10	X94-2	5	ML	0.35	22	ICOM A IN LO - TALK	2S-1
X94	6	X4	9	X3	9	X94-2	6	ML	0.35	22	ICOM A IN SHD - TALK	2S-1*
X94	2	X4	28	X3	28	X94-2	2	ML	0.35	22	ICOM A OUT HI - LISTEN (STAT TO ORB)	2S-2
X94	3	X4	19	X3	19	X94-2	3	ML	0.35	22	ICOM A OUT LO - LISTEN	2S-2
X94	7	X4	18	X3	18	X94-2	7	ML	0.35	22	ICOM A OUT SHD - LISTEN	2S-2*
X94	4	X4	22	X3	22	X94-2	4	ML	0.35	22	PAGE IN HI - TALK	2S-3
X94	8	X4	32	X3	32	X94-2	8	ML	0.35	22	PAGE IN LO - TALK	2S-3
X94	9	X4	30	X3	30	X94-2	9	ML	0.35	22	PAGE IN SHD - TALK	2S-3*
X94	10	X4	41	X3	41	X94-2	10	ML	0.35	22	PAGE OUT HI - LISTEN	2S-4
X94	16	X4	42	X3	42	X94-2	16	ML	0.35	22	PAGE OUT LO - LISTEN	2S-4
X94	17	X4	40	X3	40	X94-2	17	ML	0.35	22	PAGE OUT SHD - LISTEN	2S-4*
X94	15	X4	108	X3	108	X94-2	15	ML	0.35	22	PAGE KEY SIGNAL HI	2S-5
X94	22	X4	107	X3	107	X94-2	22	ML	0.35	22	PAGE KEY SIGNAL LO	2S-5
X94	23	X4	120	X3	120	X94-2	23	ML	0.35	22	PAGE KEY SIGNAL SHD	2S-5*
X94	13	X4	118	X3	118	X94-2	13	ML	0.35	22	AIR TO GND IN HI - TALK	2S-6
X94	14	X4	119	X3	119	X94-2	14	ML	0.35	22	AIR TO GND IN LO - TALK	2S-6
X94	21	X4	115	X3	115	X94-2	21	ML	0.35	22	AIR TO GND IN SHD - TALK	2S-6*
X94	12	X4	8	X3	8	X94-2	12	ML	0.35	22	AIR TO GND OUT HI - LISTEN	2S-7
X94	19	X4	7	X3	7	X94-2	19	ML	0.35	22	AIR TO GND OUT LO - LISTEN	2S-7
X94	20	X4	6	X3	6	X94-2	20	ML	0.35	22	AIR TO GND OUT SHD - LISTEN	2S-7*
X94	11	X4	13	X3	13	X94-2	11	ML	0.35	22	AIR TO AIR IN HI - TALK	2S-8
X94	18	X4	16	X3	16	X94-2	18	ML	0.35	22	AIR TO AIR IN LO - TALK	2S-8
X94	26	X4	15	X3	15	X94-2	26	ML	0.35	22	AIR TO AIR IN SHD - TALK	2S-8*
X94	27	X4	36	X3	36	X94-2	27	ML	0.35	22	AIR TO AIR OUT HI - LISTEN	2S-9
X94	34	X4	27	X3	27	X94-2	34	ML	0.35	22	AIR TO AIR OUT LO - LISTEN	2S-9
X94	35	X4	26	X3	26	X94-2	35	ML	0.35	22	AIR TO AIR OUT SHD - LISTEN	2S-9*
X94	41	X4	45	X3	45	X94-2	41	ML	0.35	22	AIR TO AIR KEY SIG HI	2S-10
X94	42	X4	33	X3	33	X94-2	42	ML	0.35	22	AIR TO AIR KEY SIG LO	2S-10
X94	47	X4	46	X3	46	X94-2	47	ML	0.35	22	AIR TO AIR KEY SIG SHD	2S-10*

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X111	1	X3	161	X4	161	X111-2	1	RF2	0.2*	22	1553 BUS - 1A HI	2S-11
X111	2	X3	162	X4	162	X111-2	2	RF2	0.2*	22	1553 BUS - 1A LO	2S-11
X111	3	X3	163	X4	163	X111-2	3	RF2	0.35	22	1553 BUS - 1A SHD	2S-11*
X111	11	X3	164	X4	164	X111-2	11	RF2	0.2*	22	SPARE	B
X111	12	X3	165	X4	165	X111-2	12	RF2	0.2*	22	SPARE	B
X111	13	X3	166	X4	166	X111-2	13	RF2	0.35	22	SPARE	B
X111	15	X3	167	X4	167	X111-2	15	RF2	0.2*	22	1553 BUS - 2A HI	2S-13
X111	16	X3	168	X4	168	X111-2	16	RF2	0.2*	22	1553 BUS - 2A LO	2S-13
X111	17	X3	169	X4	169	X111-2	17	RF2	0.35	22	1553 BUS - 2A SHD	2S-13*
X111	20	X3	170	X4	170	X111-2	20	RF2	0.2*	22	SPARE	B
X111	21	X3	171	X4	171	X111-2	21	RF2	0.2*	22	SPARE	B
X111	22	X3	172	X4	172	X111-2	22	RF2	0.35	22	SPARE	B
X110	1	X4	161	X3	161	X110-2	1	RF1	0.2*	22	1553 BUS - 1B HI	2S-15
X110	2	X4	162	X3	162	X110-2	2	RF1	0.2*	22	1553 BUS - 1B LO	2S-15
X110	3	X4	163	X3	163	X110-2	3	RF1	0.35	22	1553 BUS - 1B SHD	2S-15*
X110	11	X4	164	X3	164	X110-2	11	RF1	0.2*	22	SPARE	B
X110	12	X4	165	X3	165	X110-2	12	RF1	0.2*	22	SPARE	B
X110	13	X4	166	X3	166	X110-2	13	RF1	0.35	22	SPARE	B
X110	15	X4	167	X3	167	X110-2	15	RF1	0.2*	22	1553 BUS - 2B HI	2S-17
X110	16	X4	168	X3	168	X110-2	16	RF1	0.2*	22	1553 BUS - 2B LO	2S-17
X110	17	X4	169	X3	169	X110-2	17	RF1	0.35	22	1553 BUS - 2B SHD	2S-17*
X110	20	X4	170	X3	170	X110-2	20	RF1	0.2*	22	SPARE	B
X110	21	X4	171	X3	171	X110-2	21	RF1	0.2*	22	SPARE	B
X110	22	X4	172	X3	172	X110-2	22	RF1	0.35	22	SPARE	B
X111	34	X3	109	X4	109	X111-2	34	RF	0.2*	22	ISSA VIDEO TO ORB HI	2S-19
X111	35	X3	110	X4	110	X111-2	35	RF	0.2*	22	ISSA VIDEO TO ORB LO	2S-19
X111	36	X3	111	X4	111	X111-2	36	RF	0.35	22	ISSA VIDEO TO ORB SHD	2S-19*
X111	38	X3	116	X4	116	X111-2	38	RF	0.2*	22	ORB VIDEO TO ISSA HI	2S-20

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X111	39	X3	119	X4	119	X111-2	39	RF	0.2*	22	ORB VIDEO TO ISSA LO	2S-20
X111	40	X3	120	X4	120	X111-2	40	RF	0.35	22	ORB VIDEO TO ISSA SHD	2S-20*
X111	48	X3	115	X4	115	X111-2	48	RF	0.2*	22	ORB VIDEO TO ISSA (RMS SUPPORT) HI	2S-21
X111	49	X3	116	X4	116	X111-2	49	RF	0.2*	22	ORB VIDEO TO ISSA (RMS SUPPORT) LO	2S-21
X111	50	X3	117	X4	117	X111-2	50	RF	0.35	22	ORB VIDEO TO ISSA (RMS SUPPORT) SHD	2S-21*
X94	36	X4	179	X3	179	X94-2	36	HO1	0.35	20	PASS MECH M6 GROUP 1 HOOKS	
X94	37	X4	180	X3	180	X94-2	37	HO1	0.35	20	PASS MECH M6 GROUP 1 HOOKS	
X94	29	X4	173	X3	173	X94-2	29	HO1	0.35	20	PASS MECH M6 GROUP 1 HOOKS	
X94	28	X4	174	X3	174	X94-2	28	HO1	0.35	20	PASS MECH M6 GROUP 1 HOOKS	
X94	31	X4	181	X3	181	X94-2	31	HO1	0.35	20	PASS MECH M8 GROUP 2 HOOKS	D
X94	30	X4	175	X3	175	X94-2	30	HO1	0.35	20	PASS MECH M8 GROUP 2 HOOKS	
X94	39	X4	178	X3	178	X94-2	39	HO1	0.35	20	PASS MECH M8 GROUP 2 HOOKS	D
X94	38	X4	151	X3	151	X94-2	38	HO1	0.35	20	PASS MECH M8 GROUP 2 HOOKS	
X99	36	X3	173	X4	173	X99-2	36	HO2	0.35	20	PASS MECH M7 GROUP 1 HOOKS	
X99	37	X3	174	X4	174	X99-2	37	HO2	0.35	20	PASS MECH M7 GROUP 1 HOOKS	
X99	29	X3	179	X4	179	X99-2	29	HO2	0.35	20	PASS MECH M7 GROUP 1 HOOKS	
X99	28	X3	180	X4	180	X99-2	28	HO2	0.35	20	PASS MECH M7 GROUP 1 HOOKS	
X99	31	X3	178	X4	178	X99-2	31	HO2	0.35	20	PASS MECH M9 GROUP 2 HOOKS	D
X99	30	X3	184	X4	184	X99-2	30	HO2	0.35	20	PASS MECH M9 GROUP 2 HOOKS	
X99	39	X3	175	X4	175	X99-2	39	HO2	0.35	20	PASS MECH M9 GROUP 2 HOOKS	D
X99	38	X3	156	X4	156	X99-2	38	HO2	0.35	20	PASS MECH M9 GROUP 2 HOOKS	
X94	32	X4	44	X3	44	X94-2	32	HO1	0.35	22	PASS MECH M6 GRP 1 HKS OPEN IND/INHIBIT	
X94	33	X4	43	X3	43	X94-2	33	HO1	0.35	22	PASS MECH M6 GRP 1 HKS OPEN IND SOURCE	
X94	24	X4	38	X3	38	X94-2	24	HO1	0.35	22	PASS MECH M6 GRP 1 HKS CLOS IND/INHIBIT	
X94	25	X4	37	X3	37	X94-2	25	HO1	0.35	22	PASS MECH M6 GRP 1 HKS CLOS IND SOURCE	
X94	43	X4	31	X3	31	X94-2	43	HO1	0.35	22	PASS MECH M8 GRP 2 HKS OPEN IND/INHIBIT	
X94	44	X4	39	X3	39	X94-2	44	HO1	0.35	22	PASS MECH M8 GRP 2 HKS OPEN IND SOURCE	

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X94	48	X4	35	X3	35	X94-2	48	HO1	0.35	22	PASS MECH M8 GRP 2 HKS CLOS IND/INHIBIT	
X94	49	X4	34	X3	34	X94-2	49	HO1	0.35	22	PASS MECH M8 GRP 2 HKS CLOS IND SOURCE	
X99	32	X3	1	X4	1	X99-2	32	HO2	0.35	22	PASS MECH M7 GRP 1 HKS OPEN IND/INHIBIT	
X99	33	X3	5	X4	5	X99-2	33	HO2	0.35	22	PASS MECH M7 GRP 1 HKS OPEN IND SOURCE	
X99	24	X3	95	X4	95	X99-2	24	HO2	0.35	22	PASS MECH M7 GRP 1 HKS CLOS IND/INHIBIT	
X99	25	X3	96	X4	96	X99-2	25	HO2	0.35	22	PASS MECH M7 GRP 1 HKS CLOS IND SOURCE	
X99	43	X3	54	X4	54	X99-2	43	HO2	0.35	22	PASS MECH M9 GRP 2 HKS OPEN IND/INHIBIT	
X99	44	X3	60	X4	60	X99-2	44	HO2	0.35	22	PASS MECH M9 GRP 2 HKS OPEN IND SOURCE	
X99	48	X3	97	X4	97	X99-2	48	HO2	0.35	22	PASS MECH M9 GRP 2 HKS CLOS IND/INHIBIT	
X99	49	X3	98	X4	98	X99-2	49	HO2	0.35	22	PASS MECH M9 GRP 2 HKS CLOS IND SOURCE	
X94	40	X4	72	X3	72	X94-2	40	ML1	0.35	22	PASS MECH HKS 1,3,5 CLOSED IND SOURCE	
X94	45	X4	109	X3	109	X94-2	45	ML1	0.35	22	PASS MECH HKS 1,3,5 CLOSED IND	
X94	46	X4	101	X3	101	X94-2	46	ML1	0.35	22	PASS MECH HKS 7,9,11 CLOSED IND SOURCE	
X94	50	X4	102	X3	102	X94-2	50	ML1	0.35	22	PASS MECH HKS 7,9,11 CLOSED IND	
X99	40	X3	99	X4	99	X99-2	40	ML2	0.35	22	PASS MECH HKS 2,4,6 CLOSED IND SOURCE	
X99	45	X3	100	X4	100	X99-2	45	ML2	0.35	22	PASS MECH HKS 2,4,6 CLOSED IND	
X99	46	X3	101	X4	101	X99-2	46	ML2	0.35	22	PASS MECH HKS 8,10,12 CLOSED IND SOURCE	
X99	50	X3	102	X4	102	X99-2	50	ML2	0.35	22	PASS MECH HKS 8,10,12 CLOSED IND	
X92	20	X4	112	X3	112	X92-2	20	HO1	0.35	20	DOCK MECH HEATER (H1-1 +)	C
X92	21	X4	104	X3	104	X92-2	21	HO1	0.35	20	DOCK MECH HEATER (H1-1 -)	C
X96	20	X3	89	X4	89	X96-2	20	HO2	0.35	20	DOCK MECH HEATER (H1-2 +)	C
X96	21	X3	85	X4	85	X96-2	21	HO2	0.35	20	DOCK MECH HEATER (H1-2 -)	C
X92	22	X4	116	X3	116	X92-2	22	HO3	0.35	20	DOCK MECH HEATER (H1-3 +)	C
X92	23	X4	110	X3	110	X92-2	23	HO3	0.35	20	DOCK MECH HEATER (H1-3 -)	C
X96	22	X3	92	X4	92	X96-2	22	HO3	0.35	20	DOCK MECH HEATER (H2-1 +)	C
X96	23	X3	88	X4	88	X96-2	23	HO3	0.35	20	DOCK MECH HEATER (H2-1 -)	C

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X92	26	X4	113	X3	113	X92-2	26	HO1	0.35	20	DOCK MECH HEATER (H2-2 +)	C
X92	27	X4	105	X3	105	X92-2	27	HO1	0.35	20	DOCK MECH HEATER (H2-2 -)	C
X92	28	X4	114	X3	114	X92-2	28	HO2	0.35	20	DOCK MECH HEATER (H2-3 +)	C
X92	29	X4	106	X3	106	X92-2	29	HO2	0.35	20	DOCK MECH HEATER (H2-3 -)	C
X92	30	X4	117	X3	117	X92-2	30	HO3	0.35	20	DOCK MECH HEATER (H3-1 +)	C
X92	31	X4	111	X3	111	X92-2	31	HO3	0.35	20	DOCK MECH HEATER (H3-1 -)	C
X96	26	X3	91	X4	91	X96-2	26	HO2	0.35	20	DOCK MECH HEATER (H3-2 +)	C
X96	27	X3	87	X4	87	X96-2	27	HO2	0.35	20	DOCK MECH HEATER (H3-2 -)	C
X96	28	X3	90	X4	90	X96-2	28	HO1	0.35	20	DOCK MECH HEATER (H3-3 +)	C
X96	29	X3	86	X4	86	X96-2	29	HO1	0.35	20	DOCK MECH HEATER (H3-3 -)	C
X92	13	X4	57	X3	57	X92-2	13	HO1	0.35	22	RING ALIGNED	C
X96	13	X3	40	X4	40	X96-2	13	HO2	0.35	22	RING ALIGNED	C
X92	14	X4	58	X3	58	X92-2	14	HO1	0.35	22	INITIAL CONTACT	C
X96	14	X3	41	X4	41	X96-2	14	HO2	0.35	22	INITIAL CONTACT	C
X92	18	X4	56	X3	56	X92-2	18	HO1	0.35	22	CAPTURE (SHORT)	C
X96	18	X3	39	X4	39	X96-2	18	HO2	0.35	22	CAPTURE (SHORT)	C
X92	19	X4	55	X3	55	X92-2	19	HO1	0.35	22	CAPTURE (LONG)	C
X96	19	X3	38	X4	38	X96-2	19	HO2	0.35	22	CAPTURE (LONG)	C
X92	1	X4	23	X3	23	X92-2	1	HO1	0.35	20	PWR SUP TO RING MTR (M4)	C
X92	2	X4	24	X3	24	X92-2	2	HO1	0.35	20	PWR SUP TO RING MTR (M4)	C
X92	47	X4	5	X3	5	X92-2	47	HO1	0.35	20	PWR SUP TO RING MTR (M4)	C
X92	48	X4	11	X3	11	X92-2	48	HO1	0.35	20	PWR SUP TO RING MTR (M4)	C
X96	2	X3	24	X4	24	X96-2	2	HO2	0.35	20	PWR SUP TO RING MTR (M5)	C
X96	1	X3	23	X4	23	X96-2	1	HO2	0.35	20	PWR SUP TO RING MTR (M5)	C
X96	48	X3	7	X4	7	X96-2	48	HO2	0.35	20	PWR SUP TO RING MTR (M5)	C
X96	47	X3	6	X4	6	X96-2	47	HO2	0.35	20	PWR SUP TO RING MTR (M5)	C
X92	24	X4	61	X3	61	X92-2	24	HO1	0.35	22	RING FINAL POSITION	C
X96	24	X3	44	X4	44	X96-2	24	HO2	0.35	22	RING FINAL POSITION	C

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X96	46	X3	61	X4	61	X96-2	46	HO3	0.35	22	CONTROL SENSOR RETURN	C
X92	45	X4	77	X3	77	X92-2	45	HO1	0.35	22	CONTROL SENSOR RETURN	C
X92	46	X4	78	X3	78	X92-2	46	HO2	0.35	22	CONTROL SENSOR RETURN	C
X92	3	X4	59	X3	59	X92-2	3	HO1	0.35	22	RING INITIAL POSITION	C
X96	3	X3	42	X4	42	X96-2	3	HO2	0.35	22	RING INITIAL POSITION	C
X92	4	X4	60	X3	60	X92-2	4	HO1	0.35	22	RING FORWARD POSITION	C
X96	4	X3	43	X4	43	X96-2	4	HO2	0.35	22	RING FORWARD POSITION	C
X92	11	X4	53	X3	53	X92-2	11	HO1	0.35	22	CAPTURE LATCHES OPEN IND	C
X96	11	X3	36	X4	36	X96-2	11	HO2	0.35	22	CAPTURE LATCHES OPEN IND	C
X92	12	X4	54	X3	54	X92-2	12	HO1	0.35	22	CAPTURE LATCHES CLOS IND	C
X96	12	X3	37	X4	37	X96-2	12	HO2	0.35	22	CAPTURE LATCHES CLOS IND	C
X96	5	X3	2	X4	2	X96-2	5	HO2	0.35	20	PWR SUP TO CAP LAT MTR (M1) +	C
X92	5	X4	1	X3	1	X92-2	5	HO1	0.35	20	PWR SUP TO CAP LAT MTR (M1) +	C
X96	41	X3	20	X4	20	X96-2	41	HO1	0.35	20	PWR SUP TO CAP LAT MTR (M1) -	C
X92	41	X4	17	X3	17	X92-2	41	HO1	0.35	20	PWR SUP TO CAP LAT MTR (M1) -	C
X92	8	X4	48	X3	48	X92-2	8	HO2	0.35	20	CAPTURE LATCH NO. 1 CLOS	C
X96	8	X3	31	X4	31	X96-2	8	HO1	0.35	20	CAPTURE LATCH NO. 1 CLOS	C
X92	15	X4	47	X3	47	X92-2	15	HO2	0.35	20	CAPTURE LATCH NO. 1 OPEN	C
X96	15	X3	30	X4	30	X96-2	15	HO1	0.35	20	CAPTURE LATCH NO. 1 OPEN	C
X92	6	X4	2	X3	2	X92-2	6	HO2	0.35	20	PWR SUP TO CAP LAT MTR (M2) +	C
X96	42	X3	21	X4	21	X96-2	42	HO2	0.35	20	PWR SUP TO CAP LAT MTR (M2) -	C
X96	6	X3	3	X4	3	X96-2	6	HO3	0.35	20	PWR SUP TO CAP LAT MTR (M2) +	C
X92	42	X4	20	X3	20	X92-2	42	HO2	0.35	20	PWR SUP TO CAP LAT MTR (M2) -	C
X92	9	X4	50	X3	50	X92-2	9	HO3	0.35	20	CAPTURE LATCH NO. 2 CLOS	C
X96	9	X3	33	X4	33	X96-2	9	HO2	0.35	20	CAPTURE LATCH NO. 2 CLOS	C
X92	16	X4	49	X3	49	X92-2	16	HO3	0.35	20	CAPTURE LATCH NO. 2 OPEN	C
X96	16	X3	32	X4	32	X96-2	16	HO2	0.35	20	CAPTURE LATCH NO. 2 OPEN	C

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-6001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X92	7	X4	3	X3	3	X92-2	7	HO3	0.35	20	PWR SUP TO CAP LAT MTR (M3) +	C
X96	43	X3	22	X4	22	X96-2	43	HO3	0.35	20	PWR SUP TO CAP LAT MTR (M3) -	C
X96	7	X3	4	X4	4	X96-2	7	HO1	0.35	20	PWR SUP TO CAP LAT MTR (M3) +	C
X92	43	X4	21	X3	21	X92-2	43	HO3	0.35	20	PWR SUP TO CAP LAT MTR (M3) -	C
X92	10	X4	52	X3	52	X92-2	10	HO1	0.35	20	CAPTURE LATCH NO. 3 CLOS	C
X96	10	X3	35	X4	35	X96-2	10	HO3	0.35	20	CAPTURE LATCH NO. 3 CLOS	C
X92	17	X4	51	X3	51	X92-2	17	HO1	0.35	20	CAPTURE LATCH NO. 3 OPEN	C
X96	17	X3	34	X4	34	X96-2	17	HO3	0.35	20	CAPTURE LATCH NO. 3 OPEN	C
X93	1	X4	25	X3	25	X93-2	1	HO1	0.35	20	PWR SUP TO M6 GROUP 1 HOOKS	C
X93	5	X4	67	X3	67	X93-2	5	HO1	0.35	20	PWR SUP TO M6 GROUP 1 HOOKS	C
X93	47	X4	12	X3	12	X93-2	47	HO1	0.35	20	PWR SUP TO M6 GROUP 1 HOOKS	C
X93	48	X4	66	X3	66	X93-2	48	HO1	0.35	20	PWR SUP TO M6 GROUP 1 HOOKS	C
X97	5	X3	50	X4	50	X97-2	5	HO2	0.35	20	PWR SUP TO M7 GROUP 1 HOOKS	C
X97	1	X3	25	X4	25	X97-2	1	HO2	0.35	20	PWR SUP TO M7 GROUP 1 HOOKS	C
X97	47	X3	8	X4	8	X97-2	47	HO2	0.35	20	PWR SUP TO M7 GROUP 1 HOOKS	C
X97	48	X3	49	X4	49	X97-2	48	HO2	0.35	20	PWR SUP TO M7 GROUP 1 HOOKS	C
X93	7	X4	63	X3	63	X93-2	7	HO1	0.35	22	GROUP 1 HOOKS CLOSED	C
X97	7	X3	46	X4	46	X97-2	7	HO2	0.35	22	GROUP 1 HOOKS CLOSED	C
X93	6	X4	62	X3	62	X93-2	6	HO1	0.35	22	GROUP 1 HOOKS OPEN	C
X97	6	X3	45	X4	45	X97-2	6	HO2	0.35	22	GROUP 1 HOOKS OPEN	C
X93	18	X4	81	X3	81	X93-2	18	HO1	0.35	20	FIXER 1 (+)	C
X97	18	X3	64	X4	64	X97-2	18	HO1	0.35	20	FIXER 1 (+)	C
X93	19	X4	82	X3	82	X93-2	19	HO1	0.35	20	FIXER 1 (-)	C
X97	19	X3	65	X4	65	X97-2	19	HO1	0.35	20	FIXER 1 (-)	C
X93	20	X4	83	X3	83	X93-2	20	HO1	0.35	20	FIXER 1 (-)	C
X97	20	X3	66	X4	66	X97-2	20	HO1	0.35	20	FIXER 1 (-)	C
X93	21	X4	84	X3	84	X93-2	21	HO2	0.35	20	FIXER 2 (+)	C
X97	21	X3	67	X4	67	X97-2	21	HO2	0.35	20	FIXER 2 (+)	C

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X93	22	X4	85	X3	85	X93-2	22	HO2	0.35	20	FIXER 2 (-)	C
X97	22	X3	68	X4	68	X97-2	22	HO2	0.35	20	FIXER 2 (-)	C
X93	23	X4	86	X3	86	X93-2	23	HO2	0.35	20	FIXER 2 (-)	C
X97	23	X3	69	X4	69	X97-2	23	HO2	0.35	20	FIXER 2 (-)	C
X93	24	X4	87	X3	87	X93-2	24	HO3	0.35	20	FIXER 3 (+)	C
X97	24	X3	70	X4	70	X97-2	24	HO3	0.35	20	FIXER 3 (+)	C
X93	30	X4	88	X3	88	X93-2	30	HO3	0.35	20	FIXER 3 (-)	C
X97	30	X3	71	X4	71	X97-2	30	HO3	0.35	20	FIXER 3 (-)	C
X93	31	X4	89	X3	89	X93-2	31	HO3	0.35	20	FIXER 3 (-)	C
X97	31	X3	72	X4	72	X97-2	31	HO3	0.35	20	FIXER 3 (-)	C
X93	16	X4	90	X3	90	X93-2	16	HO	0.35	20	FIXER 4 (+)	C
X97	16	X3	73	X4	73	X97-2	16	HO	0.35	20	FIXER 4 (+)	C
X93	17	X4	91	X3	91	X93-2	17	HO	0.35	20	FIXER 4 (-)	C
X97	17	X3	74	X4	74	X97-2	17	HO	0.35	20	FIXER 4 (-)	C
X93	25	X4	92	X3	92	X93-2	25	HO	0.35	20	FIXER 4 (-)	C
X97	25	X3	75	X4	75	X97-2	25	HO	0.35	20	FIXER 4 (-)	C
X93	27	X4	93	X3	93	X93-2	27	HO	0.35	20	FIXER 5 (+)	C
X97	27	X3	76	X4	76	X97-2	27	HO	0.35	20	FIXER 5 (+)	C
X93	28	X4	94	X3	94	X93-2	28	HO	0.35	20	FIXER 5 (-)	C
X97	28	X3	77	X4	77	X97-2	28	HO	0.35	20	FIXER 5 (-)	C
X93	29	X4	95	X3	95	X93-2	29	HO	0.35	20	FIXER 5 (-)	C
X97	29	X3	78	X4	78	X97-2	29	HO	0.35	20	FIXER 5 (-)	C
X93	26	X4	96	X3	96	X93-2	26	HO1	0.35	20	HI-ENERGY DAMPER NO. 1 (+)	C
X97	26	X3	79	X4	79	X97-2	26	HO1	0.35	20	HI-ENERGY DAMPER NO. 1 (+)	C
X93	34	X4	97	X3	97	X93-2	34	HO1	0.35	20	HI-ENERGY DAMPER NO. 1 (-)	C
X97	34	X3	80	X4	80	X97-2	34	HO1	0.35	20	HI-ENERGY DAMPER NO. 1 (-)	C
X93	35	X4	98	X3	98	X93-2	35	HO2	0.35	20	HI-ENERGY DAMPER NO. 2 (+)	C
X97	35	X3	81	X4	81	X97-2	35	HO2	0.35	20	HI-ENERGY DAMPER NO. 2 (+)	C
X93	36	X4	99	X3	99	X93-2	36	HO2	0.35	20	HI-ENERGY DAMPER NO. 2 (-)	C

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X97	36	X3	82	X4	82	X97-2	36	HO2	0.35	20	HI-ENERGY DAMPER NO. 2 (-)	C
X93	32	X4	100	X3	100	X93-2	32	HO3	0.35	20	HI-ENERGY DAMPER NO. 3 (+)	C
X97	32	X3	83	X4	83	X97-2	32	HO3	0.35	20	HI-ENERGY DAMPER NO. 3 (+)	C
X93	33	X4	103	X3	103	X93-2	33	HO3	0.35	20	HI-ENERGY DAMPER NO. 3 (-)	C
X97	33	X3	84	X4	84	X97-2	33	HO3	0.35	20	HI-ENERGY DAMPER NO. 3 (-)	C
X97	2	X3	9	X4	9	X97-2	2	HO2	0.35	20	PWR SUP TO M9 GROUP 2 HOOKS	C
X97	3	X3	51	X4	51	X97-2	3	HO2	0.35	20	PWR SUP TO M9 GROUP 2 HOOKS	C
X97	49	X3	26	X4	26	X97-2	49	HO2	0.35	20	PWR SUP TO M9 GROUP 2 HOOKS	C
X97	50	X3	52	X4	52	X97-2	50	HO2	0.35	20	PWR SUP TO M9 GROUP 2 HOOKS	C
X93	2	X4	14	X3	14	X93-2	2	HO1	0.35	20	PWR SUP TO M8 GROUP 2 HOOKS	C
X93	3	X4	68	X3	68	X93-2	3	HO1	0.35	20	PWR SUP TO M8 GROUP 2 HOOKS	C
X93	49	X4	29	X3	29	X93-2	49	HO1	0.35	20	PWR SUP TO M8 GROUP 2 HOOKS	C
X93	50	X4	69	X3	69	X93-2	50	HO1	0.35	20	PWR SUP TO M8 GROUP 2 HOOKS	C
X93	9	X4	65	X3	65	X93-2	9	HO1	0.35	22	GROUP 2 HOOKS CLOSED	C
X97	9	X3	48	X4	48	X97-2	9	HO2	0.35	22	GROUP 2 HOOKS CLOSED	C
X93	8	X4	64	X3	64	X93-2	8	HO1	0.35	22	GROUP 2 HOOKS OPEN	C
X97	8	X3	47	X4	47	X97-2	8	HO2	0.35	22	GROUP 2 HOOKS OPEN	C
X93	4	X4	73	X3	73	X93-2	4	HO1	0.35	22	GROUP 1 HOOKS IN-BETWEEN	C
X97	4	X3	56	X4	56	X97-2	4	HO2	0.35	22	GROUP 1 HOOKS IN-BETWEEN	C
X97	10	X3	57	X4	57	X97-2	10	HO1	0.35	22	GROUP 2 HOOKS IN-BETWEEN	C
X93	10	X4	74	X3	74	X93-2	10	HO2	0.35	22	GROUP 2 HOOKS IN-BETWEEN	C
X93	46	X4	79	X3	79	X93-2	46	HO2	0.35	22	CONTROL SENSOR RETURN	C
X97	46	X3	62	X4	62	X97-2	46	HO2	0.35	22	CONTROL SENSOR RETURN	C
X93	40	X4	80	X3	80	X93-2	40	HO1	0.35	22	CONTROL SENSOR RETURN	C
X93	11	X4	75	X3	75	X93-2	11	HO1	0.35	22	READY TO HOOK	C
X97	11	X3	58	X4	58	X97-2	11	HO2	0.35	22	READY TO HOOK	C
X93	12	X4	76	X3	76	X93-2	12	HO1	0.35	22	UNDOCK COMPLETE	C
X97	12	X3	59	X4	59	X97-2	12	HO2	0.35	22	UNDOCK COMPLETE	C
X93	14	X4	71	X3	71	X93-2	14	HO2	0.35	22	INTERFACE SEALED	C

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X97	15	X3	55	X4	55	X97-2	15	HO3	0.35	22	INTERFACE SEALED	C
X97	13	X3	53	X4	53	X97-2	13	HO1	0.35	22	INTERFACE SEALED	C
X93	13	X4	70	X3	70	X93-2	13	HO3	0.35	22	INTERFACE SEALED	C
X97	40	X3	63	X4	63	X97-2	40	HO1	0.35	22	CONTROL SENSOR RETURN	C
X109	1	X3	10	X4	10	X109-2	1	ML	0.35	22	BALL SCREW NO. 1 LIN ADV (COM)	C
X109	2	X3	11	X4	11	X109-2	2	ML	0.35	22	BALL SCREW NO. 1 LIN ADV (SIG)	C
X109	3	X3	12	X4	12	X109-2	3	ML	0.35	22	BALL SCREW NO. 1 LIN ADV (EXC)	C
X109	4	X3	13	X4	13	X109-2	4	ML	0.35	22	BALL SCREW NO. 2 LIN ADV (SIG)	C
X109	19	X3	128	X4	128	X109-2	19	ML	0.35	22	BALL SCREW NO. 2 LIN ADV (EXC)	C
X109	5	X3	14	X4	14	X109-2	5	ML	0.35	22	BALL SCREW NO. 3 LIN ADV (SIG)	C
X109	21	X3	135	X4	135	X109-2	21	ML	0.35	22	BALL SCREW NO. 3 LIN ADV (EXC)	C
X109	6	X3	15	X4	15	X109-2	6	ML	0.35	22	BALL SCREW NO. 1 MISALIGN (SIG)	C
X109	22	X3	136	X4	136	X109-2	22	ML	0.35	22	BALL SCREW NO. 1 MISALIGN (EXC)	C
X109	7	X3	16	X4	16	X109-2	7	ML	0.35	22	BALL SCREW NO. 2 MISALIGN (SIG)	C
X109	23	X3	137	X4	137	X109-2	23	ML	0.35	22	BALL SCREW NO. 2 MISALIGN (EXC)	C
X109	8	X3	17	X4	17	X109-2	8	ML	0.35	22	BALL SCREW NO. 3 MISALIGN (COM)	C
X109	9	X3	18	X4	18	X109-2	9	ML	0.35	22	BALL SCREW NO. 3 MISALIGN (SIG)	C
X109	10	X3	19	X4	19	X109-2	10	ML	0.35	22	BALL SCREW NO. 3 MISALIGN (EXC)	C
X109	12	X3	28	X4	28	X109-2	12	ML	0.35	22	LATCHES MANUAL REL RTN	C
X109	11	X3	27	X4	27	X109-2	11	ML	0.35	22	LATCHES MANUAL RELEASE	C
X109	13	X3	29	X4	29	X109-2	13	ML2	0.35	22	RING FINAL POSITION	C
X109	14	X3	93	X4	93	X109-2	14	ML	0.35	22	CAPTURE LATCH OPEN	C
X109	15	X3	94	X4	94	X109-2	15	ML	0.35	22	CAPTURE LATCHES CLOSED	C
X109	16	X3	124	X4	124	X109-2	16	ML	0.35	22	RING INITIAL POSITION	C
X109	17	X3	125	X4	125	X109-2	17	ML2	0.35	22	RING FORWARD POSITION	C
X108	1	X4	122	X3	122	X108-2	1	ML	0.35	22	LWR BALL SOCKET NO 1 TEMP (COM)	C, 2S-22
X108	2	X4	123	X3	123	X108-2	2	ML	0.35	22	LWR BALL SOCKET NO 1 TEMP (EXC)	C, 2S-22
X108	3	X4	124	X3	124	X108-2	3	ML	0.35	22	LWR BALL SOCKET NO 2 TEMP (COM)	C, 2S-23
X108	4	X4	125	X3	125	X108-2	4	ML	0.35	22	LWR BALL SOCKET NO 2 TEMP (EXC)	C, 2S-23

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-6001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X108	5	X4	126	X3	126	X108-2	5	ML	0.35	22	LWR BALL SOCKET NO 3 TEMP (COM)	C, 2S-24
X108	6	X4	128	X3	128	X108-2	6	ML	0.35	22	LWR BALL SOCKET NO 3 TEMP (EXC)	C, 2S-24
X108	7	X4	129	X3	129	X108-2	7	ML	0.35	22	CAPTURE LATCH NO. 1 TEMP (COM)	C, 2S-25
X108	8	X4	130	X3	130	X108-2	8	ML	0.35	22	CAPTURE LATCH NO. 1 TEMP (EXC)	C, 2S-25
X108	9	X4	131	X3	131	X108-2	9	ML	0.35	22	CAPTURE LATCH NO. 2 TEMP (COM)	C, 2S-26
X108	10	X4	132	X3	132	X108-2	10	ML	0.35	22	CAPTURE LATCH NO. 2 TEMP (EXC)	C, 2S-26
X108	11	X4	133	X3	133	X108-2	11	ML	0.35	22	CAPTURE LATCH NO. 3 TEMP (COM)	C, 2S-27
X108	12	X4	134	X3	134	X108-2	12	ML	0.35	22	CAPTURE LATCH NO. 3 TEMP (EXC)	C, 2S-27
X108	13	X4	135	X3	135	X108-2	13	ML	0.35	22	DOCKING RING DRIVE TEMP (COM)	C, 2S-28
X108	14	X4	136	X3	136	X108-2	14	ML	0.35	22	DOCKING RING DRIVE TEMP (EXC)	C, 2S-28
X109	25	X3	143	X4	143	X109-2	25	ML1	0.35	22	UNDOCK COMPLETE	C
X109	24	X3	138	X4	138	X109-2	24	ML1	0.35	22	READY TO HOOK	C
X109	20	X3	132	X4	132	X109-2	20	ML1	0.35	22	READY TO HOOK RTN	C
X109	28	X3	147	X4	147	X109-2	28	ML1	0.35	22	GROUP 1 HOOKS CLOSED POS	C
X109	27	X3	145	X4	145	X109-2	27	ML2	0.35	22	GROUP 2 HOOKS OPEN POSITION	C
X109	26	X3	144	X4	144	X109-2	26	ML1	0.35	22	GROUP 1 HOOKS OPEN POSITION	C
X109	29	X3	182	X4	182	X109-2	29	ML2	0.35	22	GROUP 2 HOOKS CLOSED POS	C
X109	18	X3	126	X4	126	X109-2	18	ML2	0.35	22	GROUP 2 HOOKS CLOSE POS RTN	C
X108	25	X4	148	X3	148	X108-2	25	ML	0.35	22	GRP 1 HKS LINEAR ADV (EXC)	C
X108	26	X4	149	X3	149	X108-2	26	ML	0.35	22	GRP 1 HKS LINEAR ADV (SIG)	C
X108	27	X4	150	X3	150	X108-2	27	ML	0.35	22	GRP 1 HKS LINEAR ADV (COM)	C
X108	28	X4	182	X3	182	X108-2	28	ML	0.35	22	GRP 2 HKS LINEAR ADV (EXC)	C
X108	29	X4	183	X3	183	X108-2	29	ML	0.35	22	GRP 2 HKS LINEAR ADV (SIG)	C
X108	30	X4	184	X3	184	X108-2	30	ML	0.35	22	GRP 2 HKS LINEAR ADV (COM)	C
X108	15	X4	137	X3	137	X108-2	15	ML	0.35	22	DOCKING I/F TEMP NO. 1 (COM)	C, 2S-29
X108	16	X4	138	X3	138	X108-2	16	ML	0.35	22	DOCKING I/F TEMP NO. 1 (EXC)	C, 2S-29
X108	17	X4	139	X3	139	X108-2	17	ML	0.35	22	DOCKING I/F TEMP NO. 2 (COM)	C, 2S-30
X108	18	X4	140	X3	140	X108-2	18	ML	0.35	22	DOCKING I/F TEMP NO. 2 (EXC)	C, 2S-30

Table 20-G2. Orbiter/PMA - 2/3 Interfaces - X3 and X4 (concluded)

ORBITER DOCKING MECHANISM (-6001/-3002)				PMA - 2/3 (-8001)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X108	19	X4	141	X3	141	X108-2	19	ML	0.35	22	DOCKING I/F TEMP NO. 3 (COM)	C, 2S-31
X108	20	X4	142	X3	142	X108-2	20	ML	0.35	22	DOCKING I/F TEMP NO. 3 (EXC)	C, 2S-31
X108	21	X4	144	X3	144	X108-2	21	ML	0.35	22	HOOKS DRIVE TEMP NO. 1 (COM)	C, 2S-32
X108	22	X4	145	X3	145	X108-2	22	ML	0.35	22	HOOKS DRIVE TEMP NO. 1 (EXC)	C, 2S-32
X108	23	X4	146	X3	146	X108-2	23	ML	0.35	22	HOOKS DRIVE TEMP NO. 2 (COM)	C, 2S-33
X108	24	X4	147	X3	147	X108-2	24	ML	0.35	22	HOOKS DRIVE TEMP NO. 2 (EXC)	C, 2S-33
X108	50	X4	143	X3	143	X108-2	50	ML	0.35	22	SHD (ALL APDS TEMP MEAS)	
X99	1	X3	129	X4	129	X99-2	1	HO	0.35	22	SPARE	B
X99	2	X3	130	X4	130	X99-2	2	HO	0.35	22	SPARE	B
X99	3	X3	148	X4	148	X99-2	3	HO	0.35	22	SPARE	B
X99	4	X3	149	X4	149	X99-2	4	HO	0.35	22	SPARE	B
X99	5	X3	150	X4	150	X99-2	5	HO	0.35	22	SPARE	B
X99	6	X3	151	X4	151	X99-2	6	HO	0.35	22	SPARE	B
X99	7	X3	153	X4	153	X99-2	7	HO	0.35	22	SPARE	B
X99	8	X3	154	X4	154	X99-2	8	HO	0.35	22	SPARE	B
X99	9	X3	155	X4	155	X99-2	9	HO	0.35	22	SPARE	B
X99	41	X3	131	X4	131	X99-2	41	HO	0.35	22	SPARE	B
X99	42	X3	146	X4	146	X99-2	42	HO	0.35	22	SPARE	B
X99	47	X3	152	X4	152	X99-2	47	HO	0.35	22	SPARE	B

NOTES: A = NO RUSSIAN PIGTAILS REQUIRED FOR ORB X3/X4 CONNECTOR MATES ON PMA-2/3 SIDE OF INTERFACE (LOOP BACK WITHIN RUSSIAN CONNECTOR)
B = NO RUSSIAN PIGTAILS REQUIRED FOR SPARE FUNCTIONS ON EITHER SIDE OF INTERFACE
C = FOR –3002 ONLY
D = FOR –3002 ONLY: X94-31 IS X94-39, X94-39 IS X94-31; X99-31 IS X99-39, X99-39 IS X99-31
2S = (FOR 2S-1 THRU 2S-21) TWO CONDUCTOR TWISTED & SHIELDED THRU A SINGLE SHIELD PIN (*DENOTES SHIELD PIN)
2S = (FOR 2S-22 THRU 2S-33) TWO CONDUCTORS TWISTED & SHIELDED WITH ALL SHIELDS TIED TOGETHER

RUSS WIRE SIZE 0.2* = 75-OHM, 0.2MM² WIRE
AFTER THE 3A MISSION, THE DOCKING MECHANISM FUNCTIONS WILL BE REMOVED

Table 20-G3. PMA - 1 FGB Interfaces - X1 and X2

PMA - 1 (-7001) DISCONN. PNL CONN	PMA - 1 (-7001) DISCONN. PNL PIN	PMA - 1 (-7001) I/F CONN	PMA - 1 (-7001) I/F PIN	FGB I/F CONN	FGB I/F PIN	FGB DISCONN. PNL CONN	FGB DISCONN. PNL PIN	EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
X106	1	X1	1	X2	1	X107	1	ML1	0.35	22	FGB SYS TB 1 / X2 CONN MATE **	
X106	4	X1	4	X2	4	X107	4	ML1	0.35	22	FGB SYS TB 1 / X2 CONN MATE **	
X106	11	X1	79	X2	79	X107	11	ML1	0.35	22	FGB SYS TB 2 / X2 CONN MATE **	
X106	17	X1	86	X2	86	X107	17	ML1	0.35	22	FGB SYS TB 2 / X2 CONN MATE **	
X106	26	X1	149	X2	149	X107	26	ML1	0.35	22	FGB SYS TB 3 / X2 CONN MATE **	
X106	33	X1	150	X2	150	X107	33	ML1	0.35	22	FGB SYS TB 3 / X2 CONN MATE **	
X107	1	X2	1	X1	1	X106	1	ML2	0.35	22	FGB SYS TB 1 / X1 CONN MATE **	
X107	4	X2	4	X1	4	X106	4	ML2	0.35	22	FGB SYS TB 1 / X1 CONN MATE **	
X107	11	X2	79	X1	79	X106	11	ML2	0.35	22	FGB SYS TB 2 / X1 CONN MATE **	
X107	17	X2	86	X1	86	X106	17	ML2	0.35	22	FGB SYS TB 2 / X1 CONN MATE **	
X107	26	X2	149	X1	149	X106	26	ML2	0.35	22	FGB SYS TB 3 / X1 CONN MATE **	
X107	33	X2	150	X1	150	X106	33	ML2	0.35	22	FGB SYS TB 3 / X1 CONN MATE **	

NOTES: CONNECTOR MATES JUMPERED AT RUSSIAN X1/X2 CONNECTOR PINS
**NO RUSSIAN PIGTAILS REQUIRED FOR CONNECTOR MATE OR SPARE FUNCTIONS
(-7001) CONNECTORS X106 & X107 TO BE CAPPED

Table 20-G3. PMA - 1 FGB Interfaces - X1 and X2 (continued)

PMA - 1 (-7001)				FGB				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X106	29	X1	61	X2	61	X107	29	HO1	0.35	22	SPARE **	
X106	30	X1	62	X2	62	X107	30	HO1	0.35	22	SPARE **	
X106	31	X1	63	X2	63	X107	31	HO1	0.35	22	SPARE **	
X106	34	X1	64	X2	64	X107	34	HO1	0.35	22	SPARE **	
X106	35	X1	72	X2	72	X107	35	HO1	0.35	22	SPARE **	
X106	36	X1	73	X2	73	X107	36	HO1	0.35	22	SPARE **	
X106	37	X1	74	X2	74	X107	37	HO1	0.35	22	SPARE **	
X106	38	X1	75	X2	75	X107	38	HO1	0.35	22	SPARE **	
X106	39	X1	81	X2	81	X107	39	HO1	0.35	22	SPARE **	
X106	40	X1	82	X2	82	X107	40	HO1	0.35	22	SPARE **	
X106	41	X1	83	X2	83	X107	41	HO1	0.35	22	SPARE **	
X106	42	X1	84	X2	84	X107	42	HO1	0.35	22	SPARE **	
X106	43	X1	90	X2	90	X107	43	HO1	0.35	22	SPARE **	
X106	44	X1	91	X2	91	X107	44	HO1	0.35	22	SPARE **	
X106	45	X1	92	X2	92	X107	45	HO1	0.35	22	SPARE **	
X106	46	X1	93	X2	93	X107	46	HO1	0.35	22	SPARE **	
X106	47	X1	101	X2	101	X107	47	HO1	0.35	22	SPARE **	
X106	48	X1	102	X2	102	X107	48	HO1	0.35	22	SPARE **	
X106	49	X1	103	X2	103	X107	49	HO1	0.35	22	SPARE **	
X106	50	X1	104	X2	104	X107	50	HO1	0.35	22	SPARE **	
X107	29	X2	61	X1	61	X106	29	HO2	0.35	22	SPARE **	
X107	30	X2	62	X1	62	X106	30	HO2	0.35	22	SPARE **	
X107	31	X2	63	X1	63	X106	31	HO2	0.35	22	SPARE **	
X107	34	X2	64	X1	64	X106	34	HO2	0.35	22	SPARE **	
X107	35	X2	72	X1	72	X106	35	HO2	0.35	22	SPARE **	
X107	36	X2	73	X1	73	X106	36	HO2	0.35	22	SPARE **	
X107	37	X2	74	X1	74	X106	37	HO2	0.35	22	SPARE **	
X107	38	X2	75	X1	75	X106	38	HO2	0.35	22	SPARE **	
X107	39	X2	81	X1	81	X106	39	HO2	0.35	22	SPARE **	

Table 20-G3. PMA - 1 FGB Interfaces - X1 and X2 (concluded)

PMA - 1 (-7001)				FGB				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X107	40	X2	82	X1	82	X106	40	HO2	0.35	22	SPARE **	
X107	41	X2	83	X1	83	X106	41	HO2	0.35	22	SPARE **	
X107	42	X2	84	X1	84	X106	42	HO2	0.35	22	SPARE **	
X107	43	X2	90	X1	90	X106	43	HO2	0.35	22	SPARE **	
X107	44	X2	91	X1	91	X106	44	HO2	0.35	22	SPARE **	
X107	45	X2	92	X1	92	X106	45	HO2	0.35	22	SPARE **	
X107	46	X2	93	X1	93	X106	46	HO2	0.35	22	SPARE **	
X107	47	X2	101	X1	101	X106	47	HO2	0.35	22	SPARE **	
X107	48	X2	102	X1	102	X106	48	HO2	0.35	22	SPARE **	
X107	49	X2	103	X1	103	X106	49	HO2	0.35	22	SPARE **	
X107	50	X2	104	X1	104	X106	50	HO2	0.35	22	SPARE **	

Table 20-G4. PMA - 1/FGB Interfaces - X3 and X4

PMA - 1 (-7001)				FGB				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X110	1	X4	161	X3	161	X110	1	RF1	0.2*	22	CB GNC - 1A HI	2S-5
X110	2	X4	162	X3	162	X110	2	RF1	0.2*	22	CB GNC - 1A LO	2S-5
X110	3	X4	163	X3	163	X110	3	RF1	0.35	22	CB GNC - 1A SHD	2S-5*
X110	10	X4	170	X3	170	X110	10	RF1	0.2*	22	CB GNC - 2A HI	2S-6
X110	9	X4	171	X3	171	X110	9	RF1	0.2*	22	CB GNC - 2A LO	2S-6
X110	8	X4	172	X3	172	X110	8	RF1	0.35	22	CB GNC - 2A SHD	2S-6*
X110	13	X4	164	X3	164	X110	13	RF1	0.2*	22	LB CHeCS - SM-A HI	2S-7
X110	12	X4	165	X3	165	X110	12	RF1	0.2*	22	LB CHeCS - SM-A LO	2S-7
X110	11	X4	166	X3	166	X110	11	RF1	0.35	22	LB CHeCS - SM-A SHD	2S-7*
X110	47	X4	100	X3	100	X110	47	RF1	0.2*	24	UB ORB - N1 - 1A HI	2S-32
X110	48	X4	101	X3	101	X110	48	RF1	0.2*	24	UB ORB - N1 - 1A LO	2S-32
X110	49	X4	102	X3	102	X110	49	RF1	0.35	22	UB ORB - N1 - 1A SHD	2S-32*
X110	23	X4	167	X3	167	X110	23	RF1	0.2*	22	UB ORB - N1 - 2A HI	2S-8
X110	24	X4	168	X3	168	X110	24	RF1	0.2*	22	UB ORB - N1 - 2A LO	2S-8
X110	25	X4	169	X3	169	X110	25	RF1	0.35	22	UB ORB - N1 - 2A SHD	2S-8*
X110	26	X4	133	X3	133	X110	26	RF1	0.2*	22	LB RS - 1A HI	2S-9
X110	27	X4	134	X3	134	X110	27	RF1	0.2*	22	LB RS - 1A LO	2S-9
X110	28	X4	135	X3	135	X110	28	RF1	0.35	22	LB RS - 1A SHD	2S-9*
X110	29	X4	144	X3	144	X110	29	RF1	0.2*	22	LB RS - 2A HI	2S-10
X110	30	X4	145	X3	145	X110	30	RF1	0.2*	22	LB RS - 2A LO	2S-10
X110	31	X4	146	X3	146	X110	31	RF1	0.35	22	LB RS - 2A SHD	2S-10*

Table 20-G4. PMA - 1/FGB Interfaces - X3 and X4 (continued)

PMA - 1 (-7001)				FGB				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X108	32	X4	4	X3	4	X108	32	ML1	0.35	22	PMA-1 X4 CONN MATE (TM/SIG)	2T-17
X108	33	X4	173	X3	173	X108	33	ML1	0.35	22	PMA-1 X4 CONN MATE (TM/PWR)	2T-17
X108	34	X4	3	X3	3	X108	34	ML1	0.35	22	FGB SYS TB 1 / X3 CONN MATE **	2T-18
X108	35	X4	180	X3	180	X108	35	ML1	0.35	22	FGB SYS TB 1 / X3 CONN MATE **	2T-18
X108	36	X4	79	X3	79	X108	36	ML1	0.35	22	FGB SYS TB 2 / X3 CONN MATE **	2T-19
X108	37	X4	86	X3	86	X108	37	ML1	0.35	22	FGB SYS TB 2 / X3 CONN MATE **	2T-19
X108	38	X4	28	X3	28	X108	38	ML1	0.35	22	FGB SYS TB 3 / X3 CONN MATE **	2T-29
X108	39	X4	29	X3	29	X108	39	ML1	0.35	22	FGB SYS TB 3 / X3 CONN MATE **	2T-29

NOTES: **NO RUSSIAN PIGTAILS REQUIRED FOR FGB CONNECTOR MATE FUNCTIONS
RUSSIAN WIRE SIZE 0.2* = 75-OHM, 0.2mm² WIRE

Table 20-G4. PMA - 1/FGB Interfaces - X3 and X4 (continued)

PMA - 1 (-7001) DISCONN. PNL CONN	PMA - 1 (-7001) DISCONN. PNL PIN	PMA - 1 (-7001) I/F CONN	PMA - 1 (-7001) I/F PIN	FGB I/F CONN	FGB I/F PIN	FGB DISCONN. PNL CONN	FGB DISCONN. PNL PIN	EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
X111	1	X3	161	X4	161	X111	1	RF2	0.2*	22	CB GNC - 1B HI	2S-11
X111	2	X3	162	X4	162	X111	2	RF2	0.2*	22	CB GNC - 1B LO	2S-11
X111	3	X3	163	X4	163	X111	3	RF2	0.35	22	CB GNC - 1B SHD	2S-11*
X111	10	X3	170	X4	170	X111	10	RF2	0.2*	22	CB GNC - 2B HI	2S-12
X111	9	X3	171	X4	171	X111	9	RF2	0.2*	22	CB GNC - 2B LO	2S-12
X111	8	X3	172	X4	172	X111	8	RF2	0.35	22	CB GNC - 2B SHD	2S-12*
X111	13	X3	164	X4	164	X111	13	RF2	0.2*	22	LB CHeCS - SM-B HI	2S-13
X111	12	X3	165	X4	165	X111	12	RF2	0.2*	22	LB CHeCS - SM-B LO	2S-13
X111	11	X3	166	X4	166	X111	11	RF2	0.35	22	LB CHeCS - SM-B SHD	2S-13*
X111	47	X3	100	X4	100	X111	47	RF2	0.2*	24	UB ORB - N1 - 1B HI	2S-36
X111	48	X3	101	X4	101	X111	48	RF2	0.2*	24	UB ORB - N1 - 1B LO	2S-36
X111	49	X3	102	X4	102	X111	49	RF2	0.35	22	UB ORB - N1 - 1B SHD	2S-36*
X111	23	X3	167	X4	167	X111	23	RF2	0.2*	22	UB ORB - N1 - 2B HI	2S-14
X111	24	X3	168	X4	168	X111	24	RF2	0.2*	22	UB ORB - N1 - 2B LO	2S-14
X111	25	X3	169	X4	169	X111	25	RF2	0.35	22	UB ORB - N1 - 2B SHD	2S-14*
X111	26	X3	133	X4	133	X111	26	RF2	0.2*	22	LB RS - 1B HI	2S-15
X111	27	X3	134	X4	134	X111	27	RF2	0.2*	22	LB RS - 1B LO	2S-15
X111	28	X3	135	X4	135	X111	28	RF2	0.35	22	LB RS - 1B SHD	2S-15*
X111	29	X3	144	X4	144	X111	29	RF2	0.2*	22	LB RS - 2B HI	2S-16
X111	30	X3	145	X4	145	X111	30	RF2	0.2*	22	LB RS - 2B LO	2S-16
X111	31	X3	146	X4	146	X111	31	RF2	0.35	22	LB RS - 2B SHD	2S-16*
X109	32	X3	4	X4	4	X109	32	ML2	0.35	22	PMA-1 X3 CONN MATE (TM/SIG)	2T-20
X109	33	X3	173	X4	173	X109	33	ML2	0.35	22	PMA-1 X3 CONN MATE (TM/PWR)	2T-20
X109	34	X3	3	X4	3	X109	34	ML2	0.35	22	FGB SYS TB 1 / X4 CONN MATE **	2T-21
X109	35	X3	180	X4	180	X109	35	ML2	0.35	22	FGB SYS TB 1 / X4 CONN MATE **	2T-21
X109	36	X3	79	X4	79	X109	36	ML2	0.35	22	FGB SYS TB 2 / X4 CONN MATE **	2T-22
X109	37	X3	86	X4	86	X109	37	ML2	0.35	22	FGB SYS TB 2 / X4 CONN MATE **	2T-22
X109	38	X3	28	X4	28	X109	38	ML2	0.35	22	FGB SYS TB 3 / X4 CONN MATE **	2T-30
X109	39	X3	29	X4	29	X109	39	ML2	0.35	22	FGB SYS TB 3 / X4 CONN MATE **	2T-30

Table 20-G4. PMA - 1/FGB Interfaces - X3 and X4 (continued)

PMA - 1 (-7001)				FGB				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X110	41	X4	109	X3	109	X110	41	RF1	0.2*	22	RS TO US VIDEO - 1 HI ***	2S-17
X110	42	X4	110	X3	110	X110	42	RF1	0.2*	22	RS TO US VIDEO - 1 LO ***	2S-17
X110	43	X4	111	X3	111	X110	43	RF1	0.35	22	RS TO US VIDEO - 1 SHD ***	2S-17*
X110	46	X4	118	X3	118	X110	46	RF1	0.2*	22	US TO RS VIDEO - 1 HI ***	2S-18
X110	45	X4	119	X3	119	X110	45	RF1	0.2*	22	US TO RS VIDEO - 1 LO ***	2S-18
X110	44	X4	120	X3	120	X110	44	RF1	0.35	22	US TO RS VIDEO - 1 SHD ***	2S-18*
X108	13	X4	33	X3	33	X108	13	ML1	0.35	22	US TO RS AUDIO CH 1 HI	2S-19
X108	12	X4	34	X3	34	X108	12	ML1	0.35	22	US TO RS AUDIO CH 1 LO	2S-19
X108	11	X4	35	X3	35	X108	11	ML1	0.35	22	US TO RS AUDIO CH 1 SHD	2S-19*
X108	23	X4	38	X3	38	X108	23	ML1	0.35	22	RS TO US AUDIO CH 1 HI	2S-20
X108	24	X4	37	X3	37	X108	24	ML1	0.35	22	RS TO US AUDIO CH 1 LO	2S-20
X108	25	X4	36	X3	36	X108	25	ML1	0.35	22	RS TO US AUDIO CH 1 SHD	2S-20*
X108	41	X4	87	X3	87	X108	41	ML1	0.35	22	RS TO US AUDIO CH 2B HI	2S-29
X108	42	X4	88	X3	88	X108	42	ML1	0.35	22	RS TO US AUDIO CH 2B LO	2S-29
X108	43	X4	89	X3	89	X108	43	ML1	0.35	22	RS TO US AUDIO CH 2B SHD	2S-29*
X108	46	X4	92	X3	92	X108	46	ML1	0.35	22	SPARE ***	2S-30
X108	45	X4	93	X3	93	X108	45	ML1	0.35	22	SPARE ***	2S-30
X108	44	X4	94	X3	94	X108	44	ML1	0.35	22	SPARE ***	2S-30*
X108	26	X4	57	X3	57	X108	26	ML1	0.35	22	US TO RS LOUD ANNUNC CH 1 HI	2S-21
X108	27	X4	58	X3	58	X108	27	ML1	0.35	22	US TO RS LOUD ANNUNC CH 1 LO	2S-21
X108	28	X4	59	X3	59	X108	28	ML1	0.35	22	US TO RS LOUD ANNUNC CH 1 SHD	2S-21*
X108	29	X4	62	X3	62	X108	29	ML1	0.35	22	RS TO US LOUD ANNUNC CH 1 HI	2S-22
X108	30	X4	61	X3	61	X108	30	ML1	0.35	22	RS TO US LOUD ANNUNC CH 1 LO	2S-22
X108	31	X4	60	X3	60	X108	31	ML1	0.35	22	RS TO US LOUD ANNUNC CH 1 SHD	2S-22*
X111	41	X3	109	X4	109	X111	41	RF2	0.2*	22	RS TO US VIDEO - 2 HI ***	2S-23
X111	42	X3	110	X4	110	X111	42	RF2	0.2*	22	RS TO US VIDEO - 2 LO ***	2S-23
X111	43	X3	111	X4	111	X111	43	RF2	0.35	22	RS TO US VIDEO - 2 SHD ***	2S-23*
X111	46	X3	118	X4	118	X111	46	RF2	0.2*	22	US TO RS VIDEO - 2 HI ***	2S-24
X111	45	X3	119	X4	119	X111	45	RF2	0.2*	22	US TO RS VIDEO - 2 LO ***	2S-24
X111	44	X3	120	X4	120	X111	44	RF2	0.35	22	US TO RS VIDEO - 2 SHD ***	2S-24*

Table 20-G4. PMA - 1/FGB Interfaces - X3 and X4 (continued)

PMA - 1 (-7001)				FGB				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X109	13	X3	33	X4	33	X109	13	ML2	0.35	22	US TO RS AUDIO CH 2 HI	2S-25
X109	12	X3	34	X4	34	X109	12	ML2	0.35	22	US TO RS AUDIO CH 2 LO	2S-25
X109	11	X3	35	X4	35	X109	11	ML2	0.35	22	US TO RS AUDIO CH 2 SHD	2S-25*
X109	23	X3	38	X4	38	X109	23	ML2	0.35	22	RS TO US AUDIO CH 2 HI	2S-26
X109	24	X3	37	X4	37	X109	24	ML2	0.35	22	RS TO US AUDIO CH 2 LO	2S-26
X109	25	X3	36	X4	36	X109	25	ML2	0.35	22	RS TO US AUDIO CH 2 SHD	2S-26*
X109	41	X3	87	X4	87	X109	41	ML2	0.35	22	RS TO US AUDIO CH 1B HI	2S-33
X109	42	X3	88	X4	88	X109	42	ML2	0.35	22	RS TO US AUDIO CH 1B LO	2S-33
X109	43	X3	89	X4	89	X109	43	ML2	0.35	22	RS TO US AUDIO CH 1B SHD	2S-33*
X109	46	X3	92	X4	92	X109	46	ML2	0.35	22	SPARE ***	2S-34
X109	45	X3	93	X4	93	X109	45	ML2	0.35	22	SPARE ***	2S-34
X109	44	X3	94	X4	94	X109	44	ML2	0.35	22	SPARE ***	2S-34*
X109	26	X3	57	X4	57	X109	26	ML2	0.35	22	US TO RS LOUD ANNUNC CH 2 HI	2S-27
X109	27	X3	58	X4	58	X109	27	ML2	0.35	22	US TO RS LOUD ANNUNC CH 2 LO	2S-27
X109	28	X3	59	X4	59	X109	28	ML2	0.35	22	US TO RS LOUD ANNUNC CH 2 SHD	2S-27*
X109	29	X3	62	X4	62	X109	29	ML2	0.35	22	RS TO US LOUD ANNUNC CH 2 HI	2S-28
X109	30	X3	61	X4	61	X109	30	ML2	0.35	22	RS TO US LOUD ANNUNC CH 2 LO	2S-28
X109	31	X3	60	X4	60	X109	31	ML2	0.35	22	RS TO US LOUD ANNUNC CH 2 SHD	2S-28*

Table 20-G4. PMA - 1/FGB Interfaces - X3 and X4 (concluded)

PMA - 1 (-7001)				FGB				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X108	1	X4	13	X3	13	X108	1	ML1	0.35	22	SPARE ***	2S-1
X108	2	X4	14	X3	14	X108	2	ML1	0.35	22	SPARE ***	2S-1
X108	3	X4	15	X3	15	X108	3	ML1	0.35	22	SPARE ***	2S-1*
X108	8	X4	6	X3	6	X108	8	ML1	0.35	22	SPARE ***	2S-2*
X108	9	X4	7	X3	7	X108	9	ML1	0.35	22	SPARE ***	2S-2
X108	10	X4	8	X3	8	X108	10	ML1	0.35	22	SPARE ***	2S-2
X110	36	X4	97	X3	97	X110	36	RF1	0.2*	24	SPARE ***	2S-31
X110	37	X4	98	X3	98	X110	37	RF1	0.2*	24	SPARE ***	2S-31
X110	38	X4	99	X3	99	X110	38	RF1	0.35	22	SPARE ***	2S-31*
X109	1	X3	13	X4	13	X109	1	ML2	0.35	22	SPARE ***	2S-3
X109	2	X3	14	X4	14	X109	2	ML2	0.35	22	SPARE ***	2S-3
X109	3	X3	15	X4	15	X109	3	ML2	0.35	22	SPARE ***	2S-3*
X109	8	X3	6	X4	6	X109	8	ML2	0.35	22	SPARE ***	2S-4*
X109	9	X3	7	X4	7	X109	9	ML2	0.35	22	SPARE ***	2S-4
X109	10	X3	8	X4	8	X109	10	ML2	0.35	22	SPARE ***	2S-4
X111	36	X3	97	X4	97	X111	36	RF2	0.2*	24	SPARE ***	2S-35
X111	37	X3	98	X4	98	X111	37	RF2	0.2*	24	SPARE ***	2S-35
X111	38	X3	99	X4	99	X111	38	RF2	0.35	22	SPARE ***	2S-35*

NOTES: 2S = TWO CONDUCTORS TWISTED & SHIELDED THRU A SINGLE SHIELD PIN (* DENOTES SHIELD PIN)
2T = TWO CONDUCTORS TWISTED BUT NOT SHIELDED
***NOT WIRED ACROSS INTERFACE; NO RUSSIAN PIGTAILS REQUIRED

Table 20-H-1. Fatigue Load Spectrum

Amplitude Tier Percent of Limit Load	-7001 APDA Cycle Count	-6001/-8001 APDA Cycle Count
90-100	10	10
80-90	50	50
70-80	100	100
60-70	200	700
50-60	1,000	1,000
40-50	2,000	7,000
30-40	22,000	40,000
20-30	50,000	80,000
15-20	50,000	100,000
10-15	200,000	750,000
5-10	5,000,000	6,500,000
2.5-5	5,000,000	10,000,000

Table 20-H-2. Structural Hook Simultaneous Loads Test Plan

	APDS	Hooks Active	Bending Moment	Torsion	Axial	Shear	Cycles
Limit Loading	-6001/-8001	12	6650	6650	500	500	2
	-7001	24	7930	7630	590	600	2
Fatigue Loading	-6001/-8001	12	6650	4000	n/a	n/a	10
			5985	3600			50
			5320	3200			100
			4655	2800			700
			3990	2400			1000
			3325	2000			7000
			2660	1600			40000
			1995	1200			80000
			1330	800			100000
	-6001/-8001	12	4000	6650	n/a	n/a	10
			3600	5985			50
			3200	5320			100
			2800	4655			700
	-6001/-8001	12	1000	1000	n/a	n/a	800000
	-7001	24	7930	4330	n/a	n/a	10
			7137	3897			50
			6344	3464			100
	-7001	24	5090	7630	n/a	n/a	10
			4581	6867			50
			4072	6104			100
Ultimate Loading	-6001/-8001	12	9975	9975	750	750	1
	-7001	24	11900	11450	890	900	1

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML1	0.2	X55	13	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X55	17	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X55	18	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X55	20	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X55	19	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X55	15	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	13	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	17	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	18	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	20	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	19	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	15	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	13	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	17	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	18	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	20	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	19	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	15	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	13	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	17	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	18	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	20	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	19	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	15	PFCU CONNECTOR MATE JUMPER
ML1	0.35	X55	21	PYRO 1 ACTIVE HOOK ASSY NO. 1 +
ML1	0.35	X55	1	PYRO 1 ACTIVE HOOK ASSY NO. 1 -
ML1	0.35	X55	5	PYRO 1 ACTIVE HOOK ASSY NO. 11 -
ML1	0.35	X55	25	PYRO 1 ACTIVE HOOK ASSY NO. 11 +
ML1	0.35	X55	3	PYRO 1 ACTIVE HOOK ASSY NO. 3 -
ML1	0.35	X55	23	PYRO 1 ACTIVE HOOK ASSY NO. 3 +
ML1	0.35	X55	27	PYRO 1 ACTIVE HOOK ASSY NO. 2 +
ML1	0.35	X55	7	PYRO 1 ACTIVE HOOK ASSY NO. 2 -
ML1	0.35	X56	3	PYRO 1 ACTIVE HOOK ASSY NO. 7 -

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML1	0.35	X56	23	PYRO 1 ACTIVE HOOK ASSY NO. 7 +
ML1	0.35	X56	21	PYRO 1 ACTIVE HOOK ASSY NO. 5 +
ML1	0.35	X56	1	PYRO 1 ACTIVE HOOK ASSY NO. 5 -
ML1	0.35	X56	25	PYRO 1 ACTIVE HOOK ASSY NO. 9 +
ML1	0.35	X56	5	PYRO 1 ACTIVE HOOK ASSY NO. 9 -
ML1	0.35	X55	11	PYRO 1 ACTIVE HOOK ASSY NO. 12 -
ML1	0.35	X55	31	PYRO 1 ACTIVE HOOK ASSY NO. 12 +
ML1	0.35	X55	29	PYRO 1 ACTIVE HOOK ASSY NO. 10 +
ML1	0.35	X55	9	PYRO 1 ACTIVE HOOK ASSY NO. 10 -
ML1	0.35	X56	11	PYRO 1 ACTIVE HOOK ASSY NO. 8 -
ML1	0.35	X56	31	PYRO 1 ACTIVE HOOK ASSY NO. 8 +
ML1	0.35	X56	29	PYRO 1 ACTIVE HOOK ASSY NO. 6 +
ML1	0.35	X56	9	PYRO 1 ACTIVE HOOK ASSY NO. 6 -
ML1	0.35	X56	7	PYRO 1 ACTIVE HOOK ASSY NO. 4 -
ML1	0.35	X56	27	PYRO 1 ACTIVE HOOK ASSY NO. 4 +
ML2	0.35	X65	1	PYRO 2 ACTIVE HOOK ASSY NO. 1 +
ML2	0.35	X65	21	PYRO 2 ACTIVE HOOK ASSY NO. 1 -
ML2	0.35	X65	25	PYRO 2 ACTIVE HOOK ASSY NO. 11 -
ML2	0.35	X65	5	PYRO 2 ACTIVE HOOK ASSY NO. 11 +
ML2	0.35	X65	23	PYRO 2 ACTIVE HOOK ASSY NO. 3 -
ML2	0.35	X65	3	PYRO 2 ACTIVE HOOK ASSY NO. 3 +
ML2	0.35	X65	7	PYRO 2 ACTIVE HOOK ASSY NO. 2 +
ML2	0.35	X65	27	PYRO 2 ACTIVE HOOK ASSY NO. 2 -
ML2	0.35	X66	23	PYRO 2 ACTIVE HOOK ASSY NO. 7 -
ML2	0.35	X66	3	PYRO 2 ACTIVE HOOK ASSY NO. 7 +
ML2	0.35	X66	1	PYRO 2 ACTIVE HOOK ASSY NO. 5 +
ML2	0.35	X66	21	PYRO 2 ACTIVE HOOK ASSY NO. 5 -
ML2	0.35	X66	5	PYRO 2 ACTIVE HOOK ASSY NO. 9 +
ML2	0.35	X66	25	PYRO 2 ACTIVE HOOK ASSY NO. 9 -

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML2	0.35	X65	31	PYRO 2 ACTIVE HOOK ASSY NO. 12 -
ML2	0.35	X65	11	PYRO 2 ACTIVE HOOK ASSY NO. 12 +
ML2	0.35	X65	9	PYRO 2 ACTIVE HOOK ASSY NO. 10 +
ML2	0.35	X65	29	PYRO 2 ACTIVE HOOK ASSY NO. 10 -
ML2	0.35	X66	31	PYRO 2 ACTIVE HOOK ASSY NO. 8 -
ML2	0.35	X66	11	PYRO 2 ACTIVE HOOK ASSY NO. 8 +
ML2	0.35	X66	9	PYRO 2 ACTIVE HOOK ASSY NO. 6 +
ML2	0.35	X66	29	PYRO 2 ACTIVE HOOK ASSY NO. 6 -
ML2	0.35	X66	27	PYRO 2 ACTIVE HOOK ASSY NO. 4 -
ML2	0.35	X66	7	PYRO 2 ACTIVE HOOK ASSY NO. 4 +
ML1	0.35	X55	22	PYRO 1 PASSIVE HOOK ASSY NO. 1 +
ML1	0.35	X55	2	PYRO 1 PASSIVE HOOK ASSY NO. 1 -
ML1	0.35	X55	6	PYRO 1 PASSIVE HOOK ASSY NO. 11 -
ML1	0.35	X55	26	PYRO 1 PASSIVE HOOK ASSY NO. 11 +
ML1	0.35	X55	4	PYRO 1 PASSIVE HOOK ASSY NO. 3 -
ML1	0.35	X55	24	PYRO 1 PASSIVE HOOK ASSY NO. 3 +
ML1	0.35	X55	28	PYRO 1 PASSIVE HOOK ASSY NO. 2 +
ML1	0.35	X55	8	PYRO 1 PASSIVE HOOK ASSY NO. 2 -
ML1	0.35	X56	4	PYRO 1 PASSIVE HOOK ASSY NO. 7 -
ML1	0.35	X56	24	PYRO 1 PASSIVE HOOK ASSY NO. 7 +
ML1	0.35	X56	22	PYRO 1 PASSIVE HOOK ASSY NO. 5 +
ML1	0.35	X56	2	PYRO 1 PASSIVE HOOK ASSY NO. 5 -
ML1	0.35	X56	26	PYRO 1 PASSIVE HOOK ASSY NO. 9 +
ML1	0.35	X56	6	PYRO 1 PASSIVE HOOK ASSY NO. 9 -
ML1	0.35	X55	12	PYRO 1 PASSIVE HOOK ASSY NO. 12 -
ML1	0.35	X55	32	PYRO 1 PASSIVE HOOK ASSY NO. 12 +
ML1	0.35	X55	30	PYRO 1 PASSIVE HOOK ASSY NO. 10 +
ML1	0.35	X55	10	PYRO 1 PASSIVE HOOK ASSY NO. 10 -
ML1	0.35	X56	12	PYRO 1 PASSIVE HOOK ASSY NO. 8 -
ML1	0.35	X56	32	PYRO 1 PASSIVE HOOK ASSY NO. 8 +
ML1	0.35	X56	30	PYRO 1 PASSIVE HOOK ASSY NO. 6 +
ML1	0.35	X56	10	PYRO 1 PASSIVE HOOK ASSY NO. 6 -

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F		FUNCTION
		CONN	PIN	
ML1	0.35	X56	8	PYRO 1 PASSIVE HOOK ASSY NO. 4 -
ML1	0.35	X56	28	PYRO 1 PASSIVE HOOK ASSY NO. 4 +
ML2	0.35	X65	2	PYRO 2 PASSIVE HOOK ASSY NO. 1 +
ML2	0.35	X65	22	PYRO 2 PASSIVE HOOK ASSY NO. 1 -
ML2	0.35	X65	26	PYRO 2 PASSIVE HOOK ASSY NO. 11 -
ML2	0.35	X65	6	PYRO 2 PASSIVE HOOK ASSY NO. 11 +
ML2	0.35	X65	24	PYRO 2 PASSIVE HOOK ASSY NO. 3 -
ML2	0.35	X65	4	PYRO 2 PASSIVE HOOK ASSY NO. 3 +
ML2	0.35	X65	8	PYRO 2 PASSIVE HOOK ASSY NO. 2 +
ML2	0.35	X65	28	PYRO 2 PASSIVE HOOK ASSY NO. 2 -
ML2	0.35	X66	24	PYRO 2 PASSIVE HOOK ASSY NO. 7 -
ML2	0.35	X66	4	PYRO 2 PASSIVE HOOK ASSY NO. 7 +
ML2	0.35	X66	2	PYRO 2 PASSIVE HOOK ASSY NO. 5 +
ML2	0.35	X66	22	PYRO 2 PASSIVE HOOK ASSY NO. 5 -
ML2	0.35	X66	6	PYRO 2 PASSIVE HOOK ASSY NO. 9 +
ML2	0.35	X66	26	PYRO 2 PASSIVE HOOK ASSY NO. 9 -
ML2	0.35	X65	32	PYRO 2 PASSIVE HOOK ASSY NO. 12 -
ML2	0.35	X65	12	PYRO 2 PASSIVE HOOK ASSY NO. 12 +
ML2	0.35	X65	10	PYRO 2 PASSIVE HOOK ASSY NO. 10 +
ML2	0.35	X65	30	PYRO 2 PASSIVE HOOK ASSY NO. 10 -
ML2	0.35	X66	32	PYRO 2 PASSIVE HOOK ASSY NO. 8 -
ML2	0.35	X66	12	PYRO 2 PASSIVE HOOK ASSY NO. 8 +
ML2	0.35	X66	10	PYRO 2 PASSIVE HOOK ASSY NO. 6 +
ML2	0.35	X66	30	PYRO 2 PASSIVE HOOK ASSY NO. 6 -
ML2	0.35	X66	28	PYRO 2 PASSIVE HOOK ASSY NO. 4 -
ML2	0.35	X66	8	PYRO 2 PASSIVE HOOK ASSY NO. 4 +
HO1	0.35	X68	3	DOCK MECH HEATER (H1-1 +)
HO1	0.35	X68	48	DOCK MECH HEATER (H1-1 -)
HO2	0.35	X68	1	DOCK MECH HEATER (H1-2 +)
HO2	0.35	X68	50	DOCK MECH HEATER (H1-2 -)
HO3	0.35	X68	9	DOCK MECH HEATER (H1-3 +)

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F		FUNCTION
		CONN	PIN	
HO3	0.35	X68	41	DOCK MECH HEATER (H1-3 -)
HO3	0.35	X68	7	DOCK MECH HEATER (H2-1 +)
HO3	0.35	X68	44	DOCK MECH HEATER (H2-1 -)
HO1	0.35	X68	5	DOCK MECH HEATER (H2-2 +)
HO1	0.35	X68	46	DOCK MECH HEATER (H2-2 -)
HO2	0.35	X68	17	DOCK MECH HEATER (H2-3 +)
HO2	0.35	X68	34	DOCK MECH HEATER (H2-3 -)
HO3	0.35	X68	13	DOCK MECH HEATER (H3-1 +)
HO3	0.35	X68	38	DOCK MECH HEATER (H3-1 -)
HO2	0.35	X68	11	DOCK MECH HEATER (H3-2 +)
HO2	0.35	X68	40	DOCK MECH HEATER (H3-2 -)
HO1	0.35	X68	24	DOCK MECH HEATER (H3-3 +)
HO1	0.35	X68	26	DOCK MECH HEATER (H3-3 -)
HO1	0.2	X74	16	RING ALIGNED
HO2	0.2	X74	24	RING ALIGNED
HO1	0.2	X74	25	INITIAL CONTACT
HO2	0.2	X74	12	INITIAL CONTACT
HO1	0.35	X74	32	CAPTURE (SHORT)
HO2	0.35	X74	47	CAPTURE (SHORT)
HO1	0.2	X74	36	CAPTURE (LONG)
HO2	0.2	X74	13	CAPTURE (LONG)
HO1	0.35	X75	10	PWR SUP TO RING MTR (M4)
HO1	0.35	X75	4	PWR SUP TO RING MTR (M4)
HO1	0.35	X75	41	PWR SUP TO RING MTR (M4)
HO1	0.35	X75	50	PWR SUP TO RING MTR (M4)
HO2	0.35	X75	7	PWR SUP TO RING MTR (M5)
HO2	0.35	X75	8	PWR SUP TO RING MTR (M5)
HO2	0.35	X75	47	PWR SUP TO RING MTR (M5)
HO2	0.35	X75	48	PWR SUP TO RING MTR (M5)

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO1	0.2	X75	35	RING FINAL POSITION
HO2	0.35	X75	43	RING FINAL POSITION
HO3	0.35	X75	22	CONTROL SENSOR RETURN
HO1	0.2	X75	24	CONTROL SENSOR RETURN
HO2	0.2	X75	25	CONTROL SENSOR RETURN
HO1	0.35	X69	34	RING INITIAL POSITION
HO2	0.35	X69	26	RING INITIAL POSITION
HO1	0.35	X69	27	RING FORWARD POSITION
HO2	0.35	X69	28	RING FORWARD POSITION
HO1	0.35	X69	12	CAPTURE LATCHES OPEN IND
HO2	0.35	X69	11	CAPTURE LATCHES OPEN IND
HO1	0.35	X69	4	CAPTURE LATCHES CLOS IND
HO2	0.35	X69	8	CAPTURE LATCHES CLOS IND
HO1	0.2	X69	35	CAPTURE LATCHES IND RTN
HO2	0.2	X69	36	CAPTURE LATCHES IND RTN
HO2	0.35	X72	35	PWR SUP TO CAP LAT MTR (M1) +
HO1	0.35	X72	36	PWR SUP TO CAP LAT MTR (M1) +
HO1	0.2	X72	2	PWR SUP TO CAP LAT MTR (M1) -
HO1	0.2	X72	4	PWR SUP TO CAP LAT MTR (M1) -
HO2	0.35	X72	11	CAPTURE LATCH NO. 1 CLOS
HO1	0.35	X72	25	CAPTURE LATCH NO. 1 CLOS
HO2	0.35	X72	32	CAPTURE LATCH NO. 1 OPEN
HO1	0.35	X72	27	CAPTURE LATCH NO. 1 OPEN
HO2	0.35	X72	43	PWR SUP TO CAP LAT MTR (M2) +
HO2	0.35	X72	42	PWR SUP TO CAP LAT MTR (M2) +
HO3	0.2	X72	5	PWR SUP TO CAP LAT MTR (M2) -
HO2	0.2	X72	1	PWR SUP TO CAP LAT MTR (M2) -
HO3	0.35	X72	24	CAPTURE LATCH NO. 2 CLOS
HO2	0.35	X72	19	CAPTURE LATCH NO. 2 CLOS

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	DOCKING MECH. I/F PIN	FUNCTION
HO3	0.35	X72	26	CAPTURE LATCH NO. 2 OPEN
HO2	0.35	X72	40	CAPTURE LATCH NO. 2 OPEN
HO3	0.35	X72	48	PWR SUP TO CAP LAT MTR (M3) +
HO3	0.35	X72	47	PWR SUP TO CAP LAT MTR (M3) +
HO1	0.2	X72	9	PWR SUP TO CAP LAT MTR (M3) -
HO3	0.2	X72	10	PWR SUP TO CAP LAT MTR (M3) -
HO1	0.35	X72	18	CAPTURE LATCH NO. 3 CLOS
HO3	0.35	X72	33	CAPTURE LATCH NO. 3 CLOS
HO1	0.35	X72	39	CAPTURE LATCH NO. 3 OPEN
HO3	0.35	X72	34	CAPTURE LATCH NO. 3 OPEN
HO1	0.35	X76	4	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76	8	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76	1	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76	5	PWR SUP TO M6 GROUP 1 HOOKS **
HO2	0.35	X76	9	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76	10	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76	11	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76	12	PWR SUP TO M7 GROUP 1 HOOKS **
HO1	0.35	X76	6	GROUP 1 HOOKS CLOSED **
HO2	0.35	X76	20	GROUP 1 HOOKS CLOSED **
HO1	0.35	X76	15	GROUP 1 HOOKS OPEN **
HO2	0.35	X76	22	GROUP 1 HOOKS OPEN **
HO2	0.2	X76	24	GROUP 1 HOOKS CLOSED RETURN **
HO1	0.2	X76	33	GROUP 1 HOOKS CLOSED RETURN **
HO1	0.2	X76	32	GROUP 1 HOOKS OPEN RETURN **
HO2	0.2	X76	30	GROUP 1 HOOKS OPEN RETURN **
HO1	0.35	X70	4	FIXER 1 (+)
HO1	0.35	X70	2	FIXER 1 (+)

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO1	0.35	X70	28	FIXER 1 (-)
HO1	0.35	X70	31	FIXER 1 (-)
HO1	0.35	X70	46	FIXER 1 (-)
HO1	0.35	X70	45	FIXER 1 (-)
HO2	0.35	X70	10	FIXER 2 (+)
HO2	0.35	X70	9	FIXER 2 (+)
HO2	0.35	X70	27	FIXER 2 (-)
HO2	0.35	X70	26	FIXER 2 (-)
HO2	0.35	X70	50	FIXER 2 (-)
HO2	0.35	X70	49	FIXER 2 (-)
HO3	0.35	X70	8	FIXER 3 (+)
HO3	0.35	X70	14	FIXER 3 (+)
HO3	0.35	X70	25	FIXER 3 (-)
HO3	0.35	X70	24	FIXER 3 (-)
HO3	0.35	X70	44	FIXER 3 (-)
HO3	0.35	X70	43	FIXER 3 (-)
HO	0.35	X70	13	FIXER 4 (+)
HO	0.35	X70	20	FIXER 4 (+)
HO	0.35	X70	17	FIXER 4 (-)
HO	0.35	X70	16	FIXER 4 (-)
HO	0.35	X70	48	FIXER 4 (-)
HO	0.35	X70	47	FIXER 4 (-)
HO	0.35	X70	19	FIXER 5 (+)
HO	0.35	X70	18	FIXER 5 (+)
HO	0.35	X70	33	FIXER 5 (-)
HO	0.35	X70	32	FIXER 5 (-)
HO	0.35	X70	42	FIXER 5 (-)
HO	0.35	X70	41	FIXER 5 (-)

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO2	0.2	X77	14	HOOKS IN-BETWEEN RETURN
HO1	0.2	X77	6	HOOKS IN-BETWEEN RETURN
HO2	0.2	X76	36	CONTROL SENSOR RETURN
HO1	0.2	X76	45	CONTROL SENSOR RETURN
HO2	0.2	X76	43	CONTROL SENSOR RETURN
HO2	0.2	X76	49	CONTROL SENSOR RETURN
HO1	0.2	X77	2	CONTROL SENSOR RETURN
HO2	0.2	X77	3	CONTROL SENSOR RETURN
HO3	0.2	X77	8	CONTROL SENSOR RETURN
HO1	0.2	X77	45	READY TO HOOK
HO2	0.2	X77	48	READY TO HOOK
HO1	0.35	X77	49	UNDOCK COMPLETE
HO2	0.35	X77	50	UNDOCK COMPLETE
HO2	0.35	X77	32	INTERFACE SEALED
HO3	0.35	X77	39	INTERFACE SEALED
HO1	0.35	X77	24	INTERFACE SEALED
HO1	0.2	X77	18	CONTROL SENSOR RETURN
HO1	0.2	X77	26	CONTROL SENSOR RETURN
HO2	0.2	X77	34	CONTROL SENSOR RETURN
ML	0.35	X71	28	BALL SCREW NO. 1 LIN ADV (COM)
ML	0.35	X71	23	BALL SCREW NO. 1 LIN ADV (SIG)
ML	0.35	X71	40	BALL SCREW NO. 1 LIN ADV (EXC)
ML	0.35	X71	27	BALL SCREW NO. 2 LIN ADV (COM)
ML	0.35	X71	24	BALL SCREW NO. 2 LIN ADV (SIG)
ML	0.35	X71	39	BALL SCREW NO. 2 LIN ADV (EXC)
ML	0.35	X71	26	BALL SCREW NO. 3 LIN ADV (COM)
ML	0.35	X71	25	BALL SCREW NO. 3 LIN ADV (SIG)
ML	0.35	X71	45	BALL SCREW NO. 3 LIN ADV (EXC)
ML	0.35	X71	35	BALL SCREW NO. 1 MISALIGN (COM)
ML	0.35	X71	18	BALL SCREW NO. 1 MISALIGN (SIG)

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML	0.35	X71	50	BALL SCREW NO. 1 MISALIGN (EXC)
ML	0.35	X71	36	BALL SCREW NO. 2 MISALIGN (COM)
ML	0.35	X71	19	BALL SCREW NO. 2 MISALIGN (SIG)
ML	0.35	X71	49	BALL SCREW NO. 2 MISALIGN (EXC)
ML	0.35	X71	34	BALL SCREW NO. 3 MISALIGN (COM)
ML	0.35	X71	20	BALL SCREW NO. 3 MISALIGN (SIG)
ML	0.35	X71	48	BALL SCREW NO. 3 MISALIGN (EXC)
ML	0.35	X71	13	LATCHES MANUAL REL RTN
ML	0.35	X71	17	LATCHES MANUAL RELEASE
ML2	0.35	X71	10	RING FINAL POSITION
ML2	0.35	X71	31	RING FINAL POSITION RTN
ML	0.35	X73	44	CAPTURE LATCH OPEN
ML	0.35	X73	10	CAPTURE LATCH OPEN RTN
ML	0.35	X73	43	CAPTURE LATCHES CLOSED
ML	0.35	X73	5	CAPTURE LATCHES CLOS RTN
ML	0.35	X73	7	RING INITIAL POSITION RTN
ML	0.35	X73	47	RING INITIAL POSITION
ML2	0.35	X73	11	RING FORWARD POSITION RTN
ML2	0.35	X73	48	RING FORWARD POSITION
ML	0.35	X73	21	LWR BALL SOCKET NO 1 TEMP (COM)
ML	0.35	X73	20	LWR BALL SOCKET NO 1 TEMP (SIG)
ML	0.35	X73	18	LWR BALL SOCKET NO 1 TEMP (EXC)
ML	0.35	X73	28	LWR BALL SOCKET NO 2 TEMP (COM)
ML	0.35	X73	27	LWR BALL SOCKET NO 2 TEMP (SIG)
ML	0.35	X73	39	LWR BALL SOCKET NO 2 TEMP (EXC)
ML	0.35	X73	37	LWR BALL SOCKET NO 3 TEMP (COM)
ML	0.35	X73	36	LWR BALL SOCKET NO 3 TEMP (SIG)
ML	0.35	X73	34	LWR BALL SOCKET NO 3 TEMP (EXC)
ML	0.35	X73	17	CAPTURE LATCH NO. 1 TEMP (COM)
ML	0.35	X73	16	CAPTURE LATCH NO. 1 TEMP (SIG)
ML	0.35	X73	14	CAPTURE LATCH NO. 1 TEMP (EXC)

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML	0.35	X73	25	CAPTURE LATCH NO. 2 TEMP (COM)
ML	0.35	X73	24	CAPTURE LATCH NO. 2 TEMP (SIG)
ML	0.35	X73	22	CAPTURE LATCH NO. 2 TEMP (EXC)
ML	0.35	X73	33	CAPTURE LATCH NO. 3 TEMP (COM)
ML	0.35	X73	32	CAPTURE LATCH NO. 3 TEMP (SIG)
ML	0.35	X73	30	CAPTURE LATCH NO. 3 TEMP (EXC)
ML	0.35	X73	29	DOCKING RING DRIVE TEMP (COM)
ML	0.35	X73	40	DOCKING RING DRIVE TEMP (SIG)
ML	0.35	X73	45	DOCKING RING DRIVE TEMP (EXC)
ML	0.35	X73	6	SHIELD
ML1	0.35	X79	22	UNDOCK COMPLETE
ML1	0.35	X79	23	UNDOCK COMPLETE RTN
ML1	0.35	X79	3	READY TO HOOK
ML1	0.35	X79	9	READY TO HOOK RTN
ML1	0.35	X79	26	GROUP 1 HOOKS CLOSED POS **
ML1	0.35	X79	16	GROUP 1 HOOKS CLOS POS RTN **
ML2	0.35	X79	25	GROUP 2 HOOKS OPEN POSITION **
ML2	0.35	X79	35	GROUP 2 HOOKS OPEN POS RTN **
ML1	0.35	X79	24	GROUP 1 HOOKS OPEN POSITION **
ML1	0.35	X79	34	GROUP 1 HOOKS OPEN POS RTN **
ML2	0.35	X79	17	GROUP 2 HOOKS CLOSED POS **
ML2	0.35	X79	27	GROUP 2 HOOKS CLOS POS RTN **
ML	0.35	X79	31	GROUP 1 HOOKS LINEAR ADV (EXC) **
ML	0.35	X79	40	GROUP 1 HOOKS LINEAR ADV (SIG) **
ML	0.35	X79	50	GROUP 1 HOOKS LINEAR ADV (COM) **
ML	0.35	X79	30	GROUP 2 HOOKS LINEAR ADV (EXC) **
ML	0.35	X79	46	GROUP 2 HOOKS LINEAR ADV (SIG) **
ML	0.35	X79	39	GROUP 2 HOOKS LINEAR ADV (COM) **
ML	0.35	X78	1	DOCKING I/F TEMP NO. 1 (COM)
ML	0.35	X78	2	DOCKING I/F TEMP NO. 1 (SIG)

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML	0.35	X78	4	DOCKING I/F TEMP NO. 1 (EXC)
ML	0.35	X78	5	DOCKING I/F TEMP NO. 2 (COM)
ML	0.35	X78	6	DOCKING I/F TEMP NO. 2 (SIG)
ML	0.35	X78	8	DOCKING I/F TEMP NO. 2 (EXC)
ML	0.35	X78	9	DOCKING I/F TEMP NO. 3 (COM)
ML	0.35	X78	10	DOCKING I/F TEMP NO. 3 (SIG)
ML	0.35	X78	12	DOCKING I/F TEMP NO. 3 (EXC)
ML	0.35	X78	30	HOOKS DRIVE TEMP NO. 1 (COM)
ML	0.35	X78	31	HOOKS DRIVE TEMP NO. 1 (SIG)
ML	0.35	X78	33	HOOKS DRIVE TEMP NO. 1 (EXC)
ML	0.35	X78	37	HOOKS DRIVE TEMP NO. 2 (COM)
ML	0.35	X78	38	HOOKS DRIVE TEMP NO. 2 (SIG)
ML	0.35	X78	40	HOOKS DRIVE TEMP NO. 2 (EXC)
ML	0.35	X78	34	SHD (ALL APDS TEMP MEAS)
ML1	0.35	X79	2	ORB HOOKS 1 CLOSED IND
ML1	0.35	X79	5	ORB HOOKS 3 CLOSED IND
ML1	0.35	X79	6	ORB HOOKS 5 CLOSED IND
ML1	0.35	X79	13	ORB HOOKS 7 CLOSED IND
ML1	0.35	X79	7	ORB HOOKS 9 CLOSED IND
ML1	0.35	X79	12	ORB HOOKS 11 CLOSED IND
ML1	0.35	X79	1	ORB HKS 1,3,5,7,9,11 CLS IND SOURCE (1)
ML1	0.35	X79	11	ORB HKS 1,3,5,7,9,11 CLS IND SOURCE (2)
ML2	0.35	X79	19	ORB HOOKS 2 CLOSED IND
ML2	0.35	X79	20	ORB HOOKS 4 CLOSED IND
ML2	0.35	X79	21	ORB HOOKS 6 CLOSED IND
ML2	0.35	X79	47	ORB HOOKS 8 CLOSED IND
ML2	0.35	X79	48	ORB HOOKS 10 CLOSED IND
ML2	0.35	X79	49	ORB HOOKS 12 CLOSED IND
ML2	0.35	X79	18	ORB HKS 2,4,6,8,10,12 CLS IND SOURCE (1)
ML2	0.35	X79	45	ORB HKS 2,4,6,8,10,12 CLS IND SOURCE (2)
HO1	0.35	X75	13	PWR SUP TO SLIP CLUTCH MOTORS (M10)
HO1	0.35	X75	14	PWR SUP TO SLIP CLUTCH MOTORS (M10)
HO1	0.35	X75	18	PWR SUP TO SLIP CLUTCH MOTORS (M10)

Table 20-I. Electrical Interface Connections Between Orbiter and APDA-6001 (concluded)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO1	0.35	X75	19	PWR SUP TO SLIP CLUTCH MOTORS (M10)
HO2	0.35	X75	32	PWR SUP TO SLIP CLUTCH MOTORS (M11)
HO2	0.35	X75	33	PWR SUP TO SLIP CLUTCH MOTORS (M11)
HO2	0.35	X75	28	PWR SUP TO SLIP CLUTCH MOTORS (M11)
HO2	0.35	X75	29	PWR SUP TO SLIP CLUTCH MOTORS (M11)
HO	0.35	X69	3	SLIP CLUTCH INITIAL POSITION (1)
HO	0.35	X69	14	SLIP CLUTCH INITIAL POSITION (1)
HO	0.35	X69	15	SLIP CLUTCH INITIAL POSITION (2)
HO	0.35	X69	20	SLIP CLUTCH INITIAL POSITION (2)
HO	0.35	X69	30	SLIP CLUTCH FINAL POSITION (1)
HO	0.35	X69	31	SLIP CLUTCH FINAL POSITION (1)
HO	0.35	X69	32	SLIP CLUTCH FINAL POSITION (2)
HO	0.35	X69	33	SLIP CLUTCH FINAL POSITION (2)
HO	0.35	X73	3	SLIP CLUTCH INITIAL POSITION TM
HO	0.35	X73	8	SLIP CLUTCH INITIAL POSITION TM
HO	0.35	X73	12	SLIP CLUTCH FINAL POSITION TM
HO	0.35	X73	13	SLIP CLUTCH FINAL POSITION TM
HO1	0.2	X67	11	LO-ENERGY DAMPER NO. 1 (+)
HO1	0.2	X67	12	LO-ENERGY DAMPER NO. 1 (+)
HO1	0.2	X67	25	LO-ENERGY DAMPER NO. 1 (-)
HO1	0.2	X67	24	LO-ENERGY DAMPER NO. 1 (-)
HO2	0.2	X67	18	LO-ENERGY DAMPER NO. 2 (+)
HO2	0.2	X67	19	LO-ENERGY DAMPER NO. 2 (+)
HO2	0.2	X67	32	LO-ENERGY DAMPER NO. 2 (-)
HO2	0.2	X67	33	LO-ENERGY DAMPER NO. 2 (-)
HO3	0.2	X67	27	LO-ENERGY DAMPER NO. 3 (+)
HO3	0.2	X67	26	LO-ENERGY DAMPER NO. 3 (+)
HO3	0.2	X67	37	LO-ENERGY DAMPER NO. 3 (-)
HO3	0.2	X67	38	LO-ENERGY DAMPER NO. 3 (-)

GROUP 1 HOOKS CONSIST OF HOOKS 1, 3, 5, 7, 9, & 11.
GROUP 2 HOOKS CONSIST OF HOOKS 2, 4, 6, 8, 10, & 12.

GROUP 1 & 2 HOOKS ACTUATOR ASSEMBLIES ATTACHED WITH HOOKS 7 & 6, RESPECTIVELY.

Table 20-J. Electrical Interface Connections Between PMA-1 and APDA-7001

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO1	0.35	X68	3	DOCK MECH HEATER (H1-1 +)
HO1	0.35	X68	48	DOCK MECH HEATER (H1-1 -)
HO2	0.35	X68	1	DOCK MECH HEATER (H1-2 +)
HO2	0.35	X68	50	DOCK MECH HEATER (H1-2 -)
HO3	0.35	X68	9	DOCK MECH HEATER (H1-3 +)
HO3	0.35	X68	41	DOCK MECH HEATER (H1-3 -)
HO3	0.35	X68	7	DOCK MECH HEATER (H2-1 +)
HO3	0.35	X68	44	DOCK MECH HEATER (H2-1 -)
HO1	0.35	X68	5	DOCK MECH HEATER (H2-2 +)
HO1	0.35	X68	46	DOCK MECH HEATER (H2-2 -)
HO2	0.35	X68	17	DOCK MECH HEATER (H2-3 +)
HO2	0.35	X68	34	DOCK MECH HEATER (H2-3 -)
HO3	0.35	X68	13	DOCK MECH HEATER (H3-1 +)
HO3	0.35	X68	38	DOCK MECH HEATER (H3-1 -)
HO2	0.35	X68	11	DOCK MECH HEATER (H3-2 +)
HO2	0.35	X68	40	DOCK MECH HEATER (H3-2 -)
HO1	0.35	X68	24	DOCK MECH HEATER (H3-3 +)
HO1	0.35	X68	26	DOCK MECH HEATER (H3-3 -)
HO1	0.35	X74	16	RING ALIGNED
HO2	0.35	X74	24	RING ALIGNED
HO1	0.35	X74	25	INITIAL CONTACT
HO2	0.35	X74	12	INITIAL CONTACT
HO1	0.35	X74	32	CAPTURE (SHORT)
HO2	0.35	X74	47	CAPTURE (SHORT)
HO1	0.35	X74	36	CAPTURE (LONG)
HO2	0.35	X74	13	CAPTURE (LONG)
HO1	0.35	X75	10	PWR SUP TO RING MTR (M4)
HO1	0.35	X75	4	PWR SUP TO RING MTR (M4)
HO1	0.35	X75	41	PWR SUP TO RING MTR (M4)
HO1	0.35	X75	50	PWR SUP TO RING MTR (M4)
HO2	0.35	X75	7	PWR SUP TO RING MTR (M5)

Table 20-J. Electrical Interface Connections Between PMA-1 and APDA-7001 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO2	0.35	X75	8	PWR SUP TO RING MTR (M5)
HO2	0.35	X75	47	PWR SUP TO RING MTR (M5)
HO2	0.35	X75	48	PWR SUP TO RING MTR (M5)
HO1	0.35	X75	35	RING FINAL POSITION
HO2	0.35	X75	43	RING FINAL POSITION
HO3	0.35	X75	22	CONTROL SENSOR RETURN
HO1	0.35	X75	24	CONTROL SENSOR RETURN
HO2	0.35	X75	25	RING FINAL POS 1 RTN
HO1	0.35	X69	34	RING INITIAL POSITION
HO2	0.35	X69	26	RING INITIAL POSITION
HO1	0.35	X69	27	RING FORWARD POSITION
HO2	0.35	X69	28	RING FORWARD POSITION
HO1	0.35	X69	12	CAPTURE LATCHES OPEN IND
HO2	0.35	X69	11	CAPTURE LATCHES OPEN IND
HO1	0.35	X69	4	CAPTURE LATCHES CLOS IND
HO2	0.35	X69	8	CAPTURE LATCHES CLOS IND
HO2	0.35	X72	35	PWR SUP TO CAP LAT MTR (M1) +
HO1	0.35	X72	36	PWR SUP TO CAP LAT MTR (M1) +
HO1	0.35	X72	2	PWR SUP TO CAP LAT MTR (M1) -
HO1	0.35	X72	4	PWR SUP TO CAP LAT MTR (M1) -
HO2	0.35	X72	11	CAPTURE LATCH NO. 1 CLOS
HO1	0.35	X72	25	CAPTURE LATCH NO. 1 CLOS
HO2	0.35	X72	32	CAPTURE LATCH NO. 1 OPEN
HO1	0.35	X72	27	CAPTURE LATCH NO. 1 OPEN
HO2	0.35	X72	43	PWR SUP TO CAP LAT MTR (M2) +
HO2	0.35	X72	42	PWR SUP TO CAP LAT MTR (M2) +
HO3	0.35	X72	5	PWR SUP TO CAP LAT MTR (M2) -
HO2	0.35	X72	1	PWR SUP TO CAP LAT MTR (M2) -
HO3	0.35	X72	24	CAPTURE LATCH NO. 2 CLOS

Table 20-J. Electrical Interface Connections Between PMA-1 and APDA-7001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO2	0.35	X72	19	CAPTURE LATCH NO. 2 CLOS
HO3	0.35	X72	26	CAPTURE LATCH NO. 2 OPEN
HO2	0.35	X72	40	CAPTURE LATCH NO. 2 OPEN
HO3	0.35	X72	48	PWR SUP TO CAP LAT MTR (M3) +
HO3	0.35	X72	47	PWR SUP TO CAP LAT MTR (M3) +
HO1	0.35	X72	9	PWR SUP TO CAP LAT MTR (M3) -
HO3	0.35	X72	10	PWR SUP TO CAP LAT MTR (M3) -
HO1	0.35	X72	18	CAPTURE LATCH NO. 3 CLOS
HO3	0.35	X72	33	CAPTURE LATCH NO. 3 CLOS
HO1	0.35	X72	39	CAPTURE LATCH NO. 3 OPEN
HO3	0.35	X72	34	CAPTURE LATCH NO. 3 OPEN
HO1	0.35	X76	4	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76	8	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76	1	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76	5	PWR SUP TO M6 GROUP 1 HOOKS **
HO2	0.35	X76	9	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76	10	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76	11	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76	12	PWR SUP TO M7 GROUP 1 HOOKS **
HO1	0.35	X76	6	GROUP 1 HOOKS CLOSED **
HO2	0.35	X76	20	GROUP 1 HOOKS CLOSED **
HO1	0.35	X76	15	GROUP 1 HOOKS OPEN **
HO2	0.35	X76	22	GROUP 1 HOOKS OPEN **
HO1	0.35	X70	4	FIXER 1 (+)
HO1	0.35	X70	2	FIXER 1 (+)
HO1	0.35	X70	28	FIXER 1 (-)
HO1	0.35	X70	31	FIXER 1 (-)
HO1	0.35	X70	46	FIXER 1 (-)
HO1	0.35	X70	45	FIXER 1 (-)

Table 20-J. Electrical Interface Connections Between PMA-1 and APDA-7001 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO2	0.35	X70	10	FIXER 2 (+)
HO2	0.35	X70	9	FIXER 2 (+)
HO2	0.35	X70	27	FIXER 2 (-)
HO2	0.35	X70	26	FIXER 2 (-)
HO2	0.35	X70	50	FIXER 2 (-)
HO2	0.35	X70	49	FIXER 2 (-)
HO3	0.35	X70	8	FIXER 3 (+)
HO3	0.35	X70	14	FIXER 3 (+)
HO3	0.35	X70	25	FIXER 3 (-)
HO3	0.35	X70	24	FIXER 3 (-)
HO3	0.35	X70	44	FIXER 3 (-)
HO3	0.35	X70	43	FIXER 3 (-)
HO	0.35	X70	13	FIXER 4 (+)
HO	0.35	X70	20	FIXER 4 (+)
HO	0.35	X70	17	FIXER 4 (-)
HO	0.35	X70	16	FIXER 4 (-)
HO	0.35	X70	48	FIXER 4 (-)
HO	0.35	X70	47	FIXER 4 (-)
HO	0.35	X70	19	FIXER 5 (+)
HO	0.35	X70	18	FIXER 5 (+)
HO	0.35	X70	33	FIXER 5 (-)
HO	0.35	X70	32	FIXER 5 (-)
HO	0.35	X70	42	FIXER 5 (-)
HO	0.35	X70	41	FIXER 5 (-)
HO1	0.35	X67	4	HI-ENERGY DAMPER NO. 1 (+)
HO1	0.35	X67	3	HI-ENERGY DAMPER NO. 1 (+)
HO1	0.35	X67	39	HI-ENERGY DAMPER NO. 1 (-)
HO1	0.35	X67	40	HI-ENERGY DAMPER NO. 1 (-)
HO2	0.35	X67	17	HI-ENERGY DAMPER NO. 2 (+)
HO2	0.35	X67	16	HI-ENERGY DAMPER NO. 2 (+)
HO2	0.35	X67	50	HI-ENERGY DAMPER NO. 2 (-)

Table 20-J. Electrical Interface Connections Between PMA-1 and APDA-7001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO2	0.35	X67	49	HI-ENERGY DAMPER NO. 2 (-)
HO3	0.35	X67	6	HI-ENERGY DAMPER NO. 3 (+)
HO3	0.35	X67	5	HI-ENERGY DAMPER NO. 3 (+)
HO3	0.35	X67	35	HI-ENERGY DAMPER NO. 3 (-)
HO3	0.35	X67	34	HI-ENERGY DAMPER NO. 3 (-)
HO2	0.35	X76	41	PWR SUP TO M9 GROUP 2 HOOKS **
HO2	0.35	X76	42	PWR SUP TO M9 GROUP 2 HOOKS **
HO2	0.35	X76	39	PWR SUP TO M9 GROUP 2 HOOKS **
HO2	0.35	X76	40	PWR SUP TO M9 GROUP 2 HOOKS **
HO1	0.35	X76	47	PWR SUP TO M8 GROUP 2 HOOKS **
HO1	0.35	X76	48	PWR SUP TO M8 GROUP 2 HOOKS **
HO1	0.35	X76	50	PWR SUP TO M8 GROUP 2 HOOKS **
HO1	0.35	X76	46	PWR SUP TO M8 GROUP 2 HOOKS **
HO1	0.35	X76	19	GROUP 2 HOOKS CLOSED **
HO2	0.35	X76	28	GROUP 2 HOOKS CLOSED **
HO1	0.35	X76	18	GROUP 2 HOOKS OPEN **
HO2	0.35	X76	27	GROUP 2 HOOKS OPEN **
HO1	0.35	X77	1	GROUP 1 HOOKS IN-BETWEEN **
HO2	0.35	X77	5	GROUP 1 HOOKS IN-BETWEEN **
HO1	0.35	X77	38	GROUP 2 HOOKS IN-BETWEEN **
HO2	0.35	X77	37	GROUP 2 HOOKS IN-BETWEEN **
HO2	0.35	X76	36	CONTROL SENSOR RETURN
HO2	0.35	X76	43	CONTROL SENSOR RETURN
HO1	0.35	X77	6	CONTROL SENSOR RETURN
HO1	0.35	X77	45	READY TO HOOK
HO2	0.35	X77	48	READY TO HOOK
HO1	0.35	X77	49	UNDOCK COMPLETE
HO2	0.35	X77	50	UNDOCK COMPLETE
HO2	0.35	X77	32	INTERFACE SEALED
HO3	0.35	X77	39	INTERFACE SEALED

Table 20-J. Electrical Interface Connections Between PMA-1 and APDA-7001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO1	0.2	X77	24	INTERFACE SEALED
HO1	0.35	X77	14	CONTROL SENSOR RETURN
ML	0.35	X71	28	BALL SCREW NO. 1 LIN ADV (COM)
ML	0.35	X71	23	BALL SCREW NO. 1 LIN ADV (SIG)
ML	0.35	X71	40	BALL SCREW NO. 1 LIN ADV (EXC)
ML	0.35	X71	24	BALL SCREW NO. 2 LIN ADV (SIG)
ML	0.35	X71	39	BALL SCREW NO. 2 LIN ADV (EXC)
ML	0.35	X71	25	BALL SCREW NO. 3 LIN ADV (SIG)
ML	0.35	X71	45	BALL SCREW NO. 3 LIN ADV (EXC)
ML	0.35	X71	18	BALL SCREW NO. 1 MISALIGN (SIG)
ML	0.35	X71	50	BALL SCREW NO. 1 MISALIGN (EXC)
ML	0.35	X71	19	BALL SCREW NO. 2 MISALIGN (SIG)
ML	0.35	X71	49	BALL SCREW NO. 2 MISALIGN (EXC)
ML	0.35	X71	34	BALL SCREW NO. 3 MISALIGN (COM)
ML	0.35	X71	20	BALL SCREW NO. 3 MISALIGN (SIG)
ML	0.35	X71	48	BALL SCREW NO. 3 MISALIGN (EXC)
ML	0.35	X71	13	LATCHES MANUAL REL RTN
ML	0.35	X71	17	LATCHES MANUAL RELEASE
ML2	0.35	X71	10	RING FINAL POSITION
ML	0.35	X73	44	CAPTURE LATCH OPEN
ML	0.35	X73	43	CAPTURE LATCHES CLOSED
ML	0.35	X73	47	RING INITIAL POSITION
ML2	0.35	X73	48	RING FORWARD POSITION
ML	0.35	X73	21	LWR BALL SOCKET NO 1 TEMP (COM)
ML	0.35	X73	18	LWR BALL SOCKET NO 1 TEMP (EXC)
ML	0.35	X73	28	LWR BALL SOCKET NO 2 TEMP (COM)
ML	0.35	X73	39	LWR BALL SOCKET NO 2 TEMP (EXC)
ML	0.35	X73	37	LWR BALL SOCKET NO 3 TEMP (COM)
ML	0.35	X73	34	LWR BALL SOCKET NO 3 TEMP (EXC)
ML	0.35	X73	17	CAPTURE LATCH NO. 1 TEMP (COM)
ML	0.35	X73	14	CAPTURE LATCH NO. 1 TEMP (EXC)

Table 20-J. Electrical Interface Connections Between PMA-1 and APDA-7001 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML	0.35	X73	25	CAPTURE LATCH NO. 2 TEMP (COM)
ML	0.35	X73	22	CAPTURE LATCH NO. 2 TEMP (EXC)
ML	0.35	X73	33	CAPTURE LATCH NO. 3 TEMP (COM)
ML	0.35	X73	30	CAPTURE LATCH NO. 3 TEMP (EXC)
ML	0.35	X73	6	SHIELD
ML	0.35	X73	29	DOCKING RING DRIVE TEMP (COM)
ML	0.35	X73	45	DOCKING RING DRIVE TEMP (EXC)
ML2	0.35	X73	10	CONTROL SENSOR RETURN
ML1	0.35	X79	23	UNDOCK COMPLETE
ML1	0.35	X79	3	READY TO HOOK
ML1	0.35	X79	9	CONTROL SENSOR RETURN
ML1	0.35	X79	26	GROUP 1 HOOKS CLOSED POS **
ML2	0.35	X79	25	GROUP 2 HOOKS OPEN POSITION **
ML1	0.35	X79	24	GROUP 1 HOOKS OPEN POSITION **
ML2	0.35	X79	17	GROUP 2 HOOKS CLOSED POS **
ML	0.35	X79	31	GROUP 1 HOOKS LINEAR ADV (EXC) **
ML	0.35	X79	40	GROUP 1 HOOKS LINEAR ADV (SIG) **
ML	0.35	X79	50	GROUP 1 HOOKS LINEAR ADV (COM) **
ML	0.35	X79	30	GROUP 2 HOOKS LINEAR ADV (EXC) **
ML	0.35	X79	46	GROUP 2 HOOKS LINEAR ADV (SIG) **
ML	0.35	X79	39	GROUP 2 HOOKS LINEAR ADV (COM) **
ML	0.35	X78	1	DOCKING I/F TEMP NO. 1 (COM)
ML	0.35	X78	4	DOCKING I/F TEMP NO. 1 (EXC)
ML	0.35	X78	5	DOCKING I/F TEMP NO. 2 (COM)
ML	0.35	X78	8	DOCKING I/F TEMP NO. 2 (EXC)
ML	0.35	X78	9	DOCKING I/F TEMP NO. 3 (COM)
ML	0.35	X78	12	DOCKING I/F TEMP NO. 3 (EXC)
ML	0.35	X78	30	HOOKS DRIVE TEMP NO. 1 (COM)
ML	0.35	X78	33	HOOKS DRIVE TEMP NO. 1 (EXC)
ML	0.35	X78	37	HOOKS DRIVE TEMP NO. 2 (COM)

Table 20-J. Electrical Interface Connections Between PMA-1 and APDA-7001 (concluded)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML	0.35	X78	40	HOOKS DRIVE TEMP NO. 2 (EXC)
ML	0.35	X78	34	SHD (ALL APDS TEMP MEAS)
ML1	0.35	X79	2	PMA-1 HOOKS 1 CLOSED IND
ML1	0.35	X79	5	PMA-1 HOOKS 3 CLOSED IND
ML1	0.35	X79	6	PMA-1 HOOKS 5 CLOSED IND
ML1	0.35	X79	7	PMA-1 HOOKS 9 CLOSED IND
ML1	0.35	X79	12	PMA-1 HOOKS 11 CLOSED IND
ML1	0.35	X79	1	PMA-1 HOOKS 1,3,5,9,11 CLOS IND SOURCE (1)
ML1	0.35	X79	11	PMA-1 HOOKS 1,3,5,9,11 CLOS IND SOURCE (2)
ML2	0.35	X79	19	PMA-1 HOOKS 2 CLOSED IND
ML2	0.35	X79	20	PMA-1 HOOKS 4 CLOSED IND
ML2	0.35	X79	47	PMA-1 HOOKS 8 CLOSED IND
ML2	0.35	X79	48	PMA-1 HOOKS 10 CLOSED IND
ML2	0.35	X79	49	PMA-1 HOOKS 12 CLOSED IND
ML2	0.35	X79	18	PMA-1 HOOKS 2,4,8,10,12 CLOS IND SOURCE (1)
ML2	0.35	X79	45	PMA-1 HOOKS 2,4,8,10,12 CLOS IND SOURCE (2)

** NOTE: GROUP 1 HOOKS CONSIST OF HOOKS 1, 3, 5, 7, 9, & 11.
GROUP 2 HOOKS CONSIST OF HOOKS 2, 4, 6, 8, 10, & 12.

GROUP 1 & 2 HOOKS ACTUATOR ASSEMBLIES ATTACHED WITH HOOKS 7 & 6, RESPECTIVELY.

Table 20-K. Electrical Interface Connections Between PMA-2/3 and APDA-8001

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO1	0.35	XF73-2	32	CAPTURE SENSOR 1-1 (SHORT - SIG)
HO1	0.35	XF73-2	43	CAPTURE SENSOR 1-1 (SHORT - RTN)
HO1	0.35	XF73-2	22	CAPTURE SENSOR 2-1 (SHORT - SIG)
HO1	0.35	XF73-2	42	CAPTURE SENSOR 2-1 (SHORT - RTN)
HO1	0.35	XF73-2	8	CAPTURE SENSOR 3-1 (SHORT - SIG)
HO1	0.35	XF73-2	27	CAPTURE SENSOR 3-1 (SHORT - RTN)
HO2	0.35	XF74-2	47	CAPTURE SENSOR 1-2 (SHORT - SIG)
HO2	0.35	XF74-2	21	CAPTURE SENSOR 1-2 (SHORT - RTN)
HO2	0.35	XF74-2	41	CAPTURE SENSOR 2-2 (SHORT - SIG)
HO2	0.35	XF74-2	30	CAPTURE SENSOR 2-2 (SHORT - RTN)
HO2	0.35	XF74-2	26	CAPTURE SENSOR 3-2 (SHORT - SIG)
HO2	0.35	XF74-2	14	CAPTURE SENSOR 3-2 (SHORT - RTN)
HO1	0.35	XF73-2	36	CAPTURE SENSOR 1 (LONG - SIG)
HO1	0.35	XF73-2	33	CAPTURE SENSOR 1 (LONG - RTN)
HO2	0.35	XF74-2	13	CAPTURE SENSOR 2 (LONG - SIG)
HO2	0.35	XF74-2	48	CAPTURE SENSOR 2 (LONG - RTN)
HO1	0.35	X76-2	4	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76-2	8	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76-2	1	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76-2	5	PWR SUP TO M6 GROUP 1 HOOKS **
HO2	0.35	X76-2	9	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76-2	10	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76-2	11	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76-2	12	PWR SUP TO M7 GROUP 1 HOOKS **
HO1	0.35	X76-2	6	PASS MECH M6 GRP 1 HKS CLOS IND/INHIBIT **
HO2	0.35	X76-2	20	PASS MECH M7 GRP 1 HKS CLOS IND/INHIBIT **
HO1	0.35	X76-2	15	PASS MECH M6 GRP 1 HKS OPEN IND/INHIBIT **
HO2	0.35	X76-2	22	PASS MECH M7 GRP 1 HKS OPEN IND/INHIBIT **
HO2	0.35	X76-2	24	PASS MECH M6 GRP 1 HKS CLOS IND SOURCE **
HO1	0.35	X76-2	33	PASS MECH M7 GRP 1 HKS CLOS IND SOURCE **

Table 20-K. Electrical Interface Connections Between PMA-2/3 and APDA-8001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO1	0.35	X76-2	32	PASS MECH M6 GRP 1 HKS OPEN IND SOURCE **
HO2	0.35	X76-2	30	PASS MECH M7 GRP 1 HKS OPEN IND SOURCE **
HO1	0.35	X78-2	4	PWR SUP TO M8 GROUP 2 HOOKS **
HO1	0.35	X78-2	8	PWR SUP TO M8 GROUP 2 HOOKS **
HO1	0.35	X78-2	1	PWR SUP TO M8 GROUP 2 HOOKS **
HO1	0.35	X78-2	5	PWR SUP TO M8 GROUP 2 HOOKS **
HO2	0.35	X78-2	9	PWR SUP TO M9 GROUP 2 HOOKS **
HO2	0.35	X78-2	10	PWR SUP TO M9 GROUP 2 HOOKS **
HO2	0.35	X78-2	11	PWR SUP TO M9 GROUP 2 HOOKS **
HO2	0.35	X78-2	12	PWR SUP TO M9 GROUP 2 HOOKS **
HO1	0.35	X78-2	6	PASS MECH M8 GRP 2 HKS CLOS IND/INHIBIT **
HO2	0.35	X78-2	20	PASS MECH M9 GRP 2 HKS CLOS IND/INHIBIT **
HO1	0.35	X78-2	15	PASS MECH M8 GRP 2 HKS OPEN IND/INHIBIT **
HO2	0.35	X78-2	22	PASS MECH M9 GRP 2 HKS OPEN IND/INHIBIT **
HO1	0.35	X78-2	24	PASS MECH M8 GRP 2 HKS CLOS IND SOURCE **
HO2	0.35	X78-2	33	PASS MECH M9 GRP 2 HKS CLOS IND SOURCE **
HO1	0.35	X78-2	32	PASS MECH M8 GRP 2 HKS OPEN IND SOURCE **
HO2	0.35	X78-2	30	PASS MECH M9 GRP 2 HKS OPEN IND SOURCE **
HO1	0.35	X77-2	15	UNDOCK COMPLETE 1-1 (SIG)
HO1	0.35	X77-2	30	UNDOCK COMPLETE 1-1 (RTN)
HO1	0.35	X77-2	21	UNDOCK COMPLETE 2-1 (SIG)
HO1	0.35	X77-2	49	UNDOCK COMPLETE 2-1 (RTN)
HO2	0.35	X77-2	16	UNDOCK COMPLETE 1-2 (SIG)
HO2	0.35	X77-2	31	UNDOCK COMPLETE 1-2 (RTN)
HO2	0.35	X77-2	22	UNDOCK COMPLETE 2-2 (SIG)
HO2	0.35	X77-2	50	UNDOCK COMPLETE 2-2 (RTN)
HO1	0.35	X77-2	18	INTERFACE SEALED SENSOR 1-1 (SIG)
HO1	0.35	X77-2	24	INTERFACE SEALED SENSOR 1-1 (RTN)

Table 20-K. Electrical Interface Connections Between PMA-2/3 and APDA-8001 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO1	0.35	X77-2	26	INTERFACE SEALED SENSOR 2-1 (SIG)
HO1	0.35	X77-2	32	INTERFACE SEALED SENSOR 2-1 (RTN)
HO1	0.35	X77-2	34	INTERFACE SEALED SENSOR 3-1 (SIG)
HO1	0.35	X77-2	39	INTERFACE SEALED SENSOR 3-1 (RTN)
HO2	0.35	X77-2	19	INTERFACE SEALED SENSOR 1-2 (SIG)
HO2	0.35	X77-2	25	INTERFACE SEALED SENSOR 1-2 (RTN)
HO2	0.35	X77-2	27	INTERFACE SEALED SENSOR 2-2 (SIG)
HO2	0.35	X77-2	33	INTERFACE SEALED SENSOR 2-2 (RTN)
HO2	0.35	X77-2	35	INTERFACE SEALED SENSOR 3-2 (SIG)
HO2	0.35	X77-2	40	INTERFACE SEALED SENSOR 3-2 (RTN)
ML	0.35	XF74-2	1	DOCKING I/F TEMP NO. 4 (COM)
ML	0.35	XF74-2	3	DOCKING I/F TEMP NO. 4 (EXC)
ML	0.35	XF74-2	5	DOCKING I/F TEMP NO. 5 (COM)
ML	0.35	XF74-2	7	DOCKING I/F TEMP NO. 5 (EXC)
ML	0.35	XF74-2	11	GUIDE RING TEMP NO. 6 (COM)
ML	0.35	XF74-2	16	GUIDE RING TEMP NO. 6 (EXC)
ML	0.35	XF74-2	37	PMA 2/3 HATCH TEMP NO. 7 (COM)
ML	0.35	XF74-2	39	PMA 2/3 HATCH TEMP NO. 7 (EXC)
ML	0.35	XF74-2	50	TEMP SENSORS 4-7 SHD
ML1	0.35	X77-2	5	PASS MECH HKS 1,3,5 CLOSED IND
ML1	0.35	X77-2	1	PASS MECH HKS 1,3,5 CLOSED IND SOURCE
ML1	0.35	X77-2	11	PASS MECH HKS 7,9,11 CLOSED IND
ML1	0.35	X77-2	7	PASS MECH HKS 7,9,11 CLOSED IND SOURCE
ML2	0.35	X77-2	6	PASS MECH HKS 2,4,6 CLOSED IND
ML2	0.35	X77-2	2	PASS MECH HKS 2,4,6 CLOSED IND SOURCE
ML2	0.35	X77-2	12	PASS MECH HKS 8,10,12 CLOSED IND
ML2	0.35	X77-2	8	PASS MECH HKS 8,10,12 CLOSED IND SOURCE
ML	0.35	X84-2	28	HATCH SENSOR 1
ML	0.35	X84-2	29	HATCH SENSOR 2

Table 20-K. Electrical Interface Connections Between PMA-2/3 and APDA-8001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML	0.35	X84-2	30	HATCH SENSOR 3
ML	0.35	X84-2	1	HATCH SENSOR 1 RTN
ML	0.35	X84-2	2	HATCH SENSOR 2 RTN
ML	0.35	X84-2	3	HATCH SENSOR 3 RTN

** NOTE: GROUP 1 HOOKS CONSIST OF HOOKS 1, 3, 5, 7, 9, & 11.

GROUP 2 HOOKS CONSIST OF HOOKS 2, 4, 6, 8, 10, & 12.

GROUP 1 & 2 HOOKS ACTUATOR ASSEMBLIES ATTACHED WITH HOOKS 7 & 6, RESPECTIVELY.

GROUP HOOKS OPEN/CLOS IND/INHIBIT/SOURCE USED FOR AUTO CONTROLS VIA U.S. AFT FLIGHT DECK PANEL.

RUSS WIRE SIZE 0.2* = 75-OHM, 0.2MM² WIRE

X84 IS CAPPED AND UNUSED

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
RF1	0.2*	X55-2	1	1553 BUS - 2B HI-1 (STAT TO SW1)
RF1	0.2*	X55-2	2	1553 BUS - 2B LO-1 (STAT TO SW1)
RF1	0.35	X55-2	3	1553 BUS - 2B SHD-1 (STAT TO SW1)
RF1	0.2*	X55-2	5	1553 BUS - 2B HI-1 (SW1 TO STAT)
RF1	0.2*	X55-2	6	1553 BUS - 2B LO-1 (SW1 TO STAT)
RF1	0.35	X55-2	7	1553 BUS - 2B SHD-1 (SW1 TO STAT)
RF1	0.2*	X55-2	15	1553 BUS - 2B HI-1 (SW1 TO ORB)
RF1	0.2*	X55-2	16	1553 BUS - 2B LO-1 (SW1 TO ORB)
RF1	0.35	X55-2	17	1553 BUS - 2B SHD-1 (SW1 TO ORB)
RF1	0.2*	X55-2	11	1553 BUS - 2B HI-2 (STAT TO SW1)
RF1	0.2*	X55-2	12	1553 BUS - 2B LO-2 (STAT TO SW1)
RF1	0.35	X55-2	13	1553 BUS - 2B SHD-2 (STAT TO SW1)
RF1	0.2*	X55-2	18	1553 BUS - 2B HI-2 (SW1 TO STAT)
RF1	0.2*	X55-2	19	1553 BUS - 2B LO-2 (SW1 TO STAT)
RF1	0.35	X55-2	20	1553 BUS - 2B SHD-2 (SW1 TO STAT)

Table 20-K. Electrical Interface Connections Between PMA-2/3 and APDA-8001 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
RF1	0.2*	X55-2	26	SPARE
RF1	0.2*	X55-2	27	SPARE
RF1	0.35	X55-2	28	SPARE
RF1	0.2*	X56-2	1	1553 BUS - 2A HI-1 (STAT TO SW4)
RF1	0.2*	X56-2	2	1553 BUS - 2A LO-1 (STAT TO SW4)
RF1	0.35	X56-2	3	1553 BUS - 2A SHD-1 (STAT TO SW4)
RF1	0.2*	X56-2	5	1553 BUS - 2A HI-1 (SW4 TO STAT)
RF1	0.2*	X56-2	6	1553 BUS - 2A LO-1 (SW4 TO STAT)
RF1	0.35	X56-2	7	1553 BUS - 2A SHD-1 (SW4 TO STAT)
RF1	0.2*	X56-2	15	1553 BUS - 2A HI-1 (SW4 TO ORB)
RF1	0.2*	X56-2	16	1553 BUS - 2A LO-1 (SW4 TO ORB)
RF1	0.35	X56-2	17	1553 BUS - 2A SHD-1 (SW4 TO ORB)
RF1	0.2*	X56-2	11	1553 BUS - 2A HI-2 (STAT TO SW4)
RF1	0.2*	X56-2	12	1553 BUS - 2A LO-2 (STAT TO SW4)
RF1	0.35	X56-2	13	1553 BUS - 2A SHD-2 (STAT TO SW4)
RF1	0.2*	X56-2	18	1553 BUS - 2A HI-2 (SW4 TO STAT)
RF1	0.2*	X56-2	19	1553 BUS - 2A LO-2 (SW4 TO STAT)
RF1	0.35	X56-2	20	1553 BUS - 2A SHD-2 (SW4 TO STAT)
RF1	0.2*	X56-2	26	SPARE
RF1	0.2*	X56-2	27	SPARE
RF1	0.35	X56-2	28	SPARE
RF2	0.2*	X65-2	1	1553 BUS - 1B HI-1 (STAT TO SW2)
RF2	0.2*	X65-2	2	1553 BUS - 1B LO-1 (STAT TO SW2)
RF2	0.35	X65-2	3	1553 BUS - 1B SHD-1 (STAT TO SW2)
RF2	0.2*	X65-2	5	1553 BUS - 1B HI-1 (SW2 TO STAT)
RF2	0.2*	X65-2	6	1553 BUS - 1B LO-1 (SW2 TO STAT)
RF2	0.35	X65-2	7	1553 BUS - 1B SHD-1 (SW2 TO STAT)
RF2	0.2*	X65-2	15	1553 BUS - 1B HI-1 (SW2 TO ORB)
RF2	0.2*	X65-2	16	1553 BUS - 1B LO-1 (SW2 TO ORB)
RF2	0.35	X65-2	17	1553 BUS - 1B SHD-1 (SW2 TO ORB)
RF2	0.2*	X65-2	11	1553 BUS - 1B HI-2 (STAT TO SW2)
RF2	0.2*	X65-2	12	1553 BUS - 1B LO-2 (STAT TO SW2)

Table 20-K. Electrical Interface Connections Between PMA-2/3 and APDA-8001 (concluded)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
RF2	0.35	X65-2	13	1553 BUS - 1B SHD-2 (STAT TO SW2)
RF2	0.2*	X65-2	18	1553 BUS - 1B HI-2 (SW2 TO STAT)
RF2	0.2*	X65-2	19	1553 BUS - 1B LO-2 (SW2 TO STAT)
RF2	0.35	X65-2	20	1553 BUS - 1B SHD-2 (SW2 TO STAT)
RF2	0.2*	X65-2	26	SPARE
RF2	0.2*	X65-2	27	SPARE
RF2	0.35	X65-2	28	SPARE
RF2	0.2*	X66-2	1	1553 BUS - 1A HI-1 (STAT TO SW3)
RF2	0.2*	X66-2	2	1553 BUS - 1A LO-1 (STAT TO SW3)
RF2	0.35	X66-2	3	1553 BUS - 1A SHD-1 (STAT TO SW3)
RF2	0.2*	X66-2	5	1553 BUS - 1A HI-1 (SW3 TO STAT)
RF2	0.2*	X66-2	6	1553 BUS - 1A LO-1 (SW3 TO STAT)
RF2	0.35	X66-2	7	1553 BUS - 1A SHD-1 (SW3 TO STAT)
RF2	0.2*	X66-2	15	1553 BUS - 1A HI-1 (SW3 TO ORB)
RF2	0.2*	X66-2	16	1553 BUS - 1A LO-1 (SW3 TO ORB)
RF2	0.35	X66-2	17	1553 BUS - 1A SHD-1 (SW3 TO ORB)
RF2	0.2*	X66-2	11	1553 BUS - 1A HI-2 (STAT TO SW3)
RF2	0.2*	X66-2	12	1553 BUS - 1A LO-2 (STAT TO SW3)
RF2	0.35	X66-2	13	1553 BUS - 1A SHD-2 (STAT TO SW3)
RF2	0.2*	X66-2	18	1553 BUS - 1A HI-2 (SW3 TO STAT)
RF2	0.2*	X66-2	19	1553 BUS - 1A LO-2 (SW3 TO STAT)
RF2	0.35	X66-2	20	1553 BUS - 1A SHD-2 (SW3 TO STAT)
RF2	0.2*	X66-2	26	SPARE
RF2	0.2*	X66-2	27	SPARE
RF2	0.35	X66-2	28	SPARE

Table 20-L. Electrical Interface Connections Between Orbiter and APDA-3002

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML1	0.2	X55	13	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X55	17	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X55	18	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X55	20	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X55	19	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X55	15	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	13	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	17	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	18	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	20	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	19	PFCU CONNECTOR MATE JUMPER
ML1	0.2	X56	15	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	13	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	17	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	18	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	20	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	19	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X65	15	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	13	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	17	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	18	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	20	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	19	PFCU CONNECTOR MATE JUMPER
ML2	0.2	X66	15	PFCU CONNECTOR MATE JUMPER
ML1	0.35	X55	21	PYRO 1 ACTIVE HOOK ASSY NO. 1 +
ML1	0.35	X55	1	PYRO 1 ACTIVE HOOK ASSY NO. 1 -
ML1	0.35	X55	5	PYRO 1 ACTIVE HOOK ASSY NO. 11 -
ML1	0.35	X55	25	PYRO 1 ACTIVE HOOK ASSY NO. 11 +
ML1	0.35	X55	3	PYRO 1 ACTIVE HOOK ASSY NO. 3 -
ML1	0.35	X55	23	PYRO 1 ACTIVE HOOK ASSY NO. 3 +
ML1	0.35	X55	27	PYRO 1 ACTIVE HOOK ASSY NO. 2 +
ML1	0.35	X55	7	PYRO 1 ACTIVE HOOK ASSY NO. 2 -
ML1	0.35	X56	3	PYRO 1 ACTIVE HOOK ASSY NO. 7 -
ML1	0.35	X56	23	PYRO 1 ACTIVE HOOK ASSY NO. 7 +
ML1	0.35	X56	21	PYRO 1 ACTIVE HOOK ASSY NO. 5 +
ML1	0.35	X56	1	PYRO 1 ACTIVE HOOK ASSY NO. 5 -

Table 20-L. Electrical Interface Connections Between Orbiter and APDA-3002 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML1	0.35	X56	25	PYRO 1 ACTIVE HOOK ASSY NO. 9 +
ML1	0.35	X56	5	PYRO 1 ACTIVE HOOK ASSY NO. 9 -
ML1	0.35	X55	11	PYRO 1 ACTIVE HOOK ASSY NO. 12 -
ML1	0.35	X55	31	PYRO 1 ACTIVE HOOK ASSY NO. 12 +
ML1	0.35	X55	29	PYRO 1 ACTIVE HOOK ASSY NO. 10 +
ML1	0.35	X55	9	PYRO 1 ACTIVE HOOK ASSY NO. 10 -
ML1	0.35	X56	11	PYRO 1 ACTIVE HOOK ASSY NO. 8 -
ML1	0.35	X56	31	PYRO 1 ACTIVE HOOK ASSY NO. 8 +
ML1	0.35	X56	29	PYRO 1 ACTIVE HOOK ASSY NO. 6 +
ML1	0.35	X56	9	PYRO 1 ACTIVE HOOK ASSY NO. 6 -
ML1	0.35	X56	7	PYRO 1 ACTIVE HOOK ASSY NO. 4 -
ML1	0.35	X56	27	PYRO 1 ACTIVE HOOK ASSY NO. 4 +
ML2	0.35	X65	1	PYRO 2 ACTIVE HOOK ASSY NO. 1 +
ML2	0.35	X65	21	PYRO 2 ACTIVE HOOK ASSY NO. 1 -
ML2	0.35	X65	25	PYRO 2 ACTIVE HOOK ASSY NO. 11 -
ML2	0.35	X65	5	PYRO 2 ACTIVE HOOK ASSY NO. 11 +
ML2	0.35	X65	23	PYRO 2 ACTIVE HOOK ASSY NO. 3 -
ML2	0.35	X65	3	PYRO 2 ACTIVE HOOK ASSY NO. 3 +
ML2	0.35	X65	7	PYRO 2 ACTIVE HOOK ASSY NO. 2 +
ML2	0.35	X65	27	PYRO 2 ACTIVE HOOK ASSY NO. 2 -
ML2	0.35	X66	23	PYRO 2 ACTIVE HOOK ASSY NO. 7 -
ML2	0.35	X66	3	PYRO 2 ACTIVE HOOK ASSY NO. 7 +
ML2	0.35	X66	1	PYRO 2 ACTIVE HOOK ASSY NO. 5 +
ML2	0.35	X66	21	PYRO 2 ACTIVE HOOK ASSY NO. 5 -
ML2	0.35	X66	5	PYRO 2 ACTIVE HOOK ASSY NO. 9 +
ML2	0.35	X66	25	PYRO 2 ACTIVE HOOK ASSY NO. 9 -
ML2	0.35	X65	31	PYRO 2 ACTIVE HOOK ASSY NO. 12 -
ML2	0.35	X65	11	PYRO 2 ACTIVE HOOK ASSY NO. 12 +
ML2	0.35	X65	9	PYRO 2 ACTIVE HOOK ASSY NO. 10 +
ML2	0.35	X65	29	PYRO 2 ACTIVE HOOK ASSY NO. 10 -
ML2	0.35	X66	31	PYRO 2 ACTIVE HOOK ASSY NO. 8 -
ML2	0.35	X66	11	PYRO 2 ACTIVE HOOK ASSY NO. 8 +
ML2	0.35	X66	9	PYRO 2 ACTIVE HOOK ASSY NO. 6 +
ML2	0.35	X66	29	PYRO 2 ACTIVE HOOK ASSY NO. 6 -
ML2	0.35	X66	27	PYRO 2 ACTIVE HOOK ASSY NO. 4 -
ML2	0.35	X66	7	PYRO 2 ACTIVE HOOK ASSY NO. 4 +

Table 20-L. Electrical Interface Connections Between Orbiter and APDA-3002 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML1	0.35	X55	22	PYRO 1 PASSIVE HOOK ASSY NO. 1 +
ML1	0.35	X55	2	PYRO 1 PASSIVE HOOK ASSY NO. 1 -
ML1	0.35	X55	6	PYRO 1 PASSIVE HOOK ASSY NO. 11 -
ML1	0.35	X55	26	PYRO 1 PASSIVE HOOK ASSY NO. 11 +
ML1	0.35	X55	4	PYRO 1 PASSIVE HOOK ASSY NO. 3 -
ML1	0.35	X55	24	PYRO 1 PASSIVE HOOK ASSY NO. 3 +
ML1	0.35	X55	28	PYRO 1 PASSIVE HOOK ASSY NO. 2 +
ML1	0.35	X55	8	PYRO 1 PASSIVE HOOK ASSY NO. 2 -
ML1	0.35	X56	4	PYRO 1 PASSIVE HOOK ASSY NO. 7 -
ML1	0.35	X56	24	PYRO 1 PASSIVE HOOK ASSY NO. 7 +
ML1	0.35	X56	22	PYRO 1 PASSIVE HOOK ASSY NO. 5 +
ML1	0.35	X56	2	PYRO 1 PASSIVE HOOK ASSY NO. 5 -
ML1	0.35	X56	26	PYRO 1 PASSIVE HOOK ASSY NO. 9 +
ML1	0.35	X56	6	PYRO 1 PASSIVE HOOK ASSY NO. 9 -
ML1	0.35	X55	12	PYRO 1 PASSIVE HOOK ASSY NO. 12 -
ML1	0.35	X55	32	PYRO 1 PASSIVE HOOK ASSY NO. 12 +
ML1	0.35	X55	30	PYRO 1 PASSIVE HOOK ASSY NO. 10 +
ML1	0.35	X55	10	PYRO 1 PASSIVE HOOK ASSY NO. 10 -
ML1	0.35	X56	12	PYRO 1 PASSIVE HOOK ASSY NO. 8 -
ML1	0.35	X56	32	PYRO 1 PASSIVE HOOK ASSY NO. 8 +
ML1	0.35	X56	30	PYRO 1 PASSIVE HOOK ASSY NO. 6 +
ML1	0.35	X56	10	PYRO 1 PASSIVE HOOK ASSY NO. 6 -
ML1	0.35	X56	8	PYRO 1 PASSIVE HOOK ASSY NO. 4 -
ML1	0.35	X56	28	PYRO 1 PASSIVE HOOK ASSY NO. 4 +
ML2	0.35	X65	2	PYRO 2 PASSIVE HOOK ASSY NO. 1 +
ML2	0.35	X65	22	PYRO 2 PASSIVE HOOK ASSY NO. 1 -
ML2	0.35	X65	26	PYRO 2 PASSIVE HOOK ASSY NO. 11 -
ML2	0.35	X65	6	PYRO 2 PASSIVE HOOK ASSY NO. 11 +
ML2	0.35	X65	24	PYRO 2 PASSIVE HOOK ASSY NO. 3 -
ML2	0.35	X65	4	PYRO 2 PASSIVE HOOK ASSY NO. 3 +
ML2	0.35	X65	8	PYRO 2 PASSIVE HOOK ASSY NO. 2 +
ML2	0.35	X65	28	PYRO 2 PASSIVE HOOK ASSY NO. 2 -
ML2	0.35	X66	24	PYRO 2 PASSIVE HOOK ASSY NO. 7 -
ML2	0.35	X66	4	PYRO 2 PASSIVE HOOK ASSY NO. 7 +
ML2	0.35	X66	2	PYRO 2 PASSIVE HOOK ASSY NO. 5 +
ML2	0.35	X66	22	PYRO 2 PASSIVE HOOK ASSY NO. 5 -

Table 20-L. Electrical Interface Connections Between Orbiter and APDA-3002 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML2	0.35	X66	6	PYRO 2 PASSIVE HOOK ASSY NO. 9 +
ML2	0.35	X66	26	PYRO 2 PASSIVE HOOK ASSY NO. 9 -
ML2	0.35	X65	32	PYRO 2 PASSIVE HOOK ASSY NO. 12 -
ML2	0.35	X65	12	PYRO 2 PASSIVE HOOK ASSY NO. 12 +
ML2	0.35	X65	10	PYRO 2 PASSIVE HOOK ASSY NO. 10 +
ML2	0.35	X65	30	PYRO 2 PASSIVE HOOK ASSY NO. 10 -
ML2	0.35	X66	32	PYRO 2 PASSIVE HOOK ASSY NO. 8 -
ML2	0.35	X66	12	PYRO 2 PASSIVE HOOK ASSY NO. 8 +
ML2	0.35	X66	10	PYRO 2 PASSIVE HOOK ASSY NO. 6 +
ML2	0.35	X66	30	PYRO 2 PASSIVE HOOK ASSY NO. 6 -
ML2	0.35	X66	28	PYRO 2 PASSIVE HOOK ASSY NO. 4 -
ML2	0.35	X66	8	PYRO 2 PASSIVE HOOK ASSY NO. 4 +
HO1	0.35	X68	3	DOCK MECH HEATER (H1-1 +)
HO1	0.35	X68	48	DOCK MECH HEATER (H1-1 -)
HO2	0.35	X68	1	DOCK MECH HEATER (H1-2 +)
HO2	0.35	X68	50	DOCK MECH HEATER (H1-2 -)
HO3	0.35	X68	9	DOCK MECH HEATER (H1-3 +)
HO3	0.35	X68	41	DOCK MECH HEATER (H1-3 -)
HO3	0.35	X68	7	DOCK MECH HEATER (H2-1 +)
HO3	0.35	X68	44	DOCK MECH HEATER (H2-1 -)
HO1	0.35	X68	5	DOCK MECH HEATER (H2-2 +)
HO1	0.35	X68	46	DOCK MECH HEATER (H2-2 -)
HO2	0.35	X68	17	DOCK MECH HEATER (H2-3 +)
HO2	0.35	X68	34	DOCK MECH HEATER (H2-3 -)
HO3	0.35	X68	13	DOCK MECH HEATER (H3-1 +)
HO3	0.35	X68	38	DOCK MECH HEATER (H3-1 -)
HO2	0.35	X68	11	DOCK MECH HEATER (H3-2 +)
HO2	0.35	X68	40	DOCK MECH HEATER (H3-2 -)
HO1	0.35	X68	24	DOCK MECH HEATER (H3-3 +)
HO1	0.35	X68	26	DOCK MECH HEATER (H3-3 -)
HO1	0.2	X74	16	RING ALIGNED
HO2	0.2	X74	24	RING ALIGNED
HO1	0.2	X74	25	INITIAL CONTACT
HO2	0.2	X74	12	INITIAL CONTACT

Table 20-L. Electrical Interface Connections Between Orbiter and APDA-3002 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO1	0.35	X74	32	CAPTURE (SHORT)
HO2	0.35	X74	47	CAPTURE (SHORT)
HO1	0.2	X74	36	CAPTURE (LONG)
HO2	0.2	X74	13	CAPTURE (LONG)
HO1	0.35	X75	10	PWR SUP TO RING MTR (M4)
HO1	0.35	X75	4	PWR SUP TO RING MTR (M4)
HO1	0.35	X75	41	PWR SUP TO RING MTR (M4)
HO1	0.35	X75	50	PWR SUP TO RING MTR (M4)
HO2	0.35	X75	7	PWR SUP TO RING MTR (M5)
HO2	0.35	X75	8	PWR SUP TO RING MTR (M5)
HO2	0.35	X75	47	PWR SUP TO RING MTR (M5)
HO2	0.35	X75	48	PWR SUP TO RING MTR (M5)
HO1	0.2	X75	35	RING FINAL POSITION
HO2	0.35	X75	43	RING FINAL POSITION
HO3	0.35	X75	22	CONTROL SENSOR RETURN
HO1	0.2	X75	24	CONTROL SENSOR RETURN
HO2	0.2	X75	25	CONTROL SENSOR RETURN
HO1	0.35	X69	34	RING INITIAL POSITION
HO2	0.35	X69	26	RING INITIAL POSITION
HO1	0.35	X69	27	RING FORWARD POSITION
HO2	0.35	X69	28	RING FORWARD POSITION
HO1	0.35	X69	12	CAPTURE LATCHES OPEN IND
HO2	0.35	X69	11	CAPTURE LATCHES OPEN IND
HO1	0.35	X69	4	CAPTURE LATCHES CLOS IND
HO2	0.35	X69	8	CAPTURE LATCHES CLOS IND
HO1	0.2	X69	35	CAPTURE LATCHES IND RTN
HO2	0.2	X69	36	CAPTURE LATCHES IND RTN
HO2	0.35	X72	35	PWR SUP TO CAP LAT MTR (M1) +
HO1	0.35	X72	36	PWR SUP TO CAP LAT MTR (M1) +
HO1	0.2	X72	2	PWR SUP TO CAP LAT MTR (M1) -
HO1	0.2	X72	4	PWR SUP TO CAP LAT MTR (M1) -
HO2	0.35	X72	11	CAPTURE LATCH NO. 1 CLOS
HO1	0.35	X72	25	CAPTURE LATCH NO. 1 CLOS

Table 20-L. Electrical Interface Connections Between Orbiter and APDA-3002 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO2	0.35	X72	32	CAPTURE LATCH NO. 1 OPEN
HO1	0.35	X72	27	CAPTURE LATCH NO. 1 OPEN
HO2	0.35	X72	43	PWR SUP TO CAP LAT MTR (M2) +
HO2	0.35	X72	42	PWR SUP TO CAP LAT MTR (M2) +
HO3	0.2	X72	5	PWR SUP TO CAP LAT MTR (M2) -
HO2	0.2	X72	1	PWR SUP TO CAP LAT MTR (M2) -
HO3	0.35	X72	24	CAPTURE LATCH NO. 2 CLOS
HO2	0.35	X72	19	CAPTURE LATCH NO. 2 CLOS
HO3	0.35	X72	26	CAPTURE LATCH NO. 2 OPEN
HO2	0.35	X72	40	CAPTURE LATCH NO. 2 OPEN
HO3	0.35	X72	48	PWR SUP TO CAP LAT MTR (M3) +
HO3	0.35	X72	47	PWR SUP TO CAP LAT MTR (M3) +
HO1	0.2	X72	9	PWR SUP TO CAP LAT MTR (M3) -
HO3	0.2	X72	10	PWR SUP TO CAP LAT MTR (M3) -
HO1	0.35	X72	18	CAPTURE LATCH NO. 3 CLOS
HO3	0.35	X72	33	CAPTURE LATCH NO. 3 CLOS
HO1	0.35	X72	39	CAPTURE LATCH NO. 3 OPEN
HO3	0.35	X72	34	CAPTURE LATCH NO. 3 OPEN
HO1	0.35	X76	4	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76	8	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76	1	PWR SUP TO M6 GROUP 1 HOOKS **
HO1	0.35	X76	5	PWR SUP TO M6 GROUP 1 HOOKS **
HO2	0.35	X76	9	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76	10	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76	11	PWR SUP TO M7 GROUP 1 HOOKS **
HO2	0.35	X76	12	PWR SUP TO M7 GROUP 1 HOOKS **
HO1	0.35	X76	6	GROUP 1 HOOKS CLOSED **
HO2	0.35	X76	20	GROUP 1 HOOKS CLOSED **
HO1	0.35	X76	15	GROUP 1 HOOKS OPEN **
HO2	0.35	X76	22	GROUP 1 HOOKS OPEN **
HO2	0.2	X76	24	GROUP 1 HOOKS CLOSED RETURN **
HO1	0.2	X76	33	GROUP 1 HOOKS CLOSED RETURN **
HO1	0.2	X76	32	GROUP 1 HOOKS OPEN RETURN **
HO2	0.2	X76	30	GROUP 1 HOOKS OPEN RETURN **

Table 20-L. Electrical Interface Connections Between Orbiter and APDA-3002 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO1	0.35	X70	4	FIXER 1 (+)
HO1	0.35	X70	2	FIXER 1 (+)
HO1	0.35	X70	28	FIXER 1 (-)
HO1	0.35	X70	31	FIXER 1 (-)
HO1	0.35	X70	46	FIXER 1 (-)
HO1	0.35	X70	45	FIXER 1 (-)
HO2	0.35	X70	10	FIXER 2 (+)
HO2	0.35	X70	9	FIXER 2 (+)
HO2	0.35	X70	27	FIXER 2 (-)
HO2	0.35	X70	26	FIXER 2 (-)
HO2	0.35	X70	50	FIXER 2 (-)
HO2	0.35	X70	49	FIXER 2 (-)
HO3	0.35	X70	8	FIXER 3 (+)
HO3	0.35	X70	14	FIXER 3 (+)
HO3	0.35	X70	25	FIXER 3 (-)
HO3	0.35	X70	24	FIXER 3 (-)
HO3	0.35	X70	44	FIXER 3 (-)
HO3	0.35	X70	43	FIXER 3 (-)
HO	0.35	X70	13	FIXER 4 (+)
HO	0.35	X70	20	FIXER 4 (+)
HO	0.35	X70	17	FIXER 4 (-)
HO	0.35	X70	16	FIXER 4 (-)
HO	0.35	X70	48	FIXER 4 (-)
HO	0.35	X70	47	FIXER 4 (-)
HO	0.35	X70	19	FIXER 5 (+)
HO	0.35	X70	18	FIXER 5 (+)
HO	0.35	X70	33	FIXER 5 (-)
HO	0.35	X70	32	FIXER 5 (-)
HO	0.35	X70	42	FIXER 5 (-)
HO	0.35	X70	41	FIXER 5 (-)
HO1	0.2	X67	4	HI-ENERGY DAMPER NO. 1 (+)
HO1	0.2	X67	3	HI-ENERGY DAMPER NO. 1 (+)
HO1	0.2	X67	39	HI-ENERGY DAMPER NO. 1 (-)
HO1	0.2	X67	40	HI-ENERGY DAMPER NO. 1 (-)
HO2	0.2	X67	17	HI-ENERGY DAMPER NO. 2 (+)
HO2	0.2	X67	16	HI-ENERGY DAMPER NO. 2 (+)

Table 20-L. Electrical Interface Connections Between Orbiter and APDA-3002 (continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO2	0.2	X67	50	HI-ENERGY DAMPER NO. 2 (-)
HO2	0.2	X67	49	HI-ENERGY DAMPER NO. 2 (-)
HO3	0.2	X67	6	HI-ENERGY DAMPER NO. 3 (+)
HO3	0.2	X67	5	HI-ENERGY DAMPER NO. 3 (+)
HO3	0.2	X67	35	HI-ENERGY DAMPER NO. 3 (-)
HO3	0.2	X67	34	HI-ENERGY DAMPER NO. 3 (-)
HO2	0.35	X76	41	PWR SUP TO M9 GROUP 2 HOOKS **
HO2	0.35	X76	42	PWR SUP TO M9 GROUP 2 HOOKS **
HO2	0.35	X76	39	PWR SUP TO M9 GROUP 2 HOOKS **
HO2	0.35	X76	40	PWR SUP TO M9 GROUP 2 HOOKS **
HO1	0.35	X76	47	PWR SUP TO M8 GROUP 2 HOOKS **
HO1	0.35	X76	48	PWR SUP TO M8 GROUP 2 HOOKS **
HO1	0.35	X76	50	PWR SUP TO M8 GROUP 2 HOOKS **
HO1	0.35	X76	46	PWR SUP TO M8 GROUP 2 HOOKS **
HO1	0.35	X76	19	GROUP 2 HOOKS CLOSED **
HO2	0.35	X76	28	GROUP 2 HOOKS CLOSED **
HO1	0.35	X76	18	GROUP 2 HOOKS OPEN **
HO2	0.35	X76	27	GROUP 2 HOOKS OPEN **
HO1	0.35	X77	1	GROUP 1 HOOKS IN-BETWEEN **
HO2	0.35	X77	5	GROUP 1 HOOKS IN-BETWEEN **
HO1	0.35	X77	38	GROUP 2 HOOKS IN-BETWEEN **
HO2	0.35	X77	37	GROUP 2 HOOKS IN-BETWEEN **
HO1	0.2	X77	20	HOOKS IN-BETWEEN RETURN
HO2	0.2	X77	28	HOOKS IN-BETWEEN RETURN
HO2	0.2	X77	14	HOOKS IN-BETWEEN RETURN
HO1	0.2	X77	6	HOOKS IN-BETWEEN RETURN
HO2	0.2	X76	36	CONTROL SENSOR RETURN
HO1	0.2	X76	45	CONTROL SENSOR RETURN
HO2	0.2	X76	43	CONTROL SENSOR RETURN
HO2	0.2	X76	49	CONTROL SENSOR RETURN
HO1	0.2	X77	2	CONTROL SENSOR RETURN
HO2	0.2	X77	3	CONTROL SENSOR RETURN
HO3	0.2	X77	8	CONTROL SENSOR RETURN
HO1	0.2	X77	45	READY TO HOOK
HO2	0.2	X77	48	READY TO HOOK
HO1	0.35	X77	49	UNDOCK COMPLETE

Table 20-L. Electrical Interface Connections Between Orbiter and APDA-3002 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO2	0.35	X77	50	UNDOCK COMPLETE
HO2	0.35	X77	32	INTERFACE SEALED
HO3	0.35	X77	39	INTERFACE SEALED
HO1	0.35	X77	24	INTERFACE SEALED
HO1	0.2	X77	18	CONTROL SENSOR RETURN
HO1	0.2	X77	26	CONTROL SENSOR RETURN
HO2	0.2	X77	34	CONTROL SENSOR RETURN
ML	0.35	X71	28	BALL SCREW NO. 1 LIN ADV (COM)
ML	0.35	X71	23	BALL SCREW NO. 1 LIN ADV (SIG)
ML	0.35	X71	40	BALL SCREW NO. 1 LIN ADV (EXC)
ML	0.35	X71	27	BALL SCREW NO. 2 LIN ADV (COM)
ML	0.35	X71	24	BALL SCREW NO. 2 LIN ADV (SIG)
ML	0.35	X71	39	BALL SCREW NO. 2 LIN ADV (EXC)
ML	0.35	X71	26	BALL SCREW NO. 3 LIN ADV (COM)
ML	0.35	X71	25	BALL SCREW NO. 3 LIN ADV (SIG)
ML	0.35	X71	45	BALL SCREW NO. 3 LIN ADV (EXC)
ML	0.35	X71	35	BALL SCREW NO. 1 MISALIGN (COM)
ML	0.35	X71	18	BALL SCREW NO. 1 MISALIGN (SIG)
ML	0.35	X71	50	BALL SCREW NO. 1 MISALIGN (EXC)
ML	0.35	X71	36	BALL SCREW NO. 2 MISALIGN (COM)
ML	0.35	X71	19	BALL SCREW NO. 2 MISALIGN (SIG)
ML	0.35	X71	49	BALL SCREW NO. 2 MISALIGN (EXC)
ML	0.35	X71	34	BALL SCREW NO. 3 MISALIGN (COM)
ML	0.35	X71	20	BALL SCREW NO. 3 MISALIGN (SIG)
ML	0.35	X71	48	BALL SCREW NO. 3 MISALIGN (EXC)
ML	0.35	X71	13	LATCHES MANUAL REL RTN
ML	0.35	X71	17	LATCHES MANUAL RELEASE
ML2	0.35	X71	10	RING FINAL POSITION
ML2	0.35	X71	31	RING FINAL POSITION RTN
ML	0.35	X73	44	CAPTURE LATCH OPEN
ML	0.35	X73	10	CAPTURE LATCH OPEN RTN
ML	0.35	X73	43	CAPTURE LATCHES CLOSED
ML	0.35	X73	5	CAPTURE LATCHES CLOS RTN
ML	0.35	X73	7	RING INITIAL POSITION RTN
ML	0.35	X73	47	RING INITIAL POSITION
ML2	0.35	X73	11	RING FORWARD POSITION RTN

Table 20-L. Electrical Interface Connections Between Orbiter and APDA-3002 (continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML2	0.35	X73	48	RING FORWARD POSITION
ML	0.35	X73	21	LWR BALL SOCKET NO 1 TEMP (COM)
ML	0.35	X73	20	LWR BALL SOCKET NO 1 TEMP (SIG)
ML	0.35	X73	18	LWR BALL SOCKET NO 1 TEMP (EXC)
ML	0.35	X73	28	LWR BALL SOCKET NO 2 TEMP (COM)
ML	0.35	X73	27	LWR BALL SOCKET NO 2 TEMP (SIG)
ML	0.35	X73	39	LWR BALL SOCKET NO 2 TEMP (EXC)
ML	0.35	X73	37	LWR BALL SOCKET NO 3 TEMP (COM)
ML	0.35	X73	36	LWR BALL SOCKET NO 3 TEMP (SIG)
ML	0.35	X73	34	LWR BALL SOCKET NO 3 TEMP (EXC)
ML	0.35	X73	17	CAPTURE LATCH NO. 1 TEMP (COM)
ML	0.35	X73	16	CAPTURE LATCH NO. 1 TEMP (SIG)
ML	0.35	X73	14	CAPTURE LATCH NO. 1 TEMP (EXC)
ML	0.35	X73	25	CAPTURE LATCH NO. 2 TEMP (COM)
ML	0.35	X73	24	CAPTURE LATCH NO. 2 TEMP (SIG)
ML	0.35	X73	22	CAPTURE LATCH NO. 2 TEMP (EXC)
ML	0.35	X73	33	CAPTURE LATCH NO. 3 TEMP (COM)
ML	0.35	X73	32	CAPTURE LATCH NO. 3 TEMP (SIG)
ML	0.35	X73	30	CAPTURE LATCH NO. 3 TEMP (EXC)
ML	0.35	X73	29	DOCKING RING DRIVE TEMP (COM)
ML	0.35	X73	40	DOCKING RING DRIVE TEMP (SIG)
ML	0.35	X73	45	DOCKING RING DRIVE TEMP (EXC)
ML	0.35	X73	6	SHIELD
ML1	0.35	X79	22	UNDOCK COMPLETE
ML1	0.35	X79	23	UNDOCK COMPLETE RTN
ML1	0.35	X79	3	READY TO HOOK
ML1	0.35	X79	9	READY TO HOOK RTN
ML1	0.35	X79	26	GROUP 1 HOOKS CLOSED POS **
ML1	0.35	X79	16	GROUP 1 HOOKS CLOS POS RTN **
ML2	0.35	X79	25	GROUP 2 HOOKS OPEN POSITION **
ML2	0.35	X79	35	GROUP 2 HOOKS OPEN POS RTN **
ML1	0.35	X79	24	GROUP 1 HOOKS OPEN POSITION **
ML1	0.35	X79	34	GROUP 1 HOOKS OPEN POS RTN **
ML2	0.35	X79	17	GROUP 2 HOOKS CLOSED POS **
ML2	0.35	X79	27	GROUP 2 HOOKS CLOS POS RTN **
ML	0.35	X79	31	GROUP 1 HOOKS LINEAR ADV (EXC) **
ML	0.35	X79	40	GROUP 1 HOOKS LINEAR ADV (SIG) **

Table 20-L. Electrical Interface Connections Between Orbiter and APDA-3002 (concluded)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML	0.35	X79	50	GROUP 1 HOOKS LINEAR ADV (COM) **
ML	0.35	X79	30	GROUP 2 HOOKS LINEAR ADV (EXC) **
ML	0.35	X79	46	GROUP 2 HOOKS LINEAR ADV (SIG) **
ML	0.35	X79	39	GROUP 2 HOOKS LINEAR ADV (COM) **
ML	0.35	X78	1	DOCKING I/F TEMP NO. 1 (COM)
ML	0.35	X78	2	DOCKING I/F TEMP NO. 1 (SIG)
ML	0.35	X78	4	DOCKING I/F TEMP NO. 1 (EXC)
ML	0.35	X78	5	DOCKING I/F TEMP NO. 2 (COM)
ML	0.35	X78	6	DOCKING I/F TEMP NO. 2 (SIG)
ML	0.35	X78	8	DOCKING I/F TEMP NO. 2 (EXC)
ML	0.35	X78	9	DOCKING I/F TEMP NO. 3 (COM)
ML	0.35	X78	10	DOCKING I/F TEMP NO. 3 (SIG)
ML	0.35	X78	12	DOCKING I/F TEMP NO. 3 (EXC)
ML	0.35	X78	30	HOOKS DRIVE TEMP NO. 1 (COM)
ML	0.35	X78	31	HOOKS DRIVE TEMP NO. 1 (SIG)
ML	0.35	X78	33	HOOKS DRIVE TEMP NO. 1 (EXC)
ML	0.35	X78	37	HOOKS DRIVE TEMP NO. 2 (COM)
ML	0.35	X78	38	HOOKS DRIVE TEMP NO. 2 (SIG)
ML	0.35	X78	40	HOOKS DRIVE TEMP NO. 2 (EXC)
ML	0.35	X78	34	SHD (ALL APDS TEMP MEAS)

** NOTE: GROUP 1 HOOKS CONSIST OF HOOKS 1, 3, 5, 7, 9, & 11.

GROUP 2 HOOKS CONSIST OF HOOKS 2, 4, 6, 8, 10, & 12.

GROUP 1 & 2 HOOKS ACTUATOR ASSEMBLIES ATTACHED WITH HOOKS 7 & 6, RESPECTIVELY.

Appendix III

30. DOCKING SYSTEM CONTROL UNIT

30.1 SCOPE

This appendix defines the detailed requirements for the Docking System Control Unit (DSCU).

30.2 APPLICABLE DOCUMENTS

N/A

30.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

30.3.1 Item Definition

The Docking System Control Unit shall consist of signal conditioning, power protection, switching functions, to provide controls and commands to the APDS boxes.

30.3.1.1 Item Diagram

A functional block diagram of the Docking System Control Unit is illustrated in Figure 30-A.

30.3.1.2 Interface Definition

The functional and physical interface requirements between the Docking System Control Unit, the other APDS boxes, and the Orbiter Avionics are defined in the following paragraphs.

30.3.1.2.1 Mechanical Characteristics.

30.3.1.2.1.1 Mounting

Provisions for mounting the Docking System Control Unit shall be as shown in Figure 30-B.

30.3.1.2.1.2 Connectors

The Docking System Control Unit shall have connectors located as shown in Figure 30-B, with pin assignments as shown in Table 30-C.

30.3.1.3 Item Identification

The Docking System Control Unit shall be identified as follows:

Nomenclature	Buyer Control No.	Seller Part No.	Traceability Classification	Maintenance Level
DSCU	MC621-0087- 2002	33U.5212. 005-02	Ts	LRU

30.3.2.1.2.4 Deletion of Automatic Drive Activation Capability

As the capability to automatically activate the docking mechanism drive is to be deleted, the DSCU shall be rewired so as to remove time relays KT61-KT63, KT25-KT27, KT31-KT33, and KT25-KT27. Also to be removed are relays E208, E28, E30-1, E180, E130, E26, E27, and E29. Drive actuation commands shall be wired for manual delivery from the DCP.

30.3.2.1.3 Signal Characteristics

Characteristics of signals that are unique to the Docking System Control Unit are as follows:

TBS

30.3.2.2 Physical Characteristics.

30.3.2.2.1 Envelope

The Docking System Control Unit shall have an envelope as defined in Figure 30-B.

30.3.2.2.2 Weight

The weight of the Docking System Control Unit shall not exceed 24.3 lbs.

30.3.2.3 Reliability

The requirements of 3.2.3 of the basic specification apply.

30.3.2.4 Environment

The requirements of 3.2.5.1.2 and 3.2.5.2.2 of the basic specification apply.

30.3.2.5 Transportability

The requirements in 3.2.6 of the basic specification apply.

30.3.3 Design and Construction

The requirements of 3.3 of the basic specification apply, except the following paragraph shall take precedence over 3.3.3.2.1.

30.3.3.1 Power Consumption

Power consumed by the DSCU shall not exceed 116 watts.

30.4 QUALITY ASSURANCE PROVISIONS.

30.4.1 General Requirements

The requirements of 4.1 of the basic specification apply.

30.4.2 Quality Conformance

30.4.2.1 Development

The requirements in 4.2.1 of the basic specification apply.

30.4.2.2 Acceptance

Acceptance tests and inspections shall be performed on the DSCU, to be employed on the delivered units to the Buyer. The minimum number of tests and inspections, and the sequence thereof shall be as specified in Table 30-A. The Seller shall perform any other test deemed necessary , subject to approval of the Buyer.

Table 0-A. Acceptance Requirements

Paragraph listed in Inspection & Test	Recommended Sequence
Examination of Product	30.4.2.2.1
Functional & Performance Test	30.4.2.2.2
Insulation Resistance Test	30.4.2.2.2.1
Dielectric Strength Test	30.4.2.2.2.2
Acceptance Vibration Test	30.4.2.2.3
Acceptance Thermal Test	30.4.2.2.4
Acceptance Humidity Test	30.4.2.2.5
Functional & Performance Recheck	30.4.2.2.2

30.4.2.2.1 Examination of Product

The requirements in 4.2.2.1 of the basic specification apply.

30.4.2.2.2 Functional and Performance Tests

The requirements in 4.2.2.2 of the basic specification apply.

30.4.2.2.2.1 Insulation Resistance Test

The requirements in 4.2.2.2.1 of the basic specification apply.

30.4.2.2.2.2 Dielectric Strength Test

The requirements in 4.2.2.2.2 of the basic specification apply.

30.4.2.2.3 Acceptance Vibration Test (AVT)

The requirements in 4.2.2.3 of the basic specification apply.

30.4.2.2.4 Acceptance Thermal Test (ATT)

The requirements of 4.2.2.4 of the basic specification apply, except that the DSCU shall be exposed to the maximum and minimum operating temperatures for a duration of not less than 3 hours. Rate of change shall not exceed 240 °F (133.3 °C) per hour, nor be less than 60 °F (33.3 °C) per hour. The thermal exposure may be performed by cycling from one extreme to the other, or by separate tests with a performance test between exposures.

30.4.2.2.5 Acceptance Humidity Test

The requirements in 4.2.2.5 of the basic specification apply.

30.4.2.3 Assessment

The requirements in 4.2.3 of the basic specification apply.

30.4.2.3.1 Reliability

The requirements in 4.2.3.1 of the basic specification apply.

30.4.2.3.2 Materials and Processes

The requirements in 4.2.3.2 of the basic specification apply.

30.4.2.3.3 Parts Standardization

The requirements in 4.2.3.3 of the basic specification apply.

30.4.2.3.4 Electrical Design Requirements

The requirements in 4.2.3.4 of the basic specification apply.

30.4.2.3.5 Interchangeability

The requirements in 4.2.3.5 of the basic specification apply.

30.4.2.3.6 Human Performance/Human Engineering

The requirements in 4.2.3.6 of the basic specification apply.

30.4.2.3.7 Safety

The requirements in 4.2.3.7 of the basic specification apply.

30.4.2.3.8 Identification and Marking

The requirements in 4.2.3.8 of the basic specification apply.

30.4.2.4 Certification

The requirements in 4.2.4 of the basic specification apply.

30.4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements specified in the performance and design verification matrix of Section 4, Table V shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in Table 30-B.

Table 0-B. Qualification Requirements

Test sequence	Paragraph
Acceptance Test	30.4.2.2
Performance Test	30.4.2.4.1.2
Transportation Test	30.4.2.4.1.11
Power Test	30.4.2.4.1.7
Vibration	30.4.2.4.1.4
Shock.	30.4.2.4.1.6
Acceleration	30.4.2.4.1.5
Thermal Vacuum Test	30.4.2.4.1.10
Qualification Humidity Test	30.4.2.4.1.3
* EMC Test	30.4.2.4.1.9
Life Test	30.4.2.4.1.12
Final Performance Test	30.4.2.4.1.2

* Test and analysis will be conducted and documented by Buyer.

30.4.2.4.1.1 Test Hardware

Qualification test hardware shall be of the same configuration as flight hardware.

30.4.2.4.1.2 Performance Requirements

The requirements in 4.2.4.1.2 of the basic specification apply.

30.4.2.4.1.3 Qualification Humidity Test

The requirements in 4.2.4.1.3 of the basic specification apply.

30.4.2.4.1.4 Vibration.

30.4.2.4.1.4.1 Qualification - Acceptance Vibration Test (QAVT)

The requirements in 4.2.4.1.4.1 of the basic specification apply.

30.4.2.4.1.5 Acceleration

The requirements in 4.2.4.1.5 of the basic specification apply.

30.4.2.4.1.6 Shock

The requirements in 4.2.4.1.6 of the basic specification apply.

30.4.2.4.1.7 Power Test

The requirements in 4.2.4.1.7 of the basic specification apply. Power tests may be verified as part of the Functional/Performance tests.

30.4.2.4.1.8 Lightning

The requirements in 4.2.4.2.12 of the basic specification apply.

30.4.2.4.1.9 Electromagnetic Compatibility Tests

The requirements in 4.2.4.1.9 of the basic specification apply.

30.4.2.4.1.10 Thermal Vacuum Test

The requirements in 4.2.4.1.10 of the basic specification apply except that the first four cycles are performed at ambient pressure and circuit monitoring may be limited due to operating life of DSCU.

30.4.2.4.1.11 Transportation Test

The requirements in 4.2.4.1.11 of the basic specification apply.

30.4.2.4.1.12 Operating Life Test

The requirements in 4.2.4.1.12 of the basic specification apply.

30.4.2.4.2 Certification By Analysis

The requirements in 4.2.4.2 of the basic specification apply.

30.4.2.4.2.1 Storage/Operating Life

The requirements in 4.2.4.2.1 of the basic specification apply.

30.4.2.4.2.2 Physical Characteristics

The requirements in 4.2.4.2.2 of the basic specification apply.

30.4.2.4.2.3 Reliability

The requirements in 4.2.4.2.3 of the basic specification apply.

30.4.2.4.2.4 Salt Fog

The requirements in 4.2.4.2.4 of the basic specification apply.

30.4.2.4.2.5 Ozone

The requirements in 4.2.4.2.5 of the basic specification apply.

30.4.2.4.2.6 Fungus

The requirements in 4.2.4.2.6 of the basic specification apply.

30.4.2.4.2.7 Materials and Processes

The requirements in 4.2.4.2.7 of the basic specification apply.

30.4.2.4.2.8 Electromagnetic Compatibility

The requirements in 4.2.4.2.8 of the basic specification apply.

30.4.2.4.2.9 Electrical Design Requirements

The requirements in 4.2.4.2.9 of the basic specification apply.

30.4.2.4.2.10 Safety

The requirements in 4.2.4.2.10 of the basic specification apply.

30.4.2.4.2.11 Sand and Dust

The requirements in 4.2.4.2.11 of the basic specification apply.

30.4.2.4.2.12 Certification by Other Test Data

The requirements in 4.2.4.2.12 of the basic specification apply.

30.4.2.5 Verification Requirements Matrices

The requirements in 4.2.5 of the basic specification apply.

30.5 PREPARATION FOR DELIVERY

The requirements in Section 5 of the basic specification apply.

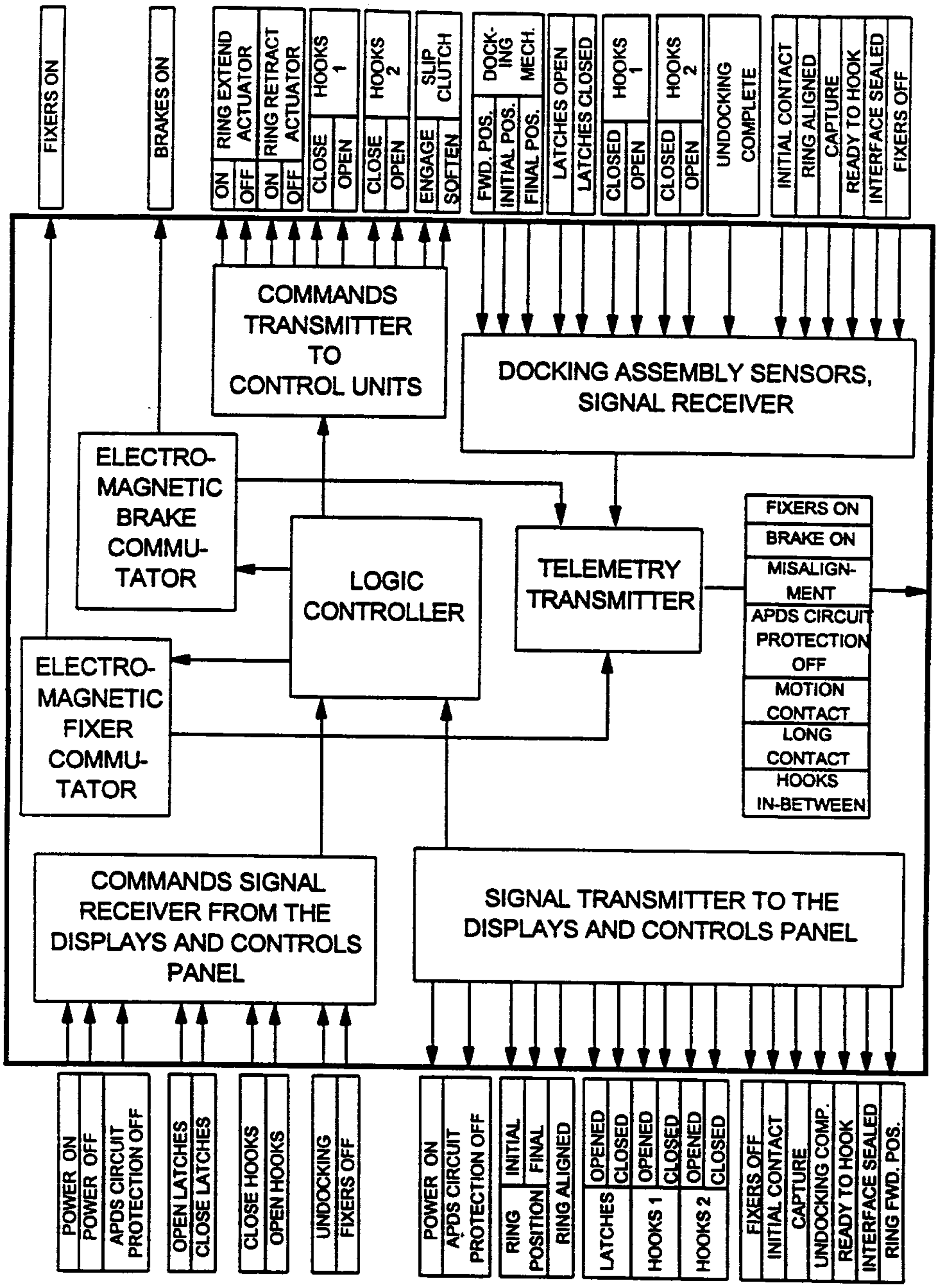


Figure 0-A. A functional block diagram of the DSCU

ITEM LIST

RSC-E IDENTIFICATION	REFERENCE DESIGNATOR	IDENTIFICATION NUMBER	NOMENCLATURE OR DESCRIPTION
33Y 5212 005	45V53A2A2	MC621-0087-2002	DOCKING SYS CNTRL UNIT (DSCU)

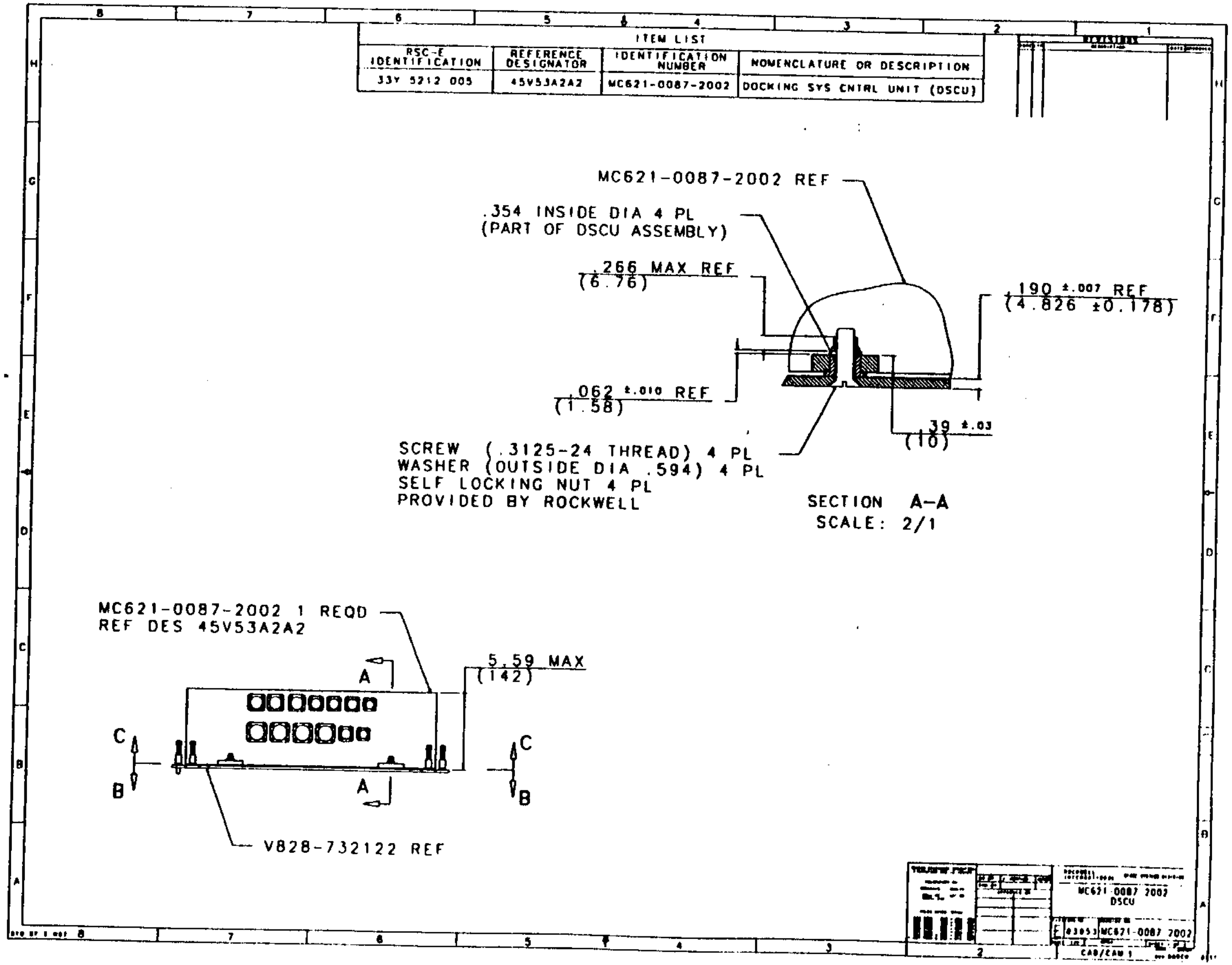


Figure 0-B. DSCU Mounting and Connectors Location Diagram (1 of 2)

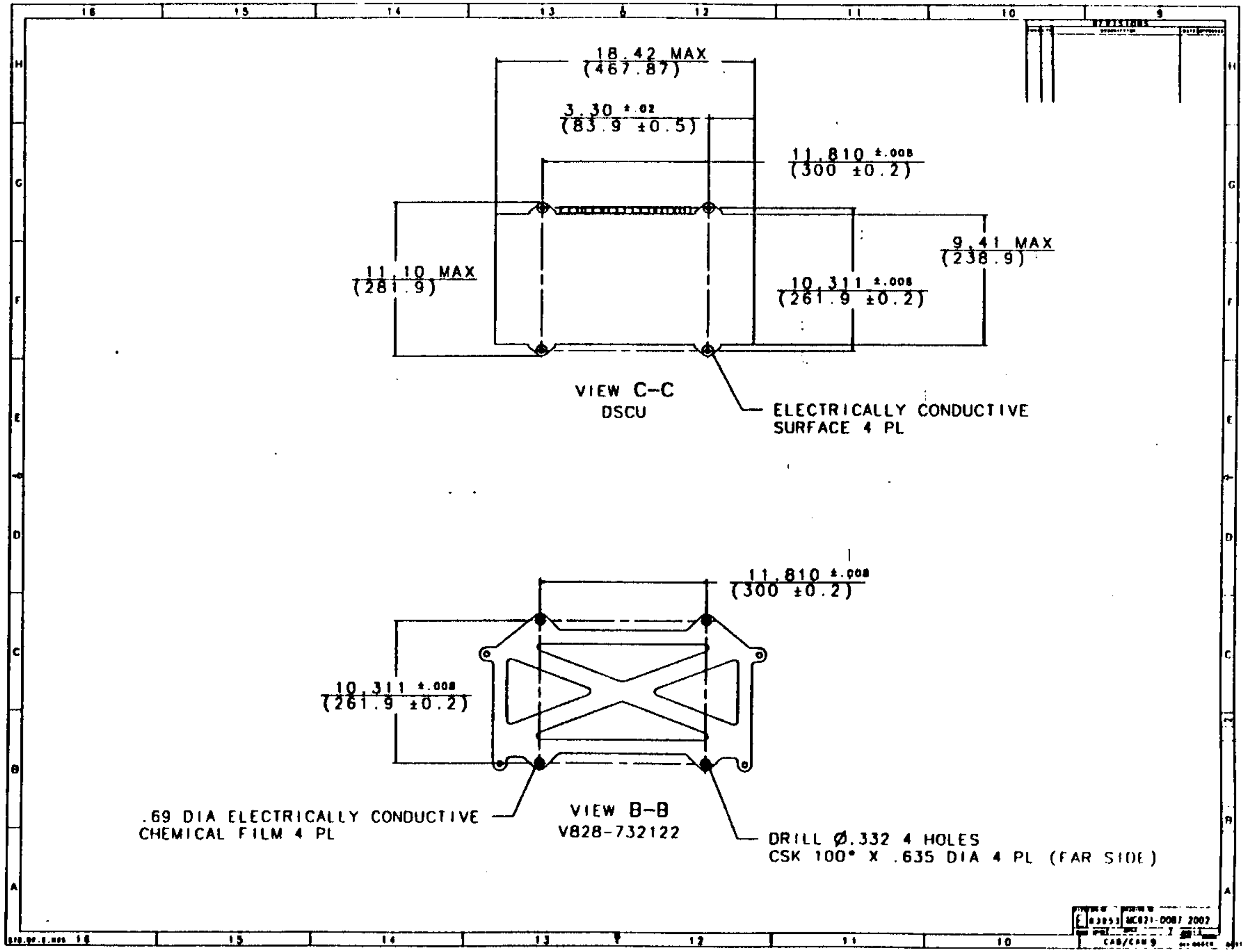


Figure 30-B. DSCU Mounting and Connectors Location Diagram (2 of 2)

Table 0-C. DSCU Pin Assignments

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DSCU	X30	1	OPEN LATCHES CMD	A/L FL
DSCU	X30	2	OPEN LATCHES CMD	A/L FL
DSCU	X30	3	OPEN LATCHES CMD	A/L FL
DSCU	X30	4	CLOSE LATCHES CMD	A/L FL
DSCU	X30	5	CLOSE LATCHES CMD	A/L FL
DSCU	X30	6	CLOSE LATCHES CMD	A/L FL
DSCU	X30	7	OPEN HOOKS CMD	A/L FL
DSCU	X30	8	OPEN HOOKS CMD	A/L FL
DSCU	X30	9	OPEN HOOKS CMD	A/L FL
DSCU	X30	10	CLOSE HOOKS CMD	A/L FL
DSCU	X30	11	CLOSE HOOKS CMD	A/L FL
DSCU	X30	12	CLOSE HOOKS CMD	A/L FL
DSCU	X30	13	FIXERS OFF CMD	A/L FL
DSCU	X30	14	FIXERS OFF CMD	A/L FL
DSCU	X30	15	FIXERS OFF CMD	A/L FL
DSCU	X30	16	OPEN HOOKS CMD	A/L FL
DSCU	X30	17	OPEN HOOKS CMD	A/L FL
DSCU	X30	18	OPEN HOOKS CMD	A/L FL
DSCU	X30	19	CLOSE HOOKS CMD	A/L FL
DSCU	X30	20	CLOSE HOOKS CMD	A/L FL
DSCU	X30	23	CLOSE HOOKS CMD	A/L FL
DSCU	X30	24	POWER ON CMD	A/L FL
DSCU	X30	25	POWER ON CMD	A/L FL
DSCU	X30	26	POWER ON CMD	A/L FL
DSCU	X30	27	RING IN CMD	A/L FL
DSCU	X30	31	RING OUT CMD	A/L FL
DSCU	X30	32	RING OUT CMD	A/L FL
DSCU	X30	33	RING OUT CMD	A/L FL
DSCU	X30	34	RING IN CMD	A/L FL
DSCU	X30	35	RING IN CMD	A/L FL
DSCU	X30	38	POWER OFF CMD	A/L FL
DSCU	X30	39	POWER OFF CMD	A/L FL
DSCU	X30	40	POWER OFF CMD	A/L FL
DSCU	X30	47	DSCU: KA1 DC RTN	A/L FL
DSCU	X30	48	DSCU: Kb1 DC RTN	A/L FL
DSCU	X30	49	DSCU: KB1 DC RTN	A/L FL
DSCU	X31	1	DSCU: KA3 DC RTN	A/L FL
DSCU	X31	2	DSCU: Kb3 DC RTN	A/L FL
DSCU	X31	3	DSCU: KB3 DC RTN	A/L FL
DSCU	X31	7	CAPTURE IND	A/L FL
DSCU	X31	8	CAPTURE IND	A/L FL
DSCU	X31	9	CAPTURE IND	A/L FL
DSCU	X31	34	APDS CIRC PROT OFF CMD	A/L FL
DSCU	X31	35	APDS CIRC PROT OFF CMD	A/L FL
DSCU	X31	36	APDS CIRC PROT OFF CMD	A/L FL
DSCU	X31	38	UNDOCKING CMD	A/L FL
DSCU	X31	39	UNDOCKING CMD	A/L FL
DSCU	X31	40	UNDOCKING CMD	A/L FL
DSCU	X31	47	APDS C.P. OFF/UNDCK CMD RTN	A/L FL
DSCU	X31	48	APDS C.P. OFF/UNDCK CMD RTN	A/L FL

Table 30-C. DSCU Pin Assignments (continued)				
PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DSCU	X31	49	APDS C.P. OFF/UNDCK CMD RTN	A/L FL
DSCU	X32	1	DSCU: CA1 DC RTN	A/L FL
DSCU	X32	2	DSCU: Cb1 DC RTN	A/L FL
DSCU	X32	3	DSCU: CB1 DC RTN	A/L FL
DSCU	X32	4	RING INITIAL POSITION IND	A/L FL
DSCU	X32	5	RING INITIAL POSITION IND	A/L FL
DSCU	X32	6	RING INITIAL POSITION IND	A/L FL
DSCU	X32	7	RING FINAL POSITION IND	A/L FL
DSCU	X32	8	RING FINAL POSITION IND	A/L FL
DSCU	X32	9	RING FINAL POSITION IND	A/L FL
DSCU	X32	10	FIXERS OFF IND	A/L FL
DSCU	X32	11	FIXERS OFF IND	A/L FL
DSCU	X32	12	FIXERS OFF IND	A/L FL
DSCU	X32	13	LATCHES OPEN IND	A/L FL
DSCU	X32	14	LATCHES OPEN IND	A/L FL
DSCU	X32	15	LATCHES OPEN IND	A/L FL
DSCU	X32	16	LATCHES CLOSED IND	A/L FL
DSCU	X32	17	LATCHES CLOSED IND	A/L FL
DSCU	X32	18	LATCHES CLOSED IND	A/L FL
DSCU	X32	19	GRP 1 HKS OPEN IND	A/L FL
DSCU	X32	20	GRP 1 HKS OPEN IND	A/L FL
DSCU	X32	21	GRP 1 HKS OPEN IND	A/L FL
DSCU	X32	22	GRP 1 HKS CLOSED IND	A/L FL
DSCU	X32	23	GRP 1 HKS CLOSED IND	A/L FL
DSCU	X32	24	GRP 1 HKS CLOSED IND	A/L FL
DSCU	X32	25	GRP 2 HKS OPEN IND	A/L FL
DSCU	X32	26	GRP 2 HKS OPEN IND	A/L FL
DSCU	X32	27	GRP 2 HKS OPEN IND	A/L FL
DSCU	X32	28	GRP 2 HKS CLOSED IND	A/L FL
DSCU	X32	29	GRP 2 HKS CLOSED IND	A/L FL
DSCU	X32	30	GRP 2 HKS CLOSED IND	A/L FL
DSCU	X32	31	DSCU: CA2 DC RTN	A/L FL
DSCU	X32	32	DSCU: Cb2 DC RTN	A/L FL
DSCU	X32	33	DSCU: CB2 DC RTN	A/L FL
DSCU	X32	34	RING FORWARD POSITION IND	A/L FL
DSCU	X32	35	RING FORWARD POSITION IND	A/L FL
DSCU	X32	36	RING FORWARD POSITION IND	A/L FL
DSCU	X32	37	RING ALIGNED IND	A/L FL
DSCU	X32	38	RING ALIGNED IND	A/L FL
DSCU	X32	39	RING ALIGNED IND	A/L FL
DSCU	X32	46	READY TO HOOK IND	A/L FL
DSCU	X32	47	READY TO HOOK IND	A/L FL
DSCU	X32	48	READY TO HOOK IND	A/L FL
DSCU	X32	49	INTERFACE SEALED IND	A/L FL
DSCU	X32	50	INTERFACE SEALED IND	A/L FL
DSCU	X32	51	INTERFACE SEALED IND	A/L FL
DSCU	X32	52	INITIAL CONTACT IND	A/L FL
DSCU	X32	53	INITIAL CONTACT IND	A/L FL
DSCU	X32	54	INITIAL CONTACT IND	A/L FL

Table 30-C. DSCU Pin Assignments (continued)

PALLET BOX	CONN	PIN	FUNCTION	TYPE
DSCU	X32	55	POWER ON IND	A/L FL
DSCU	X32	56	POWER ON IND	A/L FL
DSCU	X32	57	POWER ON IND	A/L FL
DSCU	X32	66	DSCU: CA3 DC RTN	A/L FL
DSCU	X32	67	DSCU: Cb3 DC RTN	A/L FL
DSCU	X32	68	UNDOCKING COMPLETE IND	A/L FL
DSCU	X32	69	UNDOCKING COMPLETE IND	A/L FL
DSCU	X32	70	APDS CIRC PROT OFF IND	A/L FL
DSCU	X32	71	APDS CIRC PROT OFF IND	A/L FL
DSCU	X210	1	RING OUT CMD	I/P
DSCU	X210	3	RING OUT STOP CMD	I/P
DSCU	X210	4	RING OUT STOP CMD	I/P
DSCU	X210	5	RING OUT CMD	I/P
DSCU	X210	6	RING OUT CMD	I/P
DSCU	X210	8	RING IN CMD	I/P
DSCU	X210	10	RING OUT STOP CMD	I/P
DSCU	X210	11	DC RTN	I/P
DSCU	X210	13	DC RTN JPR	I/P
DSCU	X210	14	RING IN CMD	I/P
DSCU	X210	15	RING IN CMD	I/P
DSCU	X210	16	SLIP CLUTCH FINAL POS (1)	A/L FL
DSCU	X210	17	RING IN STOP CMD	I/P
DSCU	X210	18	DC RTN JPR	I/P
DSCU	X210	20	ACTUAT OF DCKNG RING DRV	I/P
DSCU	X210	21	SLIP CLUTCH FINAL POS (2)	A/L FL
DSCU	X210	22	SLIP CLUTCH INITIAL POS (1)	A/L FL
DSCU	X210	23	SLIP CLUTCH INITIAL POS (2)	A/L FL
DSCU	X210	24	RING IN STOP CMD	I/P
DSCU	X210	25	RING IN STOP CMD	I/P
DSCU	X210	26	P.S. TO SLIP CLUTCH MTR (M10)	A/L FL
DSCU	X210	27	P.S. TO SLIP CLUTCH MTR (M10)	A/L FL
DSCU	X210	28	P.S. TO SLIP CLUTCH MTR (M11)	A/L FL
DSCU	X210	29	P.S. TO SLIP CLUTCH MTR (M11)	A/L FL
DSCU	X210	30	P.S. TO SLIP CLUTCH MTR (M10)	A/L FL
DSCU	X210	31	P.S. TO SLIP CLUTCH MTR (M10)	A/L FL
DSCU	X210	32	P.S. TO SLIP CLUTCH MTR (M11)	A/L FL
DSCU	X210	33	P.S. TO SLIP CLUTCH MTR (M11)	A/L FL
DSCU	X210	34	RING FORWARD POSITION	A/L FL
DSCU	X210	36	RING FINAL POSITION	A/L FL
DSCU	X210	37	RING FINAL POSITION	A/L FL
DSCU	X210	39	CONTROL SENSOR RETURN	A/L FL
DSCU	X210	39	CONTROL SENSOR RETURN	A/L FL
DSCU	X210	39	CONTROL SENSOR RETURN	A/L FL
DSCU	X210	40	CONTROL SENSOR RETURN	A/L FL
DSCU	X210	40	CONTROL SENSOR RETURN	A/L FL
DSCU	X210	41	RING FORWARD POSITION	A/L FL
DSCU	X210	45	CONTROL SENSOR RETURN	A/L FL
DSCU	X210	45	CONTROL SENSOR RETURN	A/L FL
DSCU	X210	45	CONTROL SENSOR RETURN	A/L FL

Table 30-C. DSCU Pin Assignments (continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DSCU	X210	46	CONTROL SENSOR RETURN	A/L FL
DSCU	X210	46	CONTROL SENSOR RETURN	A/L FL
DSCU	X210	46	CONTROL SENSOR RETURN	A/L FL
DSCU	X210	48	RING INITIAL POSITION	A/L FL
DSCU	X210	49	RING INITIAL POSITION	A/L FL
DSCU	X211	1	CLOSE LATCHES CMD	I/P
DSCU	X211	2	CLOSE LATCHES CMD	I/P
DSCU	X211	4	CLOSE LATCHES CMD	I/P
DSCU	X211	5	OPEN LATCHES CMD	I/P
DSCU	X211	8	CAPTURE LATCH IND	I/P
DSCU	X211	9	LATCH POS IND	I/P
DSCU	X211	10	OPEN LATCHES CMD	I/P
DSCU	X211	14	ACTUAT OF CAPT LATCH DRV	I/P
DSCU	X211	15	LATCH POS IND	I/P
DSCU	X211	16	OPEN LATCHES CMD	I/P
DSCU	X211	21	LATCH POS IND	I/P
DSCU	X211	24	LATCH POS IND	I/P
DSCU	X211	25	RING IN LOGIC CKT	I/P
DSCU	X211	26	LATCH POS IND	I/P
DSCU	X211	28	LATCH POS IND	I/P
DSCU	X211	29	RING IN LOGIC CKT	I/P
DSCU	X211	30	RING IN LOGIC CKT	I/P
DSCU	X212	1	GRP 1 HKS CLOSE	B2B
DSCU	X212	2	GRP 1 HKS CLOSE	B2B
DSCU	X212	4	GRP 2 HKS CLOSE	B2B
DSCU	X212	5	GRP 2 HKS CLOSE	B2B
DSCU	X212	6	RING ALIGNED	A/L FL
DSCU	X212	7	RING ALIGNED	A/L FL
DSCU	X212	8	CAPTURE (SHORT)	A/L FL
DSCU	X212	9	CAPTURE (SHORT)	A/L FL
DSCU	X212	10	CAPTURE (LONG)	A/L FL
DSCU	X212	11	CAPTURE (LONG)	A/L FL
DSCU	X212	12	READY TO HOOK	A/L FL
DSCU	X212	13	READY TO HOOK	A/L FL
DSCU	X212	16	GROUP 1 HOOKS IN-BETWEEN	A/L FL
DSCU	X212	17	GROUP 1 HOOKS IN-BETWEEN	A/L FL
DSCU	X212	18	GROUP 2 HOOKS IN-BETWEEN	A/L FL
DSCU	X212	19	GROUP 2 HOOKS IN-BETWEEN	A/L FL
DSCU	X212	20	INITIAL CONTACT	A/L FL
DSCU	X212	21	INITIAL CONTACT	A/L FL
DSCU	X212	26	UNDOCK COMPLETE	A/L FL
DSCU	X212	27	UNDOCK COMPLETE	A/L FL
DSCU	X212	32	INTERFACE SEALED	A/L FL
DSCU	X212	33	INTERFACE SEALED	A/L FL
DSCU	X212	40	INTERFACE SEALED	A/L FL
DSCU	X213	1	FIXER 1 (-)	A/L FL
DSCU	X213	2	FIXER 1 (-)	A/L FL
DSCU	X213	3	FIXER 2 (-)	A/L FL
DSCU	X213	4	FIXER 2 (-)	A/L FL

Table 30-C. DSCU Pin Assignments (continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DSCU	X213	5	FIXER 3 (-)	A/L FL
DSCU	X213	6	FIXER 3 (-)	A/L FL
DSCU	X213	7	FIXER 4 (-)	A/L FL
DSCU	X213	8	FIXER 4 (-)	A/L FL
DSCU	X213	9	FIXER 5 (-)	A/L FL
DSCU	X213	10	FIXER 5 (-)	A/L FL
DSCU	X213	11	FIXER 1 (-)	A/L FL
DSCU	X213	12	FIXER 1 (-)	A/L FL
DSCU	X213	13	FIXER 2 (-)	A/L FL
DSCU	X213	14	FIXER 2 (-)	A/L FL
DSCU	X213	15	FIXER 3 (-)	A/L FL
DSCU	X213	16	FIXER 3 (-)	A/L FL
DSCU	X213	17	FIXER 4 (-)	A/L FL
DSCU	X213	18	FIXER 4 (-)	A/L FL
DSCU	X213	19	FIXER 5 (-)	A/L FL
DSCU	X213	20	FIXER 5 (-)	A/L FL
DSCU	X213	21	HI/LO - ENERGY DAMPERS 1 (-)	A/L FL
DSCU	X213	22	HI/LO - ENERGY DAMPERS 1 (-)	A/L FL
DSCU	X213	23	HI/LO - ENERGY DAMPERS 2 (-)**	A/L FL
DSCU	X213	24	HI/LO - ENERGY DAMPERS 2 (-)**	A/L FL
DSCU	X213	25	HI/LO - ENERGY DAMPERS 3 (-)**	A/L FL
DSCU	X213	33	HI/LO - ENERGY DAMPERS 3 (-)**	A/L FL
DSCU	X213	34	FIXER 1 (+)	A/L FL
DSCU	X213	35	FIXER 1 (+)	A/L FL
DSCU	X213	36	FIXER 2 (+)	A/L FL
DSCU	X213	37	FIXER 2 (+)	A/L FL
DSCU	X213	38	FIXER 3 (+)	A/L FL
DSCU	X213	39	FIXER 3 (+)	A/L FL
DSCU	X213	41	FIXER 4 (+)	A/L FL
DSCU	X213	42	FIXER 4 (+)	A/L FL
DSCU	X213	43	FIXER 5 (+)	A/L FL
DSCU	X213	44	FIXER 5 (+)	A/L FL
DSCU	X213	45	HI/LO - ENERGY DAMPERS 1 (+)	A/L FL
DSCU	X213	46	HI/LO - ENERGY DAMPERS 1 (+)	A/L FL
DSCU	X213	47	HI/LO - ENERGY DAMPERS 2 (+)**	A/L FL
DSCU	X213	48	HI/LO - ENERGY DAMPERS 2 (+)**	A/L FL
DSCU	X213	49	HI/LO - ENERGY DAMPERS 3 (+)**	A/L FL
DSCU	X213	50	HI/LO - ENERGY DAMPERS 3 (+)**	A/L FL
DSCU	X214	1	GRP 1 HKS OPEN CMD	B2B
DSCU	X214	2	GRP 2 HKS OPEN CMD	B2B
DSCU	X214	4	GRP 1 HKS CLOSE CMD	B2B
DSCU	X214	5	GRP 1 HKS OPEN CMD	B2B
DSCU	X214	6	GRP 1 HKS OPEN CMD	B2B
DSCU	X214	7	GRP 2 HKS OPEN CMD	B2B
DSCU	X214	8	GRP 2 HKS OPEN CMD	B2B
DSCU	X214	9	GRP 1 HKS CLOSE CMD	B2B
DSCU	X214	10	GRP 1 HKS CLOSE CMD	B2B
DSCU	X214	11	GRP 2 HKS CLOSE CMD	B2B
DSCU	X214	18	GRP 2 HKS CLOSE CMD	B2B

Table 30-C. DSCU Pin Assignments (continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DSCU	X214	19	GRP 2 HKS CLOSE CMD	B2B
DSCU	X214	24	GRP 1 HKS CLOSE	B2B
DSCU	X214	25	GRP 1 HKS CLOSE	B2B
DSCU	X214	26	GRP 2 HKS CLOSE	B2B
DSCU	X214	27	GRP 2 HKS CLOSE	B2B
DSCU	X214	32	GRP 2 HKS OPEN	B2B
DSCU	X214	33	GRP 1 HKS CLOSE	B2B
DSCU	X214	34	GRP 2 HKS CLOSE	B2B
DSCU	X214	35	GRP 1 HKS OPEN	B2B
DSCU	X214	36	GRP 1 HKS LOGIC CKT	B2B
DSCU	X214	38	GRP 2 HKS LOGIC CKT	B2B
DSCU	X214	39	GRP 2 HKS OPEN	B2B
DSCU	X214	41	GRP 1 HKS OPEN	B2B
DSCU	X214	43	GRP 1 HKS LOGIC CKT	B2B
DSCU	X214	44	ACTUAT OF HKS NO. 1 DRV	B2B
DSCU	X214	45	GRP 1 HKS LOGIC CKT	B2B
DSCU	X214	48	GRP 2 HKS LOGIC CKT	B2B
DSCU	X214	49	GRP 2 HKS LOGIC CKT	B2B
DSCU	X214	50	ACTUAT OF HKS NO. 2 DRV	B2B
DSCU	X218	1	DC RTN	B2B
DSCU	X218	4	DC RTN	B2B
DSCU	X218	6	DC RTN	B2B
DSCU	X218	8	DC RTN	B2B
DSCU	X218	10	DC RTN	B2B
DSCU	X218	11	DC RTN	B2B
DSCU	X218	12	DC RTN	B2B
DSCU	X218	13	DC RTN	B2B
DSCU	X218	14	DC RTN	B2B
DSCU	X218	15	DC RTN	B2B
DSCU	X218	16	DC RTN	B2B
DSCU	X218	17	DC RTN	I/P
DSCU	X218	26	DC BUS	B2B
DSCU	X218	32	DC BUS	B2B
DSCU	X218	34	DC BUS	B2B
DSCU	X218	36	DC BUS	B2B
DSCU	X218	37	DC BUS	B2B
DSCU	X218	38	DC BUS	B2B
DSCU	X218	39	DC BUS	B2B
DSCU	X218	41	DC BUS	B2B
DSCU	X218	43	DC BUS	B2B
DSCU	X218	44	DC BUS	B2B
DSCU	X218	45	DC BUS	B2B
DSCU	X218	47	DC BUS	B2B
DSCU	X218	48	DC BUS	B2B
DSCU	X218	50	DC BUS	B2B
DSCU	X219	5	ACTUAT OF DCKNG RING DRV	I/P
DSCU	X219	6	ACTUAT OF HKS NO. 1 DRV	I/P
DSCU	X219	9	ACTUAT OF HKS NO. 2 DRV	I/P
DSCU	X219	10	ACTUAT OF CAPT LATCH DRV	I/P

Table 30-C. DSCU Pin Assignments (continued)

PALLET		PIN	FUNCTION	TYPE
BOX	CONN			
DSCU	X219	11	CAPTURE	I/P
DSCU	X219	12	APDS CIRC PROT OFF	I/P
DSCU	X219	15	DC RTN	I/P
DSCU	X219	16	FIXER ACTUATION	I/P
DSCU	X219	20	INITIAL CONTACT IND	I/P
DSCU	X219	21	RING ALIGNMENT IND	I/P
DSCU	X219	25	DC RTN	I/P
DSCU	X219	30	ELECTROMAG BRAKE ACTIV	I/P
DSCU	X220	1	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	2	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	4	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	5	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	7	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	8	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	9	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	10	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	11	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	23	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	25	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	26	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	27	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	28	POWER ON/OFF CNTRL CKT	B2B
DSCU	X220	30	POWER ON/OFF CNTRL CKT	B2B
DSCU	X221	1	TEST	A/L FL
DSCU	X221	2	TEST	A/L FL
DSCU	X221	3	TEST	A/L FL
DSCU	X221	4	TEST	A/L FL
DSCU	X221	5	TEST	A/L FL
DSCU	X221	6	TEST	A/L FL
DSCU	X221	7	TEST	A/L FL
DSCU	X221	8	TEST	A/L FL
DSCU	X221	9	TEST	A/L FL
DSCU	X221	10	TEST	A/L FL
DSCU	X221	11	TEST	A/L FL
DSCU	X221	12	TEST	A/L FL
DSCU	X221	13	TEST	A/L FL
DSCU	X221	14	TEST	A/L FL
DSCU	X221	15	TEST	A/L FL
DSCU	X221	16	TEST	A/L FL
DSCU	X221	17	TEST	A/L FL
DSCU	X221	18	TEST	A/L FL
DSCU	X221	19	TEST	A/L FL
DSCU	X221	20	TEST	A/L FL
DSCU	X221	21	TEST	A/L FL
DSCU	X221	22	TEST	A/L FL
DSCU	X221	23	TEST	A/L FL
DSCU	X221	24	TEST	A/L FL
DSCU	X221	25	TEST	A/L FL
DSCU	X221	26	TEST	A/L FL

Table 30-C. DSCU Pin Assignments (continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DSCU	X221	30	TEST	A/L FL
DSCU	X221	31	TEST	A/L FL
DSCU	X221	32	TEST	A/L FL
DSCU	X221	36	TEST	A/L FL
DSCU	X221	37	TEST	A/L FL
DSCU	X221	38	TEST	A/L FL
DSCU	X221	39	TEST	A/L FL
DSCU	X221	40	TEST	A/L FL
DSCU	X221	41	TEST	A/L FL
DSCU	X221	42	TEST	A/L FL
DSCU	X221	43	TEST	A/L FL
DSCU	X221	44	TEST	A/L FL
DSCU	X221	45	TEST	A/L FL
DSCU	X221	46	TEST	A/L FL
DSCU	X221	60	TEST	A/L FL
DSCU	X221	61	TEST	A/L FL
DSCU	X221	63	TEST	A/L FL
DSCU	X221	64	TEST	A/L FL
DSCU	X221	65	TEST	A/L FL
DSCU	X221	66	TEST	A/L FL
DSCU	X221	67	TEST	A/L FL
DSCU	X221	68	TEST	A/L FL
DSCU	X224	1	TEST	A/L FL
DSCU	X224	2	TEST	A/L FL
DSCU	X224	3	TEST	A/L FL
DSCU	X224	4	TEST	A/L FL
DSCU	X224	5	TEST	A/L FL
DSCU	X224	6	TEST	A/L FL
DSCU	X224	7	TEST	A/L FL
DSCU	X224	8	TEST	A/L FL
DSCU	X224	9	TEST	A/L FL
DSCU	X224	10	TEST	A/L FL
DSCU	X224	11	TEST	A/L FL
DSCU	X224	12	TEST	A/L FL
DSCU	X224	13	TEST	A/L FL
DSCU	X224	14	TEST	A/L FL
DSCU	X224	15	TEST	A/L FL
DSCU	X224	16	TEST	A/L FL
DSCU	X224	17	TEST	A/L FL
DSCU	X224	18	TEST	A/L FL
DSCU	X224	23	TEST	A/L FL
DSCU	X224	24	TEST	A/L FL
DSCU	X224	25	TEST	A/L FL
DSCU	X224	26	TEST	A/L FL
DSCU	X224	27	TEST	A/L FL
DSCU	X224	28	TEST	A/L FL
DSCU	X224	29	TEST	A/L FL
DSCU	X224	30	TEST	A/L FL
DSCU	X224	31	TEST	A/L FL

Table 30-C. DSCU Pin Assignments (concluded)				
PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DSCU	X224	32	TEST	A/L FL
DSCU	X224	33	TEST	A/L FL
DSCU	X224	34	TEST	A/L FL
DSCU	X224	35	TEST	A/L FL
DSCU	X224	37	TEST	A/L FL
DSCU	X224	38	TEST	A/L FL
DSCU	X224	39	TEST	A/L FL
DSCU	X224	40	TEST	A/L FL
DSCU	X224	41	TEST	A/L FL
DSCU	X224	42	TEST	A/L FL
DSCU	X224	43	TEST	A/L FL
DSCU	X224	44	TEST	A/L FL
DSCU	X224	45	TEST	A/L FL
DSCU	X224	46	TEST	A/L FL
DSCU	X224	47	TEST	A/L FL
DSCU	X224	48	TEST	A/L FL
DSCU	X224	49	TEST	A/L FL
DSCU	X224	50	TEST	A/L FL
DSCU	X224	51	TEST	A/L FL
DSCU	X224	52	TEST	A/L FL
DSCU	X224	53	TEST	A/L FL
DSCU	X224	54	TEST	A/L FL
DSCU	X224	55	TEST	A/L FL
DSCU	X224	56	TEST	A/L FL
DSCU	X224	57	TEST	A/L FL

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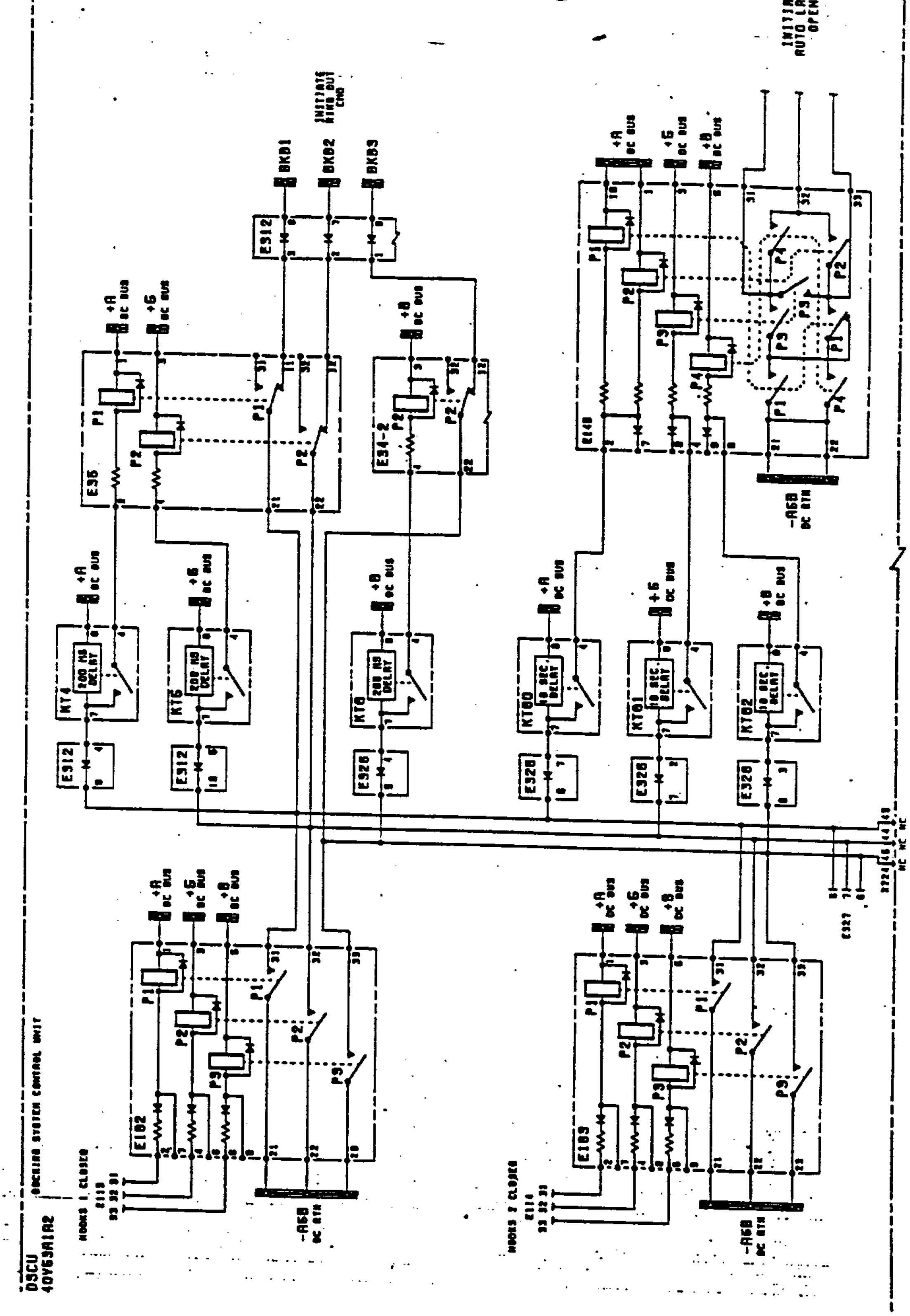

Figure 30-D - Rewire Diagram of Hooks Closed Sensor Relays

AS CHANGED

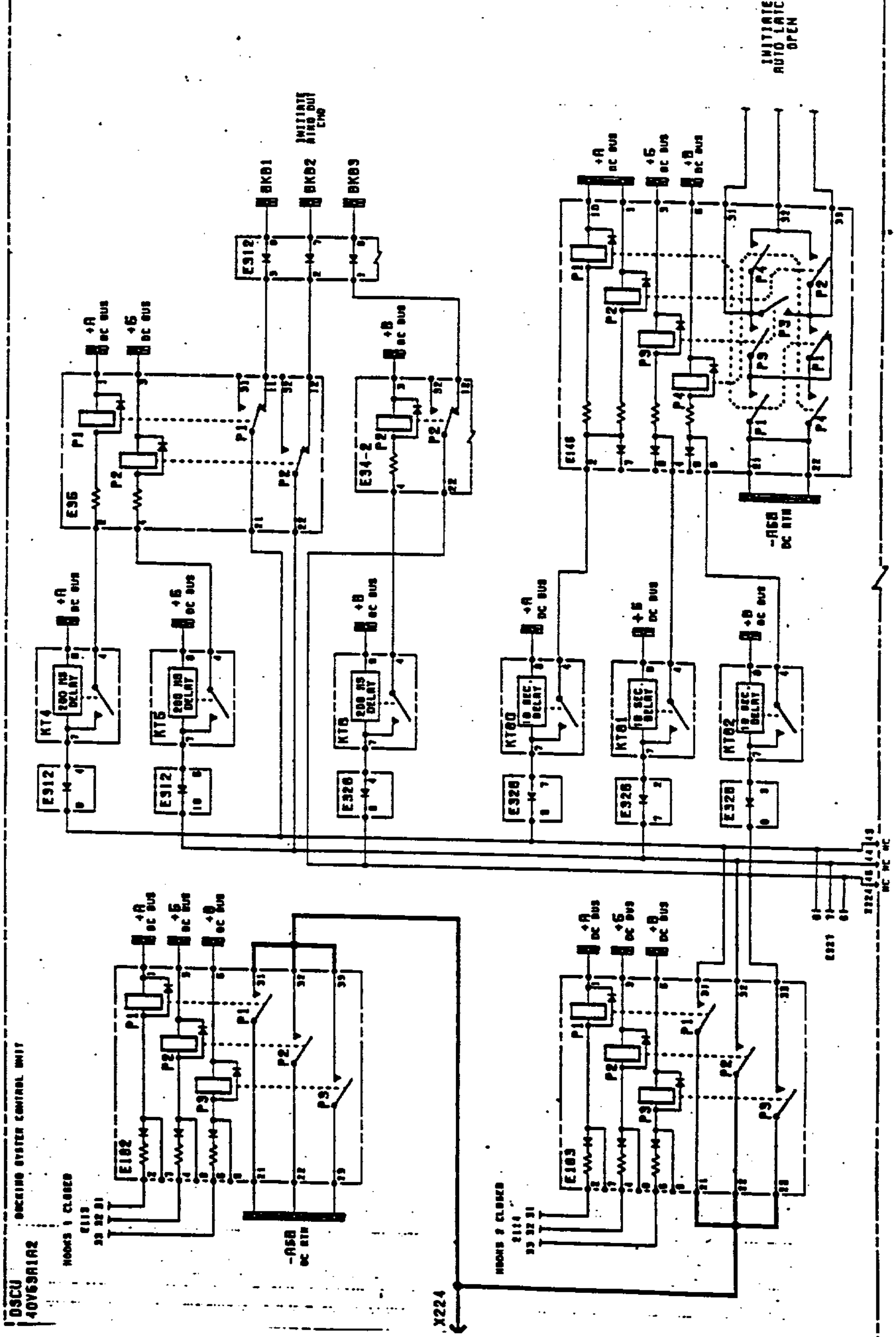

Figure 30-D continued

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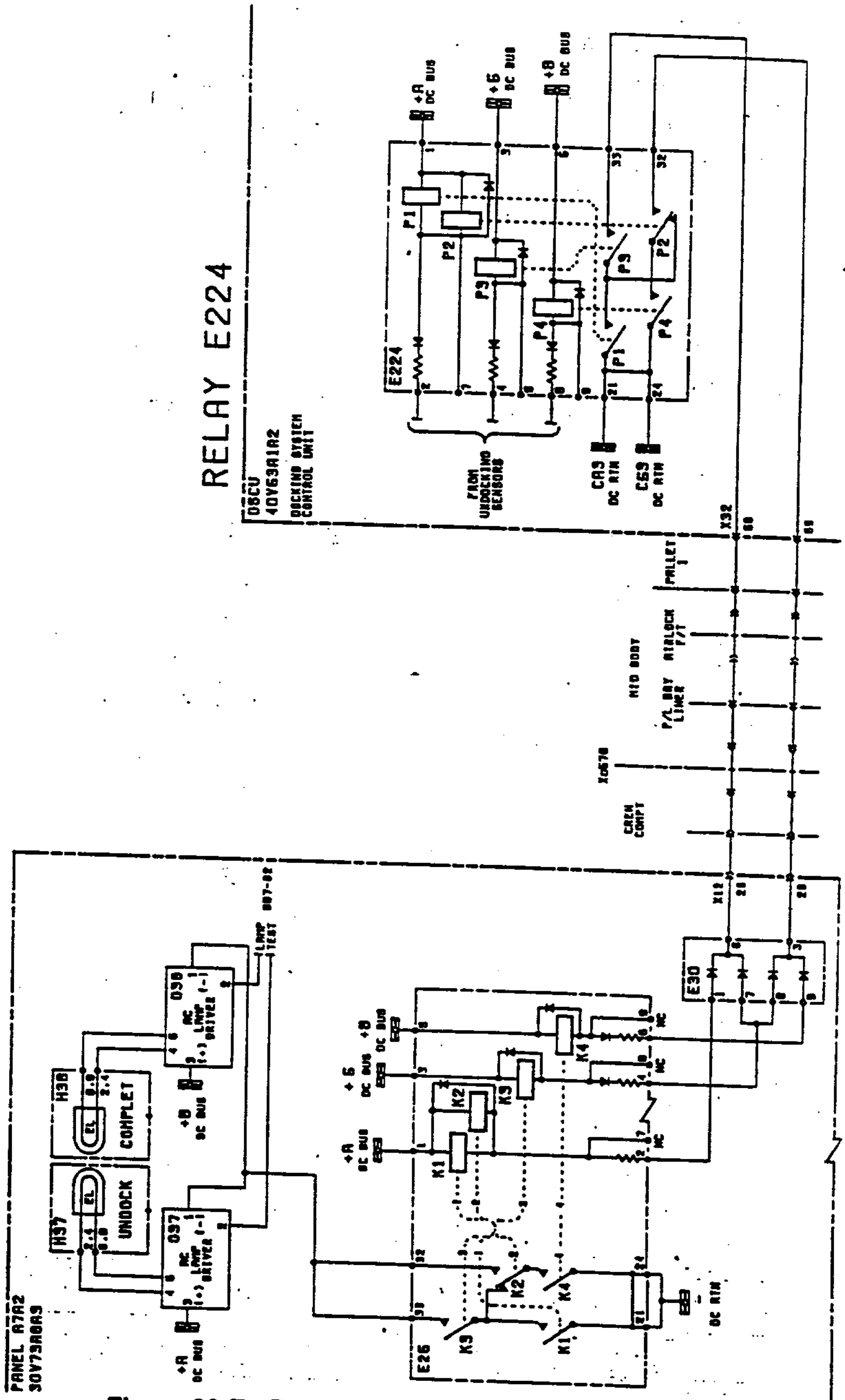

Figure 30-E - Rewire Diagram of Panel Indicator Relay Output

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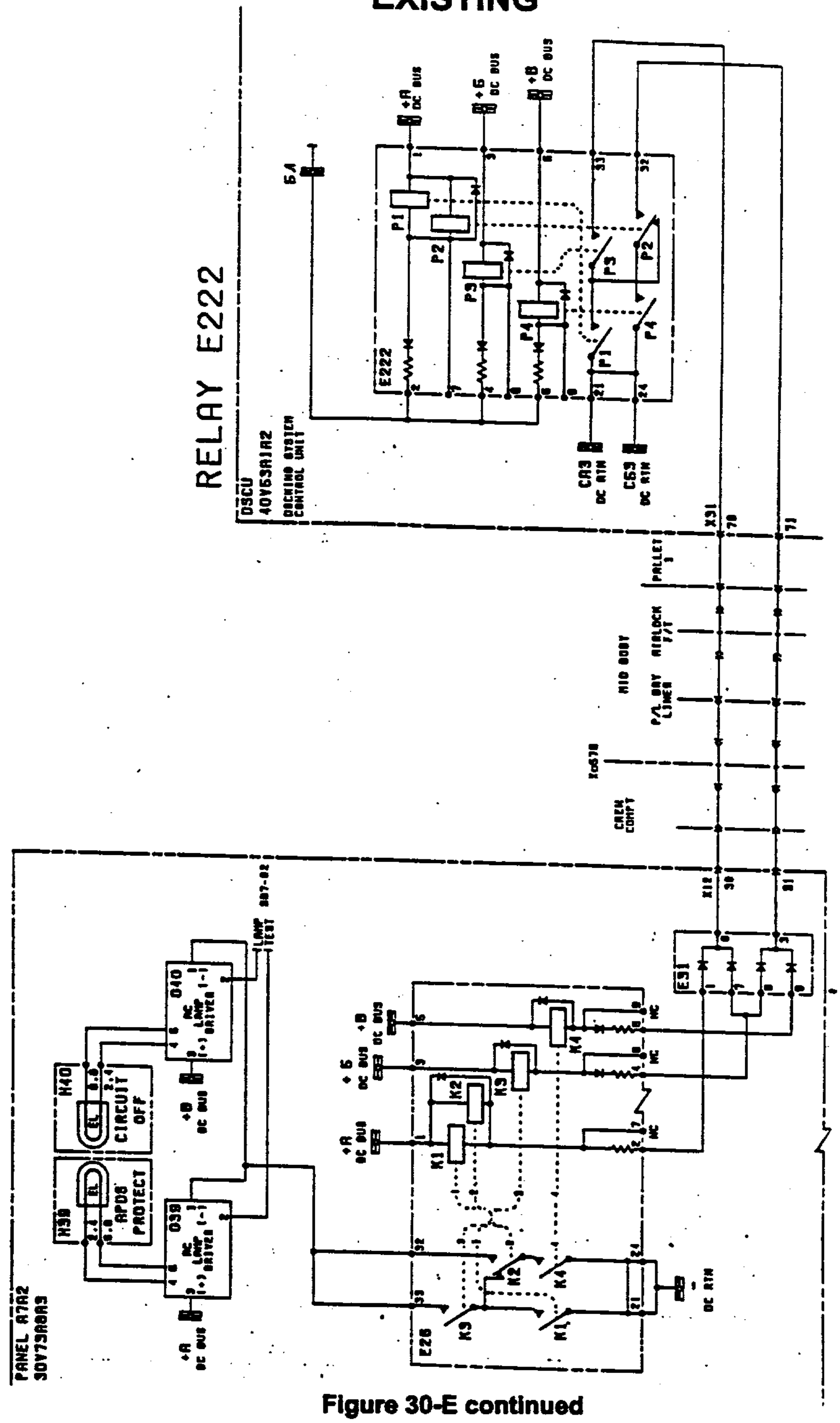

Figure 30-E continued

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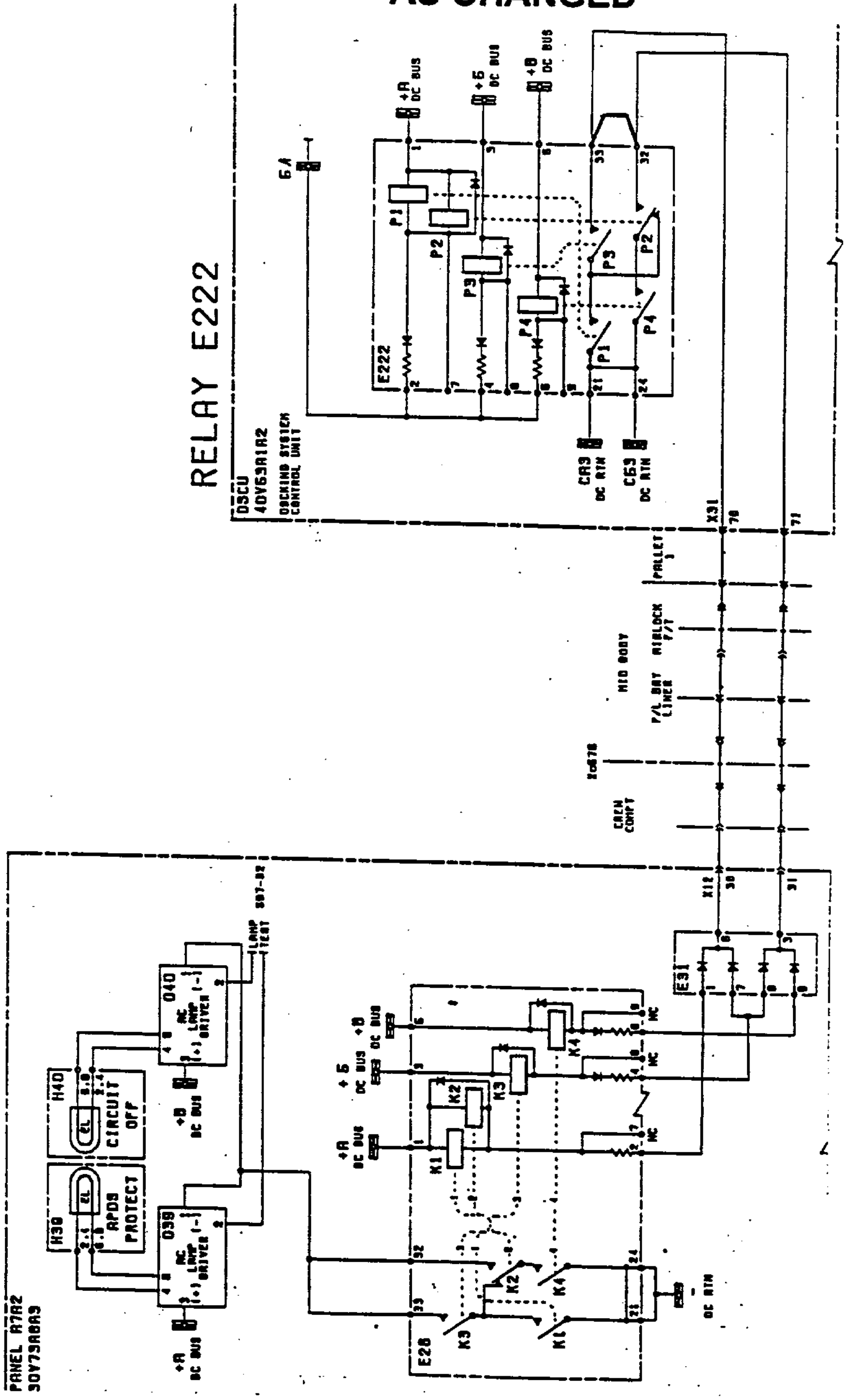

Figure 30-E continued

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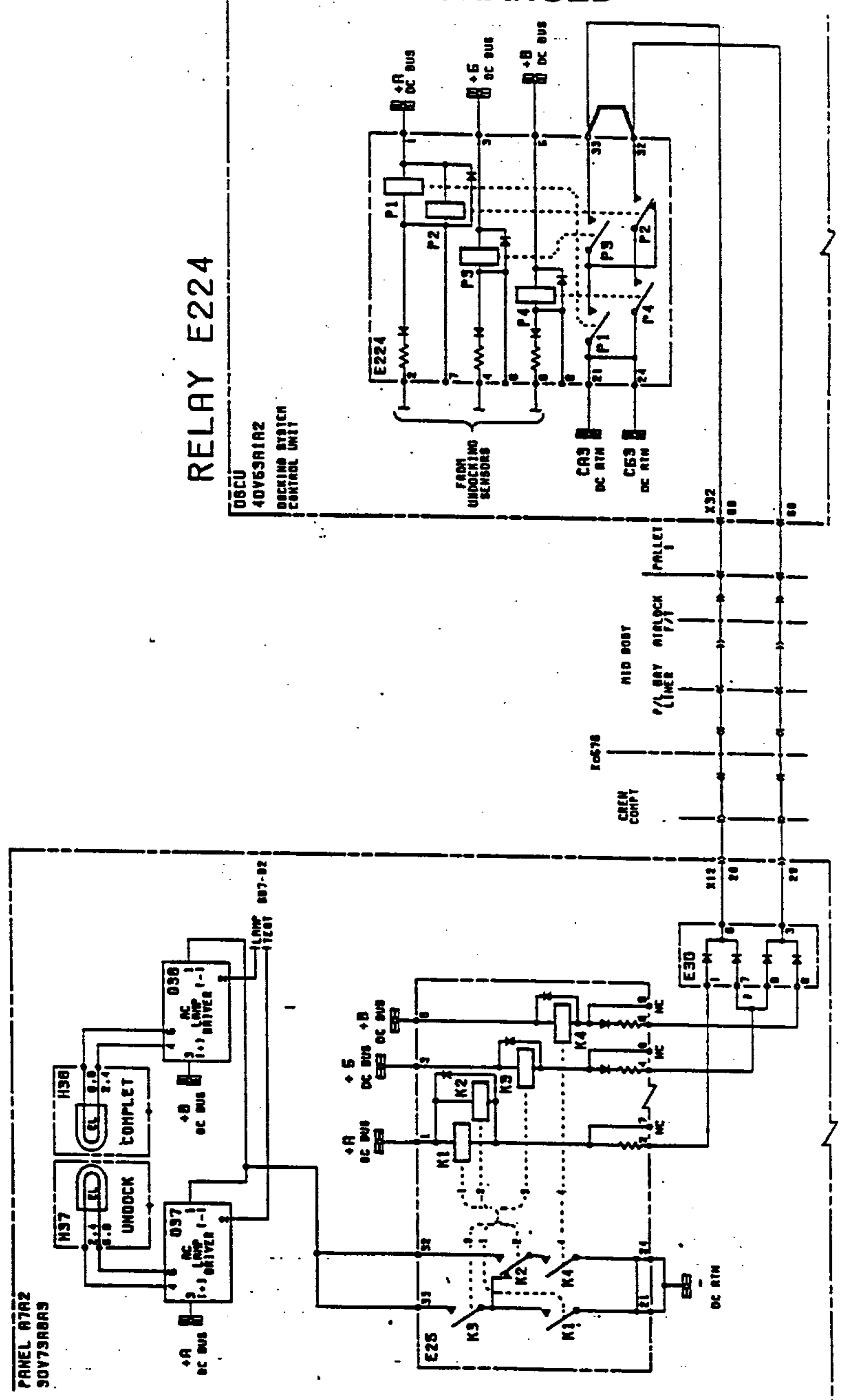

Figure 30-E concluded

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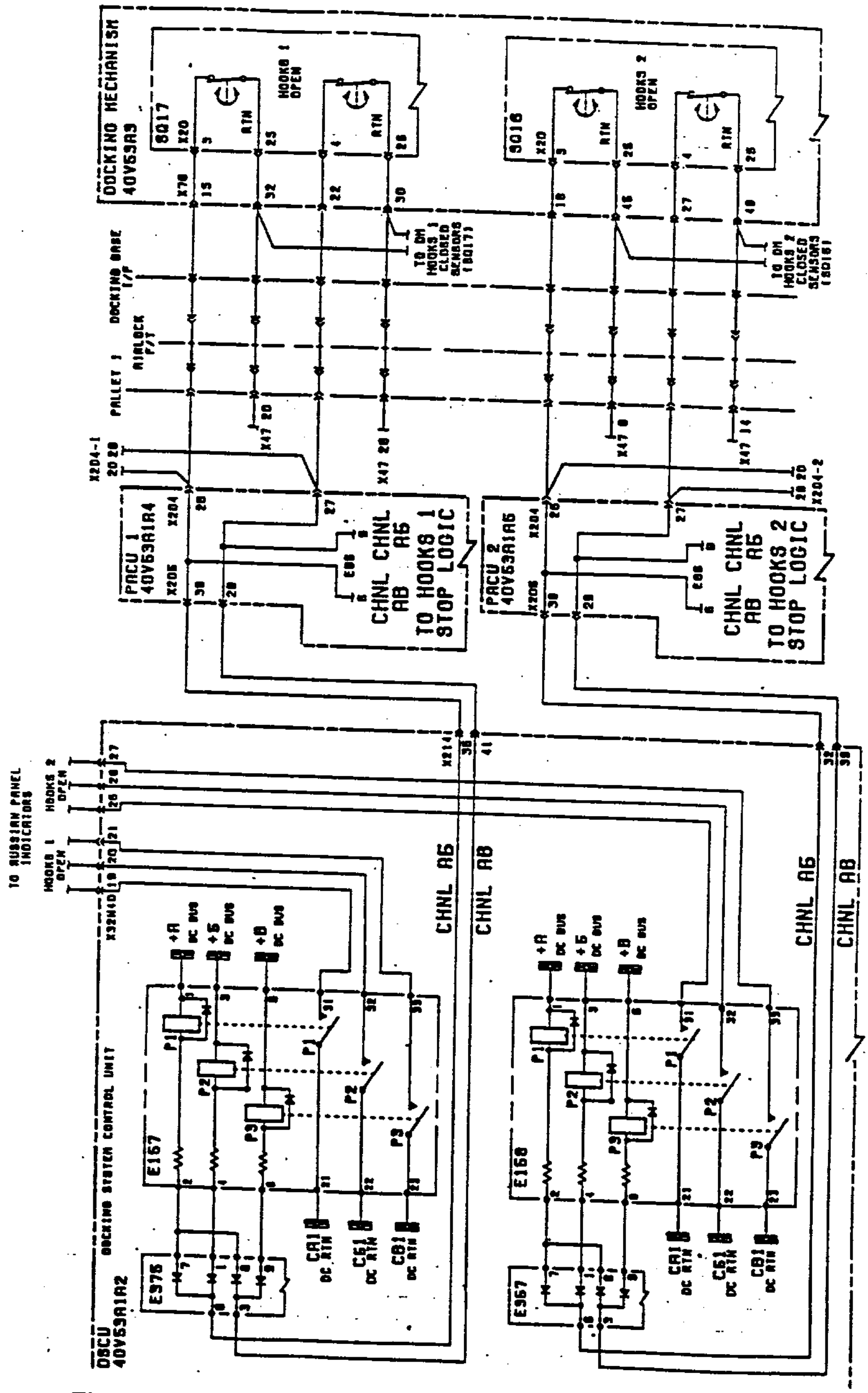

Figure 30-F - Rewire Diagram of Hooks Open Sensor Connection

AS CHANGED

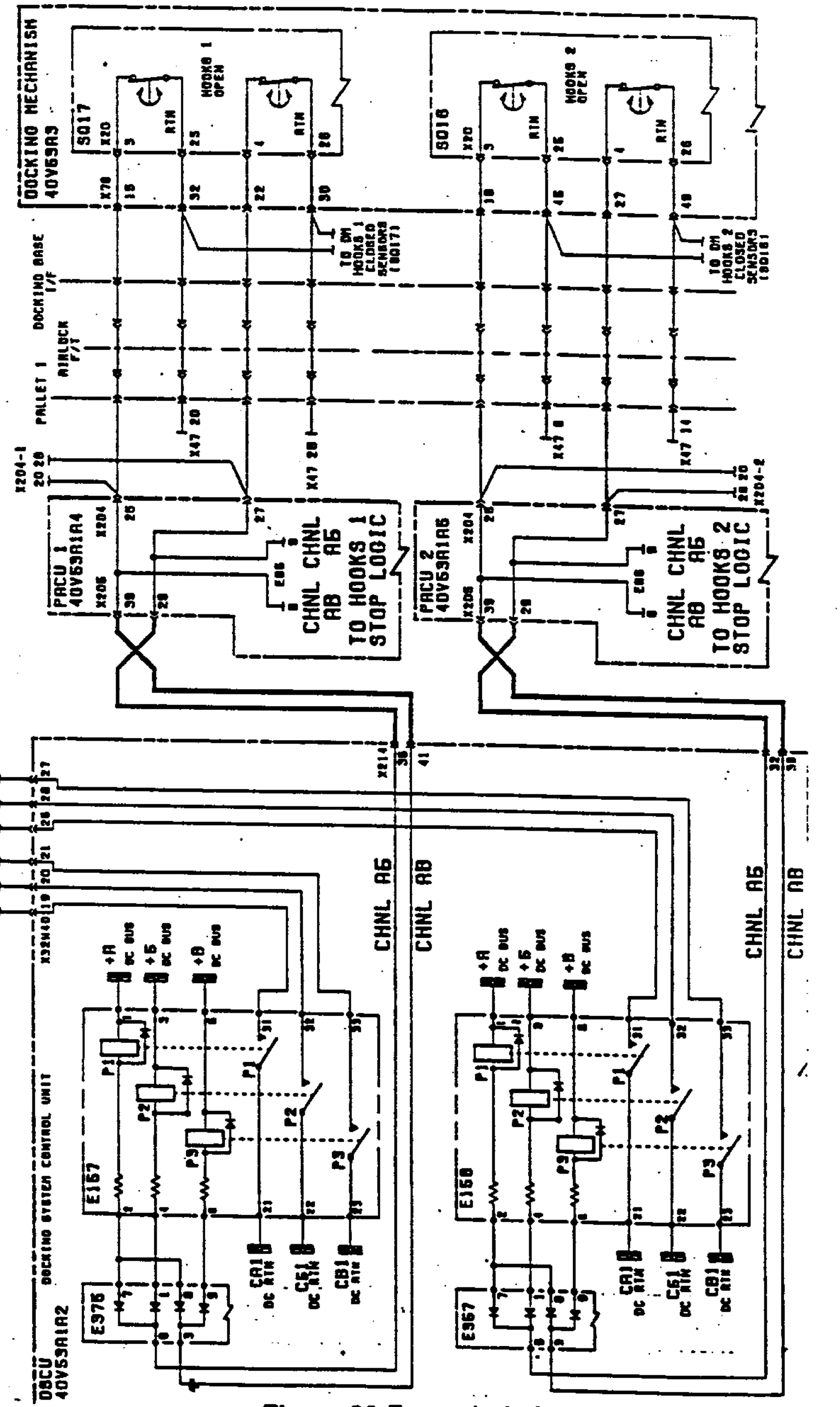

Figure 30-F concluded

Appendix IV

40. POWER SWITCHING UNIT

40.1 SCOPE

This appendix defines the detailed requirements for the Power Switching Unit (PSU).

40.2 APPLICABLE DOCUMENTS

N/A

40.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

40.3.1 Item Definition

The Power Switching Unit shall consist of power conditioning, power protection, power switching functions, to provide means to provide power to the APDS boxes.

40.3.1.1 Item Diagram

A functional block diagram of the Power Switching Unit is illustrated in Figure 40-A.

40.3.1.2 Interface Definition

The functional and physical interface requirements between the Power Switching Unit, other APDS boxes and the Orbiter Avionics are defined in the following paragraphs.

40.3.1.2.1 Electrical Power Characteristics

The electrical power characteristics shall be in accordance with the requirements specified in 3.1.2.1 of the basic specification.

40.3.1.2.2 Mechanical Characteristics.

40.3.1.2.2.1 Mounting

Provisions for mounting the Power Switching Unit shall be as shown in Figure 40-B.

40.3.1.2.2.2 Connectors

The Power Switching Unit shall have connectors located as shown in Figure 40-B, with pin assignments as shown in Table 40-C.

40.3.1.3 Item Identification

The Power Switching Unit shall be identified as follows:

Nomenclature	Buyer Control No.	Seller Part No.	Traceability Classification	Maintenance Level
PSU	MC621-0087-2003	33U.5114.007-02	Ts	LRU

40.3.2 Characteristics.

40.3.2.1 Performance Characteristics

The PSU shall provide the means to perform the functions allocated to it, in concert with the other avionics LRUs provided by the Seller, to achieve optimal mating and demating of the ISS with the Orbiter. hormone

40.3.2.1.1 Life

The requirements in 3.2.1.1 of the basic specification apply.

40.3.2.1.1.1 Design Approach

The requirements in 3.2.1.2 of the basic specification apply. Specific changes to the existing PSU design are identified as follows.

40.3.2.1.1.2 Telemetry Return Buss Circuit

PSU wiring shall be revised by eliminating relay contacts K12, K14, and K16 and connecting telemetry return busses VT1 and VT2 directly to return busses -CW1 and -CW2. This is depicted in Figure 40-D.

40.3.2.1.1.3 Signal Characteristics

Characteristics of signals unique to the Power Switching Unit are as follows:

TBS

40.3.2.2 Physical Characteristics

40.3.2.2.1 Envelope

The Power Switching Unit shall have an envelope defined in Figure 40-B.

40.3.2.2.2 Weight

The weight of the Power Switching Unit shall not exceed 5.3 lbs.

40.3.2.3 Reliability

The requirements of 3.2.3 of the basic specification apply.

40.3.2.4 Environment

The requirements of 3.2.5.1.2 and 3.2.5.2.2 of the basic specification apply.

40.3.2.5 Transportability

The requirements of 3.2.6 of the basic specification apply.

40.3.3 Design and Construction

The requirements of 3.3 of the basic specification apply, except that the following paragraph takes precedence over 3.3.3.2.1.

40.3.3.1 Power Consumption

Power consumed by the PSU shall not exceed 5.4 watts.

40.4 QUALITY ASSURANCE PROVISIONS.

40.4.1 General Requirements

The requirements of 4.1 of the basic specification apply.

40.4.2 Quality Conformance

40.4.2.1 Development

The requirements in 4.2.1 of the basic specification apply.

40.4.2.2 Acceptance

Acceptance tests and inspections shall be performed on the PSU, to be employed on the delivered units to the Buyer. The minimum number of tests and inspections, and the sequence thereof shall be as specified in Table 40-A. The Seller shall perform any other test deemed necessary , subject to approval of the Buyer.

Table 40-A. Acceptance Requirements

Inspection & Test	Paragraph Listed in Recommended Sequence
Examination of Product	40.4.2.2.1
Functional & Performance Test	40.4.2.2.2
Insulation Resistance Test	40.4.2.2.2.1
Dielectric Strength Test	40.4.2.2.2.2
Acceptance Vibration Test	40.4.2.2.3
Acceptance Thermal Test	40.4.2.2.4
Acceptance Humidity Test	40.4.2.2.5
Functional & Performance Recheck	40.4.2.2.2

40.4.2.2.1 Examination of Product

The requirements in 4.2.2.1 of the basic specification apply.

40.4.2.2.2 Functional and Performance Tests

The requirements in 4.2.2.2 of the basic specification apply.

40.4.2.2.2.1 Insulation Resistance Test

The requirements in 4.2.2.2.1 of the basic specification apply.

40.4.2.2.2.2 Dielectric Strength Test

The requirements in 4.2.2.2.2 of the basic specification apply.

40.4.2.2.3 Acceptance Vibration Test (AVT)

The requirements in 4.2.2.3 of the basic specification apply.

40.4.2.2.4 Acceptance Thermal Test (ATT)

The requirements of 4.2.2.4 of the basic specification apply, except that the PSU shall be exposed to the maximum and minimum operating temperatures for a duration not less than 3 hours. Rate of change shall not exceed 240 °F (133.3 °C) per hour, nor be less than 60 °F (33.3 °C) per hour. The thermal exposure may be performed by cycling from one extreme to the other, or by separate tests with a performance test between exposures.

40.4.2.2.5 Acceptance Humidity Test

The requirements in 4.2.2.5 of the basic specification apply.

40.4.2.3 Assessment

The requirements in 4.2.3 of the basic specification apply.

40.4.2.3.1 Reliability

The requirements in 4.2.3.1 of the basic specification apply.

40.4.2.3.2 Materials and Processes

The requirements in 4.2.3.2 of the basic specification apply.

40.4.2.3.3 Parts Standardization

The requirements in 4.2.3.3 of the basic specification apply.

40.4.2.3.4 Electrical Design Requirements

The requirements in 4.2.3.4 of the basic specification apply.

40.4.2.3.5 Interchangeability

The requirements in 4.2.3.5 of the basic specification apply.

40.4.2.3.6 Human Performance/Human Engineering

The requirements in 4.2.3.6 of the basic specification apply.

40.4.2.3.7 Safety

The requirements in 4.2.3.7 of the basic specification apply.

40.4.2.3.8 Identification and Marking

The requirements in 4.2.3.8 of the basic specification apply.

40.4.2.4 Certification

The requirements in 4.2.4 of the basic specification apply.

40.4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements specified in the performance and design verification matrix of Section 4, Table V shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in Table 40-B.

Table 40-B. Qualification Requirements

Test sequence	Paragraph
Acceptance Test	40.4.2.2
Performance Test	40.4.2.4.1.2
Transportation Test	40.4.2.4.1.11
Power Test	40.4.2.4.1.7
Vibration	40.4.2.4.1.4
Shock	40.4.2.4.1.6
Acceleration	40.4.2.4.1.5
Thermal Vacuum Test	40.4.2.4.1.10
Qualification Humidity Test	40.4.2.4.1.3
* EMC Test	40.4.2.4.1.9
Life Test	40.4.2.4.1.12
Final Performance Test	40.4.2.4.1.2

* Test and analysis will be conducted and documented by Buyer.

40.4.2.4.1.1 Test Hardware

Qualification test hardware shall be of the same configuration as flight hardware.

40.4.2.4.1.2 Performance Requirements

The requirements in 4.2.4.1.2 of the basic specification apply.

40.4.2.4.1.3 Qualification Humidity Test

The requirements in 4.2.4.1.3 of the basic specification apply.

40.4.2.4.1.4 Vibration.

40.4.2.4.1.4.1 Qualification - Acceptance Vibration Test (QAVT)

The requirements in 4.2.4.1.4.1 of the basic specification apply.

40.4.2.4.1.5 Acceleration

The requirements in 4.2.4.1.5 of the basic specification apply.

40.4.2.4.1.6 Shock

The requirements in 4.2.4.1.6 of the basic specification apply.

40.4.2.4.1.7 Power Test

The requirements in 4.2.4.1.7 of the basic specification apply. Power tests may be verified as part of the Functional/Performance tests.

40.4.2.4.1.8 Lightning

The requirements in 4.2.4.2.12 of the basic specification apply.

40.4.2.4.1.9 Electromagnetic Compatibility Tests

The requirements in 4.2.4.1.9 of the basic specification apply.

40.4.2.4.1.10 Thermal Vacuum Test

The requirements in 4.2.4.1.10 of the basic specification apply except that the first four cycles are performed at ambient pressure, and circuit monitoring may be limited due to operating life of PSU.

40.4.2.4.1.11 Transportation Test

The requirements in 4.2.4.1.11 of the basic specification apply.

40.4.2.4.1.12 Operating Life Test

The requirements in 4.2.4.1.12 of the basic specification apply.

40.4.2.4.2 Certification By Analysis

The requirements in 4.2.4.2 of the basic specification apply.

40.4.2.4.2.1 Storage/Operating Life

The requirements in 4.2.4.2.1 of the basic specification apply.

40.4.2.4.2.2 Physical Characteristics

The requirements in 4.2.4.2.2 of the basic specification apply.

40.4.2.4.2.3 Reliability

The requirements in 4.2.4.2.3 of the basic specification apply.

40.4.2.4.2.4 Salt Fog

The requirements in 4.2.4.2.4 of the basic specification apply.

40.4.2.4.2.5 Ozone

The requirements in 4.2.4.2.5 of the basic specification apply.

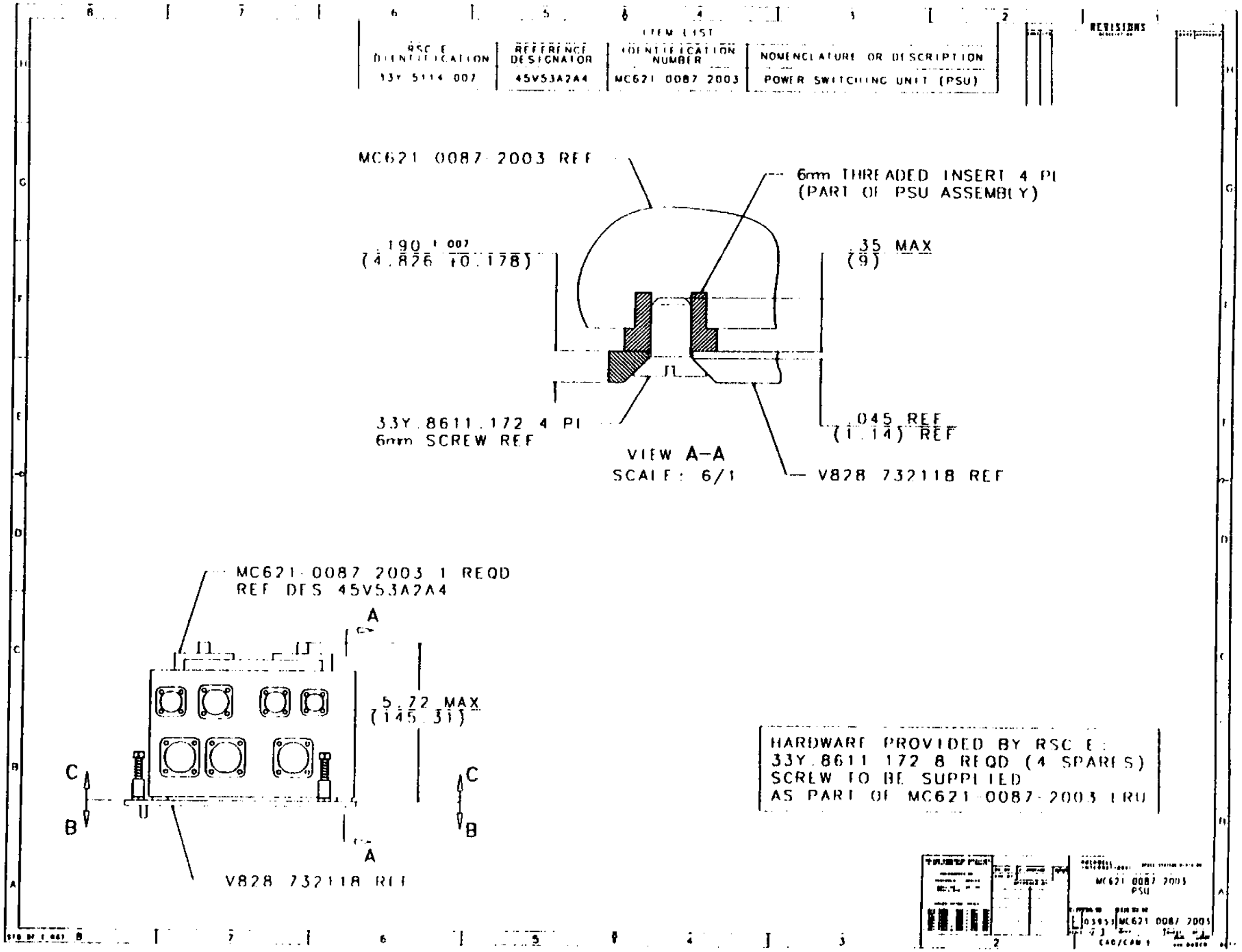

Figure 40-B. PSU Mounting and Connectors Location Diagram (1 of 2)

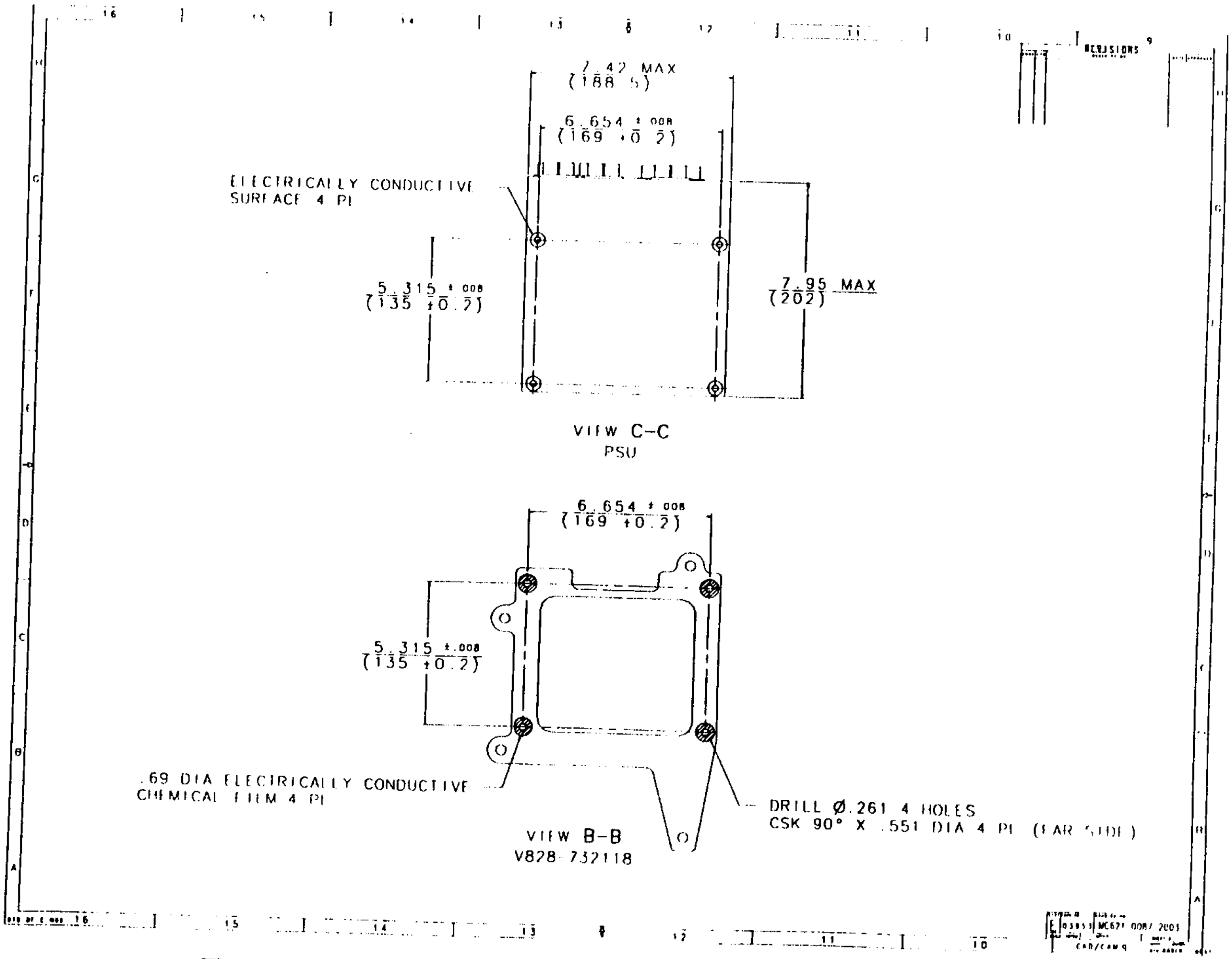

Figure 40-B. PSU Mounting and Connectors Location Diagram (2 of 2)

40.4.2.4.2.6 Fungus

The requirements in 4.2.4.2.6 of the basic specification apply.

40.4.2.4.2.7 Materials and Processes

The requirements in 4.2.4.2.7 of the basic specification apply.

40.4.2.4.2.8 Electromagnetic Compatibility

The requirements in 4.2.4.2.8 of the basic specification apply.

40.4.2.4.2.9 Electrical Design Requirements

The requirements in 4.2.4.2.9 of the basic specification apply.

40.4.2.4.2.10 Safety

The requirements in 4.2.4.2.10 of the basic specification apply.

40.4.2.4.2.11 Sand and Dust

The requirements in 4.2.4.2.11 of the basic specification apply.

40.4.2.4.2.12 Certification by Other Test Data

The requirements in 4.2.4.2.12 of the basic specification apply.

40.4.2.5 Verification Requirements Matrices

The requirements in 4.2.5 of the basic specification apply.

40.5 PREPARATION FOR DELIVERY

The requirements in Section 5 of the basic specification apply.

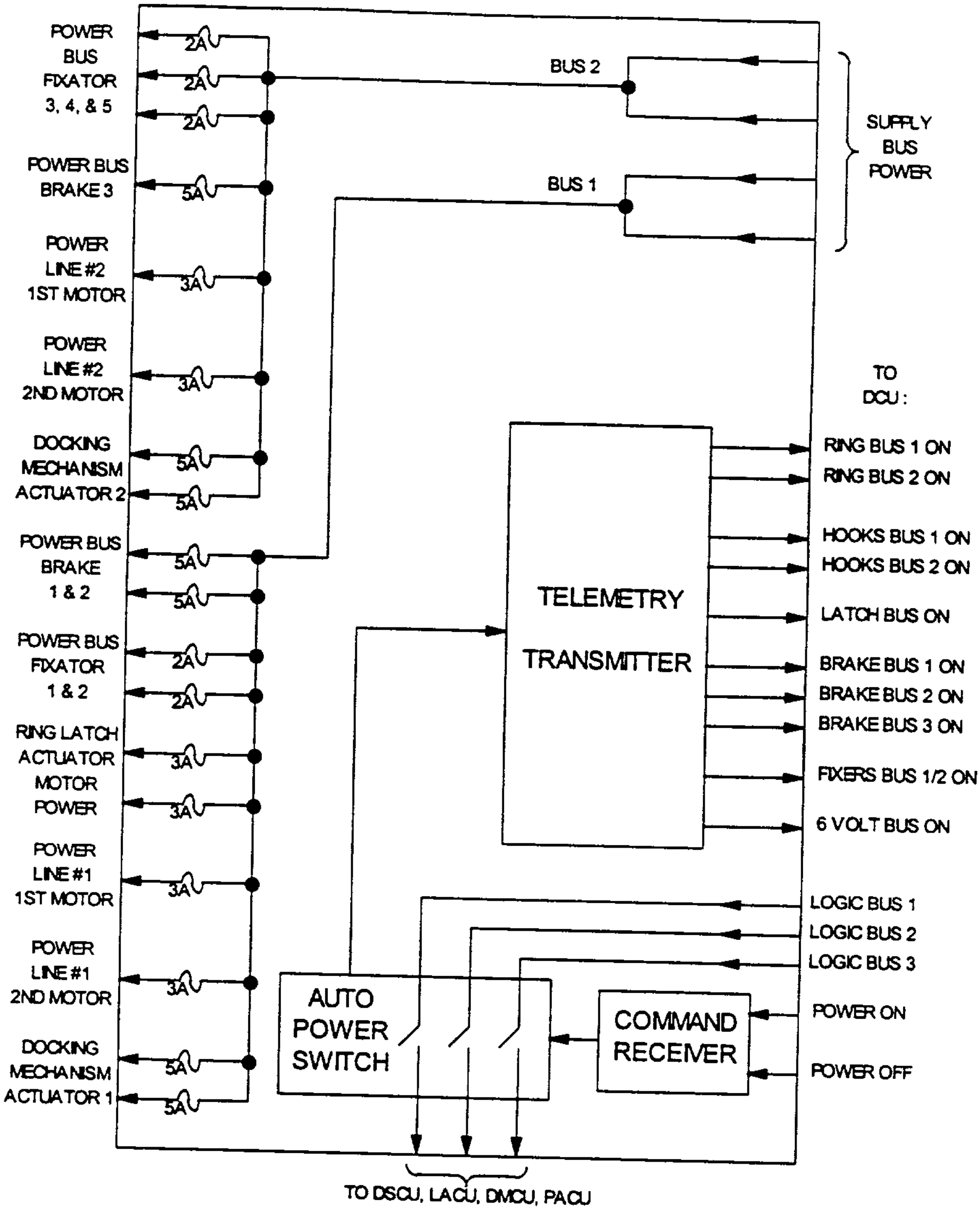

Figure 40-A. A functional block diagram of the PSU

Table 40-C. Connector and Pin Assignments, Power Switching Unit

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PSU	X3	1	APDS LOGIC PWR (Ads+)	A/L FL
PSU	X3	7	APDS LOGIC PWR (Bds+)	A/L FL
PSU	X3	8	APDS LOGIC PWR (Cds+)	A/L FL
PSU	X3	15	PSU PWR MN A DC BUS (CW1+)	A/L FL
PSU	X3	17	PSU PWR MN A DC BUS (CW1+)	A/L FL
PSU	X3	18	PSU PWR MN B DC BUS (CW2+)	A/L FL
PSU	X3	19	PSU PWR MN B DC BUS (CW2+)	A/L FL
PSU	X4	1	PSU PWR MN A DC RTN (CW1-)	A/L FL
PSU	X4	2	PSU PWR MN A DC RTN (CW1-)	A/L FL
PSU	X4	4	PSU PWR MN B DC RTN (CW2-)	A/L FL
PSU	X4	5	PSU PWR MN B DC RTN (CW2-)	A/L FL
PSU	X4	6	APDS LOGIC PWR (Ads-)	A/L FL
PSU	X4	9	APDS LOGIC PWR (Bds-)	A/L FL
PSU	X4	10	APDS LOGIC PWR (Cds-)	A/L FL
PSU	X5	1	TEST	A/L FL
PSU	X5	2	TEST	A/L FL
PSU	X5	3	TEST	A/L FL
PSU	X5	4	TEST	A/L FL
PSU	X5	5	TEST	A/L FL
PSU	X5	6	TEST	A/L FL
PSU	X5	7	TEST	A/L FL
PSU	X5	8	TEST	A/L FL
PSU	X5	9	TEST	A/L FL
PSU	X252	1	DC RTN	I/P
PSU	X252	4	DC RTN	I/P
PSU	X252	6	DC RTN	I/P
PSU	X252	8	DC RTN	B2B
PSU	X252	12	DC RTN	I/P
PSU	X252	15	DC RTN	B2B
PSU	X252	17	DC RTN	B2B
PSU	X252	18	DC RTN	B2B
PSU	X252	19	DC RTN	B2B
PSU	X252	20	DC RTN	B2B
PSU	X252	22	DC RTN	B2B
PSU	X252	23	DC RTN	B2B
PSU	X252	24	DC RTN	B2B
PSU	X252	25	DC RTN	B2B
PSU	X252	28	DC RTN	B2B
PSU	X252	29	DC RTN	B2B
PSU	X252	30	DC RTN	B2B
PSU	X252	31	DC RTN	B2B
PSU	X252	32	DC RTN	I/P
PSU	X253	1	DC BUS	I/P
PSU	X253	4	DC BUS	I/P
PSU	X253	6	DC BUS	I/P
PSU	X253	7	DC BUS	I/P
PSU	X253	8	DC BUS	I/P
PSU	X253	9	DC BUS	I/P
PSU	X253	10	DC BUS	I/P
PSU	X253	11	DC BUS	B2B

Table 40-C. Connector and Pin Assignments, Power Switching Unit (continued)

PALLET			FUNCTION	TYPE
BOX	CONN	PIN		
PSU	X253	13	DC BUS	I/P
PSU	X253	14	DC BUS	I/P
PSU	X253	15	DC BUS	I/P
PSU	X253	17	DC BUS	B2B
PSU	X253	20	DC BUS	B2B
PSU	X253	21	DC BUS	I/P
PSU	X253	22	DC BUS	I/P
PSU	X253	23	DC BUS	I/P
PSU	X253	25	DC BUS	B2B
PSU	X253	26	DC BUS	B2B
PSU	X253	27	DC BUS	B2B
PSU	X253	32	DC BUS	B2B
PSU	X253	33	DC BUS	B2B
PSU	X253	34	DC BUS	B2B
PSU	X253	35	DC BUS	B2B
PSU	X253	43	DC BUS	B2B
PSU	X253	44	DC BUS	B2B
PSU	X253	45	DC BUS	B2B
PSU	X253	46	DC BUS	I/P
PSU	X253	47	DC BUS	B2B
PSU	X253	48	DC BUS	I/P
PSU	X253	49	DC BUS	B2B
PSU	X253	50	DC BUS	I/P
PSU	X254	1	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	2	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	4	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	7	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	8	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	9	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	10	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	13	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	14	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	15	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	17	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	18	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	20	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	21	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	22	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	23	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	24	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	25	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	26	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	27	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	34	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	35	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	36	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	37	APDS PWR DISTRIB CKT	JP (RSC-E)
PSU	X254	41	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	42	POWER ON/OFF CNTRL CKT	B2B

Table 40-C. Connector and Pin Assignments, Power Switching Unit (concluded)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PSU	X254	42	POWER ON/OFF CNTRL CKT	B2B
PSU	X254	47	POWER ON/OFF CNTRL CKT	B2B
PSU	X255	7	DOCKING RING DRV BUS 1	I/P
PSU	X255	11	DOCKING RING DRV BUS 2	I/P
PSU	X255	13	HKS DRV BUS NO. 1	I/P
PSU	X255	16	APDS PWR IND CKT	I/P
PSU	X255	17	HKS DRV BUS NO. 2	I/P
PSU	X255	19	INSTRUM PWR CKT	I/P
PSU	X255	20	APDS PWR IND CKT	I/P
PSU	X255	24	FIXERS 1 & 2 BUS PWR	I/P
PSU	X255	25	BRAKES 1 & 2 BUS PWR	I/P
PSU	X255	26	BRAKES 3 BUS PWR	I/P
PSU	X255	30	FIXERS 3, 4, & 5 BUS PWR	I/P
PSU	X255	31	INSTRUM PWR CKT	I/P
PSU	X255	32	INSTRUM PWR CKT	I/P

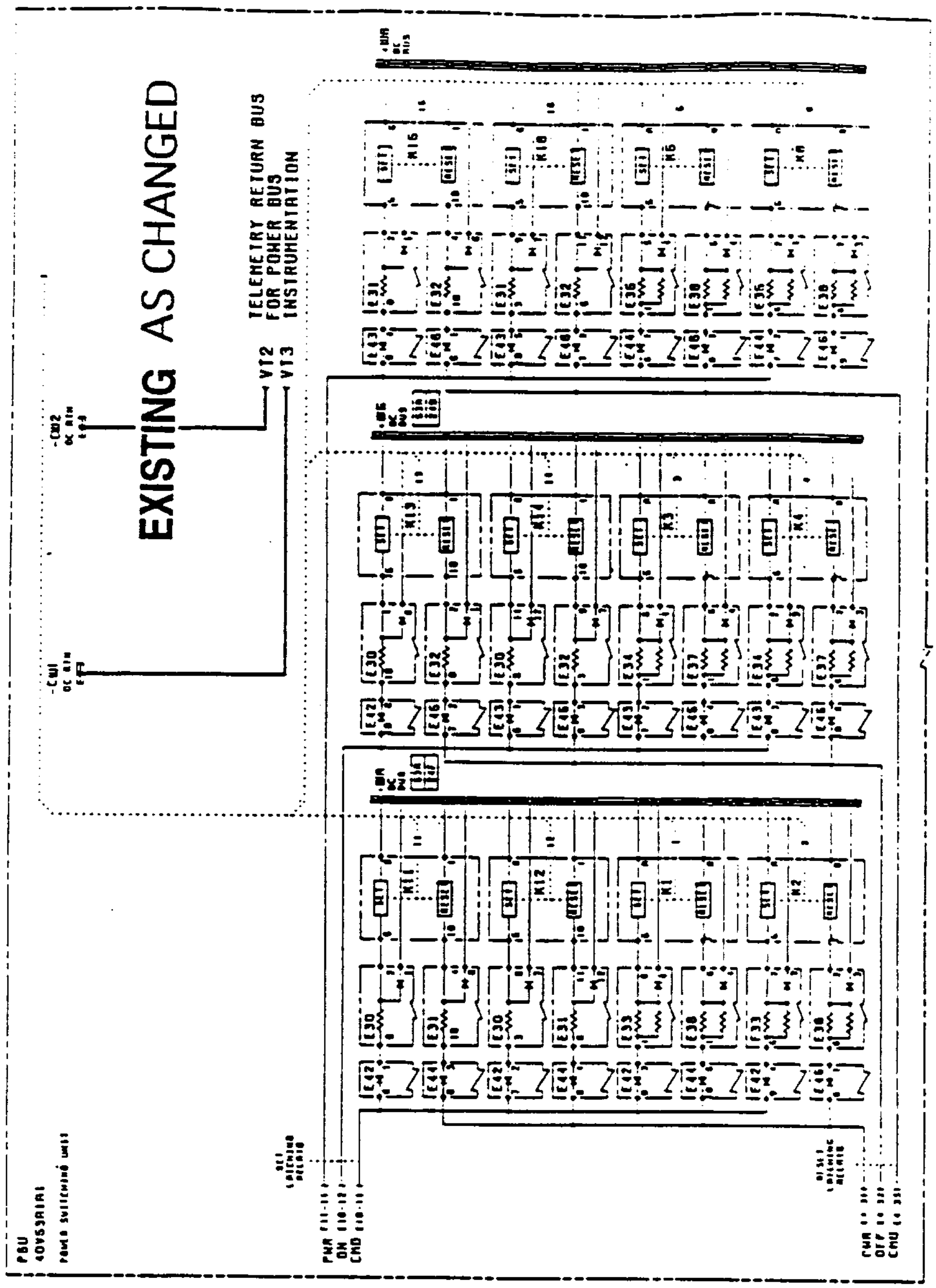

Figure 40 D Rewire Diagram
Telemetry Return Buss Circuit

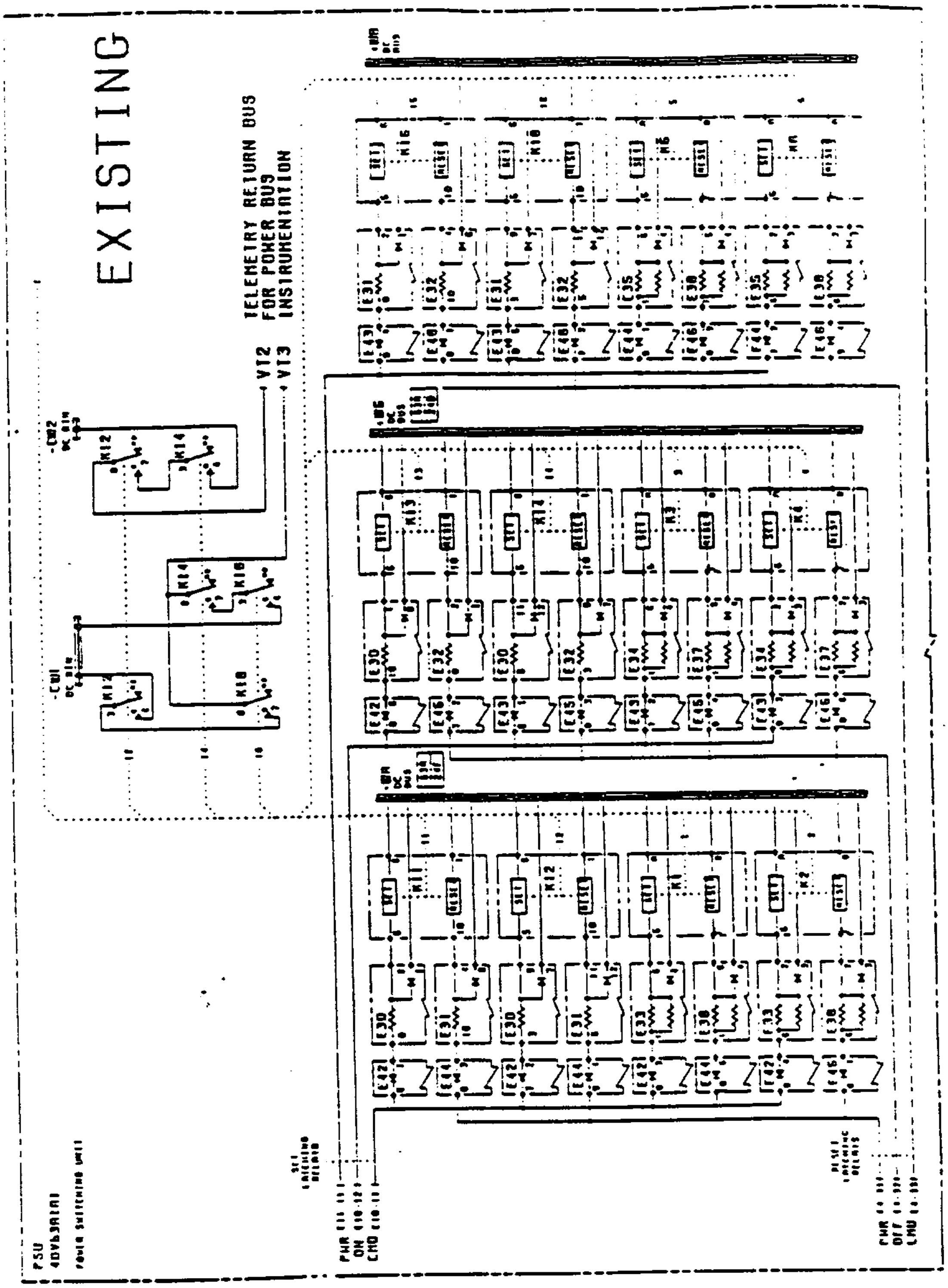

Figure 40 D concluded

Appendix V

50. LATCH ACTUATOR CONTROL UNIT

50.1 SCOPE

This appendix defines the detailed requirements for the Latch Actuator Control Unit (LACU).

50.2 APPLICABLE DOCUMENTS

N/A

50.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

50.3.1 Item Definition

The Latch Actuator Control Unit shall consist of an avionics box containing

A. the circuitry to control power to the three capture-latch motors in the APDA; and

B. the circuitry to process the signals from the latch-position sensors in the APDA for transmittal to the DCU indicators.

50.3.1.1 Item Diagram

Figure 50-A is a functional block diagram of the Latch Actuator Control Unit.

50.3.1.2 Interface Definition

The functional and physical interface requirements between the Latch Actuator Control Unit, other EDS boxes, and the Orbiter Avionics are defined in the following paragraphs.

50.3.1.2.1 Mechanical Characteristics.

50.3.1.2.1.1 Mounting

Provisions for mounting the Latch Actuator Control Unit shall be as shown in Figure 50-B.

50.3.1.2.1.2 Connectors

The Latch Actuator Control Unit shall have connectors located as shown in Figure 50-B with pin assignments as shown in Table 50-C.

50.3.1.3 Item Identification

The Latch Actuator Control Unit shall be identified as follows:

Nomenclature	Buyer Control No.	Seller Part No.	Traceability Classification	Maintenance Level
LACU	MC621-0087-2004	33U.5212. TBD	Ts	LRU

50.3.2 Characteristics.

50.3.2.1 Performance Characteristics

The LACU shall

A. provide the logic and switching to process momentary open-latch and close-latch commands from the DCP via the DSCU, using the latch-position commutator switches in the APDA, to control uni-directional current to the three capture-latch motors in the APDA;

B. process the signals from the latch-open and latch-closed sensors in the APDA for transmittal to the DCU indicators via the DSCU;

C. provide power for transmittal to the PACU;

D. provide a signal for initiation of automatic ring retraction; and

E. provide data on the state of the above operations for telemetry.

50.3.2.1.1 Life Requirements

50.3.2.1.2 The Design Approach

The requirements in 3.2.1.2 of the basic specification apply. Specific changes to the existing LACU design are identified as follows.

50.3.2.1.2.1 Capture latch logic Buss Control

The wiring of the LACU shall be revised as depicted in Figure 50-D. Capture latch 2 will be controlled from logic channels A and C, rather than from channels B and C, but will remain powered from logic buss B. Capture latch 3 will be controlled from logic channels A and B, rather than from channels B and C, but will remain powered from logic buss C. Capture latch 1 will remain controlled and powered as in the existing LACU design.

50.3.2.1.3 Signal Characteristics

Characteristics of signals that are unique to the Latch Actuator Control Unit are as follows:

TBS

50.3.2.2 Physical Characteristics

50.3.2.2.1 Envelope

The Latch Actuator Control Unit shall have an envelope defined in Figure 40-B.

50.3.2.2.2 Weight

The weight of the Latch Actuator Control Unit shall not exceed 3.1 lbs.

50.3.2.3 Reliability

The requirements of 3.2.3 of the basic specification apply.

50.3.2.4 Environment

The requirements of 3.2.5.1.2 and 3.2.5.2.2 of the basic specification apply.

50.3.2.5 Transportability

The requirements of 3.2.6 of the basic specification apply.

50.3.3 Design and Construction

The requirements of 3.3 of the basic specification apply, except the following paragraph shall take precedence over 3.3.3.2.1.

50.3.3.1 Power Consumption

Power consumed by the LACU shall not exceed 27 watts.

50.4 QUALITY ASSURANCE PROVISIONS.

50.4.1 General Requirements

The requirements of 4.1 of the basic specification apply.

50.4.2 Quality Conformance

50.4.2.1 Development

The requirements in 4.2.1 of the basic specification apply.

50.4.2.2 Acceptance

Acceptance tests and inspections shall be performed on the LACU, to be employed on the delivered units to the Buyer. The minimum number of tests and inspections, and the sequence thereof shall be as specified in Table 50-A. The Seller shall perform any other test deemed necessary , subject to approval of the Buyer.

Table 50-A. Acceptance Requirements

Inspection & Test	Paragraph Listed in Recommended Sequence
Examination of Product	50.4.2.2.1
Functional & Performance Test	50.4.2.2.2
Insulation Resistance Test	50.4.2.2.2.1
Dielectric Strength Test	50.4.2.2.2.2
Acceptance Vibration Test	50.4.2.2.3
Acceptance Thermal Test	50.4.2.2.4
Acceptance Humidity Test	50.4.2.2.5
Functional & Performance Recheck	50.4.2.2.2

50.4.2.2.1 Examination of Product

The requirements in 4.2.2.1 of the basic specification apply.

50.4.2.2.2 Functional and Performance Tests

The requirements in 4.2.2.2 of the basic specification apply.

50.4.2.2.2.1 Insulation Resistance Test

The requirements in 4.2.2.2.1 of the basic specification apply.

50.4.2.2.2.2 Dielectric Strength Test

The requirements in 4.2.2.2.2 of the basic specification apply.

50.4.2.2.3 Acceptance Vibration Test (AVT)

The requirements in 4.2.2.3 of the basic specification apply.

50.4.2.2.4 Acceptance Thermal Test (ATT)

The requirements in 4.2.2.4 of the basic specification apply, except the LACU shall be exposed to the maximum and minimum operating temperatures for a duration of not less than 3 hours. Rate of change shall not exceed 240 °F (133.3 °C) per hour, nor be less than 60 °F (33.3 °C) per hour. The thermal exposure may be performed by cycling from one extreme to the other, or by separate tests with a performance test between exposures.

50.4.2.2.5 Acceptance Humidity Test

The requirements in 4.2.2.5 of the basic specification apply.

50.4.2.3 Assessment

The requirements in 4.2.3 of the basic specification apply.

50.4.2.3.1 Reliability

The requirements in 4.2.3.1 of the basic specification apply.

50.4.2.3.2 Materials and Processes

The requirements in 4.2.3.2 of the basic specification apply.

50.4.2.3.3 Parts Standardization

The requirements in 4.2.3.3 of the basic specification apply.

50.4.2.3.4 Electrical Design Requirements

The requirements in 4.2.3.4 of the basic specification apply.

50.4.2.3.5 Interchangeability

The requirements in 4.2.3.5 of the basic specification apply.

50.4.2.3.6 Human Performance/Human Engineering

The requirements in 4.2.3.6 of the basic specification apply.

50.4.2.3.7 Safety

The requirements in 4.2.3.7 of the basic specification apply.

50.4.2.3.8 Identification and Marking

The requirements in 4.2.3.8 of the basic specification apply.

50.4.2.4 Certification

The requirements in 4.2.4 of the basic specification apply.

50.4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements in the performance and design verification matrix of Section 4 (Table V) shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in Table 50-B.

Table 50-B. Qualification Requirements

Test sequence	Paragraph
Acceptance Test	50.4.2.2
Performance Test	50.4.2.4.1.2
Transportation Test	50.4.2.4.1.11
Power Test	50.4.2.4.1.7
Vibration	50.4.2.4.1.4
Shock	50.4.2.4.1.6
Acceleration	50.4.2.4.1.5
Thermal Vacuum Test	50.4.2.4.1.10
Qualification Humidity Test	50.4.2.4.1.3
* EMC Test	50.4.2.4.1.9
Life Test	50.4.2.4.1.12
Final Performance Test	50.4.2.4.1.2

* Test and analysis will be conducted and documented by Buyer.

50.4.2.4.1.1 Test Hardware

Qualification test hardware shall be of the same configuration as flight hardware.

50.4.2.4.1.2 Performance Requirements

The requirements in 4.2.4.1.2 of the basic specification apply.

50.4.2.4.1.3 Qualification Humidity Test

The requirements in 4.2.4.1.3 of the basic specification apply.

50.4.2.4.1.4 Vibration.

50.4.2.4.1.4.1 Qualification - Acceptance Vibration Test (QAVT)

The requirements in 4.2.4.1.4.1 of the basic specification apply.

50.4.2.4.1.5 Acceleration

The requirements in 4.2.4.1.5 of the basic specification apply.

50.4.2.4.1.6 Shock

The requirements in 4.2.4.1.6 of the basic specification apply.

50.4.2.4.1.7 Power Test

The requirements in 4.2.4.1.7 of the basic specification apply. Power tests may be verified as part of the Functional/Performance tests.

50.4.2.4.1.8 Lightning

The requirements in 4.2.4.2.12 of the basic specification apply.

50.4.2.4.1.9 Electromagnetic Compatibility Tests

The requirements in 4.2.4.1.9 of the basic specification apply.

50.4.2.4.1.10 Thermal Vacuum Test

The requirements in 4.2.4.1.10 of the basic specification apply except that the first four cycles are performed at ambient pressure, and circuit monitoring may be limited due to operating life of LACU.

50.4.2.4.1.11 Transportation Test

The requirements in 4.2.4.1.11 of the basic specification apply.

50.4.2.4.1.12 Operating Life Test

The requirements in 4.2.4.1.12 of the basic specification apply.

50.4.2.4.2 Certification By Analysis

The requirements in 4.2.4.2 of the basic specification apply.

50.4.2.4.2.1 Storage/Operating Life

The requirements in 4.2.4.2.1 of the basic specification apply.

50.4.2.4.2.2 Physical Characteristics

The requirements in 4.2.4.2.2 of the basic specification apply.

50.4.2.4.2.3 Reliability

The requirements in 4.2.4.2.3 of the basic specification apply.

50.4.2.4.2.4 Salt Fog

The requirements in 4.2.4.2.4 of the basic specification apply.

50.4.2.4.2.5 Ozone

The requirements in 4.2.4.2.5 of the basic specification apply.

50.4.2.4.2.6 Fungus

The requirements in 4.2.4.2.6 of the basic specification apply.

50.4.2.4.2.7 Materials and Processes

The requirements in 4.2.4.2.7 of the basic specification apply.

50.4.2.4.2.8 Electromagnetic Compatibility

The requirements in 4.2.4.2.8 of the basic specification apply.

50.4.2.4.2.9 Electrical Design Requirements

The requirements in 4.2.4.2.9 of the basic specification apply.

50.4.2.4.2.10 Safety

The requirements in 4.2.4.2.10 of the basic specification apply.

50.4.2.4.2.11 Sand and Dust

The requirements in 4.2.4.2.11 of the basic specification apply.

50.4.2.4.2.12 Certification by Other Test Data

The requirements in 4.2.4.2.10 of the basic specification apply.

50.4.2.5 Verification Requirements Matrices

The requirements in 4.2.5 of the basic specification apply.

50.5 PREPARATION FOR DELIVERY

The requirements in Section 5 of the basic specification apply.

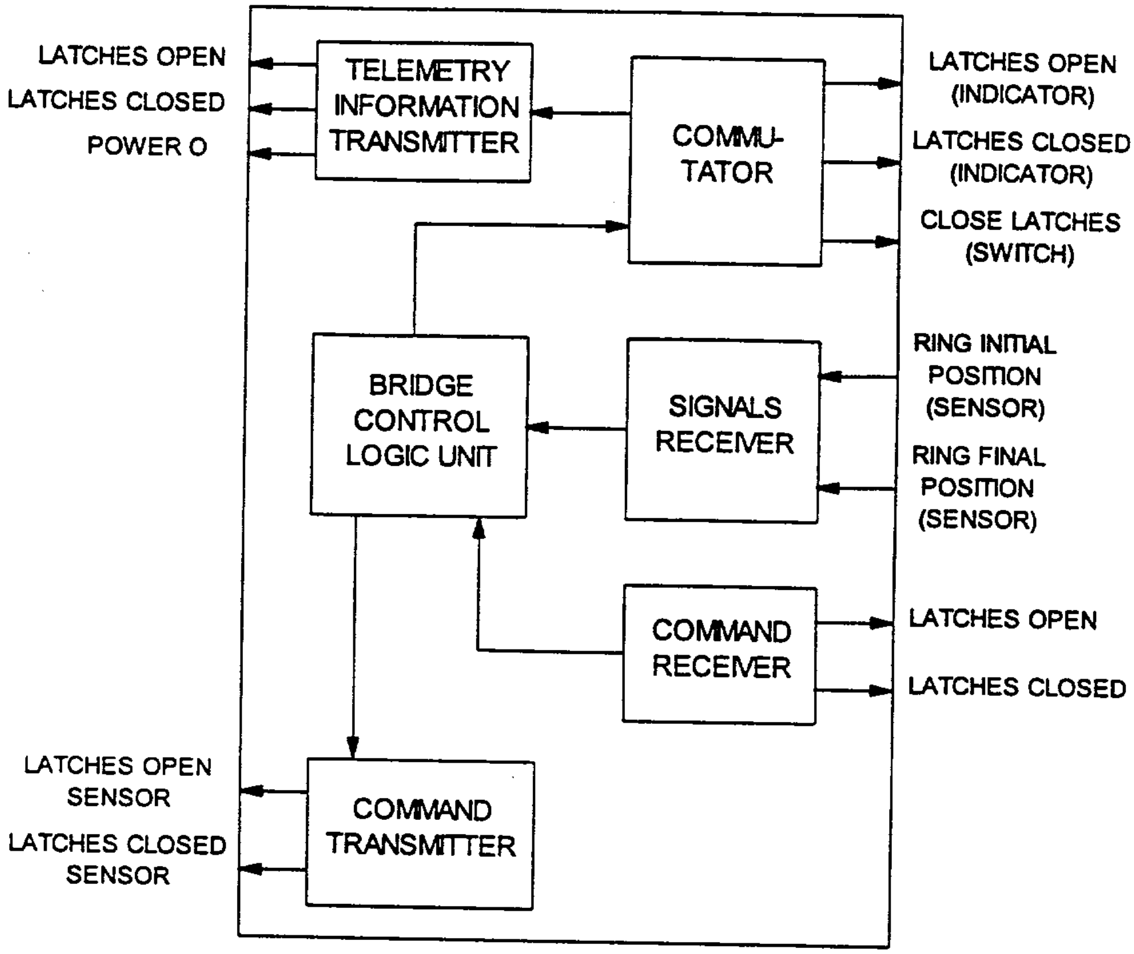

Figure 50-A. A functional block diagram of the LACU

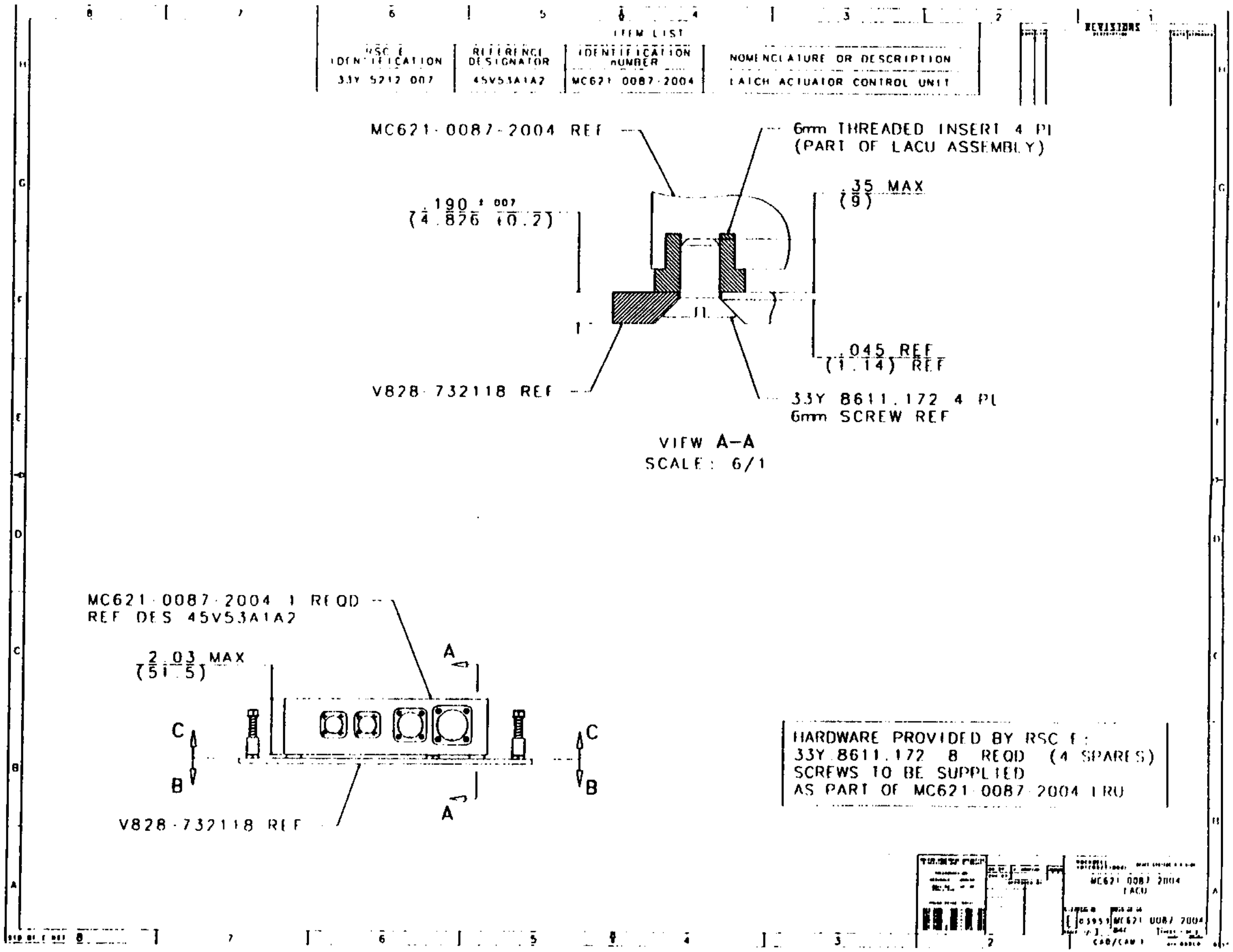

Figure 50-B: LACU Mounting and Connectors Location Diagram (1 of 2)

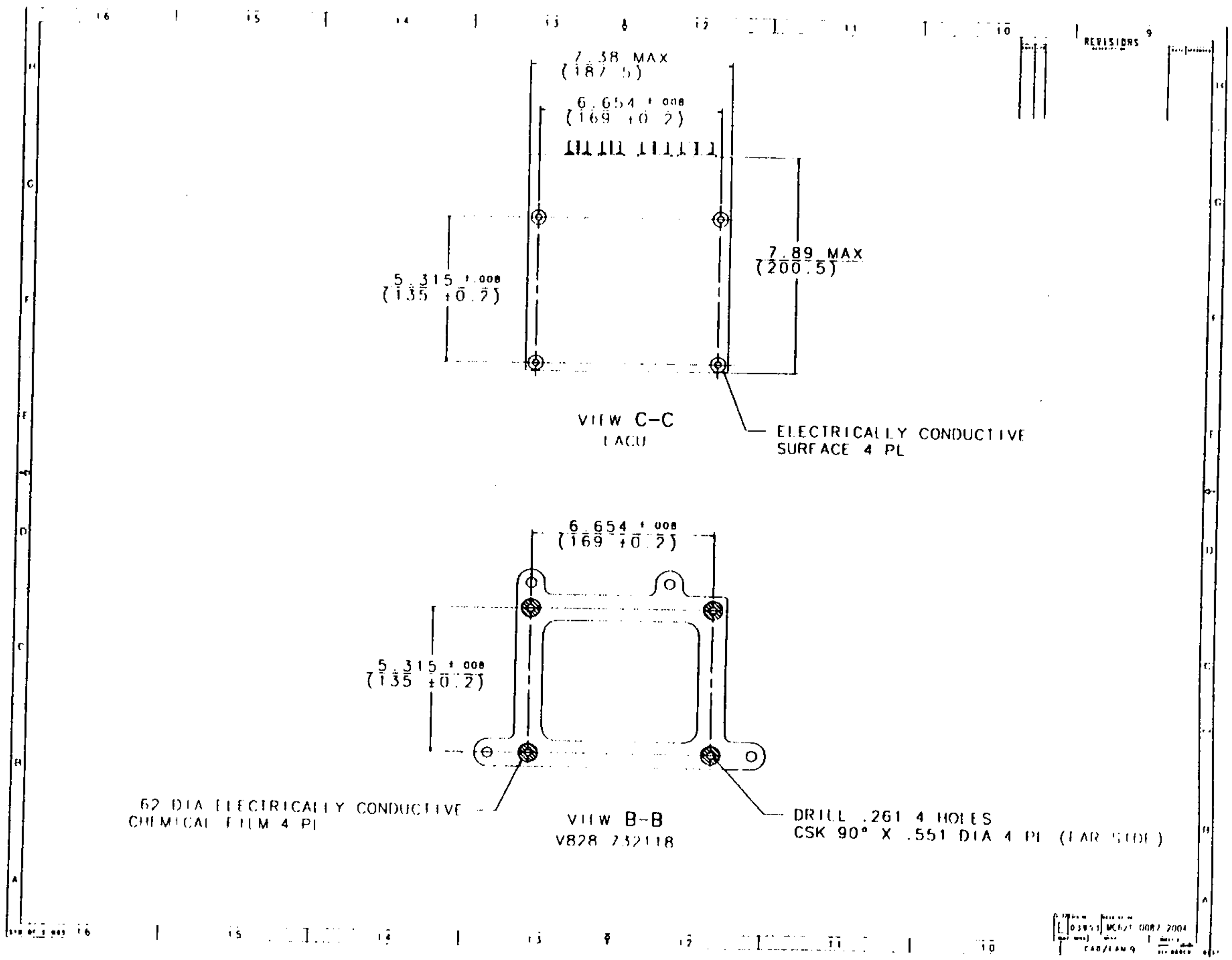

Figure 50-B: LACU Mounting and Connectors Location Diagram (2 of 2)

Table 50-C. LACU Pin Assignments

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
LACU	X207	1	TEST	A/L FL
LACU	X207	2	TEST	A/L FL
LACU	X207	4	TEST	A/L FL
LACU	X207	5	TEST	A/L FL
LACU	X207	6	TEST	A/L FL
LACU	X207	7	P.S. TO CAP LAT MTR (M1) -	A/L FL
LACU	X207	8	P.S. TO CAP LAT MTR (M1) -	A/L FL
LACU	X207	9	P.S. TO CAP LAT MTR (M3) -	A/L FL
LACU	X207	10	TEST	A/L FL
LACU	X207	11	P.S. TO CAP LAT MTR (M2) -	A/L FL
LACU	X207	12	P.S. TO CAP LAT MTR (M2) -	A/L FL
LACU	X207	16	P.S. TO CAP LAT MTR (M3) -	A/L FL
LACU	X207	17	CAPTURE LATCH NO. 1 OPEN	A/L FL
LACU	X207	18	CAPTURE LATCH NO. 1 OPEN	A/L FL
LACU	X207	19	CAPTURE LATCH NO. 2 OPEN	A/L FL
LACU	X207	24	CAPTURE LATCH NO. 2 OPEN	A/L FL
LACU	X207	25	CAPTURE LATCH NO. 3 OPEN	A/L FL
LACU	X207	26	CAPTURE LATCH NO. 3 OPEN	A/L FL
LACU	X207	27	CAPTURE LATCH NO. 1 CLOS	A/L FL
LACU	X207	32	CAPTURE LATCH NO. 1 CLOS	A/L FL
LACU	X207	33	CAPTURE LATCH NO. 2 CLOS	A/L FL
LACU	X207	34	CAPTURE LATCH NO. 2 CLOS	A/L FL
LACU	X207	35	CAPTURE LATCH NO. 3 CLOS	A/L FL
LACU	X207	36	CAPTURE LATCHES CLOS IND	A/L FL
LACU	X207	38	CAPTURE LATCHES OPEN IND	A/L FL
LACU	X207	39	CAPTURE LATCHES OPEN IND	A/L FL
LACU	X207	40	CAPTURE LATCH NO. 3 CLOS	A/L FL
LACU	X207	42	CAPTURE LATCHES CLOS IND	A/L FL
LACU	X207	43	P.S. TO CAP LAT MTR (M3) +	A/L FL
LACU	X207	44	P.S. TO CAP LAT MTR (M3) +	A/L FL
LACU	X207	46	P.S. TO CAP LAT MTR (M2) +	A/L FL
LACU	X207	48	P.S. TO CAP LAT MTR (M2) +	A/L FL
LACU	X207	49	P.S. TO CAP LAT MTR (M1) +	A/L FL
LACU	X207	50	P.S. TO CAP LAT MTR (M1) +	A/L FL
LACU	X208	1	CLOSE LATCHES CMD	I/P
LACU	X208	2	CLOSE LATCHES CMD	I/P
LACU	X208	4	CLOSE LATCHES CMD	I/P
LACU	X208	5	OPEN LATCHES CMD	I/P
LACU	X208	8	CAPTURE LATCH IND	I/P
LACU	X208	9	LATCH POS IND	I/P
LACU	X208	10	OPEN LATCHES CMD	I/P
LACU	X208	14	ACTUAT OF CAPT LATCH DRV	I/P
LACU	X208	15	LATCH POS IND	I/P
LACU	X208	16	OPEN LATCHES CMD	I/P
LACU	X208	21	LATCH POS IND	I/P
LACU	X208	24	LATCH POS IND	I/P
LACU	X208	25	RING IN LOGIC CKT	I/P
LACU	X208	26	LATCH POS IND	I/P
LACU	X208	28	LATCH POS IND	I/P

Table 50-C. LACU Pin Assignments (concluded)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
LACU	X208	29	RING IN LOGIC CKT	I/P
LACU	X208	30	RING IN LOGIC CKT	I/P
LACU	X209	1	DC RTN	I/P
LACU	X209	2	DC RTN	I/P
LACU	X209	5	DC RTN	JP (RSC-E)
LACU	X209	6	DC RTN	JP (RSC-E)
LACU	X209	7	DC RTN	I/P
LACU	X209	8	DC BUS	JP (RSC-E)
LACU	X209	9	DC BUS	JP (RSC-E)
LACU	X209	10	DC BUS	I/P
LACU	X209	11	DC BUS	JP (RSC-E)
LACU	X209	12	DC BUS	I/P
LACU	X209	13	DC BUS	I/P
LACU	X209	14	DC BUS	I/P
LACU	X209	15	DC BUS	JP (RSC-E)
LACU	X209	16	DC BUS	I/P
LACU	X209	17	DC BUS	I/P
LACU	X209	18	DC BUS	JP (RSC-E)
LACU	X209	19	DC BUS	JP (RSC-E)
LACU	X223	1	TEST	A/L FL
LACU	X223	2	TEST	A/L FL
LACU	X223	3	TEST	A/L FL
LACU	X223	4	TEST	A/L FL
LACU	X223	5	TEST	A/L FL
LACU	X223	6	TEST	A/L FL
LACU	X223	7	TEST	A/L FL
LACU	X223	8	TEST	A/L FL
LACU	X223	9	TEST	A/L FL
LACU	X223	10	TEST	A/L FL
LACU	X223	11	TEST	A/L FL
LACU	X223	12	TEST	A/L FL
LACU	X223	13	TEST	A/L FL
LACU	X223	14	TEST	A/L FL
LACU	X223	15	TEST	A/L FL
LACU	X223	16	TEST	A/L FL
LACU	X223	17	TEST	A/L FL
LACU	X223	18	TEST	A/L FL
LACU	X223	19	TEST	A/L FL
LACU	X223	20	TEST	A/L FL
LACU	X223	21	TEST	A/L FL
LACU	X223	22	TEST	A/L FL
LACU	X223	23	TEST	A/L FL
LACU	X223	24	TEST	A/L FL
LACU	X223	25	TEST	A/L FL
LACU	X223	26	TEST	A/L FL
LACU	X223	27	TEST	A/L FL
LACU	X223	28	TEST	A/L FL
LACU	X223	29	TEST	A/L FL
LACU	X223	30	TEST	A/L FL

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Figure 50-D

Rewire Diagram
Capture Latch Logic Buss Control

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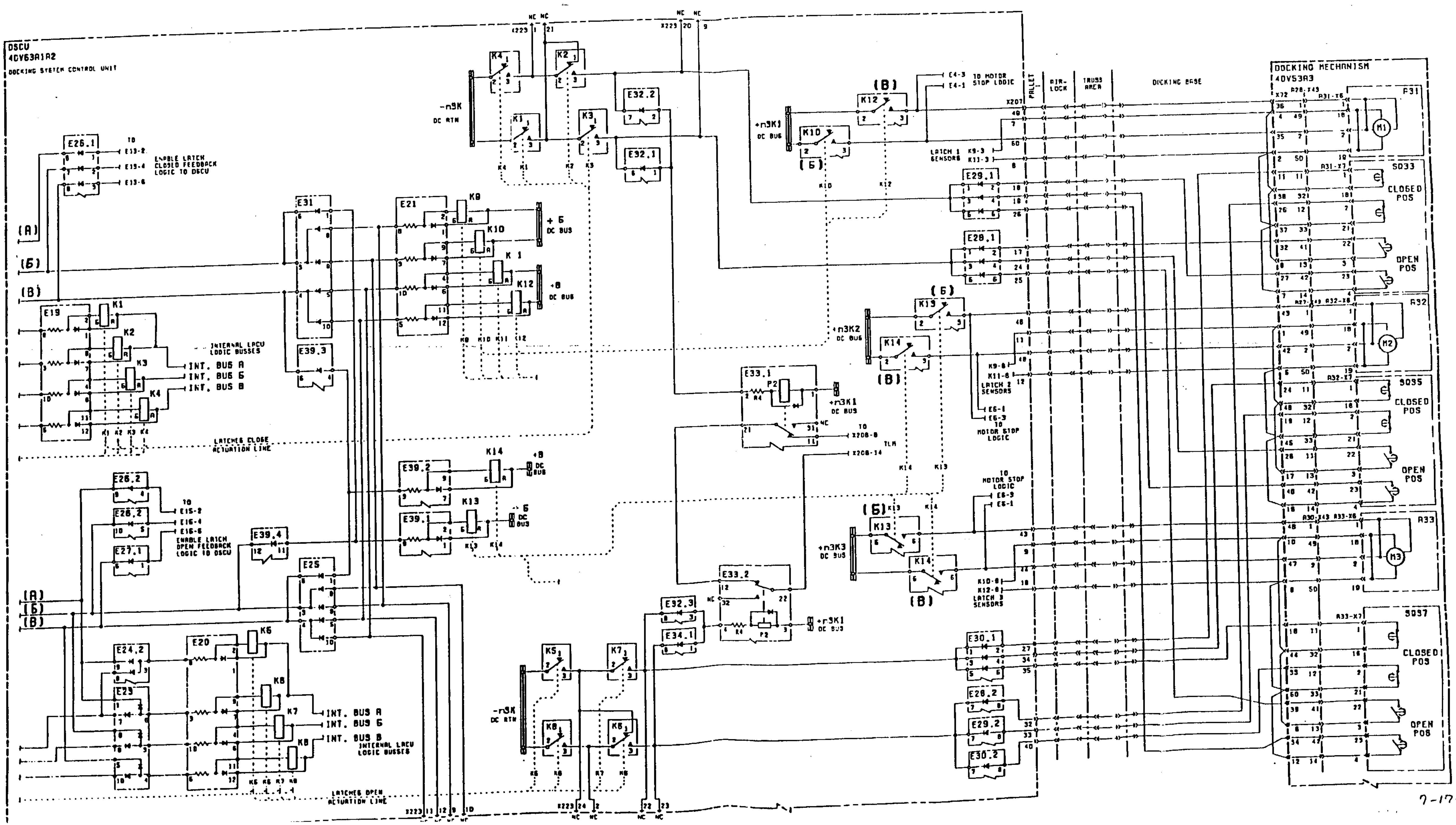

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Figure 50 D continued

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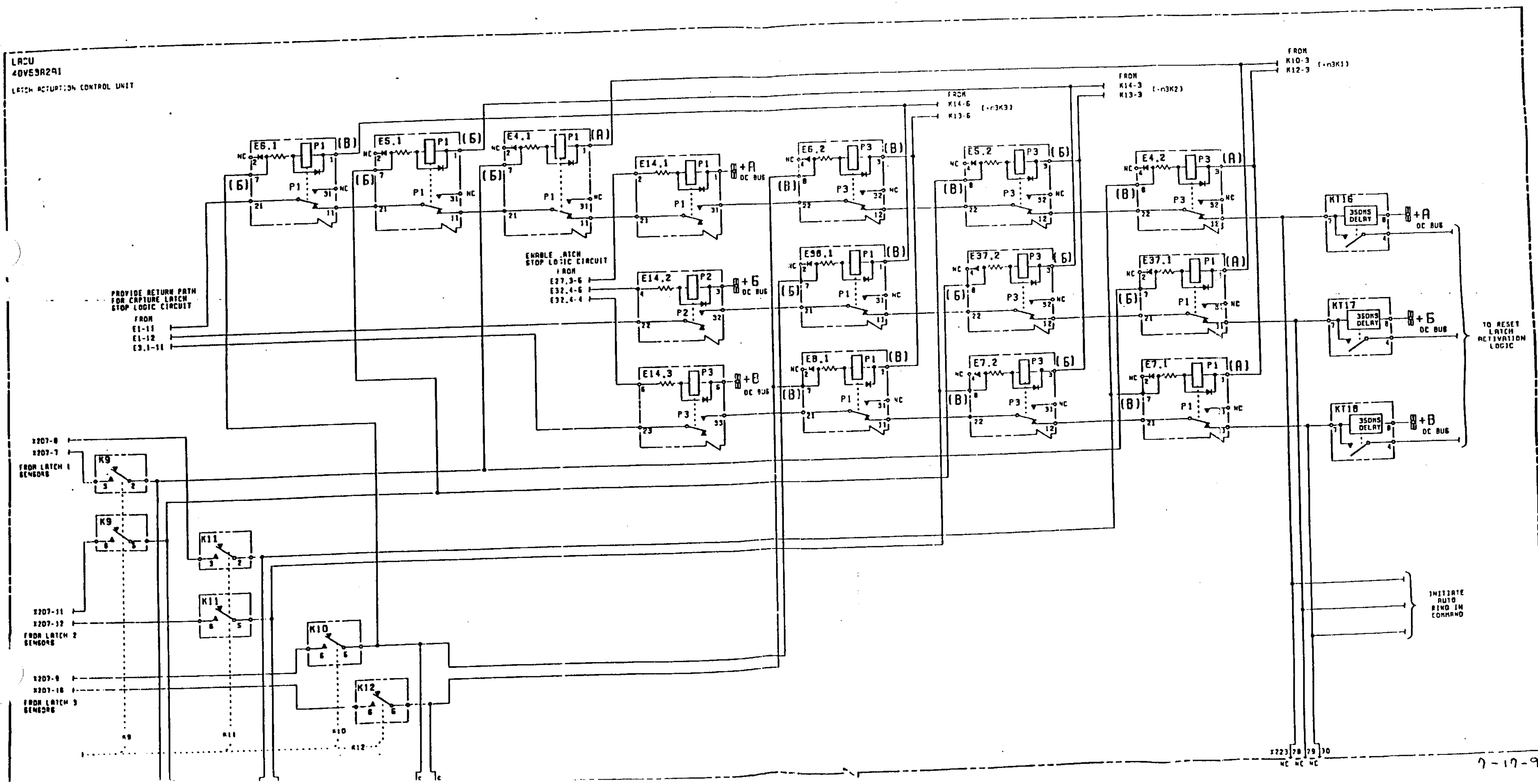

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Figure 50 D concluded

AS CHANGED

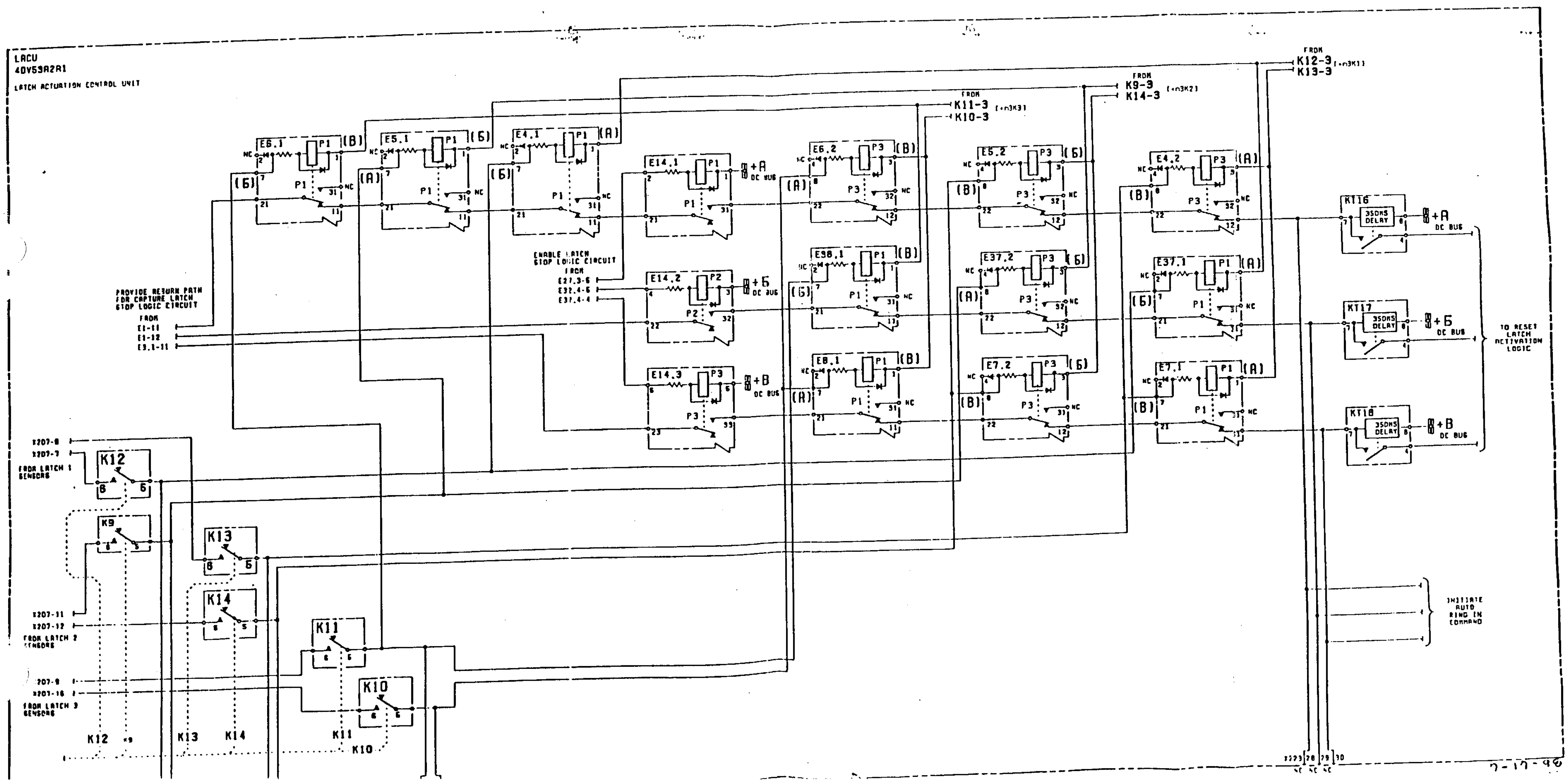

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Figure 50 D continued

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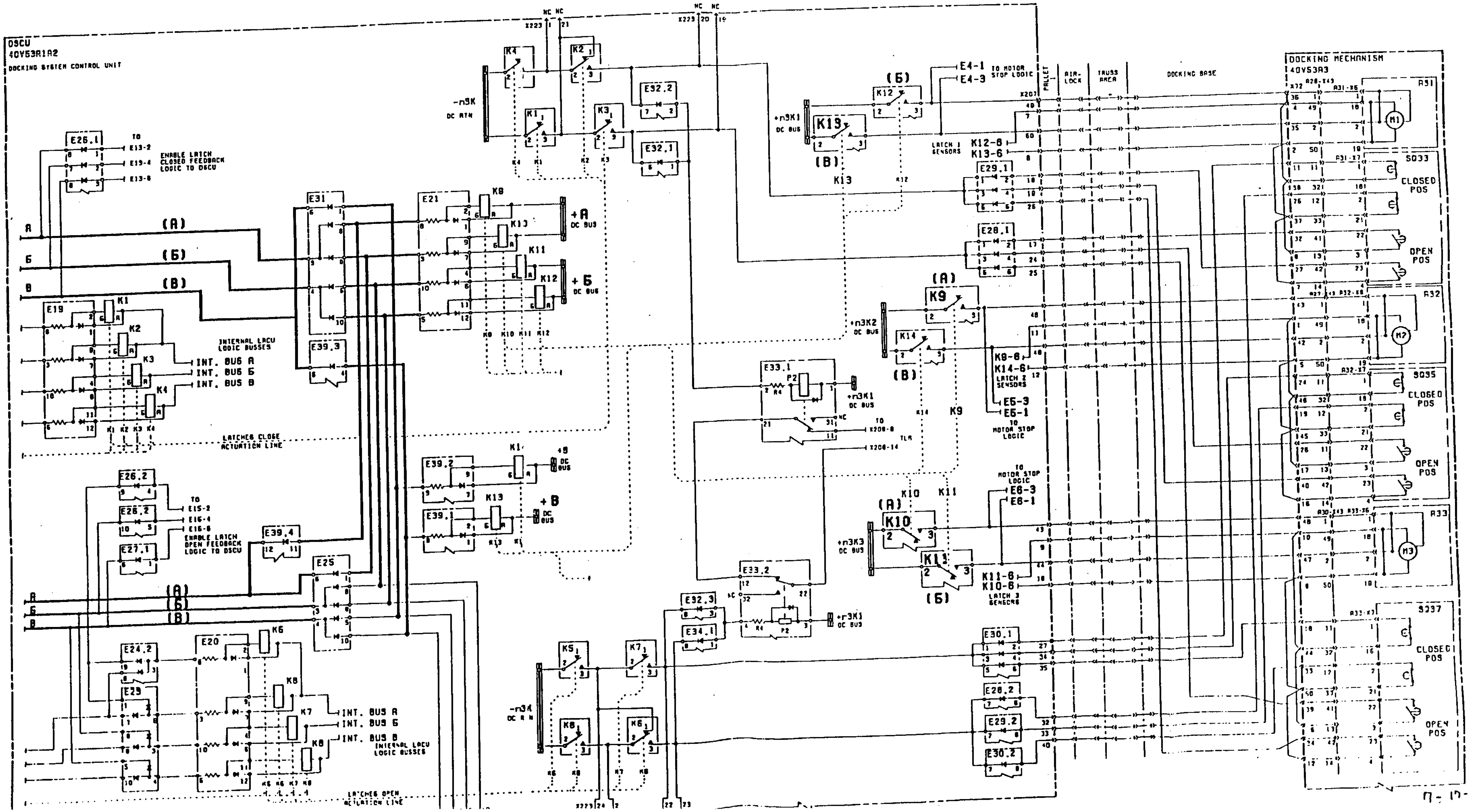

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Appendix VI

60. DOCKING MECHANISM CONTROL UNIT

60.1 SCOPE

This appendix defines the detailed requirements for the Docking Mechanism Control Unit (DMCU).

60.2 APPLICABLE DOCUMENTS

N/A

60.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

60.3.1 Item Definition

The Docking Mechanism Control Unit shall provide controls to the Capture Extend-Retract Motors of the APDA.

60.3.1.1 Item Diagram

A functional block diagram of the Docking Mechanism Control Unit is illustrated in Figure 60-A.

60.3.1.2 Interface Definition

The functional and physical interface requirements between the Docking Mechanism Control Unit, other EDS boxes and the Orbiter Avionics are defined in the following paragraphs.

60.3.1.2.1 Mechanical Characteristics

60.3.1.2.1.1 Mounting

Provisions for mounting the Docking Mechanism Control Unit shall be as shown in Figure 60-B.

60.3.1.2.1.2 Connectors

The Docking Mechanism Control Unit shall have connectors located as shown in Figure 60-B, with pin assignments as shown in Table 60-C.

60.3.1.3 Item Identification

The Docking Mechanism Control Unit shall be identified as follows:

Nomenclature	Buyer Control No.	Seller Part No.	Traceability Classification	Maintenance Level
DMCU	MC621-0087-0005	33U.5212.011	Ts	LRU

60.3.2 Characteristics

60.3.2.1 Performance Characteristics

The DMCU shall provide the means to perform the functions allocated to it, in concert with the other avionics LRUs provided by the Seller, to achieve optimal mating and demating of the ISSA with the Orbiter.

60.3.2.1.1 Life Requirements

The requirements in 3.2.1.1 of the basic specification apply.

60.3.2.1.2 Design Approach

The requirements in 3.2.1.2 of the basic specification apply.

60.3.2.1.3 Signal Characteristics

Characteristics of signals that are unique to the Docking Mechanism Control Unit are as follows:

TBS

60.3.2.2 Physical Characteristics

60.3.2.2.1 Envelope

The Docking Mechanism Control Unit shall have an envelope as defined in Figure 60-B.

60.3.2.2.2 Weight

The weight of the Docking Mechanism Control Unit shall not exceed 6.6 lbs.

60.3.2.3 Reliability

The requirements of 3.2.3 of the basic specification apply.

60.3.2.4 Environment

The requirements of 3.2.5.1.2 and 3.2.5.2.2 of the basic specification apply.

60.3.2.5 Transportability

The requirements of 3.2.6 of the basic specification apply.

60.3.3 Design and Construction

The requirements of 3.3 of the basic specification apply, except that the following paragraph takes precedence over 3.3.3.2.1.

60.3.3.1 Power Consumption

Power consumed by the DMCU shall not exceed 13.5 watts.

60.4 QUALITY ASSURANCE PROVISIONS

60.4.1 General Requirements

The requirements of 4.1 of the basic specification apply.

60.4.2 Quality Conformance

60.4.2.1 Development

The requirements in 4.2.1 of the basic specification apply.

60.4.2.2 Acceptance

Acceptance tests and inspections shall be performed on the DMCU, to be employed on the delivered units to the Buyer. The minimum number of tests and inspections, and the sequence thereof shall be as specified in Table 60-A. The Seller shall perform any other test deemed necessary, subject to approval of the Buyer.

Table 60-A. Acceptance Requirements

Inspection & Test	Paragraph Listed in Recommended Sequence
Examination of Product	60.4.2.2.1
Functional & Performance Test	60.4.2.2.2
Insulation Resistance Test	60.4.2.2.2.1
Dielectric Strength Test	60.4.2.2.2.2
Acceptance Vibration Test	60.4.2.2.3
Acceptance Thermal Test	60.4.2.2.4
Acceptance Humidity Test	60.4.2.4.5
Functional & Performance Recheck	60.4.2.2.2

60.4.2.2.1 Examination of Product

The requirements in 4.2.2.1 of the basic specification apply.

60.4.2.2.2 Functional and Performance Tests

The requirements in 4.2.2.2 of the basic specification apply.

60.4.2.2.2.1 Insulation Resistance Test

The requirements in 4.2.2.2.1 of the basic specification apply.

60.4.2.2.2.2 Dielectric Strength Test

The requirements in 4.2.2.2.2 of the basic specification apply.

60.4.2.2.3 Acceptance Vibration Test (AVT)

Acceptance vibration tests shall be per the requirements in 4.2.2.3 of the basic specification.

60.4.2.2.4 Acceptance Thermal Test (ATT)

The requirements in 4.2.2.4 of the basic specification apply, except that the DMCU shall be exposed to the maximum and minimum operating temperatures for a duration of not less than 3 hours. Rate of change shall not exceed 240 °F (133.3 °C) per hour, nor be less than 60 °F (33.3 °C) per hour. The thermal exposure may be performed by cycling from one extreme to the other, or by separate tests with a performance test between exposures.

60.4.2.2.5 Acceptance Humidity Test

The requirements in 4.2.2.5 of the basic specification apply.

60.4.2.3 Assessment

The requirements in 4.2.3 of the basic specification apply.

60.4.2.3.1 Reliability

The requirements in 4.2.3.1 of the basic specification apply.

60.4.2.3.2 Materials and Processes

The requirements in 4.2.3.2 of the basic specification apply.

60.4.2.3.3 Parts Standardization

The requirements in 4.2.3.3 of the basic specification apply.

60.4.2.3.4 Electrical Design Requirements

The requirements in 4.2.3.4 of the basic specification apply.

60.4.2.3.5 Interchangeability

The requirements in 4.2.3.5 of the basic specification apply.

60.4.2.3.6 Human Performance/Human Engineering

The requirements in 4.2.3.6 of the basic specification apply.

60.4.2.3.7 Safety

The requirements in 4.2.3.7 of the basic specification apply.

60.4.2.3.8 Identification and Marking

The requirements in 4.2.3.8 of the basic specification apply.

60.4.2.4 Certification

The requirements in 4.2.4 of the basic specification apply.

60.4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements specified in the performance and design verification matrix of Section 4 (Table V) shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in Table 60-B.

Table 60-B. Acceptance Requirements

Test sequence	Paragraph
Acceptance Test	60.4.2.2
Performance Test	60.4.2.4.1.2
Transportation Test	60.4.2.4.1.11
Power Test	60.4.2.4.1.7
Vibration	60.4.2.4.1.4
Shock	60.4.2.4.1.6
Acceleration	60.4.2.4.1.5
Thermal Vacuum Test	60.4.2.4.1.10
Qualification Humidity Test	60.4.2.4.1.3
* EMC Test	60.4.2.4.1.9
Life Test	60.4.2.4.1.12
Final Performance Test	60.4.2.4.1.2

* Test and analysis will be conducted and documented by Buyer.

60.4.2.4.1.1 Test Hardware

Qualification test hardware shall be of the same configuration as flight hardware.

60.4.2.4.1.2 Performance Requirements

The requirements in 4.2.4.1.2 of the basic specification apply.

60.4.2.4.1.3 Qualification Humidity Test

The requirements in 4.2.4.1.3 of the basic specification apply.

60.4.2.4.1.4 Vibration.

60.4.2.4.1.4.1 Qualification - Acceptance Vibration Test (QAVT)

The requirements in 4.2.4.1.4.1 of the basic specification apply.

60.4.2.4.1.5 Acceleration

The requirements in 4.2.4.1.5 of the basic specification apply.

60.4.2.4.1.6 Shock

The requirements in 4.2.4.1.6 of the basic specification apply.

60.4.2.4.1.7 Power Test

The requirements in 4.2.4.1.7 of the basic specification apply. Power tests may be verified as part of the Functional/Performance tests.

60.4.2.4.1.8 Lightning

The requirements in 4.2.4.2.12 of the basic specification apply.

60.4.2.4.1.9 Electromagnetic Compatibility Tests

The requirements in 4.2.4.1.9 of the basic specification apply.

60.4.2.4.1.10 Thermal Vacuum Test

The requirements in 4.2.4.1.10 of the basic specification apply except that the first four cycles are performed at ambient pressure, and circuit monitoring may be limited due to operating life of DMCU.

60.4.2.4.1.11 Transportation Test

The requirements in 4.2.4.1.11 of the basic specification apply.

60.4.2.4.1.12 Operating Life Test

The requirements in 4.2.4.1.12 of the basic specification apply.

60.4.2.4.2 Certification By Analysis

The requirements in 4.2.4.2 of the basic specification apply.

60.4.2.4.2.1 Storage/Operating Life

The requirements in 4.2.4.2.1 of the basic specification apply.

60.4.2.4.2.2 Physical Characteristics

The requirements in 4.2.4.2.2 of the basic specification apply.

60.4.2.4.2.3 Reliability

The requirements in 4.2.4.2.3 of the basic specification apply.

60.4.2.4.2.4 Salt Fog

The requirements in 4.2.4.2.4 of the basic specification apply.

60.4.2.4.2.5 Ozone

The requirements in 4.2.4.2.5 of the basic specification apply.

60.4.2.4.2.6 Fungus

The requirements in 4.2.4.2.6 of the basic specification apply.

60.4.2.4.2.7 Materials and Processes

The requirements in 4.2.4.2.7 of the basic specification apply.

60.4.2.4.2.8 Electromagnetic Compatibility

The requirements in 4.2.4.2.8 of the basic specification apply.

60.4.2.4.2.9 Electrical Design Requirements

The requirements in 4.2.4.2.9 of the basic specification apply.

60.4.2.4.2.10 Safety

The requirements in 4.2.4.2.10 of the basic specification apply.

60.4.2.4.2.11 Sand and Dust

The requirements in 4.2.4.2.11 of the basic specification apply.

60.4.2.4.2.12 Certification by Other Test Data

The requirements in 4.2.4.2.12 of the basic specification apply.

60.4.2.5 Verification Requirements Matrices

The requirements in 4.2.5 of the basic specification apply.

60.5 PREPARATION FOR DELIVERY

The requirements in Section 5 of the basic specification apply.

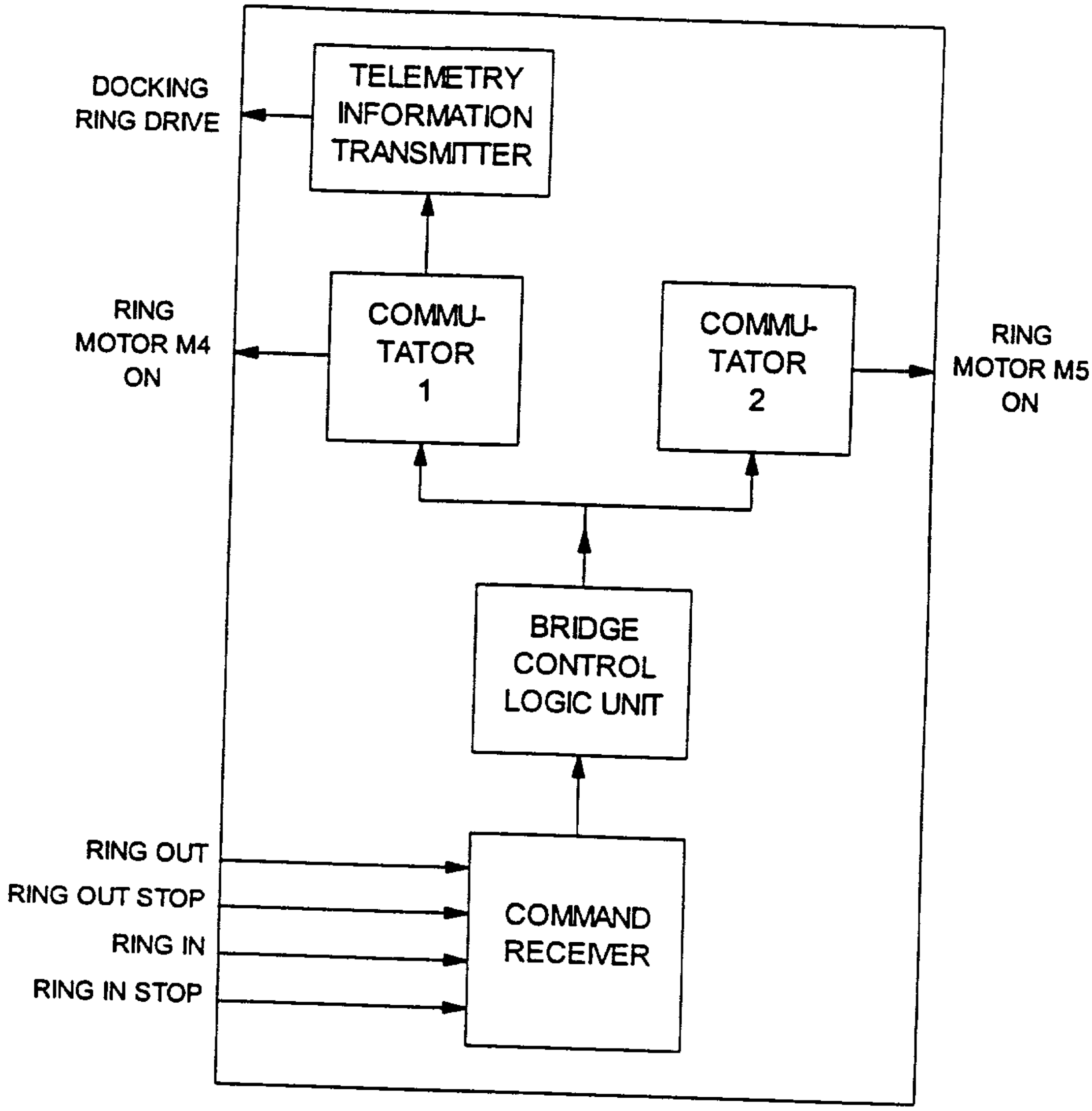

Figure 60-A. A functional block diagram of the DMCU

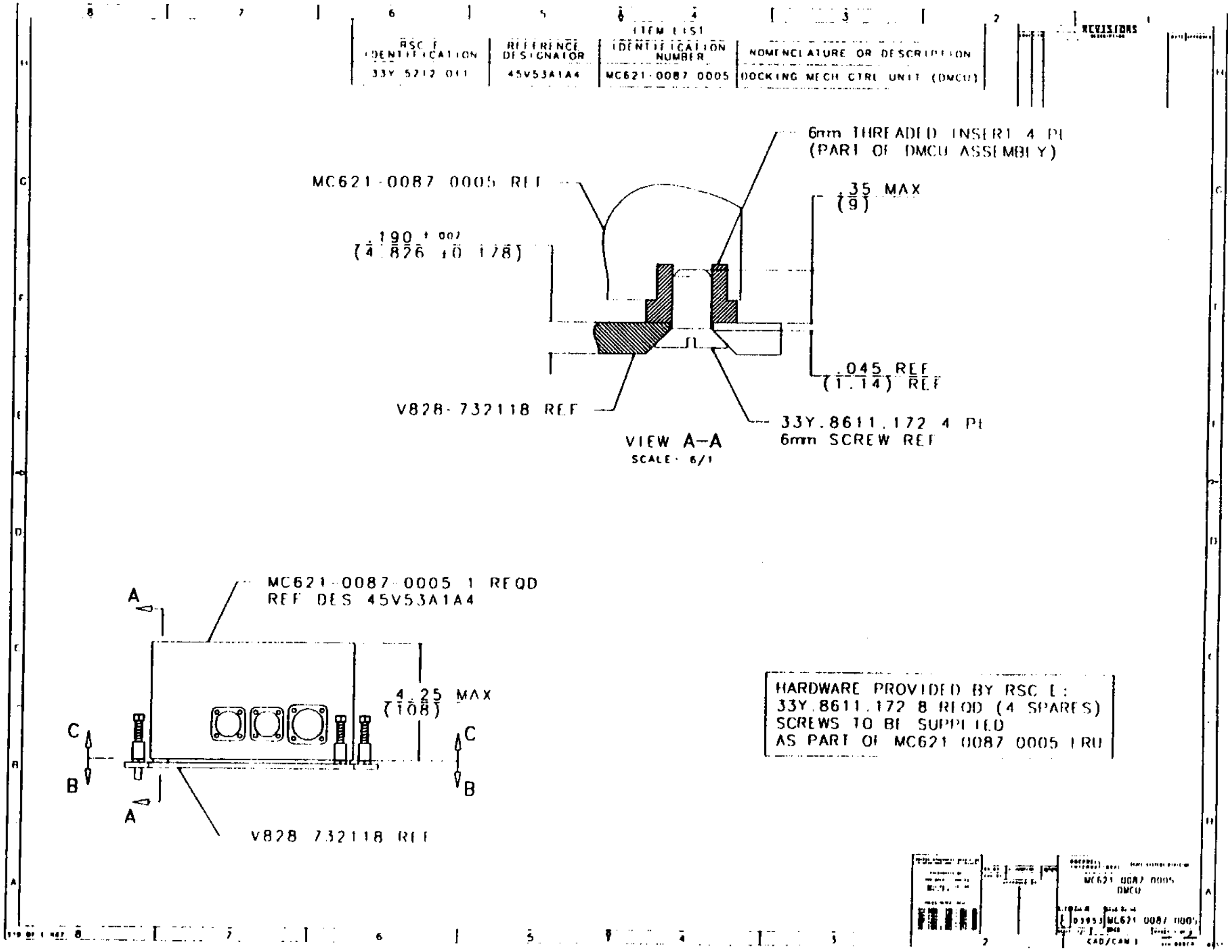

Figure 60-B. DMCU mounting and connectors location diagram (1 of 2)

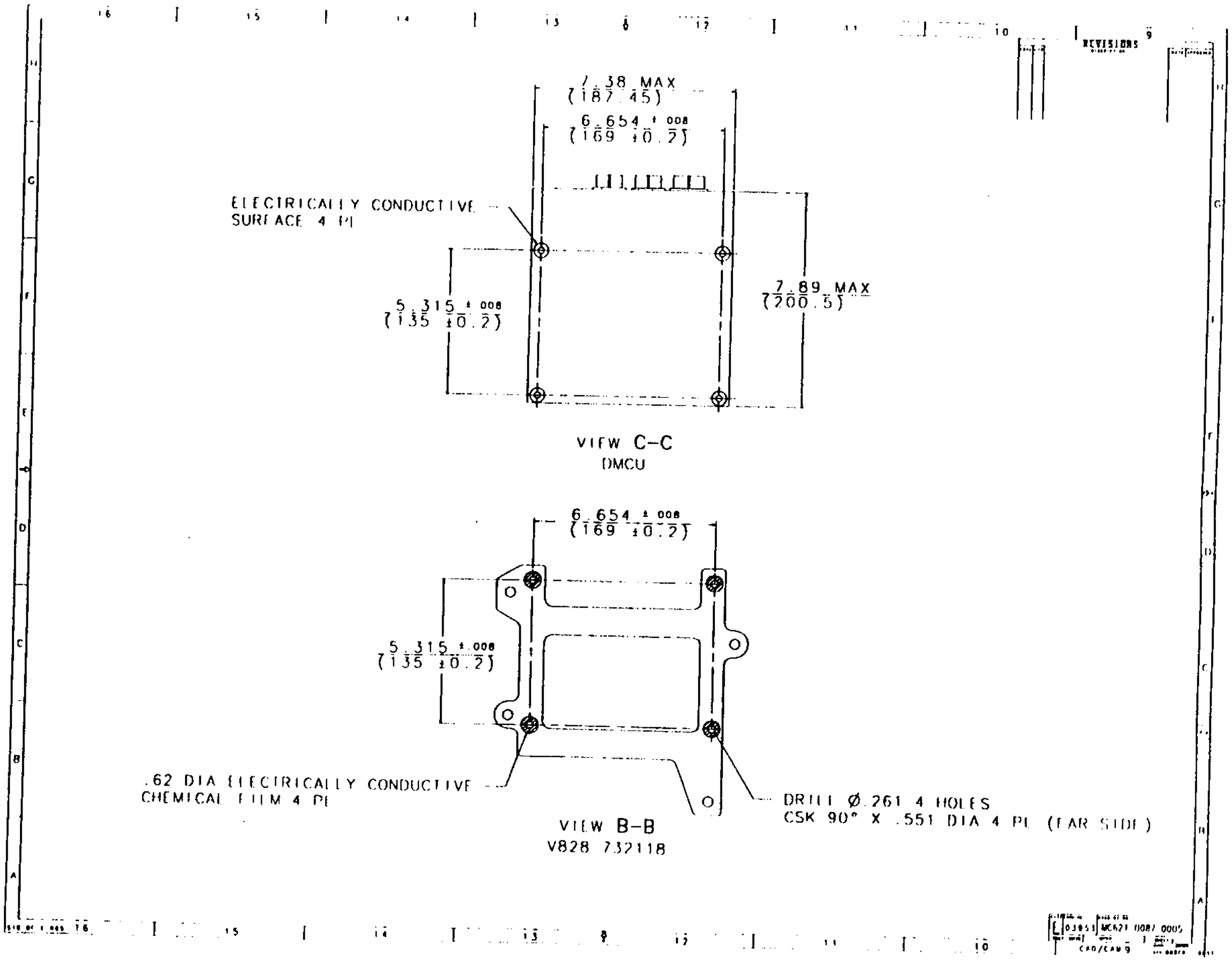

Figure 60-B. DMCU mounting and connectors location diagram (2 of 2)

Table 60-C. DMCU Pin Assignments

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DMCU	X201	2	PWR SUP TO RING MTR (M4)	A/L FL
DMCU	X201	4	PWR SUP TO RING MTR (M4)	A/L FL
DMCU	X201	7	PWR SUP TO RING MTR (M5)	A/L FL
DMCU	X201	9	PWR SUP TO RING MTR (M5)	A/L FL
DMCU	X201	23	PWR SUP TO RING MTR (M5)	A/L FL
DMCU	X201	27	PWR SUP TO RING MTR (M4)	A/L FL
DMCU	X201	29	PWR SUP TO RING MTR (M5)	A/L FL
DMCU	X201	32	PWR SUP TO RING MTR (M4)	A/L FL
DMCU	X202	1	RING OUT CMD	I/P
DMCU	X202	3	RING OUT STOP CMD	I/P
DMCU	X202	4	RING OUT STOP CMD	I/P
DMCU	X202	5	RING OUT CMD	I/P
DMCU	X202	6	RING OUT CMD	I/P
DMCU	X202	8	RING IN CMD	I/P
DMCU	X202	10	RING OUT STOP CMD	I/P
DMCU	X202	11	DC RTN	I/P
DMCU	X202	13	DC RTN JPR	I/P
DMCU	X202	14	RING IN CMD	I/P
DMCU	X202	15	RING IN CMD	I/P
DMCU	X202	17	RING IN STOP CMD	I/P
DMCU	X202	18	DC RTN JPR	I/P
DMCU	X202	19	RING OUT CONTROL CKT	JP (RSC-E)
DMCU	X202	20	ACTUAT OF DCKNG RING DRV	I/P
DMCU	X202	21	RING OUT CONTROL CKT	JP (RSC-E)
DMCU	X202	22	RING OUT CONTROL CKT	JP (RSC-E)
DMCU	X202	24	RING IN STOP CMD	I/P
DMCU	X202	25	RING IN STOP CMD	I/P
DMCU	X202	27	RING OUT CONTROL CKT	JP (RSC-E)
DMCU	X202	40	RING OUT CONTROL CKT	JP (RSC-E)
DMCU	X202	46	RING OUT CONTROL CKT	JP (RSC-E)
DMCU	X202	47	RING OUT CONTROL CKT	JP (RSC-E)
DMCU	X202	48	RING OUT CONTROL CKT	JP (RSC-E)
DMCU	X203	1	DC BUS	I/P
DMCU	X203	2	DC BUS	I/P
DMCU	X203	3	DC BUS	I/P
DMCU	X203	4	DC BUS	I/P
DMCU	X203	5	DC BUS	I/P
DMCU	X203	6	DC BUS	I/P
DMCU	X203	7	DC BUS	I/P
DMCU	X203	8	DC BUS	I/P
DMCU	X203	9	DC BUS	I/P
DMCU	X203	10	DC BUS	I/P
DMCU	X203	12	DC BUS	I/P
DMCU	X203	13	DC BUS	I/P
DMCU	X203	15	DC BUS	I/P

Table 60-C. DMCU Pin Assignments (concluded)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DMCU	X203	24	DC RTN	I/P
DMCU	X203	26	DC RTN	I/P
DMCU	X203	27	DC RTN	I/P
DMCU	X203	28	DC RTN	I/P
DMCU	X203	30	DC RTN	I/P
DMCU	X203	31	DC RTN	I/P
DMCU	X203	32	DC RTN	I/P

Appendix VII

70. PYRO FIRING CONTROL UNIT

70.1 SCOPE

This appendix defines the detailed requirements for the Pyro Firing Control Unit (PFCU).

70.2 APPLICABLE DOCUMENTS

N/A

70.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

70.3.1 Item Definition

The Pyro Firing Control Unit shall consist of switching controls for the Pressure I/F Latches Pyro Release Bolts.

70.3.1.1 Item Diagram

A functional block diagram of the Pyro Firing Control Unit is illustrated in Figure 70-A.

70.3.1.2 Interface Definition

The functional and physical interface requirements between the Pyro Firing Control Unit, other EDS boxes, and the Orbiter Avionics are defined in the following paragraphs.

70.3.1.2.1 Electrical Power Characteristics

The electrical power characteristics shall be in accordance with the requirements in 3.1.2.1 of the basic specification except as follows.

70.3.1.2.1.1 Insulation Resistance

The requirements of 3.1.2.1.6.5 of the basic specification apply except test at 30 Vdc.

70.3.1.2.1.2 Dielectric Strength

The requirements of 3.1.2.1.6.6 of the basic specification apply except test at 200 Vac.

70.3.1.2.1.3 Mechanical Characteristics

70.3.1.2.1.4 Mounting

Provisions for mounting the Pyro Firing Control Unit shall be as shown in Figure 70-B.

70.3.1.2.1.5 Connectors

The Pyro Firing Control Unit shall have connectors located as shown in Figure 70-B, with pin assignments as shown in Table 70-C.

70.3.1.3 Item Identification

The Pyro Firing Control Unit shall be identified as follows:

Nomenclature	Buyer Control No.	Seller Part No.	Traceability Classification	Maintenance Level
PFCU	MC621-0087-0006	17KS.10Yu 2601-0A		Ts LRU

70.3.1.3.1.1 Characteristics

70.3.1.4 Performance Characteristics

The PFCU shall provide the means to perform the functions allocated to it, in concert with the other avionics LRUs provided by the Seller, to achieve optimal mating and demating of the ISSA with the Orbiter.

70.3.1.4.1 Life Requirements

The Pyro Firing Control Unit shall have a minimum service life without failure of:

Actual pyro firing cycles: 1
Ground test current cycles: 9000

70.3.1.4.2 Design Approach

The requirements in 3.2.1.2 of the basic specification apply.

70.3.1.4.3 Signal Characteristics

Characteristics of signals that are unique to the Pyro Firing Control Unit are as follows:

TBS

70.3.1.5 Physical Characteristics

70.3.1.5.1 Envelope

The Pyro Firing Control Unit shall have an envelope as defined in Figure 70-B.

70.3.1.5.2 Weight

The weight of the Pyro Firing Control Unit shall not exceed 15.6 lbs.

70.3.1.6 Reliability

The requirements of 3.2.3 of the basic specification apply.

70.3.1.7 Environment

The requirements of 3.2.5.1.2 and 3.2.5.2.2 of the basic specification apply.

70.3.1.8 Transportability

The requirements of 3.2.6 the basic specifications of shall apply.

70.3.2 Design and Construction

The requirements of 3.3 of the basic specification apply, except the following paragraph shall take precedence over 3.3.3.2.1.

70.3.2.1 Power Consumption

Power consumed by the PFCU shall not exceed 56.7 watts except during pyro firing. Maximum allowable power consumption for the entire EDS during pyro firing is specified in 3.3.2.1b.

70.4 QUALITY ASSURANCE PROVISIONS

70.4.1 General Requirements

The requirements of 4.1 of the basic specification apply.

70.4.2 Quality Conformance

70.4.2.1 Development

The requirements in 4.2.1 of the basic specification apply.

70.4.2.2 Acceptance

Acceptance tests and inspections shall be performed on the PFCU, to be employed on the delivered units to the Buyer. The minimum number of tests and inspections, and the sequence thereof shall be as specified in Table 70-A. The Seller shall perform any other test deemed necessary, subject to approval of the Buyer.

Table 70-A. Acceptance Requirements

Inspection & Test	Paragraph Listed in Recommended Sequence
Examination of Product	70.4.2.2.1
Functional & Performance Test	70.4.2.2.2
Insulation Resistance Test	70.4.2.2.2.1
Dielectric Strength Test	70.4.2.2.2.2
Acceptance Vibration Test	70.4.2.2.3
Acceptance Thermal Test	70.4.2.2.4
Acceptance Humidity Test	70.4.2.2.5
Functional & Performance Recheck	70.4.2.2.2

70.4.2.2.1 Examination of Product

The requirements in 4.2.2.1 of the basic specification apply.

70.4.2.2.2 Functional and Performance Tests

The requirements in 4.2.2.2 of the basic specification apply.

70.4.2.2.2.1 Insulation Resistance Test

The requirements in 4.2.2.2.1 of the basic specification apply.

70.4.2.2.2.2 Dielectric Strength Test

The requirements in 4.2.2.2.2 of the basic specification apply.

70.4.2.2.3 Acceptance Vibration Test (AVT)

Acceptance vibration tests shall be per the requirements in 4.2.2.3 of the basic specification.

70.4.2.2.4 Acceptance Thermal Test (ATT)

The requirements in 4.2.2.4 of the basic specification apply, except that the PFCU shall be exposed to a temperature of 109 to 118 °F (43 to 48 °C) for not less than 3 hours. The PFCU shall be exposed to a temperature of zero to 8 °F (minus 18 to minus 13 °C) for not less than 5 hours. The thermal exposure may be performed by cycling from one extreme to the other, or by separate tests with a performance test between exposures.

70.4.2.2.5 Acceptance Humidity Test

The requirements in 4.2.2.5 of the basic specification apply.

70.4.2.3 Assessment

The requirements in 4.2.3 of the basic specification apply.

70.4.2.3.1 Reliability

The requirements in 4.2.3.1 of the basic specification apply.

70.4.2.3.2 Materials and Processes

The requirements in 4.2.3.2 of the basic specification apply.

70.4.2.3.3 Parts Standardization

The requirements in 4.2.3.3 of the basic specification apply.

70.4.2.3.4 Electrical Design Requirements

The requirements in 4.2.3.4 of the basic specification apply.

70.4.2.3.5 Interchangeability

The requirements in 4.2.3.5 of the basic specification apply.

70.4.2.3.6 Human Performance/Human Engineering

The requirements in 4.2.3.6 of the basic specification apply.

70.4.2.3.7 Safety

The requirements in 4.2.3.7 of the basic specification apply.

70.4.2.3.8 Identification and Marking

The requirements in 4.2.3.8 of the basic specification apply.

70.4.2.4 Certification

The requirements in 4.2.4 of the basic specification apply.

70.4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements specified in the performance and design verification matrix of Section 4, Table V shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in Table 70-B.

Table 70-B. Acceptance Requirements

Inspection & Test	Paragraph Listed in Recommended Sequence
Acceptance Test	70.4.2.2
Performance Test	70.4.2.4.1.2
Transportation Test	70.4.2.4.1.11
Power Test	70.4.2.4.1.7
Vibration	70.4.2.4.1.4
Shock	70.4.2.4.1.6
Acceleration	70.4.2.4.1.5
Thermal Vacuum Test	70.4.2.4.1.10
Qualification Humidity Test	70.4.2.4.1.3
* EMC Test	70.4.2.4.1.9
Life Test	70.4.2.4.1.12
Final Performance Test	70.4.2.4.1.2

* Test and analysis will be conducted and documented by Buyer.

70.4.2.4.1.1 Test Hardware

Qualification test hardware shall be of the same configuration as flight hardware.

70.4.2.4.1.2 Performance Requirements

The requirements in 4.2.4.1.2 of the basic specification apply.

70.4.2.4.1.3 Qualification Humidity Test

The requirements in 4.2.4.1.3 of the basic specification apply.

70.4.2.4.1.4 Vibration

70.4.2.4.1.4.1 Qualification - Acceptance Vibration Test (QAVT)

The requirements in 4.2.4.1.4.1 of the basic specification apply.

70.4.2.4.1.5 Acceleration

The requirements in 4.2.4.1.5 of the basic specification apply.

70.4.2.4.1.6 Shock

The requirements in 4.2.4.1.6 of the basic specification apply.

70.4.2.4.1.7 Power Test

The requirements in 4.2.4.1.7 of the basic specification apply. Power tests may be verified as part of the Functional/Performance tests.

70.4.2.4.1.8 Lightning

The requirements in 4.2.4.2.12 of the basic specification apply.

70.4.2.4.1.9 Electromagnetic Compatibility Tests

The requirements in 4.2.4.1.9 of the basic specification apply.

70.4.2.4.1.10 Thermal Vacuum Test

The requirements in 4.2.4.1.10 of the basic specification apply except that the first four cycles are performed at ambient pressure, and circuit monitoring may be limited due to operating life of PFCU.

70.4.2.4.1.11 Transportation Test

The requirements in 4.2.4.1.11 of the basic specification apply.

70.4.2.4.1.12 Operating Life Test

The requirements in 4.2.4.1.12 of the basic specification apply.

70.4.2.4.2 Certification By Analysis

The requirements in 4.2.4.2 of the basic specification apply.

70.4.2.4.2.1 Storage/Operating Life

The requirements in 4.2.4.2.1 of the basic specification apply.

70.4.2.4.2.2 Physical Characteristics

The requirements in 4.2.4.2.2 of the basic specification apply.

70.4.2.4.2.3 Reliability

The requirements in 4.2.4.2.3 of the basic specification apply.

70.4.2.4.2.4 Salt Fog

The requirements in 4.2.4.2.4 of the basic specification apply.

70.4.2.4.2.5 Ozone

The requirements in 4.2.4.2.5 of the basic specification apply.

70.4.2.4.2.6 Fungus

The requirements in 4.2.4.2.6 of the basic specification apply.

70.4.2.4.2.7 Materials and Processes

The requirements in 4.2.4.2.7 of the basic specification apply.

70.4.2.4.2.8 Electromagnetic Compatibility

The requirements in 4.2.4.2.8 of the basic specification apply.

70.4.2.4.2.9 Electrical Design Requirements

The requirements in 4.2.4.2.9 of the basic specification apply.

70.4.2.4.2.10 Safety

The requirements in 4.2.4.2.10 of the basic specification apply.

70.4.2.4.2.11 Sand and Dust

The requirements in 4.2.4.2.11 of the basic specification apply.

70.4.2.4.2.12 Certification by Other Test Data

The requirements in 4.2.4.2.12 of the basic specification apply.

70.4.2.5 Verification Requirements Matrices

The requirements in 4.2.5 of the basic specification apply.

70.5 PREPARATION FOR DELIVERY

The requirements in Section 5 of the basic specification apply.

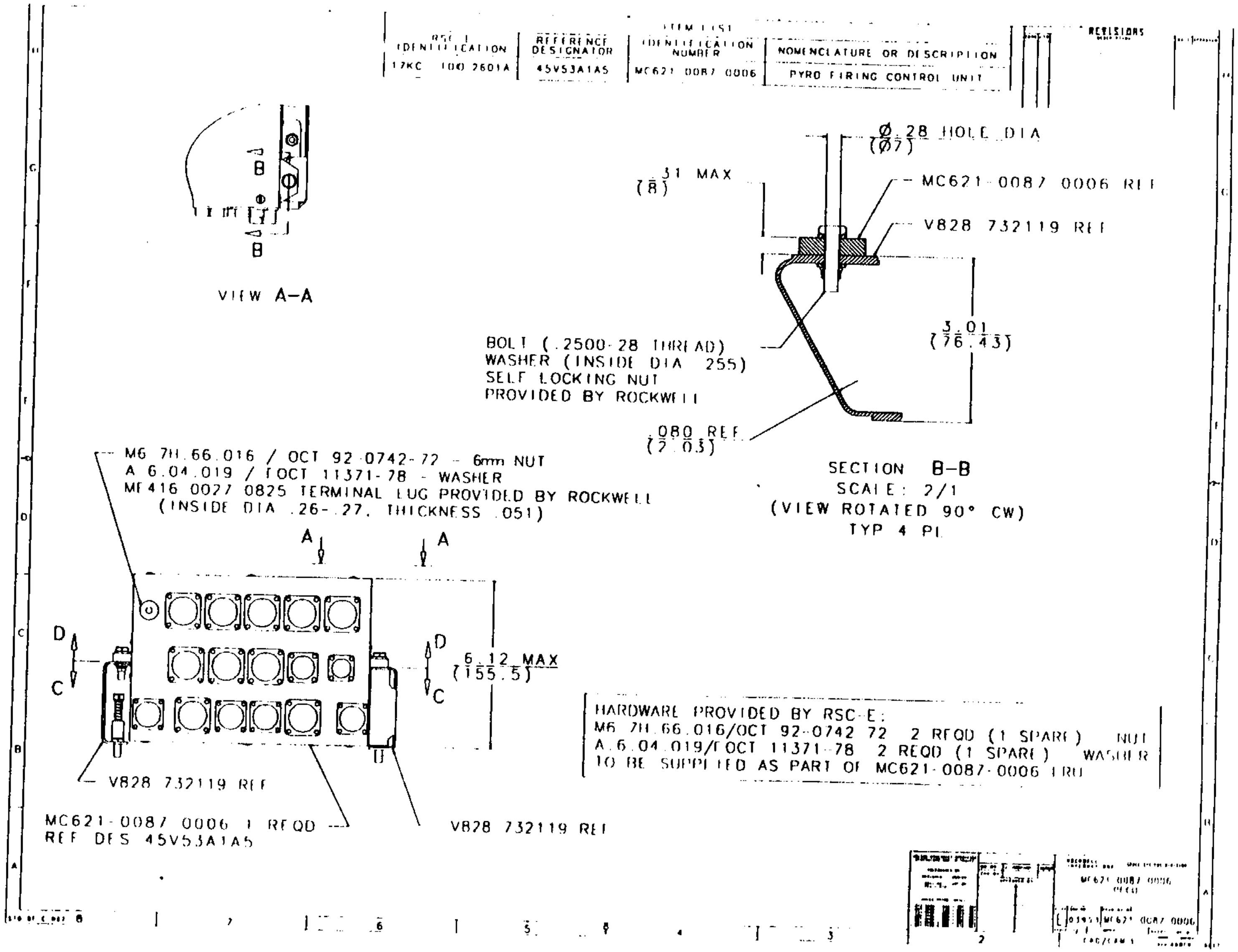

Figure 70-A. A functional block diagram of the PFCU (1 of 2)

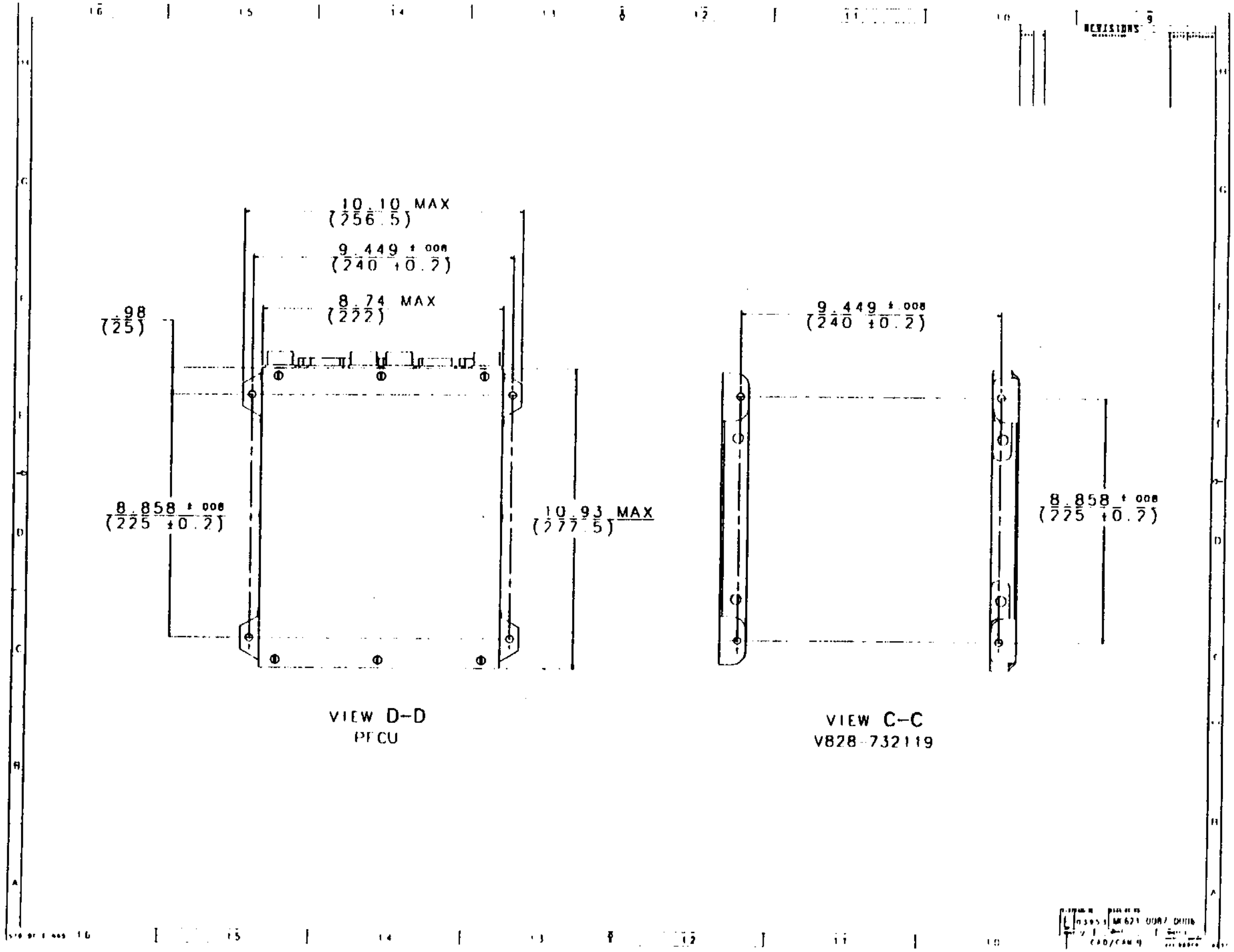

Figure 70-A. A functional block diagram of the PFCU (2 of 2)

Table 70-B. PFCU Pin Assignments

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PFCU	X1201	1	PYRO 1 ACTIVE HOOK ASSY NO. 1 +	A/L FL
PFCU	X1201	2	PYRO 1 ACTIVE HOOK ASSY NO. 7 +	A/L FL
PFCU	X1201	3	PYRO 1 ACTIVE HOOK ASSY NO. 5 +	A/L FL
PFCU	X1201	4	PYRO 1 ACTIVE HOOK ASSY NO. 11 +	A/L FL
PFCU	X1201	5	PYRO 1 ACTIVE HOOK ASSY NO. 9 +	A/L FL
PFCU	X1201	6	PYRO 1 ACTIVE HOOK ASSY NO. 3 +	A/L FL
PFCU	X1201	7	PYRO 1 ACTIVE HOOK ASSY NO. 2 +	A/L FL
PFCU	X1201	8	PYRO 1 ACTIVE HOOK ASSY NO. 8 +	A/L FL
PFCU	X1201	9	PYRO 1 ACTIVE HOOK ASSY NO. 6 +	A/L FL
PFCU	X1201	10	PYRO 1 ACTIVE HOOK ASSY NO. 12 +	A/L FL
PFCU	X1201	11	PYRO 1 ACTIVE HOOK ASSY NO. 10 +	A/L FL
PFCU	X1201	12	PYRO 1 ACTIVE HOOK ASSY NO. 4 +	A/L FL
PFCU	X1201	21	X55 CONN TEST	A/L FL
PFCU	X1201	22	X55 CONN TEST	A/L FL
PFCU	X1201	23	X55 CONN TEST	A/L FL
PFCU	X1201	24	X55 CONN TEST	A/L FL
PFCU	X1201	25	X55 CONN TEST	A/L FL
PFCU	X1201	26	X55 CONN TEST	A/L FL
PFCU	X1201	31	PYRO 1 ACTIVE HOOK ASSY NO. 1 -	A/L FL
PFCU	X1201	32	PYRO 1 ACTIVE HOOK ASSY NO. 7 -	A/L FL
PFCU	X1201	33	PYRO 1 ACTIVE HOOK ASSY NO. 5 -	A/L FL
PFCU	X1201	34	PYRO 1 ACTIVE HOOK ASSY NO. 11 -	A/L FL
PFCU	X1201	35	PYRO 1 ACTIVE HOOK ASSY NO. 9 -	A/L FL
PFCU	X1201	36	PYRO 1 ACTIVE HOOK ASSY NO. 3 -	A/L FL
PFCU	X1201	37	PYRO 1 ACTIVE HOOK ASSY NO. 2 -	A/L FL
PFCU	X1201	38	PYRO 1 ACTIVE HOOK ASSY NO. 8 -	A/L FL
PFCU	X1201	39	PYRO 1 ACTIVE HOOK ASSY NO. 6 -	A/L FL
PFCU	X1201	40	PYRO 1 ACTIVE HOOK ASSY NO. 12 -	A/L FL
PFCU	X1201	41	PYRO 1 ACTIVE HOOK ASSY NO. 10 -	A/L FL
PFCU	X1201	42	PYRO 1 ACTIVE HOOK ASSY NO. 4 -	A/L FL
PFCU	X1202	1	PYRO 2 ACTIVE HOOK ASSY NO. 1 +	A/L FL
PFCU	X1202	2	PYRO 2 ACTIVE HOOK ASSY NO. 7 +	A/L FL
PFCU	X1202	3	PYRO 2 ACTIVE HOOK ASSY NO. 5 +	A/L FL
PFCU	X1202	4	PYRO 2 ACTIVE HOOK ASSY NO. 11 +	A/L FL
PFCU	X1202	5	PYRO 2 ACTIVE HOOK ASSY NO. 9 +	A/L FL
PFCU	X1202	6	PYRO 2 ACTIVE HOOK ASSY NO. 3 +	A/L FL
PFCU	X1202	7	PYRO 2 ACTIVE HOOK ASSY NO. 2 +	A/L FL
PFCU	X1202	8	PYRO 2 ACTIVE HOOK ASSY NO. 8 +	A/L FL
PFCU	X1202	9	PYRO 2 ACTIVE HOOK ASSY NO. 6 +	A/L FL
PFCU	X1202	10	PYRO 2 ACTIVE HOOK ASSY NO. 12 +	A/L FL
PFCU	X1202	11	PYRO 2 ACTIVE HOOK ASSY NO. 10 +	A/L FL
PFCU	X1202	12	PYRO 2 ACTIVE HOOK ASSY NO. 4 +	A/L FL
PFCU	X1202	21	X65 CONN TEST	A/L FL
PFCU	X1202	22	X65 CONN TEST	A/L FL
PFCU	X1202	23	X65 CONN TEST	A/L FL
PFCU	X1202	24	X65 CONN TEST	A/L FL
PFCU	X1202	25	X65 CONN TEST	A/L FL
PFCU	X1202	26	X65 CONN TEST	A/L FL
PFCU	X1202	31	PYRO 2 ACTIVE HOOK ASSY NO. 1 -	A/L FL

Table 70-B. PFCU Pin Assignments (Continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PFCU	X1202	32	PYRO 2 ACTIVE HOOK ASSY NO. 7 -	A/L FL
PFCU	X1202	33	PYRO 2 ACTIVE HOOK ASSY NO. 5 -	A/L FL
PFCU	X1202	34	PYRO 2 ACTIVE HOOK ASSY NO. 11 -	A/L FL
PFCU	X1202	35	PYRO 2 ACTIVE HOOK ASSY NO. 9 -	A/L FL
PFCU	X1202	36	PYRO 2 ACTIVE HOOK ASSY NO. 3 -	A/L FL
PFCU	X1202	37	PYRO 2 ACTIVE HOOK ASSY NO. 2 -	A/L FL
PFCU	X1202	38	PYRO 2 ACTIVE HOOK ASSY NO. 8 -	A/L FL
PFCU	X1202	39	PYRO 2 ACTIVE HOOK ASSY NO. 6 -	A/L FL
PFCU	X1202	40	PYRO 2 ACTIVE HOOK ASSY NO. 12 -	A/L FL
PFCU	X1202	41	PYRO 2 ACTIVE HOOK ASSY NO. 10 -	A/L FL
PFCU	X1202	42	PYRO 2 ACTIVE HOOK ASSY NO. 4 -	A/L FL
PFCU	X1203	1	PYRO 1 PASSIVE HOOK ASSY NO. 1 +	A/L FL
PFCU	X1203	2	PYRO 1 PASSIVE HOOK ASSY NO. 7 +	A/L FL
PFCU	X1203	3	PYRO 1 PASSIVE HOOK ASSY NO. 5 +	A/L FL
PFCU	X1203	4	PYRO 1 PASSIVE HOOK ASSY NO. 11 +	A/L FL
PFCU	X1203	5	PYRO 1 PASSIVE HOOK ASSY NO. 9 +	A/L FL
PFCU	X1203	6	PYRO 1 PASSIVE HOOK ASSY NO. 3 +	A/L FL
PFCU	X1203	7	PYRO 1 PASSIVE HOOK ASSY NO. 2 +	A/L FL
PFCU	X1203	8	PYRO 1 PASSIVE HOOK ASSY NO. 8 +	A/L FL
PFCU	X1203	9	PYRO 1 PASSIVE HOOK ASSY NO. 6 +	A/L FL
PFCU	X1203	10	PYRO 1 PASSIVE HOOK ASSY NO. 12 +	A/L FL
PFCU	X1203	11	PYRO 1 PASSIVE HOOK ASSY NO. 10 +	A/L FL
PFCU	X1203	12	PYRO 1 PASSIVE HOOK ASSY NO. 4 +	A/L FL
PFCU	X1203	21	X56 CONN TEST	A/L FL
PFCU	X1203	22	X56 CONN TEST	A/L FL
PFCU	X1203	23	X56 CONN TEST	A/L FL
PFCU	X1203	24	X56 CONN TEST	A/L FL
PFCU	X1203	25	X56 CONN TEST	A/L FL
PFCU	X1203	26	X56 CONN TEST	A/L FL
PFCU	X1203	31	PYRO 1 PASSIVE HOOK ASSY NO. 1 -	A/L FL
PFCU	X1203	32	PYRO 1 PASSIVE HOOK ASSY NO. 7 -	A/L FL
PFCU	X1203	33	PYRO 1 PASSIVE HOOK ASSY NO. 5 -	A/L FL
PFCU	X1203	34	PYRO 1 PASSIVE HOOK ASSY NO. 11 -	A/L FL
PFCU	X1203	35	PYRO 1 PASSIVE HOOK ASSY NO. 9 -	A/L FL
PFCU	X1203	36	PYRO 1 PASSIVE HOOK ASSY NO. 3 -	A/L FL
PFCU	X1203	37	PYRO 1 PASSIVE HOOK ASSY NO. 2 -	A/L FL
PFCU	X1203	38	PYRO 1 PASSIVE HOOK ASSY NO. 8 -	A/L FL
PFCU	X1203	39	PYRO 1 PASSIVE HOOK ASSY NO. 6 -	A/L FL
PFCU	X1203	40	PYRO 1 PASSIVE HOOK ASSY NO. 12 -	A/L FL
PFCU	X1203	41	PYRO 1 PASSIVE HOOK ASSY NO. 10 -	A/L FL
PFCU	X1203	42	PYRO 1 PASSIVE HOOK ASSY NO. 4 -	A/L FL
PFCU	X1204	1	PYRO 2 PASSIVE HOOK ASSY NO. 1 +	A/L FL
PFCU	X1204	2	PYRO 2 PASSIVE HOOK ASSY NO. 7 +	A/L FL
PFCU	X1204	3	PYRO 2 PASSIVE HOOK ASSY NO. 5 +	A/L FL
PFCU	X1204	4	PYRO 2 PASSIVE HOOK ASSY NO. 11 +	A/L FL
PFCU	X1204	5	PYRO 2 PASSIVE HOOK ASSY NO. 9 +	A/L FL
PFCU	X1204	6	PYRO 2 PASSIVE HOOK ASSY NO. 3 +	A/L FL
PFCU	X1204	7	PYRO 2 PASSIVE HOOK ASSY NO. 2 +	A/L FL
PFCU	X1204	8	PYRO 2 PASSIVE HOOK ASSY NO. 8 +	A/L FL

Table 70-B. PFCU Pin Assignments (Continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PFCU	X1204	9	PYRO 2 PASSIVE HOOK ASSY NO. 6 +	A/L FL
PFCU	X1204	10	PYRO 2 PASSIVE HOOK ASSY NO. 12 +	A/L FL
PFCU	X1204	11	PYRO 2 PASSIVE HOOK ASSY NO. 10 +	A/L FL
PFCU	X1204	12	PYRO 2 PASSIVE HOOK ASSY NO. 4 +	A/L FL
PFCU	X1204	21	X66 CONN TEST	A/L FL
PFCU	X1204	22	X66 CONN TEST	A/L FL
PFCU	X1204	23	X66 CONN TEST	A/L FL
PFCU	X1204	24	X66 CONN TEST	A/L FL
PFCU	X1204	25	X66 CONN TEST	A/L FL
PFCU	X1204	26	X66 CONN TEST	A/L FL
PFCU	X1204	31	PYRO 2 PASSIVE HOOK ASSY NO. 1 -	A/L FL
PFCU	X1204	32	PYRO 2 PASSIVE HOOK ASSY NO. 7 -	A/L FL
PFCU	X1204	33	PYRO 2 PASSIVE HOOK ASSY NO. 5 -	A/L FL
PFCU	X1204	34	PYRO 2 PASSIVE HOOK ASSY NO. 11 -	A/L FL
PFCU	X1204	35	PYRO 2 PASSIVE HOOK ASSY NO. 9 -	A/L FL
PFCU	X1204	36	PYRO 2 PASSIVE HOOK ASSY NO. 3 -	A/L FL
PFCU	X1204	37	PYRO 2 PASSIVE HOOK ASSY NO. 2 -	A/L FL
PFCU	X1204	38	PYRO 2 PASSIVE HOOK ASSY NO. 8 -	A/L FL
PFCU	X1204	39	PYRO 2 PASSIVE HOOK ASSY NO. 6 -	A/L FL
PFCU	X1204	40	PYRO 2 PASSIVE HOOK ASSY NO. 12 -	A/L FL
PFCU	X1204	41	PYRO 2 PASSIVE HOOK ASSY NO. 10 -	A/L FL
PFCU	X1204	42	PYRO 2 PASSIVE HOOK ASSY NO. 4 -	A/L FL
PFCU	X1205	1	ACTIVE HOOKS FIRING CMD	A/L FL
PFCU	X1205	1	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	2	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	2	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	3	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	3	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	4	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	4	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	5	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	5	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	6	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	6	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	7	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	7	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	8	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	8	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	9	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	9	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	10	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	10	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	11	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	11	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	12	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	12	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	13	ACTIVE HOOKS FIRING CMD	A/L FL
PFCU	X1205	13	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	21	PASSIVE HOOKS FIRING CMD	A/L FL

Table 70-B. PFCU Pin Assignments (Continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PFCU	X1205	21	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	22	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	22	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	23	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	23	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	24	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	24	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	25	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	25	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	26	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	26	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	27	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	27	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	28	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	28	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	29	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	29	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	30	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	30	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	31	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	31	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	32	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	32	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	33	PASSIVE HOOKS FIRING CMD	A/L FL
PFCU	X1205	33	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1205	41	PYRO CIRC PROT OFF CMD	A/L FL
PFCU	X1205	42	PYRO CIRC PROT ON CMD	A/L FL
PFCU	X1205	49	PYRO LOGIC BUS A	A/L FL
PFCU	X1205	50	PYRO LOGIC BUS A	A/L FL
PFCU	X1206	1	ACTIVE HOOKS FIRING CMD	A/L FL
PFCU	X1206	1	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	2	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	2	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	3	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	3	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	4	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	4	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	5	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	5	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	6	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	6	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	7	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	7	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	8	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	8	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	9	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	9	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	10	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	10	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)

Table 70-B. PFCU Pin Assignments (Continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PFCU	X1206	11	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	11	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	12	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	12	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	13	ACTIVE HOOKS FIRING CMD	A/L FL
PFCU	X1206	13	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	21	PASSIVE HOOKS FIRING CMD	A/L FL
PFCU	X1206	21	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	22	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	22	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	23	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	23	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	24	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	24	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	25	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	25	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	26	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	26	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	27	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	27	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	28	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	28	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	29	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	29	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	30	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	30	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	31	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	31	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	32	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	32	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	33	PASSIVE HOOKS FIRING CMD	A/L FL
PFCU	X1206	33	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1206	41	PYRO CIRC PROT OFF CMD	A/L FL
PFCU	X1206	42	PYRO CIRC PROT ON CMD	A/L FL
PFCU	X1206	49	PYRO LOGIC BUS B	A/L FL
PFCU	X1206	50	PYRO LOGIC BUS B	A/L FL
PFCU	X1207	1	ACTIVE HOOKS FIRING CMD	A/L FL
PFCU	X1207	1	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	2	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	2	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	3	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	3	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	4	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	4	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	5	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	5	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	6	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	6	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	7	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)

Table 70-B. PFCU Pin Assignments (Continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PFCU	X1207	7	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	8	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	8	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	9	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	9	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	10	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	10	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	11	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	11	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	12	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	12	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	13	ACTIVE HOOKS FIRING CMD	A/L FL
PFCU	X1207	13	ACTIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	21	PASSIVE HOOKS FIRING CMD	A/L FL
PFCU	X1207	21	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	22	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	22	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	23	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	23	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	24	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	24	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	25	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	25	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	26	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	26	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	27	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	27	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	28	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	28	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	29	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	29	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	30	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	30	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	31	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	31	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	32	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	32	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	33	PASSIVE HOOKS FIRING CMD	A/L FL
PFCU	X1207	33	PASSIVE HKS FIRING CMD JPRS	JP (RSC-E)
PFCU	X1207	41	PYRO CIRC PROT OFF CMD	A/L FL
PFCU	X1207	42	PYRO CIRC PROT ON CMD	A/L FL
PFCU	X1207	49	PYRO LOGIC BUS C	A/L FL
PFCU	X1207	50	PYRO LOGIC BUS C	A/L FL
PFCU	X1208	1	TEST	A/L FL
PFCU	X1208	13	TEST	A/L FL
PFCU	X1208	20	TEST	A/L FL
PFCU	X1208	32	TEST	A/L FL
PFCU	X1208	46	TEST	A/L FL
PFCU	X1208	47	TEST	A/L FL

Table 70-B. PFCU Pin Assignments (Continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PFCU	X1208	80	TEST	A/L FL
PFCU	X1208	81	TEST	A/L FL
PFCU	X1208	82	TEST	A/L FL
PFCU	X1208	83	TEST	A/L FL
PFCU	X1208	84	TEST	A/L FL
PFCU	X1208	85	TEST	A/L FL
PFCU	X1208	86	TEST	A/L FL
PFCU	X1208	90	TEST	A/L FL
PFCU	X1208	91	TEST	A/L FL
PFCU	X1208	92	TEST	A/L FL
PFCU	X1208	93	TEST	A/L FL
PFCU	X1208	94	TEST	A/L FL
PFCU	X1208	95	TEST	A/L FL
PFCU	X1208	96	TEST	A/L FL
PFCU	X1208	101	TEST	A/L FL
PFCU	X1208	102	TEST	A/L FL
PFCU	X1209	1	PFCU 40A BUS 2 RTN	A/L FL
PFCU	X1209	2	PFCU 40A BUS 2 RTN	A/L FL
PFCU	X1209	3	PFCU 40A BUS 2 RTN	A/L FL
PFCU	X1209	4	PFCU 6A BUS 2 RTN	A/L FL
PFCU	X1210	1	PFCU 40A BUS 1 RTN	A/L FL
PFCU	X1210	2	PFCU 40A BUS 1 RTN	A/L FL
PFCU	X1210	3	PFCU 40A BUS 1 RTN	A/L FL
PFCU	X1210	4	PFCU 6A BUS 1 RTN	A/L FL
PFCU	X1211	1	PFCU 6A BUS 2 (MNC)	A/L FL
PFCU	X1211	2	PFCU 40A BUS 2 (MNC)	A/L FL
PFCU	X1211	3	PFCU 40A BUS 2 (MNC)	A/L FL
PFCU	X1211	4	PFCU 6A BUS 2 (MNC)	A/L FL
PFCU	X1290	1	TEST	A/L FL
PFCU	X1290	2	TEST	A/L FL
PFCU	X1290	3	TEST	A/L FL
PFCU	X1290	4	TEST	A/L FL
PFCU	X1290	5	TEST	A/L FL
PFCU	X1290	6	TEST	A/L FL
PFCU	X1290	11	TEST	A/L FL
PFCU	X1290	12	TEST	A/L FL
PFCU	X1290	13	TEST	A/L FL
PFCU	X1290	14	TEST	A/L FL
PFCU	X1290	15	TEST	A/L FL
PFCU	X1290	16	TEST	A/L FL
PFCU	X1290	21	TEST	A/L FL
PFCU	X1290	22	TEST	A/L FL
PFCU	X1290	23	TEST	A/L FL
PFCU	X1290	24	TEST	A/L FL
PFCU	X1290	25	TEST	A/L FL
PFCU	X1290	26	TEST	A/L FL
PFCU	X1290	31	TEST	A/L FL
PFCU	X1290	32	TEST	A/L FL
PFCU	X1290	33	TEST	A/L FL

Table 70-B. PFCU Pin Assignments (Continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PFCU	X1290	34	TEST	A/L FL
PFCU	X1290	35	TEST	A/L FL
PFCU	X1290	36	TEST	A/L FL
PFCU	X1291	1	TEST	A/L FL
PFCU	X1291	13	TEST	A/L FL
PFCU	X1291	20	TEST	A/L FL
PFCU	X1291	32	TEST	A/L FL
PFCU	X1291	46	TEST	A/L FL
PFCU	X1291	47	TEST	A/L FL
PFCU	X1291	80	TEST	A/L FL
PFCU	X1291	81	TEST	A/L FL
PFCU	X1291	82	TEST	A/L FL
PFCU	X1291	83	TEST	A/L FL
PFCU	X1291	84	TEST	A/L FL
PFCU	X1291	85	TEST	A/L FL
PFCU	X1291	86	TEST	A/L FL
PFCU	X1291	90	TEST	A/L FL
PFCU	X1291	91	TEST	A/L FL
PFCU	X1291	92	TEST	A/L FL
PFCU	X1291	93	TEST	A/L FL
PFCU	X1291	94	TEST	A/L FL
PFCU	X1291	95	TEST	A/L FL
PFCU	X1291	96	TEST	A/L FL
PFCU	X1291	101	TEST	A/L FL
PFCU	X1291	102	TEST	A/L FL
PFCU	X1292	2	TEST	A/L FL
PFCU	X1292	4	TEST	A/L FL
PFCU	X1292	5	TEST	A/L FL
PFCU	X1292	6	TEST	A/L FL
PFCU	X1292	7	TEST	A/L FL
PFCU	X1292	8	TEST	A/L FL
PFCU	X1292	9	TEST	A/L FL
PFCU	X1292	10	TEST	A/L FL
PFCU	X1292	11	TEST	A/L FL
PFCU	X1292	12	TEST	A/L FL
PFCU	X1292	13	TEST	A/L FL
PFCU	X1292	14	TEST	A/L FL
PFCU	X1292	15	TEST	A/L FL
PFCU	X1292	16		
PFCU	X1292	17	TEST	A/L FL
PFCU	X1292	18		
PFCU	X1292	19	TEST	A/L FL
PFCU	X1292	32	TEST	A/L FL
PFCU	X1293	4	PYRO CIRCUIT PROTECT OFF IND	A/L FL
PFCU	X1293	5	PYRO CIRCUIT PROTECT OFF IND	A/L FL
PFCU	X1293	6	PYRO CIRCUIT PROTECT OFF IND	A/L FL
PFCU	X1293	7	PYRO CIRCUIT PROTECT OFF IND	A/L FL
PFCU	X1293	8	PYRO CIRCUIT PROTECT OFF IND	B2B
PFCU	X1293	9	PYRO CIRCUIT PROTECT OFF IND	B2B

Table 70-B. PFCU Pin Assignments (Continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PFCU	X1293	10	PYRO CIRCUIT PROTECT OFF IND	B2B
PFCU	X1293	11	PYRO CIRCUIT PROTECT OFF IND	B2B
PFCU	X1294	1	PFCU 6A BUS 1 (MNA)	A/L FL
PFCU	X1294	2	PFCU 40A BUS 1 (MNA)	A/L FL
PFCU	X1294	3	PFCU 40A BUS 1 (MNA)	A/L FL
PFCU	X1294	4	PFCU 6A BUS 1 (MNA)	A/L FL

Appendix VIII

80. PRESSURIZATION ACTUATOR CONTROL UNIT

80.1 SCOPE

This appendix defines the detailed requirements for the Pressurization Actuator Control Unit (PACU).

80.2 APPLICABLE DOCUMENTS

N/A

80.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

80.3.1 Item Definition

The Pressurization Actuator Control Unit shall provide switching controls to the Pressurization Actuator Motors of the APDA.

80.3.1.1 Item Diagram

A functional block diagram of the Pressurization Actuator Control Unit is illustrated in Figure 80-A.

80.3.1.2 Interface Definition

The functional and physical interface requirements between the Pressurization Actuator Control Unit, other EDS boxes, and the Orbiter Avionics are defined in the following paragraphs.

80.3.1.2.1 Mechanical Characteristics.

80.3.1.2.1.1 Mounting

Provisions for mounting the Pressurization Actuator Control Unit shall be as shown in Figure 80-B.

80.3.1.2.1.2 Connectors

The Pressurization Actuator Control Unit shall have connectors located as shown in Figure 80-B, with pin assignments as shown in Table 80-C.

80.3.1.3 Item Identification

The Pressurization Actuator Control Unit shall be identified as follows:

Nomenclature	Buyer Control No.	Seller Part No.	Traceability Classification	Maintenance Level
PACU	MC621-0087-0007	33U.5212.006	Ts	LRU

80.3.2 Characteristics.

80.3.2.1 Performance Characteristics

The PACU shall provide the means to perform the functions allocated to it, in concert with the other avionics LRUs provided by the Seller, to achieve optimal mating and demating of the ISSA with the Orbiter.

80.3.2.1.1 Life

The requirements in 3.2.1.1 of the basic specification apply.

80.3.2.1.2 Design Approach

The requirements in 3.2.1.2 of the basic specification apply.

80.3.2.1.3 Signal Characteristics

Characteristics of signals that are unique to the Pressurization Actuator Control Unit are as follows:

TBS

80.3.2.2 Physical Characteristics

80.3.2.2.1 Envelope

The Pressurization Actuator Control Unit shall have an envelope defined in Figure 80-B.

80.3.2.2.2 Weight

The weight of the Pressurization Actuator Control Unit shall not exceed 5.9 lbs.

80.3.2.2.3 Reliability

The requirements of 3.2.3 of the basic specification apply

80.3.2.2.4 Environment

The requirements of 3.2.5.1.2 and 3.2.5.2.2 of the basic specification apply.

80.3.2.3 Transportability

The requirements of 3.2.6 the basic specifications of shall apply.

80.3.3 Design and Construction

The requirements of 3.3 of the basic specification apply, except the following paragraph shall take precedence over 3.3.3.2.1.

80.3.3.1 Power Consumption

The PACU shall consume no more than 43.2 watts.

80.4 QUALITY ASSURANCE PROVISIONS.

80.4.1 General Requirements

The requirements of 4.1 of the basic specification apply.

80.4.2 Quality Conformance

80.4.2.1 Development

The requirements in 4.2.1 of the basic specification apply.

80.4.2.2 Acceptance

Acceptance tests and inspections shall be performed on the PACU, to be employed on the delivered units to the Buyer. The minimum number of tests and inspections, and the sequence thereof shall be as specified in Table 80-A. The Seller shall perform any other test deemed necessary , subject to approval of the Buyer.

Table 80-A. Acceptance Requirements

Inspection & Test	Paragraph Listed in Recommended Sequence
Examination of Product	80.4.2.2.1
Functional & Performance Test	80.4.2.2.2
Insulation Resistance Test	80.4.2.2.2.1
Dielectric Strength Test	80.4.2.2.2.2
Acceptance Vibration Test	80.4.2.2.3
Acceptance Thermal Test	80.4.2.2.4
Acceptance Humidity Test	80.4.2.2.5
Functional & Performance Recheck	80.4.2.2.2

80.4.2.2.1 Examination of Product

The requirements in 4.2.2.1 of the basic specification apply.

80.4.2.2.2 Functional and Performance Tests

The requirements in 4.2.2.2 of the basic specification apply.

80.4.2.2.2.1 Insulation Resistance Test

The requirements in 4.2.2.2.1 of the basic specification apply.

80.4.2.2.2.2 Dielectric Strength Test

The requirements in 4.2.2.2.2 of the basic specification apply.

80.4.2.2.3 Acceptance Vibration Test (AVT).)

Acceptance vibration tests shall be per the requirements in 4.2.2.3 of the basic specification.

80.4.2.2.4 Acceptance Thermal Test (ATT)

The requirements of 4.2.2.4 of the basic specification apply, except that the PACU shall be exposed to the maximum and minimum operating temperatures for a duration of not less than 3 hours. Rate of change shall not exceed 240 °F (133.3 °C) per hour, nor be less than 60 °F (33.3 °C) per hour. The thermal exposure may be performed by cycling from one extreme to the other, or by separate tests with a performance test between exposures.

80.4.2.2.5 Acceptance Humidity Test

The requirements in 4.2.2.5 of the basic specification apply.

80.4.2.3 Assessment

The requirements in 4.2.3 of the basic specification apply.

80.4.2.3.1 Reliability

The requirements in 4.2.3.1 of the basic specification apply.

80.4.2.3.2 Materials and Processes

The requirements in 4.2.3.2 of the basic specification apply.

80.4.2.3.3 Parts Standardization

The requirements in 4.2.3.3 of the basic specification apply.

80.4.2.3.4 Electrical Design Requirements

The requirements in 4.2.3.4 of the basic specification apply.

80.4.2.3.5 Interchangeability

The requirements in 4.2.3.5 of the basic specification apply.

80.4.2.3.6 Human Performance/Human Engineering

The requirements in 4.2.3.6 of the basic specification apply.

80.4.2.3.7 Safety

The requirements in 4.2.3.7 of the basic specification apply.

80.4.2.3.8 Identification and Marking

The requirements in 4.2.3.8 of the basic specification apply.

80.4.2.4 Certification

The requirements in 4.2.4 of the basic specification apply.

80.4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements specified in the performance and design verification matrix of Section 4, Table V shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in Table 80-B.

Table 80-B. Acceptance Requirements

Test sequence	Paragraph
Acceptance Test	80.4.2.2
Performance Test	80.4.2.4.1.2
Transportation Test	80.4.2.4.1.11
Power Test	80.4.2.4.1.7
Vibration	80.4.2.4.1.4
Shock	80.4.2.4.1.6
Acceleration	80.4.2.4.1.5
Thermal Vacuum Test	80.4.2.4.1.10
Qualification Humidity Test	80.4.2.4.1.3
* EMC Test	80.4.2.4.1.9
Life Test	80.4.2.4.1.12
Final Performance Test	80.4.2.4.1.2

* Test and analysis will be conducted and documented by Buyer.

80.4.2.4.1.1 Test Hardware

Qualification test hardware shall be of the same configuration as flight hardware.

80.4.2.4.1.2 Performance Requirements

The requirements in 4.2.4.1.2 of the basic specification apply.

80.4.2.4.1.3 Qualification Humidity Test

The requirements in 4.2.4.1.3 of the basic specification apply.

80.4.2.4.1.4 Vibration.

80.4.2.4.1.4.1 Qualification - Acceptance Vibration Test (QAVT)

The requirements in 4.2.4.1.4.1 of the basic specification apply.

80.4.2.4.1.5 Acceleration

The requirements in 4.2.4.1.5 of the basic specification apply.

80.4.2.4.1.6 Shock

The requirements in 4.2.4.1.6 of the basic specification apply.

80.4.2.4.1.7 Power Test

The requirements in 4.2.4.1.7 of the basic specification apply. Power tests may be as part of the Functional/Performance tests.

80.4.2.4.1.8 Lightning

The requirements in 4.2.4.2.12 of the basic specification apply.

80.4.2.4.1.9 Electromagnetic Compatibility Tests

The requirements in 4.2.4.1.9 of the basic specification apply.

80.4.2.4.1.10 Thermal Vacuum Test

The requirements in 4.2.4.1.10 of the basic specification apply except that the first four cycles are performed at ambient pressure and circuit monitoring may be limited due to operating life of PACU.

80.4.2.4.1.11 Transportation Test

The requirements in 4.2.4.1.11 of the basic specification apply.

80.4.2.4.1.12 Operating Life Test

The requirements in 4.2.4.1.12 of the basic specification apply.

80.4.2.4.2 Certification By Analysis

The requirements in 4.2.4.2 of the basic specification apply.

80.4.2.4.2.1 Storage/Operating Life

The requirements in 4.2.4.2.1 of the basic specification apply.

80.4.2.4.2.2 Physical Characteristics

The requirements in 4.2.4.2.2 of the basic specification apply.

80.4.2.4.2.3 Reliability

The requirements in 4.2.4.2.3 of the basic specification apply.

80.4.2.4.2.4 Salt Fog

The requirements in 4.2.4.2.4 of the basic specification apply.

80.4.2.4.2.5 Ozone

The requirements in 4.2.4.2.5 of the basic specification apply.

80.4.2.4.2.6 Fungus

The requirements in 4.2.4.2.6 of the basic specification apply.

80.4.2.4.2.7 Materials and Processes

The requirements in 4.2.4.2.7 of the basic specification apply.

80.4.2.4.2.8 Electromagnetic Compatibility

The requirements in 4.2.4.2.8 of the basic specification apply.

80.4.2.4.2.9 Electrical Design Requirements

The requirements in 4.2.4.2.9 of the basic specification apply.

80.4.2.4.2.10 Safety

The requirements in 4.2.4.2.10 of the basic specification apply.

80.4.2.4.2.11 Sand and Dust

The requirements of 4.2.4.2.11 of the basic specification apply.

80.4.2.4.2.12 Certification by Other Test Data

The requirements in 4.2.4.2.12 of the basic specification apply.

80.4.2.5 Verification Requirements Matrices

The requirements in 4.2.5 of the basic specification apply.

80.5 PREPARATION FOR DELIVERY

The requirements in Section 5 of the basic specification apply.

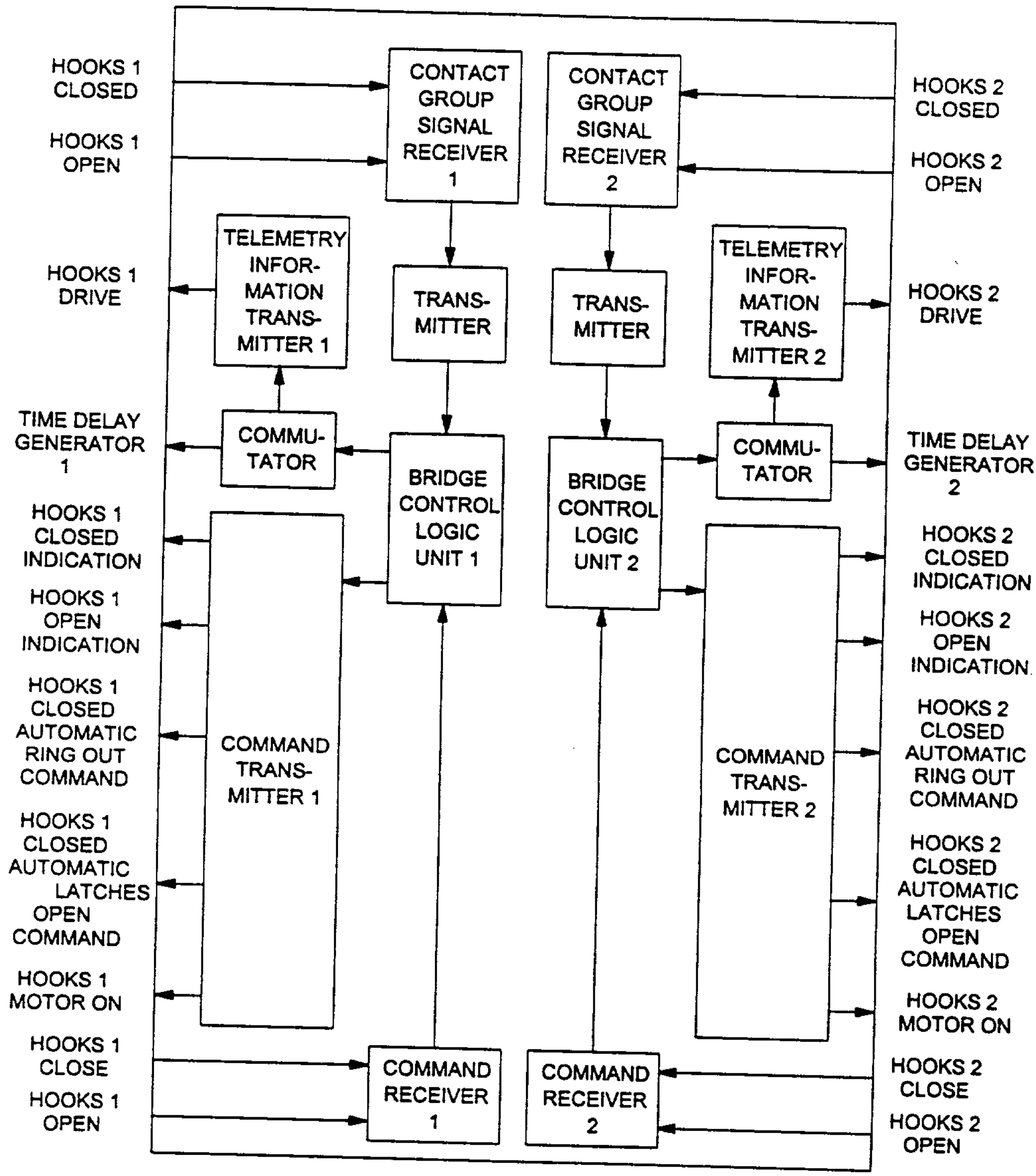

Figure 80-A. A functional block diagram of the PACU

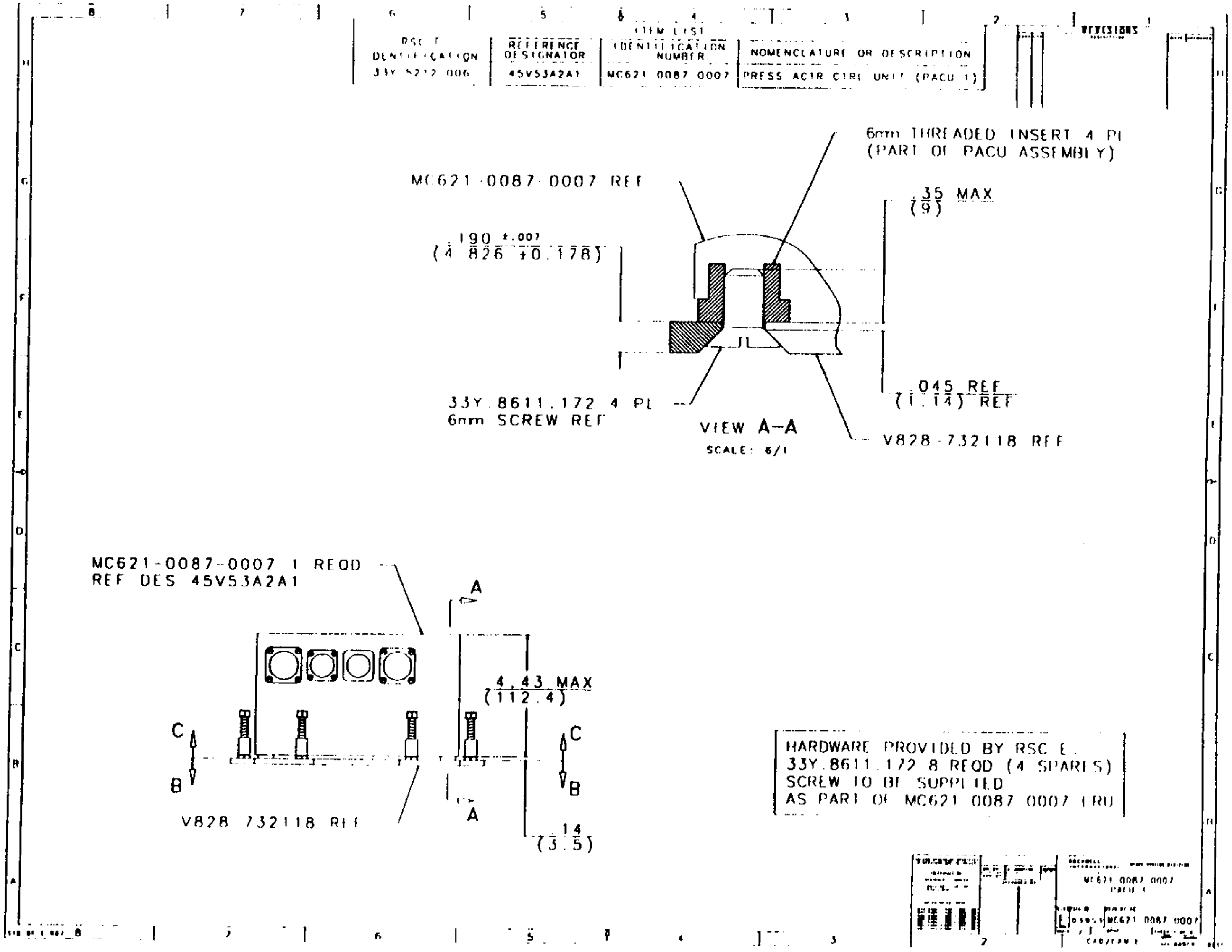

Figure 80-B. PACU-1 Mounting and Connectors Location Diagram (1 of 2)

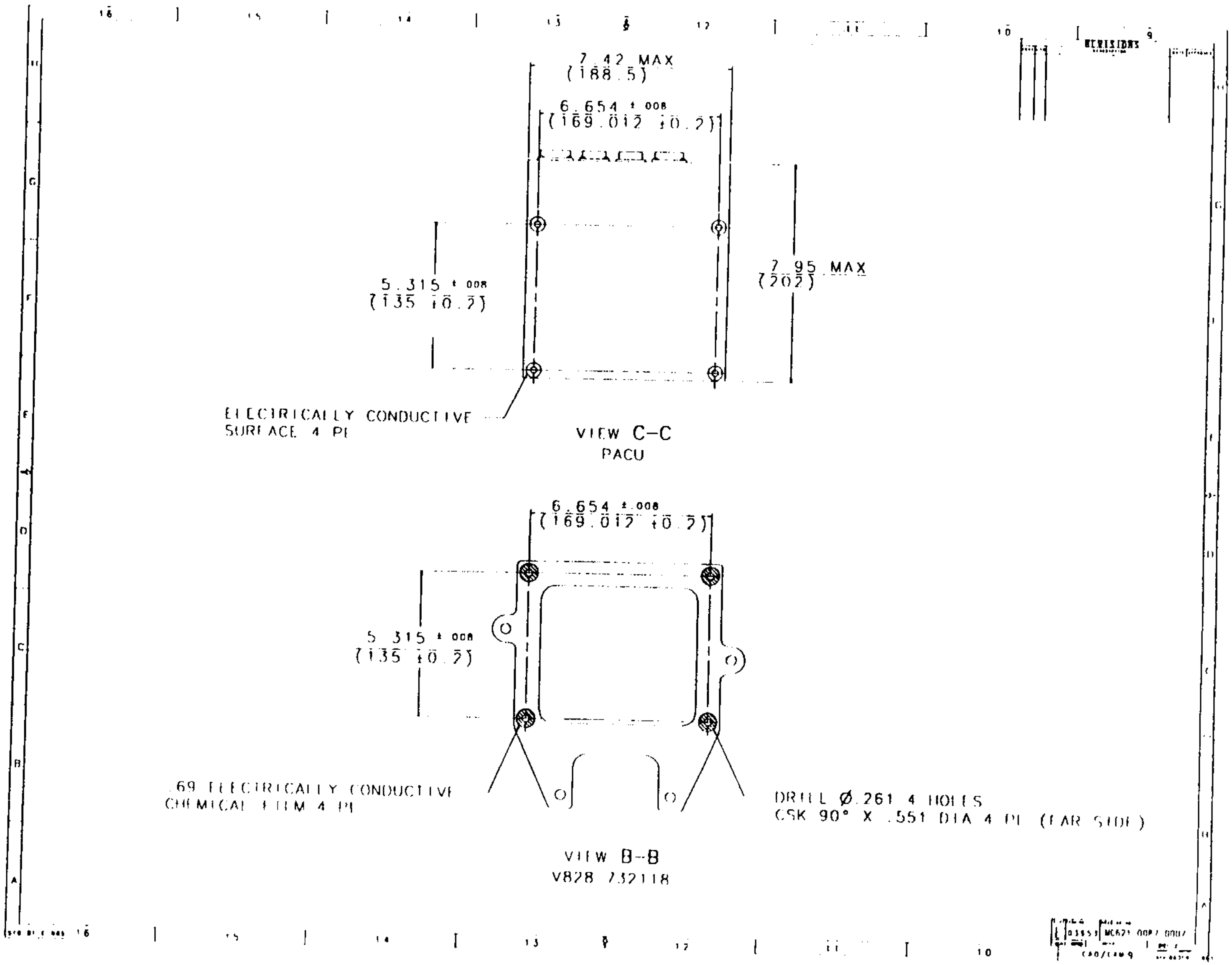

Figure 80-B. PACU-1 Mounting and Connectors Location Diagram (2 of 2)

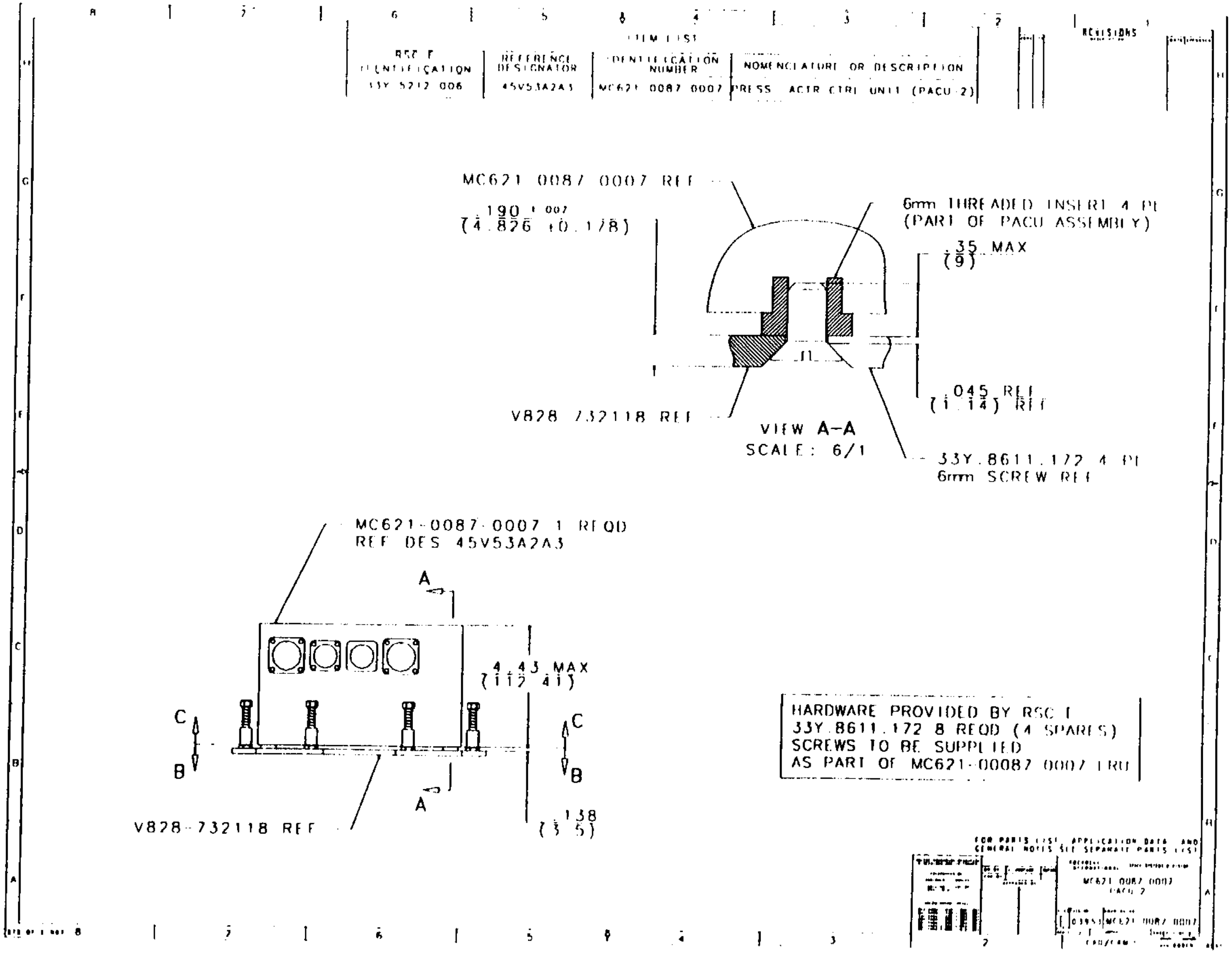

Figure 80-C. PACU-2 Mounting and Connectors Location Diagram (1 of 2)

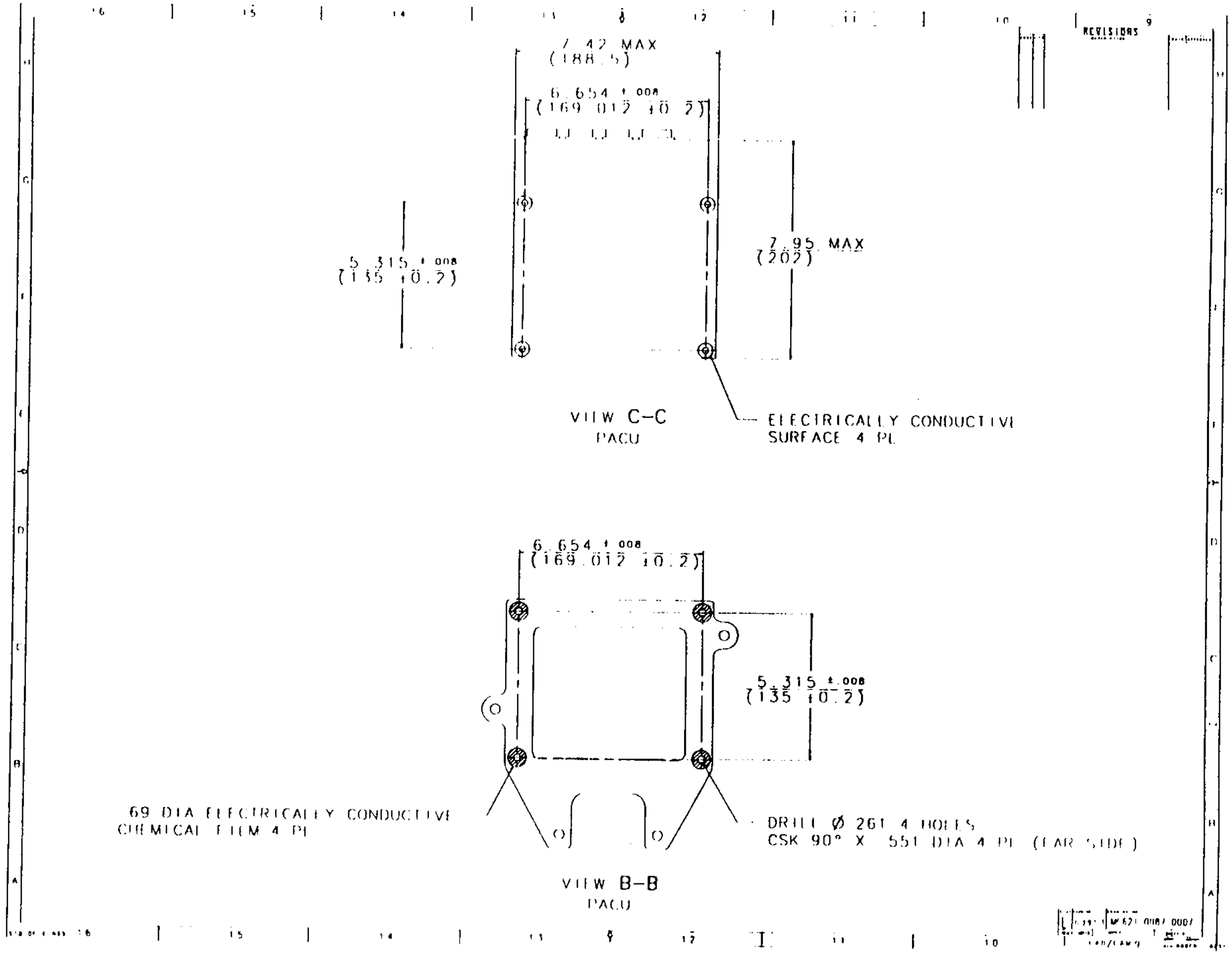

Figure 80-B. PACU-2 Mounting and Connectors Location Diagram (2 of 2)

Table 80-C1. PACU-1 Pin Assignments

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PACU-1	X204-1	1	PWR SUP TO M6 GROUP 1 HOOKS	A/L FL
PACU-1	X204-1	2	PWR SUP TO M6 GROUP 1 HOOKS	A/L FL
PACU-1	X204-1	4	PWR SUP TO M6 GROUP 1 HOOKS	A/L FL
PACU-1	X204-1	5	PWR SUP TO M7 GROUP 1 HOOKS	A/L FL
PACU-1	X204-1	6	PWR SUP TO M7 GROUP 1 HOOKS	A/L FL
PACU-1	X204-1	10	PWR SUP TO M6 GROUP 1 HOOKS	A/L FL
PACU-1	X204-1	16	PWR SUP TO M7 GROUP 1 HOOKS	A/L FL
PACU-1	X204-1	17	PWR SUP TO M7 GROUP 1 HOOKS	A/L FL
PACU-1	X204-1	20	GROUP 1 HOOKS OPEN	A/L FL
PACU-1	X204-1	20	GROUP 1 HOOKS IND CKT	JP (RSC-E)
PACU-1	X204-1	21	GROUP 1 HOOKS CLOSED	A/L FL
PACU-1	X204-1	21	GROUP 1 HOOKS IND CKT	JP (RSC-E)
PACU-1	X204-1	22	GROUP 1 HOOKS CLOSED	A/L FL
PACU-1	X204-1	22	GROUP 1 HOOKS IND CKT	JP (RSC-E)
PACU-1	X204-1	26	GROUP 1 HOOKS IND CKT	JP (RSC-E)
PACU-1	X204-1	27	GROUP 1 HOOKS OPEN	A/L FL
PACU-1	X204-1	27	GROUP 1 HOOKS IND CKT	JP (RSC-E)
PACU-1	X204-1	28	GROUP 1 HOOKS IND CKT	JP (RSC-E)
PACU-1	X204-1	39	GROUP 1 HOOKS IND CKT	JP (RSC-E)
PACU-1	X204-1	40	GROUP 1 HOOKS IND CKT	JP (RSC-E)
PACU-1	X205-1	1	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	1	GRP 1 HKS OPEN CMD	B2B
PACU-1	X205-1	2	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	3	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	4	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	6	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	6	GRP 1 HKS OPEN CMD	B2B
PACU-1	X205-1	7	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	7	GRP 1 HKS OPEN CMD	B2B
PACU-1	X205-1	8	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	9	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	10	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	11	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	11	GRP 1 HKS CLOSE CMD	B2B
PACU-1	X205-1	14	GRP 1 HKS LOGIC CKT	B2B
PACU-1	X205-1	15	GRP 1 HKS LOGIC CKT	B2B
PACU-1	X205-1	16	GRP 1 HKS LOGIC CKT	B2B
PACU-1	X205-1	17	ACTUAT OF HKS NO. 1 DRV	B2B
PACU-1	X205-1	18	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	18	GRP 1 HKS CLOSE CMD	B2B
PACU-1	X205-1	19	GROUP 1 HOOKS CNTRL CKT	JP (RI)
PACU-1	X205-1	19	GRP 1 HKS CLOSE CMD	B2B
PACU-1	X205-1	20	GRP 1 HKS CLOSE	B2B
PACU-1	X205-1	21	GRP 1 HKS CLOSE	B2B
PACU-1	X205-1	29	GRP 1 HKS OPEN	B2B
PACU-1	X205-1	30	GRP 1 HKS CLOSE	B2B
PACU-1	X205-1	39	GRP 1 HKS OPEN	B2B
PACU-1	X205-1	41	GRP 1 HKS CLOSE	B2B
PACU-1	X205-1	51	GRP 1 HKS CLOSE	B2B

Table 80-C1. PACU-1 Pin Assignments (continued)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PACU-1	X206-1	1	DC RTN	B2B
PACU-1	X206-1	4	DC RTN	B2B
PACU-1	X206-1	6	DC RTN	B2B
PACU-1	X206-1	10	DC RTN	I/P
PACU-1	X206-1	20	DC BUS	B2B
PACU-1	X206-1	21	DC BUS	B2B
PACU-1	X206-1	25	DC BUS	B2B
PACU-1	X206-1	26	DC BUS	B2B
PACU-1	X206-1	27	DC BUS	B2B
PACU-1	X206-1	29	DC BUS	B2B
PACU-1	X206-1	31	DC BUS	B2B
PACU-1	X206-1	32	DC BUS	B2B
PACU-1	X222-1	1		JP (RSC-E)
PACU-1	X222-1	2		JP (RSC-E)
PACU-1	X222-1	3		JP (RSC-E)
PACU-1	X222-1	4		JP (RSC-E)
PACU-1	X222-1	5		JP (RSC-E)
PACU-1	X222-1	6		JP (RSC-E)
PACU-1	X222-1	7		JP (RSC-E)
PACU-1	X222-1	8		JP (RSC-E)
PACU-1	X222-1	9		JP (RSC-E)
PACU-1	X222-1	10		JP (RSC-E)
PACU-1	X222-1	11		JP (RSC-E)
PACU-1	X222-1	12		JP (RSC-E)
PACU-1	X222-1	13		JP (RSC-E)
PACU-1	X222-1	14		JP (RSC-E)
PACU-1	X222-1	15		JP (RSC-E)
PACU-1	X222-1	16		JP (RSC-E)
PACU-1	X222-1	17		JP (RSC-E)
PACU-1	X222-1	18		JP (RSC-E)
PACU-1	X222-1	19		JP (RSC-E)
PACU-1	X222-1	20		JP (RSC-E)
PACU-1	X222-1	21		JP (RSC-E)
PACU-1	X222-1	22		JP (RSC-E)
PACU-1	X222-1	23		JP (RSC-E)
PACU-1	X222-1	24		JP (RSC-E)
PACU-1	X222-1	42	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	43	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	45	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	46	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	48	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	49	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	51	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	52	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	54	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	55	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	57	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	58	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)

Table 80-C1. PACU-1 Pin Assignments (concluded)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PACU-1	X222-1	60	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	61	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	63	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	64	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	66	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	67	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	69	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	70	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	72	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	73	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	75	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)
PACU-1	X222-1	76	GROUP 1 HOOKS CNTRL CKT	JP (RSC-E)

Table 80-C2. PACU-2 Pin Assignments

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PACU-2	X204-2	1	PWR SUP TO M8 GROUP 2 HOOKS	A/L FL
PACU-2	X204-2	2	PWR SUP TO M8 GROUP 2 HOOKS	A/L FL
PACU-2	X204-2	4	PWR SUP TO M8 GROUP 2 HOOKS	A/L FL
PACU-2	X204-2	5	PWR SUP TO M9 GROUP 2 HOOKS	A/L FL
PACU-2	X204-2	6	PWR SUP TO M9 GROUP 2 HOOKS	A/L FL
PACU-2	X204-2	10	PWR SUP TO M8 GROUP 2 HOOKS	A/L FL
PACU-2	X204-2	16	PWR SUP TO M9 GROUP 2 HOOKS	A/L FL
PACU-2	X204-2	17	PWR SUP TO M9 GROUP 2 HOOKS	A/L FL
PACU-2	X204-2	20	GROUP 2 HOOKS OPEN	A/L FL
PACU-2	X204-2	20	GROUP 2 HOOKS IND CKT	JP (RSC-E)
PACU-2	X204-2	21	GROUP 2 HOOKS CLOSED	A/L FL
PACU-2	X204-2	21	GROUP 2 HOOKS IND CKT	JP (RSC-E)
PACU-2	X204-2	22	GROUP 2 HOOKS CLOSED	A/L FL
PACU-2	X204-2	22	GROUP 2 HOOKS IND CKT	JP (RSC-E)
PACU-2	X204-2	26	GROUP 2 HOOKS IND CKT	JP (RSC-E)
PACU-2	X204-2	27	GROUP 2 HOOKS OPEN	A/L FL
PACU-2	X204-2	27	GROUP 2 HOOKS IND CKT	JP (RSC-E)
PACU-2	X204-2	28	GROUP 2 HOOKS IND CKT	JP (RSC-E)
PACU-2	X204-2	39	GROUP 2 HOOKS IND CKT	JP (RSC-E)
PACU-2	X204-2	40	GROUP 2 HOOKS IND CKT	JP (RSC-E)
PACU-2	X205-2	1	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	1	GRP 2 HKS OPEN CMD	B2B
PACU-2	X205-2	2	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	3	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	4	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	6	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	6	GRP 2 HKS OPEN CMD	B2B
PACU-2	X205-2	7	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	7	GRP 2 HKS OPEN CMD	B2B
PACU-2	X205-2	8	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	9	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	10	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	11	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	11	GRP 2 HKS CLOSE CMD	B2B
PACU-2	X205-2	14	GRP 2 HKS LOGIC CKT	B2B
PACU-2	X205-2	15	GRP 2 HKS LOGIC CKT	B2B
PACU-2	X205-2	16	GRP 2 HKS LOGIC CKT	B2B
PACU-2	X205-2	17	ACTUAT OF HKS NO. 2 DRV	B2B
PACU-2	X205-2	18	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	18	GRP 2 HKS CLOSE CMD	B2B
PACU-2	X205-2	19	GROUP 2 HOOKS CNTRL CKT	JP (RI)
PACU-2	X205-2	19	GRP 2 HKS CLOSE CMD	B2B
PACU-2	X205-2	20	GRP 2 HKS CLOSE	B2B
PACU-2	X205-2	21	GRP 2 HKS CLOSE	B2B
PACU-2	X205-2	29	GRP 2 HKS OPEN	B2B
PACU-2	X205-2	30	GRP 2 HKS CLOSE	B2B
PACU-2	X205-2	39	GRP 2 HKS OPEN	B2B
PACU-2	X205-2	41	GRP 2 HKS CLOSE	B2B
PACU-2	X205-2	51	GRP 2 HKS CLOSE	B2B

Table 80-C2. PACU-2 Pin Assignments (continued)				
PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PACU-2	X206-2	1	DC RTN	B2B
PACU-2	X206-2	4	DC RTN	B2B
PACU-2	X206-2	6	DC RTN	I/P
PACU-2	X206-2	9	DC RTN	I/P
PACU-2	X206-2	10	DC RTN	I/P
PACU-2	X206-2	20	DC BUS	B2B
PACU-2	X206-2	21	DC BUS	I/P
PACU-2	X206-2	25	DC BUS	B2B
PACU-2	X206-2	26	DC BUS	B2B
PACU-2	X206-2	27	DC BUS	I/P
PACU-2	X206-2	29	DC BUS	B2B
PACU-2	X206-2	31	DC BUS	B2B
PACU-2	X206-2	32	DC BUS	I/P
PACU-2	X222-2	1		JP (RSC-E)
PACU-2	X222-2	2		JP (RSC-E)
PACU-2	X222-2	3		JP (RSC-E)
PACU-2	X222-2	4		JP (RSC-E)
PACU-2	X222-2	5		JP (RSC-E)
PACU-2	X222-2	6		JP (RSC-E)
PACU-2	X222-2	7		JP (RSC-E)
PACU-2	X222-2	8		JP (RSC-E)
PACU-2	X222-2	9		JP (RSC-E)
PACU-2	X222-2	10		JP (RSC-E)
PACU-2	X222-2	11		JP (RSC-E)
PACU-2	X222-2	12		JP (RSC-E)
PACU-2	X222-2	13		JP (RSC-E)
PACU-2	X222-2	14		JP (RSC-E)
PACU-2	X222-2	15		JP (RSC-E)
PACU-2	X222-2	16		JP (RSC-E)
PACU-2	X222-2	17		JP (RSC-E)
PACU-2	X222-2	18		JP (RSC-E)
PACU-2	X222-2	19		JP (RSC-E)
PACU-2	X222-2	20		JP (RSC-E)
PACU-2	X222-2	21		JP (RSC-E)
PACU-2	X222-2	22		JP (RSC-E)
PACU-2	X222-2	23		JP (RSC-E)
PACU-2	X222-2	24		JP (RSC-E)
PACU-2	X222-2	42	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	43	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	45	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	46	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	48	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	49	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	51	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	52	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	54	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	55	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	57	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)

Table 80-C2. PACU-1 Pin Assignments (concluded)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
PACU-2	X222-2	58	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	60	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	61	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	63	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	64	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	66	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	67	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	69	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	70	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	72	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	73	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	75	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)
PACU-2	X222-2	76	GROUP 2 HOOKS CNTRL CKT	JP (RSC-E)

Appendix IX

90. DATA COLLECTION UNIT

90.1 SCOPE

This specification establishes the performance, design, development, and verification requirements for the Data Collection Unit referred to herein as DCU.

90.2 APPLICABLE DOCUMENTS

N/A

90.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

90.3.1 Item Definition

The DCU shall be designed to meet the specific input requirements of the EDS/Orbiter interface. To achieve this purpose the DCU shall perform the following functions:

A. Condition to proper level, form, and mode pickup-point signals and transducer signals which are required as inputs to the Orbiter Instrumentation System.

B. Provide buffering and isolation when required by the design limitations of the monitoring equipment.

C. Provide precision power to analog and discrete sensors as required.

90.3.1.1 Item Diagram

The functional block diagram of the Data Collection Unit is shown in Figure 90-A.

90.3.1.2 Interface Definition

The functional and physical interface requirements between the DCU, other EDS equipment and the Orbiter Avionics systems are defined in the following paragraphs.

90.3.1.2.2 Mechanical Characteristics.

90.3.1.2.2.1 Mounting

The mounting requirements of the DCU are shown in Figure 90-B.

90.3.1.2.2.2 Connectors

The Data Collection Unit shall have connectors located as shown in Figure 90-B, with pin assignments as shown in Table 90-C.

90.3.1.2.3 Signal Interface Definition

The DCU Line Replaceable Unit shall interface with the Orbiter avionics system as shown in Figure 90-A. The individual signals at the DCU/Orbiter interface are listed on Table 90-D. A detailed definition of the interface is presented in the following paragraphs.

90.3.1.2.3.1 Signal Characteristics.

90.3.1.2.3.1.1 General

A. Isolation. Each signal input and each signal output of each circuit shall be isolated from each other by a minimum of 50 megohms at 50 Vdc.

B. Signal Grounds. Input and output signal grounds shall be separated by a minimum of 50 megohms at 50 Vdc. Signal ground shall be separated from power ground by a minimum of 50 megohms at 50 Vdc.

90.3.1.2.3.1.2 5 Vdc Analog Conditioner

This circuit shall have the following characteristics.

90.3.1.2.3.1.2.1 Signal Input.

A. Potentiometer type sensor.

Voltage 0 to 5 Vdc analog.
Impedance 900 to 4700 ohms

B. Temperature type sensor (Resistance thermometer input signal).

Impedance 60 to 140 ohms, -100°C to +100°C; (-148°F to +212°F)

90.3.1.2.3.1.2.2 Signal Output

The signal output shall be an isolated analog, positive, unipolar, ungrounded voltage in the range of 0 to 5 Vdc directly proportional to the input specified in 90.3.1.2.3.1.2.1.

A. Impedance. The impedance looking back into the output terminals shall be 300 ohms or less.

B. Current. Each amplifier output shall be capable of delivering 250 micro amps of a signal current into an external load at full scale input.

C. Under/Over Voltage Limiting. The signal output shall be limited to the range of minus 1.0 to plus 6.5 vdc under any conditions.

D. Each output shall have a return line; analog outputs, however, may use one return line for each circuit group of four.

90.3.1.2.3.1.2.3 Data Frequency Response.

A. Passband. The conditioner shall have a frequency response flat within 1 percent for signal input from dc to 3 Hz, and within 5 percent for a signal input greater than 4 Hz to 10 Hz.

B. Rolloff. The data signal shall be attenuated no more than 3 dB at 35 Hz and 30 dB or greater at 400 Hz input frequency and shall roll off at a rate of 12 dB per octave or greater for frequencies above 400 Hz.

90.3.1.2.3.1.3 5 Vdc Discrete Conditioner

This circuit shall have the following characteristics:

90.3.1.2.3.1.3.1 Signal Input.

Sensor-closure bi-level open-close signal:

Voltage: Open, 0 volts; Closed, 5 volts
Impedance: Open, 100k minimum; Closed, 100 ohms maximum

90.3.1.2.3.1.3.2 Signal Output

The signal output shall be an isolated step voltage level.

A. Logic "one". The logic "one" output shall be 5.0 plus or minus 1.0 Vdc and provide maximum current of 1.25 milliamperes.

B. Logic "zero". The logic "zero" output shall be zero plus or minus 0.5 Vdc.

C. Impedance. Output impedance shall be 1200 ohms maximum.

D. Rise and Fall Time. Rise and fall time shall be greater than 20 microseconds but shall not exceed 1 millisecond.

E. One return wire can service a set of four sensors.

90.3.1.2.3.1.3.3 Data Response Times.

A. Response Time. The conditioners shall meet the specification limits for their signal output characteristics within 100 milliseconds or less under any power source, environmental or loading conditions specified herein.

B. Under- and Over-Voltage Limiting. The signal output shall be limited to a range of minus 0.5 to plus 6.5 vdc under any conditions.

90.3.1.3 Item Identification

The identification of the DCU shall be as follows:

Nomenclature	Buyer Control No.	Seller Part No.	Traceability Classification	Maintenance Level
DCU	MC621-0087-0008	TA082	Ts	LRU

90.3.2 Characteristics.

90.3.2.1 Performance Characteristics

The DCU shall have the capability to accommodate all EDS measurements required. Characteristics of the DCU shall conform to the requirements specified herein.

90.3.2.1.1 Life Requirements

The requirements in 3.2.1.1. of the basic specification apply.

90.3.2.1.2 Design Approach

The requirements in 3.2.1.2 of the basic specification apply.

90.3.2.1.3 Signal Characteristics, Error.

A. Analog Channel. The error of the analog conditioner shall not be greater than plus or minus 1.0 percent of the full-scale output. The error shall be determined by a root-sum-square determination of the errors due to non-linearity, hysteresis, repeatability, output noise, and zero and gain instability, for any combination of environment, power-source voltage, output loading, and signal source-impedance variations specified herein over operating life.

B. Discrete Channel. For every discrete input an isolated discrete output shall occur with output characteristics defined herein.

C. Total Error Band. The total error band which includes the sensors, the effects of environment, input-power variations, and unit performance that contributes to the error shall not exceed plus or minus 3.0 percent of full-scale output.

90.3.2.2 Physical Characteristics.

90.3.2.2.1 Envelope

The envelope of the DCU shall not exceed the dimensions shown in Figure 90-B.

90.3.2.2.2 Weight

The weight of each DCU shall not exceed 9.8 pounds.

90.3.2.3 Reliability

The requirements of 3.2.3 of the basic specification apply.

90.3.2.3.1 Redundancy

The DCU shall be designed so that a failure of any component or failure in any input or any circuit shall not affect more than one circuit measurement.

90.3.2.4 Environment

The requirements of 3.2.5.1.2 and 3.2.5.2.2 of the basic specification apply.

90.3.2.5 Transportability

The requirements of 3.2.6 of the basic specification apply.

90.3.3 Design and Construction

The requirements of 3.3 of the basic specification apply, except that the following paragraph takes precedence over 3.3.3.2.1.

90.3.3.1 Power Consumption

The DCU shall consume no more than 35 watts.

90.3.3.2 Instrumentation

90.3.3.2.1 Calibration Data Requirements

Calibration data and accuracies shall be provided for all measurements originating in each end item. The actual calibration requirements for each measurement shall be determined from an examination of the expected signal output characteristics and identified as applicable to one of the following categories and processed accordingly. The subcontractor shall make every effort to select instrumentation whose output signals fall into Category 1a to minimize the data-processing load during vehicle checkout.

90.3.3.2.1.1 Category 1: Linear Measurements

A. Normalized Linear Calibration and Accuracy. A theoretical straight line representing zero signal output at low engineering-scale input and full signal output at high engineering-scale input is used as a calibration reference. An error band derived from the design control specifications shall be determined and entered on a data sheet for each measurement so categorized.

B. Observed Linear Calibration and Accuracy. A theoretical straight line as described in 90.3.3.3.3.1.1a is used as a calibration reference; however, an error band derived from the actual observed calibration data shall be used and recorded on standard data sheets.

C. Linear Measurements with "y" Intercept ≠ Zero. A best-fit straight line derived from using least-squares methods defined by the actual observed data is used as a calibration reference. An error band defined by the actual observed data's deviation from the best-fit line shall be computed and plotted on graph paper for measurements so categorized.

90.3.3.2.1.2 Category 2: Non-Linear Measurements

Sufficient data shall be provided to enable data processing of a facsimile curve whose difference from the original data does not exceed 1/2 of 1 percent full scale.

A. Normalized Non-Linear Calibration and Accuracy. The polynomial calibration reference curves used shall be based on the equipment theoretical curves. An error band derived from the equipment design control specification error band shall be computed and plotted on graph paper for measurements so categorized.

B. Observed Non-Linear Calibration and Accuracy. A best-fit curve shall be based on the observed data. An error band derived from the maximum deviations of the curve fit shall be computed and plotted on graph paper for measurements so categorized.

90.3.3.2.1.3 Category 3: Special-Case Data Points

A tabulation of calibration data points shall be made for any special measurement which, due to the character of the calibration curve, does not lend itself to computer data processing (e.g., S-band power output).

90.3.3.2.1.4 Performance (Accuracy)

The subcontractor shall establish measurement design concepts and shall select measurement components compatible with the developing Seller's design goals for measurement accuracy. The measurement accuracies specified in this document shall be interpreted as the interface accuracies. The accuracy specified is defined as the range of uncertainty of the signal output value for a known input where the hysteresis history is unknown. In addition to hysteresis, the uncertainty includes the effects of non-linearity, repeatability, and stability. The term stability includes all environmentally introduced effects, zero and linearity drift, and aging factors.

90.4 QUALITY ASSURANCE PROVISIONS

90.4.1 General Requirements

The requirements in 4.1 of the basic specification apply.

90.4.2 Quality Conformance

The requirements in 4.2 of the basic specification apply.

90.4.2.1 Development

The requirements in 4.2.1 of the basic specification apply.

90.4.2.2 Acceptance

Acceptance tests and inspections shall be performed on the DCU to be employed on the delivered units to the Buyer. The minimum number of tests and inspections, and sequence thereof shall be as specified in Table 90-A. The Seller shall perform any additional test deemed necessary, subject to approval of the Buyer.

Table 90-A. Acceptance Requirements

Inspection & Test	Paragraph Listed in Recommended Sequence
Examination of Product	90.4.2.2
Functional & Performance Test	90.4.2.2.2
Insulation Resistance Test	90.4.2.2.2.1
Dielectric-Strength Test	90.4.2.2.2.2
Calibration Test	90.4.2.2.2.3
Acceptance Vibration Test	90.4.2.2.3
Acceptance Thermal Test	90.4.2.2.4
Acceptance Humidity Test	90.4.2.2.5
Functional & Performance	90.4.2.2.2.

NOTE: During acceptance tests with the environment, each measurement channel shall be tested by applying an input stimulus of known value and monitoring expected output levels.

90.4.2.2.1 Examination of Product

The requirements in 4.2.2.1 of the basic specification apply.

90.4.2.2.2 Functional and Performance Tests

The requirements in 4.2.2.2 of the basic specification apply.

90.4.2.2.2.1 Insulation Resistance Test

The requirements in 4.2.2.2.1 of the basic specification apply.

90.4.2.2.2.2 Dielectric Strength Test

The requirements in 4.2.2.2.2 of the basic specification apply.

90.4.2.2.2.3 Calibration Test

A calibration test shall be performed on each signal-conditioning channel by applying an input stimulus of known value and representative of the expected operation levels. The data shall be recorded and submitted to Buyer. The test shall be conducted as follows:

A. Category 1 and 2 measurements shall have a minimum of five steps up from zero to full-scale input, (six data points including zero and full scale), and four steps down from full-scale to zero input, (five data points including full scale and zero). Note that a) the full-scale input point is the same going up as coming down, and b) the intermediate input points between full scale and zero are different coming down than going up.

B. Category 3 measurements shall have a minimum of ten steps up from zero to full-scale input, (eleven data points including zero and full scale), and nine steps down from full-scale to zero input, (ten data points including full scale and zero). Note that a) the full-scale input point is the same going up as coming down, and b) the intermediate input points between full scale and zero are different coming down than going up.

90.4.2.2.2.3.1 Calibration Data History

All calibration performed on instrumentation signals shall be documented including that performed by the subcontractor's subtier suppliers, and submitted in accordance with the Procurement Data Requirements of Appendix XV of this specification.

90.4.2.2.3 Acceptance Vibration Tests (AVT)

The requirements in 4.2.2.3 of the basic specification apply. All acceptance vibration tests shall be performed with the DCU vibration isolators removed.

90.4.2.2.4 Acceptance Thermal Tests (ATT)

The requirements in 4.2.2.4 of the basic specification apply.

90.4.2.2.5 Acceptance Humidity Test

The requirements of 4.2.2.5 of the basic specification apply.

90.4.2.3 Assessment

The requirements in 4.2.3 of the basic specification apply.

90.4.2.3.1 Reliability

The requirements in 4.2.3.1 of the basic specification apply.

90.4.2.3.2 Materials and Processes

The requirements in 4.2.3.2 of the basic specification apply.

90.4.2.3.3 Parts Standardization

The requirements in 4.2.3.3 of the basic specification apply.

90.4.2.3.4 Electrical Design Requirements

The requirements in 4.2.3.4 of the basic specification apply.

90.4.2.3.5 Interchangeability

The requirements in 4.2.3.5 of the basic specification apply.

90.4.2.3.6 Human Performance/Human Engineering

The requirements in 4.2.3.6 of the basic specification apply.

90.4.2.3.7 Safety

The requirements in 4.2.3.7 of the basic specification apply.

90.4.2.3.8 Identification and Marking

The requirements in 4.2.3.9 of the basic specification apply.

90.4.2.4 Certification

The requirements in 4.2.4 of the basic specification apply.

90.4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements in the performance and design verification matrix of Section 4, Table V shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in the sequence shown.

Table 90-B. Qualification Requirements

Paragraph listed in Suggested Test sequence	Recommended Sequence
Acceptance Test	90.4.2.2
Performance Test	90.4.2.4.1.2
Power Test	90.4.2.4.1.7
* EMC Test	90.4.2.4.1.9
Pressure Cycle Test	90.4.2.4.1.13
Vacuum Operation Test	90.4.2.4.1.14
Vibration	90.4.2.4.1.4
Thermal Vacuum Test	90.4.2.4.1.10
Life	90.4.2.4.1.12
Shock	90.4.2.4.1.6
Final Performance Test	90.4.2.4.1.2

* Test and analysis will be conducted, and documented by Buyer.

NOTE: During qualification tests with the environment, each measurement channel shall be tested by applying an input stimulus of known value and monitoring expected output levels.

90.4.2.4.1.1 Test Hardware

Qualification test hardware shall be of the same configuration as flight hardware.

90.4.2.4.1.2 Performance Requirements

The requirements in 4.2.4.1.2 of the basic specification apply.

90.4.2.4.1.3 Humidity Test

The requirements in 4.2.4.1.3 of the basic specification apply.

90.4.2.4.1.4 Vibration

90.4.2.4.1.4.1 Qualification - Acceptance Vibration Test (QAVT)

The requirements in 4.2.4.1.4.1 of the basic specification apply except that the test shall be performed in two steps; first without DCU vibration isolators for 300 seconds per axis, then for 900 seconds per axis with vibration isolators.

90.4.2.4.1.5 Acceleration

The requirements in 4.2.4.1.5 of the basic specification apply.

90.4.2.4.1.6 Shock

The requirements in 4.2.4.1.6 of the basic specification apply.

90.4.2.4.1.7 Power Test

The requirements in 4.2.4.1.7 of the basic specification apply.

90.4.2.4.1.8 Lightning

The requirements in 4.2.4.2.12 of the basic specification apply.

90.4.2.4.1.9 Electromagnetic Compatibility Tests

The requirements in 4.2.4.1.9 of the basic specification apply.

90.4.2.4.1.10 Thermal Vacuum Test

The requirements in 4.2.4.1.10 of the basic specification apply.

90.4.2.4.1.11 Transportation Test

N/A

90.4.2.4.1.12 Operating Life Test

The requirements in 4.2.4.1.12 of the basic specification apply.

90.4.2.4.1.13 Pressure Cycle Test

The DCU shall be placed in a vacuum chamber evacuated to $1x10^{-3}$ mm Hg ($1.9x10^{-5}$ psia). The interior of the DCU shall then be subjected to twenty (20) pressure cycles between the chamber's $1x10^{-3}$ mm Hg ($1.9x10^{-5}$ psia) and 970 mm Hg (18.8 psia). The rate of change of interior pressure shall not exceed 20 mm Hg (0.4 psi) per minute. Dwell time at each pressure shall be between 8 and 10 hours. After exposure to this environment the DCU shall not show any gas leakage with its interior pressurized to 970 mm Hg (18.8 psid).

90.4.2.4.1.14 Vacuum Operation Test

The DCU shall be placed with open seals in a vacuum chamber evacuated to $1x10^{-3}$ mm Hg ($1.9x10^{-5}$ psia). The unit shall be powered-on for 5 hours every 24 hours, with functional checks at the beginning and end of each powered cycle. The total time of exposure to vacuum shall be not less than 200 hours.

90.4.2.4.2 Certification By Analysis

The requirements in 4.2.4.2 of the basic specification apply.

90.4.2.4.2.1 Storage/Operating Life

The requirements in 4.2.4.2.1 of the basic specification apply.

90.4.2.4.2.2 Physical Characteristics

The requirements in 4.2.4.2.2 of the basic specification apply.

90.4.2.4.2.3 Reliability

The requirements in 4.2.4.2.3 of the basic specification apply.

90.4.2.4.2.4 Salt Fog

The requirements in 4.2.4.2.4 of the basic specification apply.

90.4.2.4.2.5 Ozone

The requirements in 4.2.4.2.5 of the basic specification apply.

90.4.2.4.2.6 Fungus

The requirements in 4.2.4.2.6 of the basic specification apply.

90.4.2.4.2.7 Materials and Processes

The requirements in 4.2.4.2.7 of the basic specification apply.

90.4.2.4.2.8 Electromagnetic Compatibility

The requirements in 4.2.4.2.8 of the basic specification apply.

90.4.2.4.2.9 Electrical Design Requirements

The requirements in 4.2.4.2.9 of the basic specification apply.

90.4.2.4.2.10 Safety

The requirements in 4.2.4.2.10 of the basic specification apply.

90.4.2.4.2.11 Sand and Dust

The requirements of 4.2.4.2.11 of the basic specification apply.

90.4.2.4.2.12 Certification by Other Test Data

The requirements in 4.2.4.2.12 of the basic specification apply.

90.4.2.5 Verification Requirements Matrices

The requirements in 4.2.5 of the basic specification apply.

90.5 PREPARATION FOR DELIVERY

The requirements in Section 5 of the basic specification apply.

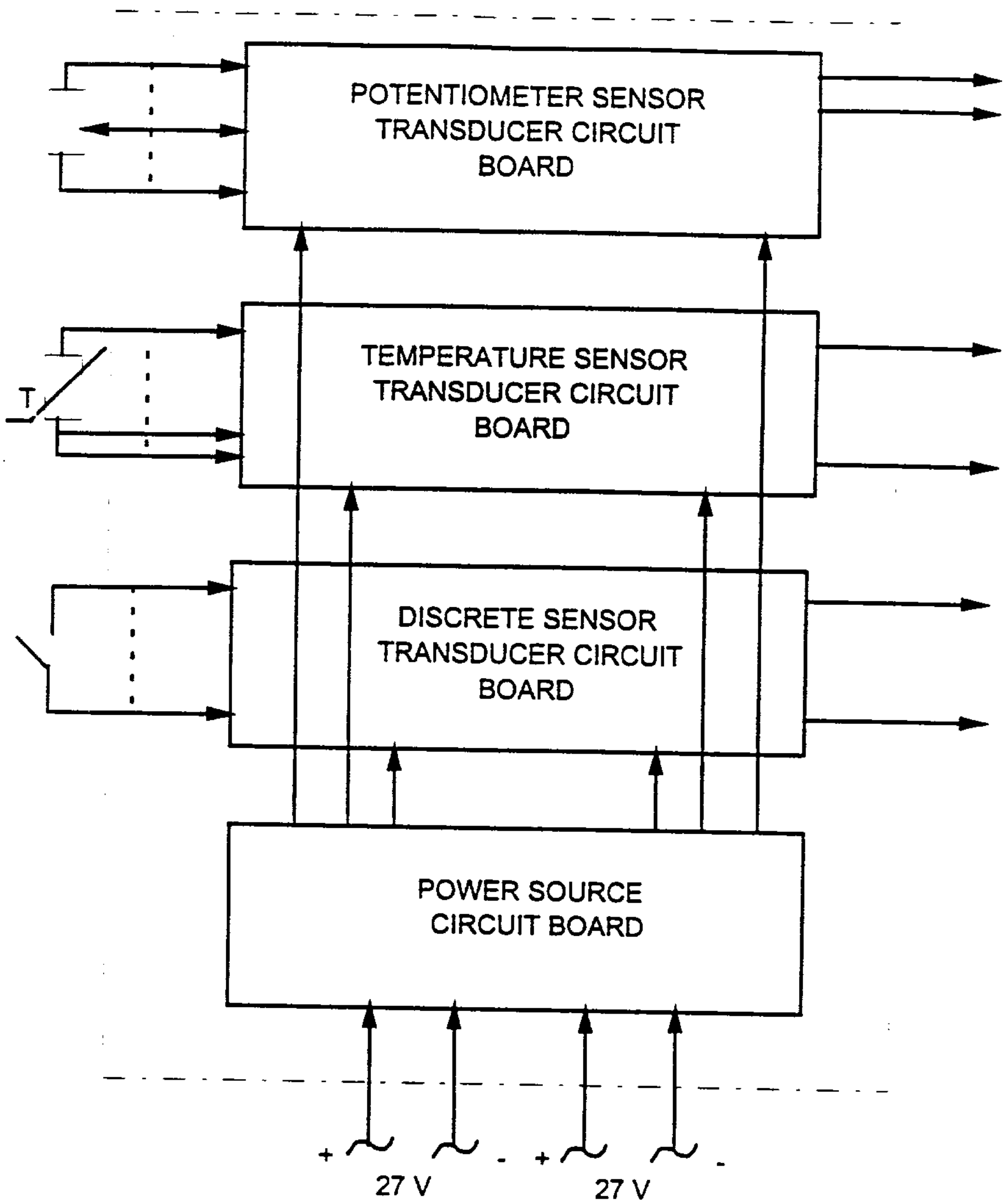

Figure 90-A. A functional block diagram of the DCU

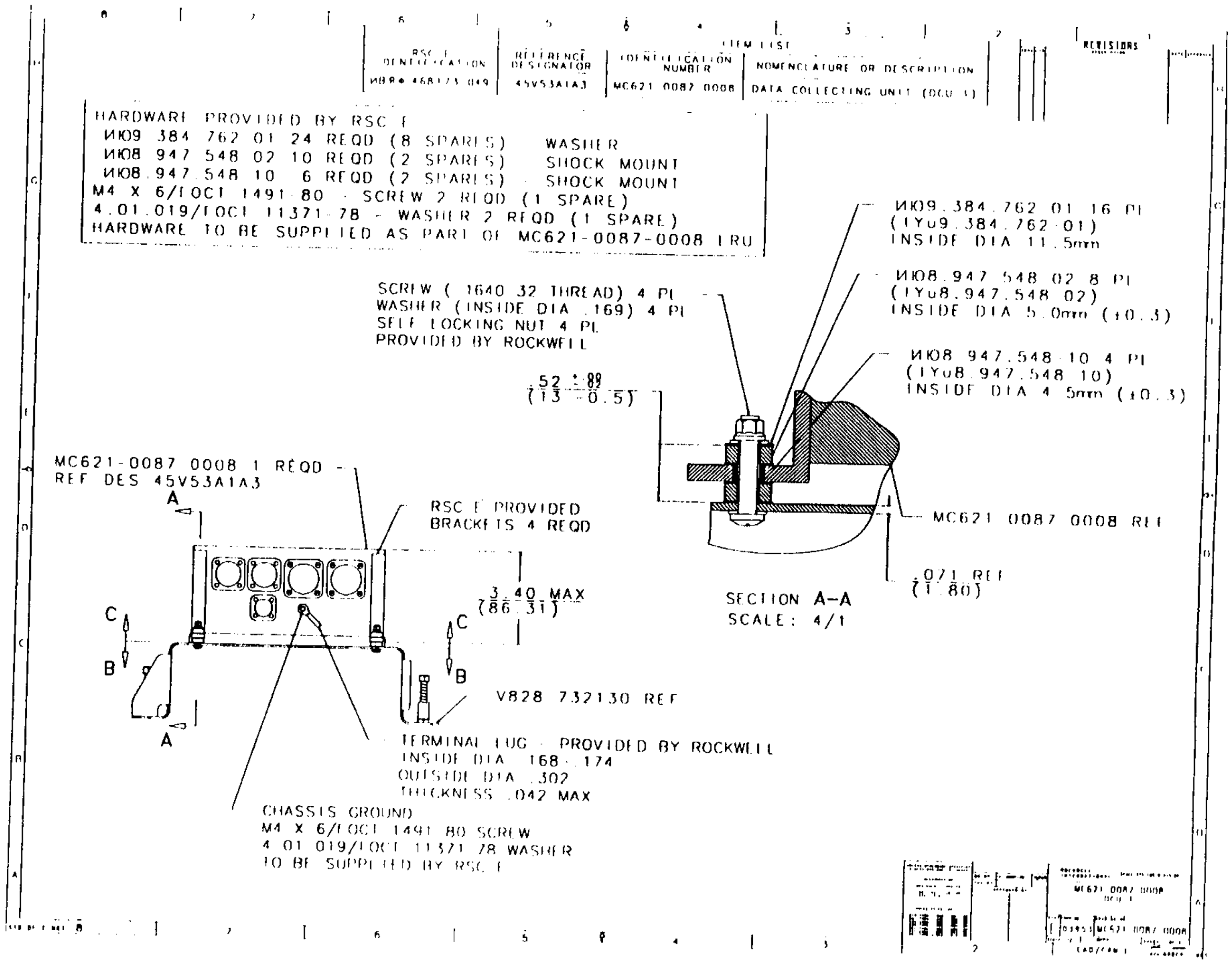

Figure 90-B. DCU-1 Mounting and Connectors Location Diagram (1 of 2)

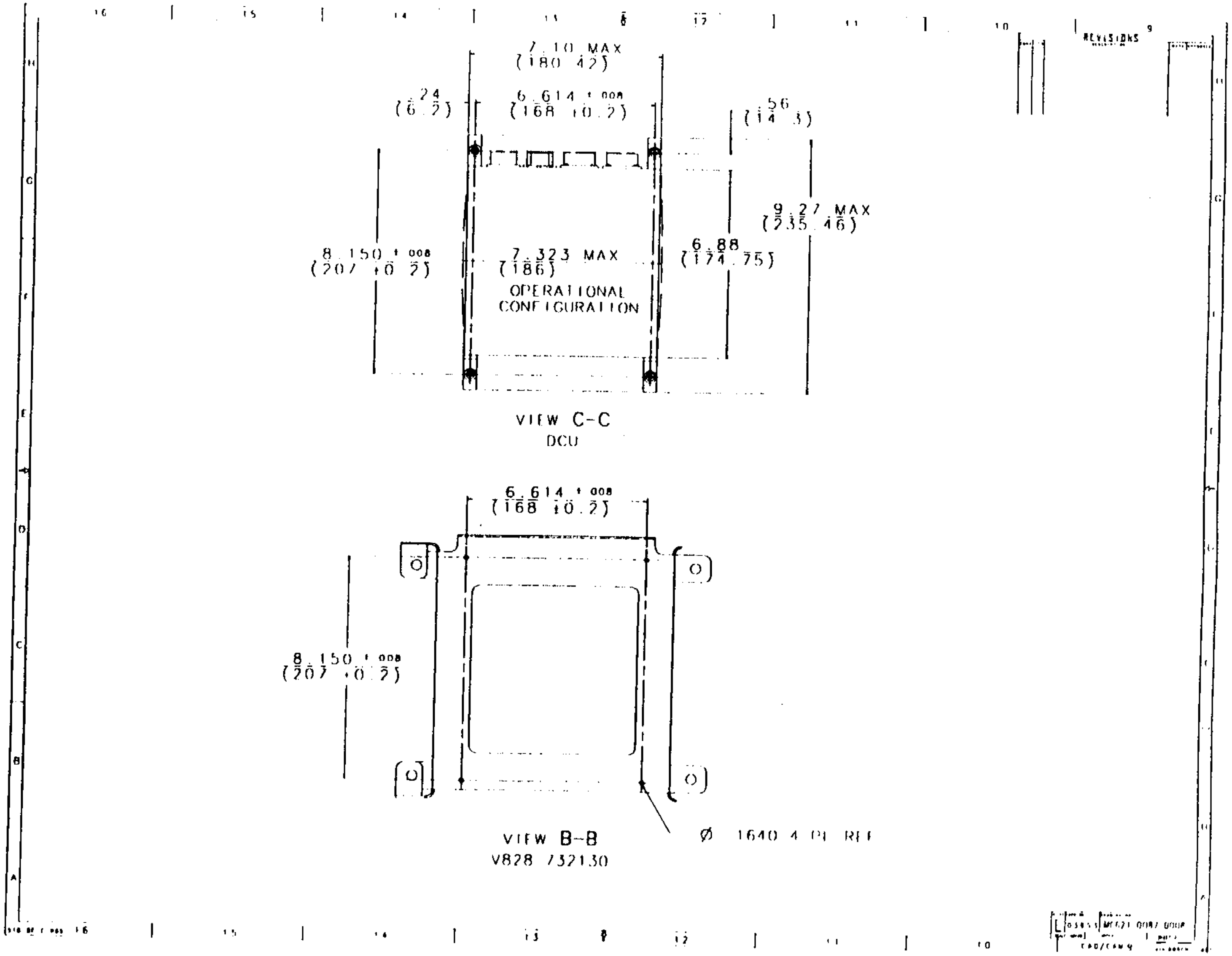

Figure 90-B. DCU-1 Mounting and Connectors Location Diagram (2 of 2)

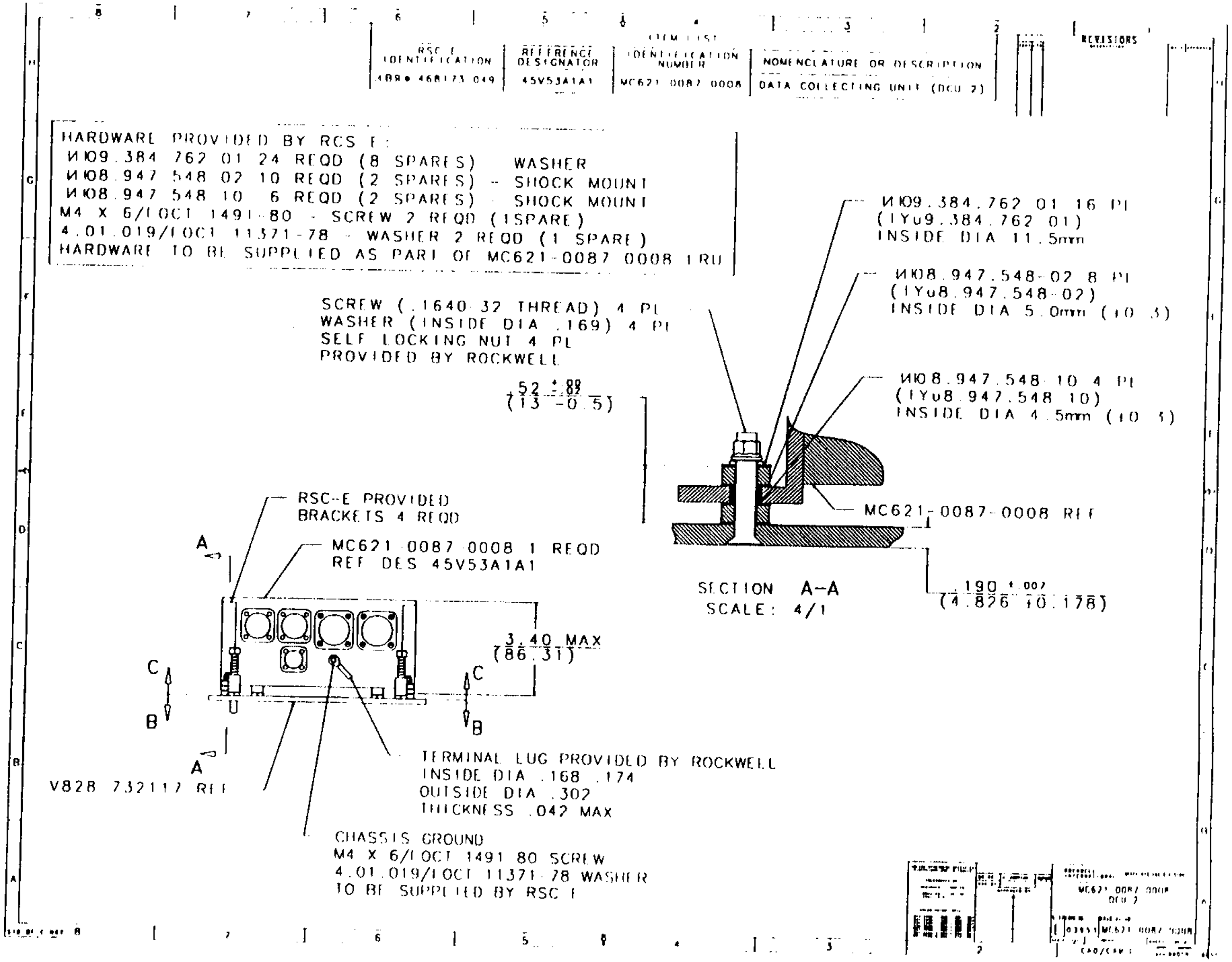

Figure 90-C. DCU-2 Mounting and Connectors Location Diagram (1 of 2)

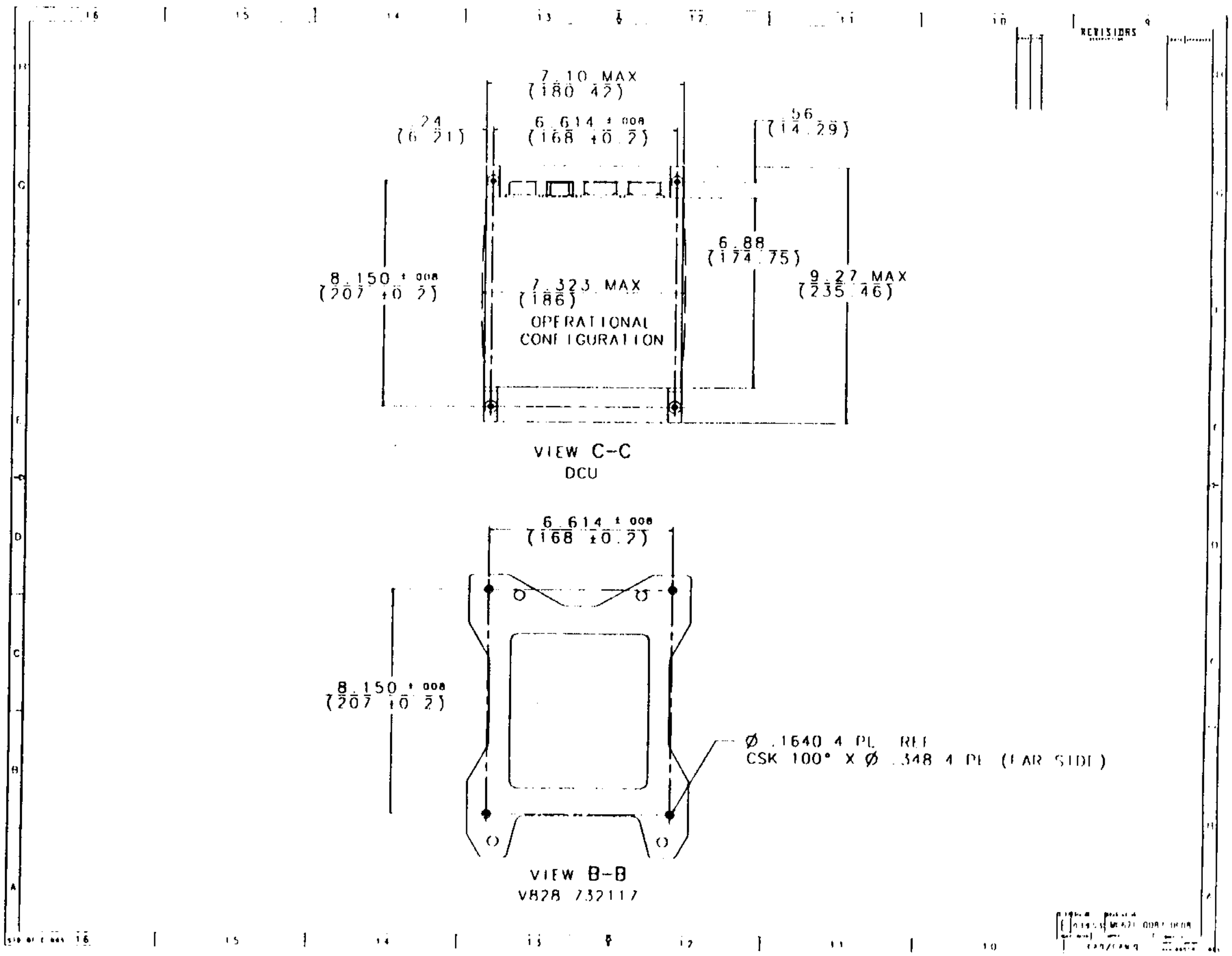

Figure 90-C. DCU-2 Mounting and Connectors Location Diagram (2 of 2)

Table 90-C1. DCU-1 Pin Assignments

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DCU-1	X1-1	1	SHD FOR ALL "A" FCNS (XT1)	A/L FL
DCU-1	X1-1	2	DOCKING I/F TEMP 1 (COM)	A/L FL
DCU-1	X1-1	3	DOCKING I/F TEMP 2 (COM)	A/L FL
DCU-1	X1-1	4	DOCKING I/F TEMP 3 (COM)	A/L FL
DCU-1	X1-1	7	HOOKS DRIVE TEMP 1 (COM)	A/L FL
DCU-1	X1-1	8	HOOKS DRIVE TEMP 2 (COM)	A/L FL
DCU-1	X1-1	9	DCKNG RING DRV TEMP (COM)	A/L FL
DCU-1	X1-1	12	DOCKING I/F TEMP 1 (EXC)	A/L FL
DCU-1	X1-1	13	DOCKING I/F TEMP 1 (SIG)	A/L FL
DCU-1	X1-1	14	DOCKING I/F TEMP 2 (EXC)	A/L FL
DCU-1	X1-1	15	DOCKING I/F TEMP 2 (SIG)	A/L FL
DCU-1	X1-1	16	DOCKING I/F TEMP 3 (EXC)	A/L FL
DCU-1	X1-1	17	DOCKING I/F TEMP 3 (SIG)	A/L FL
DCU-1	X1-1	18	HOOKS DRIVE TEMP 1 (EXC)	A/L FL
DCU-1	X1-1	19	HOOKS DRIVE TEMP 1 (SIG)	A/L FL
DCU-1	X1-1	20	HOOKS DRIVE TEMP 2 (EXC)	A/L FL
DCU-1	X1-1	21	HOOKS DRIVE TEMP 2 (SIG)	A/L FL
DCU-1	X1-1	22	DCKNG RING DRV TEMP (EXC)	A/L FL
DCU-1	X1-1	23	DCKNG RING DRV TEMP (SIG)	A/L FL
DCU-1	X1-1	39	GRP 1 HKS LINEAR ADV (COM)	A/L FL
DCU-1	X1-1	40	GRP 2 HKS LINEAR ADV (COM)	A/L FL
DCU-1	X1-1	47	GRP 1 HKS LINEAR ADV (SIG)	A/L FL
DCU-1	X1-1	49	GRP 2 HKS LINEAR ADV (SIG)	A/L FL
DCU-1	X1-1	63	GRP 1 HKS LINEAR ADV (EXC)	A/L FL
DCU-1	X1-1	64	GRP 2 HKS LINEAR ADV (EXC)	A/L FL
DCU-1	X2-1	2	DOCKING INTERFACE TEMP NO. 1	A/L FL
DCU-1	X2-1	3	DOCKING INTERFACE TEMP NO. 2	A/L FL
DCU-1	X2-1	4	DOCKING INTERFACE TEMP NO. 3	A/L FL
DCU-1	X2-1	5	HOOKS DRIVE TEMP NO. 1	A/L FL
DCU-1	X2-1	6	COMMON RTN	A/L FL
DCU-1	X2-1	7	HOOKS DRIVE TEMP NO. 2	A/L FL
DCU-1	X2-1	8	DOCKING RING DRIVE TEMP	A/L FL
DCU-1	X2-1	11	COMMON RTN	A/L FL
DCU-1	X2-1	12	LIN ADV HOOKS NO. 1 DRIVE UNIT	A/L FL
DCU-1	X2-1	13	LIN ADV HOOKS NO. 2 DRIVE UNIT	A/L FL
DCU-1	X2-1	16	COMMON RTN	A/L FL
DCU-1	X3-1	4	ACTUAT OF DCKNG RING DRV	I/P
DCU-1	X3-1	5	DC RTN	I/P
DCU-1	X3-1	6	ACTUAT OF HKS NO. 1 DRV	I/P
DCU-1	X3-1	8	ACTUAT OF HKS NO. 2 DRV	I/P
DCU-1	X3-1	10	ACTUAT OF CAPT LATCH DRV	I/P
DCU-1	X3-1	12	CAPTURE	I/P
DCU-1	X3-1	14	APDS CIRC PROT OFF	I/P
DCU-1	X3-1	16	FIXER ACTUATION	I/P
DCU-1	X3-1	18	INITIAL CONTACT IND	I/P
DCU-1	X3-1	20	RING ALIGNMENT IND	I/P
DCU-1	X3-1	22	ELECTROMAG BRAKE ACTIV	I/P
DCU-1	X3-1	23	DC RTN	I/P
DCU-1	X3-1	24	DOCKING RING DRV BUS 1	I/P

Table 90-C1. DCU-1 Pin Assignments (concluded)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DCU-1	X3-1	26	DOCKING RING DRV BUS 2	I/P
DCU-1	X3-1	27	INSTRUM PWR CKT	I/P
DCU-1	X3-1	28	HKS DRV BUS NO. 1	I/P
DCU-1	X3-1	30	HKS DRV BUS NO. 2	I/P
DCU-1	X3-1	32	BRAKES 1 & 2 BUS PWR	I/P
DCU-1	X3-1	34	BRAKES 3 BUS PWR	I/P
DCU-1	X3-1	36	FIXERS 1 & 2 BUS PWR	I/P
DCU-1	X3-1	38	INSTRUM PWR CKT	I/P
DCU-1	X3-1	40	APDS PWR IND CKT	I/P
DCU-1	X3-1	41	APDS PWR IND CKT	I/P
DCU-1	X3-1	42	FIXERS 3, 4, & 5 BUS PWR	I/P
DCU-1	X3-1	43	INSTRUM PWR CKT	I/P
DCU-1	X3-1	46	PYRO CIRCUIT PROTECT OFF IND	B2B
DCU-1	X3-1	47	PYRO CIRCUIT PROTECT OFF IND	B2B
DCU-1	X3-1	48	PYRO CIRCUIT PROTECT OFF IND	B2B
DCU-1	X3-1	49	PYRO CIRCUIT PROTECT OFF IND	B2B
DCU-1	X4-1	3	ACTUAT OF DOCKING RING DRV	A/L FL
DCU-1	X4-1	4	ACTUAT OF HOOKS 1 DRV	A/L FL
DCU-1	X4-1	5	ACTUAT OF STRUCT HK 2 DRV	A/L FL
DCU-1	X4-1	6	COMMON RTN	A/L FL
DCU-1	X4-1	7	ACTUAT OF CAPTURE LATCH DRV	A/L FL
DCU-1	X4-1	8	CAPTURE	A/L FL
DCU-1	X4-1	9	APDS CIRCUIT PROTECT OFF	A/L FL
DCU-1	X4-1	10	FIXER ACTUAT	A/L FL
DCU-1	X4-1	11	COMMON RTN	A/L FL
DCU-1	X4-1	12	INITIAL CONTACT	A/L FL
DCU-1	X4-1	13	RING ALIGNMENT	A/L FL
DCU-1	X4-1	14	ELECTROMAG BRAKE ACTUAT	A/L FL
DCU-1	X4-1	15	DOCKING RING DR BUS 1	A/L FL
DCU-1	X4-1	16	COMMON RTN	A/L FL
DCU-1	X4-1	17	DOCKING RING DRIVE BUS 2	A/L FL
DCU-1	X4-1	18	HOOKS DRIVE BUS NO. 1	A/L FL
DCU-1	X4-1	19	HOOKS DRIVE BUS NO. 2	A/L FL
DCU-1	X4-1	20	EMC BRAKE BUS PWR NO. 1	A/L FL
DCU-1	X4-1	21	COMMON RTN	A/L FL
DCU-1	X4-1	22	EMC BRAKE 2 BUS PWR	A/L FL
DCU-1	X4-1	23	EMC FIXERS 1 & 2 BUS PWR	A/L FL
DCU-1	X4-1	25	APDS LOGIC BUS PWR	A/L FL
DCU-1	X4-1	26	COMMON RTN	A/L FL
DCU-1	X4-1	27	EMC FIXERS 3, 4, & 5 BUS PWR	A/L FL
DCU-1	X4-1	29	CIRCUIT PROTECT OFF 1	A/L FL
DCU-1	X4-1	30	CIRCUIT PROTECT OFF 2	A/L FL
DCU-1	X4-1	31	COMMON RTN	A/L FL
DCU-1	X6-1	2	DCU PWR H2+ (T1 DC BUS)	A/L FL
DCU-1	X6-1	3	DCU PWR H3+ (T2 DC BUS)	A/L FL
DCU-1	X6-1	9	DCU PWR H2- (T1 DC BUS)	A/L FL
DCU-1	X6-1	10	DCU PWR H3- (T2 DC BUS)	A/L FL

Table 90-C2. DCU-2 Pin Assignments

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DCU-2	X1-2	1	SHD FOR ALL "B" FCNS (XT2)	A/L FL
DCU-2	X1-2	2	LWR BALL SCKT 1 TEMP (COM)	A/L FL
DCU-2	X1-2	3	LWR BALL SCKT 2 TEMP (COM)	A/L FL
DCU-2	X1-2	4	LWR BALL SCKT 3 TEMP (COM)	A/L FL
DCU-2	X1-2	7	CAPTURE LATCH 1 TEMP (COM)	A/L FL
DCU-2	X1-2	8	CAPTURE LATCH 2 TEMP (COM)	A/L FL
DCU-2	X1-2	9	CAPTURE LATCH 3 TEMP (COM)	A/L FL
DCU-2	X1-2	12	LWR BALL SCKT 1 TEMP (EXC)	A/L FL
DCU-2	X1-2	13	LWR BALL SCKT 1 TEMP (SIG)	A/L FL
DCU-2	X1-2	14	LWR BALL SCKT 2 TEMP (EXC)	A/L FL
DCU-2	X1-2	15	LWR BALL SCKT 2 TEMP (SIG)	A/L FL
DCU-2	X1-2	16	LWR BALL SCKT 3 TEMP (EXC)	A/L FL
DCU-2	X1-2	17	LWR BALL SCKT 3 TEMP (SIG)	A/L FL
DCU-2	X1-2	18	CAPTURE LATCH 1 TEMP (EXC)	A/L FL
DCU-2	X1-2	19	CAPTURE LATCH 1 TEMP (SIG)	A/L FL
DCU-2	X1-2	20	CAPTURE LATCH 2 TEMP (EXC)	A/L FL
DCU-2	X1-2	21	CAPTURE LATCH 2 TEMP (SIG)	A/L FL
DCU-2	X1-2	22	CAPTURE LATCH 3 TEMP (EXC)	A/L FL
DCU-2	X1-2	23	CAPTURE LATCH 3 TEMP (SIG)	A/L FL
DCU-2	X1-2	39	BALL SCREW 2 MISALIGN (COM)	A/L FL
DCU-2	X1-2	40	BALL SCREW 3 MISALIGN (COM)	A/L FL
DCU-2	X1-2	41	BALL SCREW 1 LIN ADV (COM)	A/L FL
DCU-2	X1-2	42	BALL SCREW 2 LIN ADV (COM)	A/L FL
DCU-2	X1-2	43	BALL SCREW 3 LIN ADV (COM)	A/L FL
DCU-2	X1-2	44	BALL SCREW 1 MISALIGN (COM)	A/L FL
DCU-2	X1-2	47	BALL SCREW 2 MISALIGN (SIG)	A/L FL
DCU-2	X1-2	49	BALL SCREW 3 MISALIGN (SIG)	A/L FL
DCU-2	X1-2	51	BALL SCREW 1 LIN ADV (SIG)	A/L FL
DCU-2	X1-2	53	BALL SCREW 2 LIN ADV (SIG)	A/L FL
DCU-2	X1-2	55	BALL SCREW 3 LIN ADV (SIG)	A/L FL
DCU-2	X1-2	57	BALL SCREW 1 MISALIGN (SIG)	A/L FL
DCU-2	X1-2	63	BALL SCREW 2 MISALIGN (EXC)	A/L FL
DCU-2	X1-2	64	BALL SCREW 3 MISALIGN (EXC)	A/L FL
DCU-2	X1-2	65	BALL SCREW 1 LIN ADV (EXC)	A/L FL
DCU-2	X1-2	66	BALL SCREW 2 LIN ADV (EXC)	A/L FL
DCU-2	X1-2	67	BALL SCREW 3 LIN ADV (EXC)	A/L FL
DCU-2	X1-2	68	BALL SCREW 1 MISALIGN (EXC)	A/L FL
DCU-2	X2-2	2	LOWER BALL SOCKETS NO. 1 TEMP	A/L FL
DCU-2	X2-2	3	LOWER BALL SOCKETS NO. 2 TEMP	A/L FL
DCU-2	X2-2	4	LOWER BALL SOCKETS NO. 3 TEMP	A/L FL
DCU-2	X2-2	5	CAPTURE LATCH NO. 1 TEMP	A/L FL
DCU-2	X2-2	6	COMMON RTN	A/L FL
DCU-2	X2-2	7	CAPTURE LATCH NO. 2 TEMP	A/L FL
DCU-2	X2-2	8	CAPTURE LATCH NO. 3 TEMP	A/L FL
DCU-2	X2-2	11	COMMON RTN	A/L FL
DCIJ-2	X2-2	12	PAIR BALL SCREW NO. 2 MISALIGN	A/L FL
DCU-2	X2-2	13	PAIR BALL SCREW NO. 3 MISALIGN	A/L FL
DCU-2	X2-2	14	PAIR BALL SCREW NO. 1 LIN ADV	A/L FL
DCU-2	X2-2	15	PAIR BALL SCREW NO. 2 LIN ADV	A/L FL

Table 90-C2. DCU-2 Pin Assignments (continued)

PALLET BOX	CONN	PIN	FUNCTION	TYPE
DCU-2	X2-2	16	COMMON RTN	A/L FL
DCU-2	X2-2	17	PAIR BALL SCREW NO. 3 LIN ADV	A/L FL
DCU-2	X2-2	18	PAIR BALL SCREW NO. 1 MISALIGN	A/L FL
DCU-2	X2-2	21	COMMON RTN	A/L FL
DCU-2	X3-2	2	UNDOCK COMPLETE	A/L FL
DCU-2	X3-2	3	UNDOCK COMPLETE RTN	A/L FL
DCU-2	X3-2	4	READY TO HOOK	A/L FL
DCU-2	X3-2	5	CONTROL SENSOR RETURN	A/L FL
DCU-2	X3-2	6	GROUP 1 HOOKS CLOSED POS	A/L FL
DCU-2	X3-2	7	GROUP 1 HOOKS CLOS POS RTN	A/L FL
DCU-2	X3-2	8	GROUP 1 HOOKS OPEN POSITION	A/L FL
DCU-2	X3-2	9	GROUP 1 HOOKS OPEN POS RTN	A/L FL
DCU-2	X3-2	10	GROUP 2 HOOKS CLOSED POS	A/L FL
DCU-2	X3-2	11	CONTROL SENSOR RETURN	A/L FL
DCU-2	X3-2	12	GROUP 2 HOOKS OPEN POSITION	A/L FL
DCU-2	X3-2	13	GROUP 2 HOOKS OPEN POS RTN	A/L FL
DCU-2	X3-2	14	RING FINAL POSITION	A/L FL
DCU-2	X3-2	15	RING FINAL POSITION RTN	A/L FL
DCU-2	X3-2	16	RING FORWARD POSITION	A/L FL
DCU-2	X3-2	17	RING FORWARD POSITION RTN	A/L FL
DCU-2	X3-2	18	CAPTURE LATCHES CLOSED	A/L FL
DCU-2	X3-2	19	CAPTURE LATCHES CLOS RTN	A/L FL
DCU-2	X3-2	20	CAPTURE LATCH OPEN	A/L FL
DCU-2	X3-2	21	CAPTURE LATCH OPEN RTN	A/L FL
DCU-2	X3-2	22	RING INITIAL POSITION	A/L FL
DCU-2	X3-2	23	RING INITIAL POSITION RTN	A/L FL
DCU-2	X3-2	24	LATCHES MANUAL RELEASE	A/L FL
DCU-2	X3-2	25	LATCHES MANUAL REL RTN	A/L FL
DCU-2	X3-2	26	SYSTEM POWER BUS A	A/L FL
DCU-2	X3-2	27	COMMON RTN	A/L FL
DCU-2	X3-2	28	SYSTEM POWER BUS B	A/L FL
DCU-2	X3-2	30	SYSTEM POWER BUS C	A/L FL
DCU-2	X3-2	32	PYRO LOGIC BUS A	A/L FL
DCU-2	X3-2	34	PYRO LOGIC BUS B	A/L FL
DCU-2	X3-2	36	PYRO LOGIC BUS C	A/L FL
DCU-2	X3-2	38	HEATER NO. 3/DCU POWER BUS	A/L FL
DCU-2	X3-2	40	CONT PNL LOGIC PWR BUS A	A/L FL
DCU-2	X3-2	42	CONT PNL LOGIC PWR BUS B	A/L FL
DCU-2	X3-2	44	CONT PNL LOGIC PWR BUS C	A/L FL
DCU-2	X3-2	46	HEATER NO. 1 POWER BUS	A/L FL
DCU-2	X3-2	48	HEATER NO. 2/DCU POWER BUS	A/L FL
DCU-2	X3-2	51	COMMON RTN	A/L FL
DCU-2	X4-2	2	UNDOCK COMPLETE	A/L FL
DCU-2	X4-2	3	READY TO HOOK	A/L FL
DCU-2	X4-2	4	HOOKS NO. 1 CLOSED POS	A/L FL
DCU-2	X4-2	5	HOOKS NO. 1 OPEN POS	A/L FL
DCU-2	X4-2	6	COMMON RTN	A/L FL
DCU-2	X4-2	7	HOOKS NO. 2 CLOSED POS	A/L FL
DCU-2	X4-2	8	HOOKS NO. 2 OPEN POS	A/L FL
DCU-2	X4-2	9	DOCKING RING FINAL POS	A/L FL

Table 90-C2. DCU-2 Pin Assignments (concluded)

PALLET				
BOX	CONN	PIN	FUNCTION	TYPE
DCU-2	X4-2	10	DOCKING RING FWD POS	A/L FL
DCU-2	X4-2	11	COMMON RTN	A/L FL
DCU-2	X4-2	12	CAPTURE LATCHES CLOS POS	A/L FL
DCU-2	X4-2	13	CAPTURE LATCHES OPEN POS	A/L FL
DCU-2	X4-2	14	DOCKING RING INITIAL POS	A/L FL
DCU-2	X4-2	15	LATCHES MAN REL INIT POS	A/L FL
DCU-2	X4-2	16	COMMON RTN	A/L FL
DCU-2	X4-2	17	SYSTEM POWER BUS A	A/L FL
DCU-2	X4-2	18	SYSTEM POWER BUS B	A/L FL
DCU-2	X4-2	19	SYSTEM POWER BUS C	A/L FL
DCU-2	X4-2	20	PYRO LOGIC BUS A	A/L FL
DCU-2	X4-2	21	COMMON RTN	A/L FL
DCU-2	X4-2	22	PYRO LOGIC BUS B	A/L FL
DCU-2	X4-2	23	PYRO LOGIC BUS C	A/L FL
DCU-2	X4-2	24	HEATER NO. 3/DCU POWER BUS	A/L FL
DCU-2	X4-2	25	CONT PNL LOGIC PWR BUS A	A/L FL
DCU-2	X4-2	26	COMMON RTN	A/L FL
DCU-2	X4-2	27	CONT PNL LOGIC PWR BUS B	A/L FL
DCU-2	X4-2	28	CONT PNL LOGIC PWR BUS C	A/L FL
DCU-2	X4-2	29	HEATER NO. 1 POWER BUS	A/L FL
DCU-2	X4-2	30	HEATER NO. 2/DCU POWER BUS	A/L FL
DCU-2	X4-2	31	COMMON RTN	A/L FL
DCU-2	X6-2	2	DCU PWR H2+ (T1 DC BUS)	A/L FL
DCU-2	X6-2	3	DCU PWR H3+ (T2 DC BUS)	A/L FL
DCU-2	X6-2	9	DCU PWR H2- (T1 DC BUS)	A/L FL
DCU-2	X6-2	10	DCU PWR H3- (T2 DC BUS)	A/L FL

Table 90-D. DCU Measurement List

ANALOG

1 PAIR BALL SCREW NO. 1 MISALIGNMENT
2 PAIR BALL SCREW NO. 2 MISALIGNMENT
3 PAIR BALL SCREW NO. 3 MISALIGNMENT
4 PAIR BALL SCREW NO. 1 LIN ADV
5 PAIR BALL SCREW NO. 2 LIN ADV
6 PAIR BALL SCREW NO. 3 LIN ADV
7 LIN ADV HOOKS NO. 1 DRIVE UNIT
8 LIN ADV HOOKS NO. 2 DRIVE UNIT

TEMPERATURE

1 DOCKING INTERFACE TEMP NO. 1
2 DOCKING INTERFACE TEMP NO. 2
3 DOCKING INTERFACE TEMP NO. 3
4 LWR BALL SOCKETS NO. 1 TEMP
5 LWR BALL SOCKETS NO. 2 TEMP
6 LWR BALL SOCKETS NO. 3 TEMP
7 CAPTURE LATCH NO. 1 TEMP
8 CAPTURE LATCH NO. 2 TEMP
9 CAPTURE LATCH NO. 3 TEMP
10 DOCKING RING DRIVE TEMP
11 HOOKS DRIVE TEMP NO. 1
12 HOOKS DRIVE TEMP NO. 2

DISCRETE

1 ELECTROMAG BRAKE ACTUATION
2 DOCKING RING DRIVE BUS 1
3 INITIAL CONTACT
4 RING ALIGNMENT
5 ACTUATION OF DOCKING RING DRIVE
6 ACTUATION OF HOOKS NO. 1 DRIVE
7 ACTUATION OF HOOKS NO. 2 DRIVE
8 ACTUATION OF CAPTURE LATCH DRIVE
9 APDS CIRCUIT PROTECTION OFF
10 FIXER ACTUATION
11 CAPTURE
12 PYRO CKT PROTECT OFF 1
13 PYRO CKT PROTECT OFF 2
14 ELECTROMAG FIXERS 3,4,&5 BUS POWER
15
16 UNDOCK COMPLETE
17 READY TO HOOK
18 HOOKS NO. 1 OPEN POSITION
19 HOOKS NO. 1 CLOSE POSITION
20 HOOKS NO. 2 CLOSE POSITION
21 HOOKS NO. 2 OPEN POSITION
22 DOCKING RING FINAL POS
23 DOCKING RING FORWARD POS
24 CAPTURE LATCHES CLOSED POS
25 CAPTURE LATCHES OPEN POS
26 DOCKING RING INITIAL POS
27 LATCHES MANUAL RELEASE INITIAL POS
28 CONTROL PANEL LOGIC POWER BUS B
29 CONTROL PANEL LOGIC POWER BUS C
30 HEATER NO. 1 POWER BUS
31 HEATER NO. 2/DCU POWER BUS
32 APDS POWER BUS A
33 APDS POWER BUS B
34 APDS POWER BUS C
35 PYRO LOGIC POWER BUS A
36 PYRO LOGIC POWER BUS B
37 PYRO LOGIC POWER BUS C
38 CONTROL PANEL LOGIC POWER BUS A
39 HEATER NO. 3/DCU POWER BUS
40 DOCKING RING DRIVE BUS 2
41 HOOKS DRIVE BUS NO. 1
42 HOOKS DRIVE BUS NO. 2
43 ELECTROMAG BRAKES 1 & 2 BUS POWER
44 ELECTROMAG BRAKE 3 BUS POWER
45 ELECTROMAG FIXERS 1 & 2 BUS POWER
46 APDS POWER ON

Appendix X

100. DOCKING CONTROL PANEL

100.1 SCOPE

This appendix defines the detailed requirements for the Docking Control Panel (DCP).

100.2 APPLICABLE DOCUMENTS

N/A

100.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

100.3.1 Item Definition

The DCP shall have means to provide displays and controls to the crew of critical functions driving the EDS such as Power Switching and Controls, Functional Controls and Fault Annunciation.

100.3.1.1 Item Diagram

A functional block diagram of the DCP is illustrated in Figure 100-A.

100.3.1.2 Interface Definition

The functional and physical interface requirements between the DCP, the EDS boxes, and the Orbiter Avionics are defined in the following paragraphs.

100.3.1.2.1 Electrical Power Characteristics

The electrical power characteristics shall be in accordance with the requirements in 3.1.2.1 of the basic specification.

100.3.1.2.2 Mechanical Characteristics.

100.3.1.2.2.1 Mounting

Provisions for mounting the DCP shall be as shown in Figure 100-B.

100.3.1.2.2.2 Connectors

The DCP shall have connectors located as shown in Figure 100-B, with pin assignments as shown in Table 100-C.

100.3.1.3 Item Identification

The DCP shall be identified as follows:

Nomenclature	Buyer Control No.	Seller Part No.	Traceability Classification	Maintenance Level
DCP	MC621-0087-0009	SLIYu.468312.001	Ts	LRU

100.3.2 Characteristics.

100.3.2.1 Performance Characteristics

The DCP shall provide the crew with the controls required to perform the mating and demating of the Orbiter to the ISSA; the DCP shall also have the capability to alert the crew of any out-of-range parameters, as well as the status of the EDS.

100.3.2.1.1 Life Requirements

The requirements in 3.2.1.1 of the basic specification apply.

100.3.2.1.2 Design Approach

The requirements in 3.2.1.2 of the basic specification apply.

100.3.2.1.3 Signal Characteristics

Characteristics of signals that are unique to the DCP are as follows:

TBS

100.3.2.2 Physical Characteristics

100.3.2.2.1 Envelope

The DCP shall have an envelope defined in Figure 100-B.

100.3.2.2.2 Weight

The weight of the DCP shall not exceed 26.5 lbs (12 kg).

100.3.2.2.3 Exposed Edges

The design of all hardware exposed to the flight crew during normal operations shall incorporate arrangements necessary for crew safety, such as: generous corner and edge radii, panel closures, etc. The following construction criteria shall be adhered to:

A. Panel corners shall be rounded to a minimum radius of .0125 inches (0.3175 mm).

B. Panel edges shall be rounded sufficiently to prevent injury.

100.3.2.2.4 Standing and Push Off Loads

The DCP shall be structurally designed so as to support a static 350 lb. (158.8 kg) load applied over a 4X4 inch (101.6 X 101.6 mm) area.

100.3.2.2.4.1 Panel Mounting Hardware

The preferred Panel mounting hardware head style is torque-set. All Panel mounting hardware shall be finished in such a manner as to eliminate specular reflection of light.

100.3.2.2.5 Closeouts

The DCP shall be designed to prevent any floating debris from passing through. In addition, when the DCP is installed, all cracks, gaps, etc., between the Panel and its related structure shall be covered or closed out by a suitable material to prevent floating debris from passing through.

100.3.2.2.6 Finishes

The rear Panel surface shall not be painted, but the finish shall be Buyer approved. Panel mounting surfaces shall be prepared by Buyer approved electrical bonding.

100.3.2.2.7 Color

The display colors are to be standardized and shall be subject of Buyer approval.

100.3.2.2.8 Fire Protection

The DCP shall have adequate provisions for fire protection.

100.3.2.2.8.1 Fire Holes

The DCP shall have on its form surface a "fire hole" located so as to allow a fire extinguisher nozzle to be inserted. The diameter of the hole shall be 0.50 inches (12.7 mm). The hole shall be covered by a 0.75 inch (19.05 mm) diameter circular red decal placed over the fire hole. The decal shall be solid with tear perforations across the center, the purpose being to prevent debris from entering the Panel while still allowing smoke to escape. Buyer will provide this decal.

100.3.2.2.9 Rear Panel Enclosure

In order to protect the Panel-mounted display- and-control components from damage during handling a rear Panel enclosure is recommended. There is no requirement for the enclosure to be sealed.

100.3.2.2.10 Glass Protection

All glass used in the crew compartment shall have provisions to prevent its escape into the cabin atmosphere should its breakage occur. The glass shall be subjected to an impact test in order to verify the method of glass protection. A one-inch-diameter spherical ball shall be dropped on the center of the glass five times. The energy shall be five foot-pounds. The glass shall not break, shatter, or splinter in such a manner that glass splinters could enter the cabin atmosphere.

100.3.2.2.11 Nomenclature

The preferred method of applying nomenclature to the DCP shall be the silk-screen process using a commercial "futura Demibold" font style.

100.3.2.2.12 Component Protection

In order to avoid damage to or inadvertent actuation of display and control components during both ground operation and on-orbit activities, components shall be suitably protected. The DCP shall be mounted as follows:

Toggle switches shall be mounted on the surface of flat display and control Panels.

Switch guards (wickets) shall be used to protect switches from damage or inadvertent actuation.

Pushbutton switches shall be flush mounted such that the top surface of the pushbutton is flush with the Panel surface.

100.3.2.2.13 Touch temperature

All surfaces, (instruments, annunciators, lighting overlay panels, etc.), which are exposed to the flight crew shall not exceed 113 °F in a still-air 70 °F ambient environment.

100.3.2.2.14 Display Requirements

The Panel display devices whose configuration is shown in Figure 100-C shall meet the following criteria.

100.3.2.2.14.1 Standardization

Displays, their markings, labeling, coding, location, and arrangement schemes shall be standardized for common functions. The intent of this requirement is to assure that all display and control Panels are similar in appearance.

100.3.2.2.14.2 Selection

Display devices used on the DCP shall be selected using the following criteria.

100.3.2.2.14.3 Display Window

The display window shall be designed to prevent escape into the cabin atmosphere of loose particles in the event of breakage of externally exposed frangible materials used in its construction.

100.3.2.2.14.4 Window Coating

Display windows shall be coated on exposed surfaces with a coating to reduce reflection. There shall be no imperfections in the window such as bubbles, scratches, discolorations, or striae.

100.3.2.2.14.5 Display Movements.

100.3.2.2.14.5.1 General

The movements of a display shall be consistent with the related movements or response of the equipment being controlled or monitored.

100.3.2.2.14.6 Signal Devices.

100.3.2.2.14.6.1 General

Signal devices such as event indicators, advisory, caution and warning annunciator lights, should be used for the display of discrete qualitative information.

100.3.2.2.14.6.2 Annunciator Lights

Annunciator lights are to be used for the purpose of providing subsystem and component malfunction and status information.

100.3.2.2.14.6.2.1 Light Presentation

Signal light presentation shall be steady "ON". The use of flash modes shall be limited to special applications approved by the Buyer.

100.3.2.2.14.6.2.2 Lamp Testing

Provisions shall be made to allow test of all signal lights and associated circuitry, where practical. Master light test controls shall be provided for the simultaneous testing of signal lights installed.

100.3.2.2.14.6.2.3 Advisory Lights

Advisory lights shall be white and shall be used to indicate safe or normal configuration, condition of performance, operation of essential equipment, or to attract attention and impart information for routine action purposes. Single advisory lights may be used to denote the occurrence of one or several conditions, i.e., several signals may be "or'd" into one light.

100.3.2.2.14.7 Displays & Controls, Arrangement and Grouping

Displays and controls shall be designed and arranged with consideration of the human aspects of operating and maintaining the equipment.

100.3.2.2.14.7.1 Functional Grouping. Displays and Controls which have sequential relations, which have to do with a particular function or operation, or which must be simultaneously viewed, shall be grouped together along with their associated displays or controls.

100.3.2.2.14.7.1.1 Sequential Grouping

Sequential grouping shall be used within functional groups when appropriate. Sequential grouping shall be used when the system operations require continuity, connection, and order.

100.3.2.2.14.8 Display & Control Panel Marking

Labeling shall be used to identify the function of each display/control, and to identify the mode of operation which each display indicates and each control selects.

100.3.2.2.14.8.1 Display & Control Labeling

All labeling shall utilize the English language. Labeling of display/control devices shall adhere to the following criteria:

100.3.2.2.14.8.1.1 Label Consistency

Labels shall be designed and located in a consistent manner throughout the DCP.

100.3.2.2.14.8.1.2 Label Location

Labels shall be centered immediately above their associated controls and be so spaced that the Panel will not appear cluttered.

100.3.2.2.14.8.1.3 Label Orientation

Labels shall read horizontally and be oriented to read left to right.

100.3.2.2.14.8.2 Label Characters

All labeling characters shall utilize the English alphabet except where special characters are used per 100.3.2.2.14.8.5.

100.3.2.2.14.8.3 Font Style

Shall be Buyer approved.

100.3.2.2.14.8.4 Character Height

Shall be Buyer approved.

100.3.2.2.14.8.4.1 Mode of Operation

Shall be Buyer approved.

100.3.2.2.14.8.4.2 Functional Labels

Function labels serve as a title for the function of a display/control. Nominal heights of function labels shall be Buyer approved.

100.3.2.2.14.8.4.3 System Titles

System titles describe the system being monitored or controlled. Nominal heights of system titles shall be Buyer approved.

100.3.2.2.14.8.4.4 Size Graduation

In general, the heights of the Panel nomenclature shall increase by Buyer approved percent when going from the mode title to the next higher category. The use of the same size characters on a Panel is acceptable for solving Panel space limitations and clarity problems, but the overall effect on the Panel shall be considered.

100.3.2.2.14.8.5 Special Characters

Special characters shall adhere to the following criteria:

100.3.2.2.14.8.5.1 Numeric Subscripts and Upper Case Letter Subscripts

The base of the subscript numeral or letter shall be at the same level as adjacent capital letters.

100.3.2.2.14.8.5.2 Lower Case Letter Subscripts

The base of lower case letters and the ovals of g, p, q, etc., shall be at the same level as the base of adjacent capital letters.

100.3.2.2.14.8.5.3 Degree Symbol

Shall be Buyer approved.

100.3.2.2.14.8.5.4 Delta Symbol

An equilateral triangle with its height equal to that of its associated lettering.

100.3.2.2.14.8.5.5 Slash or Diagonal Shall be Buyer approved.

100.3.2.2.14.8.5.6 Phase or PHI

Shall be Buyer approved.

100.3.2.2.14.8.5.7 Percentage Symbol

Shall be Buyer approved.

100.3.2.2.14.8.6 Character and Line Spacing.

100.3.2.2.14.8.6.1 Letters and Numerals

The spacing between letters within words and numerals within groups shall be approximately one stroke width.

100.3.2.2.14.8.6.2 Word Spacing

The spacing between words in groups shall be one standard letter.

100.3.2.2.14.8.6.3 Line Spacing

The space between the bottom of one line and the top of another line in the same entry shall be a minimum of Buyer approved percent of the character height. Where there are two character sizes used in the same entry, the line spacing shall be Buyer approved percent of the larger character height.

100.3.2.2.14.8.6.4 Group Spacing

The space between the bottom of one line of one group of nomenclature and the top line of another groups of nomenclature shall be a minimum of Buyer approved inch.

100.3.2.2.14.8.6.5 Abbreviations

Shall be Buyer approved.

100.3.2.2.14.8.7 Component labeling

Shall be Buyer approved.

100.3.2.3 Reliability

The requirements of 3.2.3 of the basic specification apply.

100.3.2.4 Environment

The requirements of 3.2.5.1.1 and 3.2.5.1.2 of the basic specification apply.

100.3.2.5 Transportability

The requirements of 3.2.6 the basic specification apply.

100.3.3 Design and Construction

The requirements of 3.3 of the basic specification apply, except that the following paragraph takes precedence over 3.3.3.2.1.

100.3.3.1.1 Power Consumption

The DCP shall consume no more than 38 watts.

100.4 QUALITY ASSURANCE PROVISIONS.

100.4.1 General Requirements

The requirements of 4.1 of the basic specification apply.

100.4.2 Quality Conformance

100.4.2.1 Development

The requirements in 4.2.1 of the basic specification apply.

100.4.2.2 Acceptance

Acceptance tests and inspections shall be performed on the DCP, to be employed on the delivered units to the Buyer. The minimum number of tests and inspections, and the sequence thereof shall be as specified in Table 100-A. The Seller shall perform any other test deemed necessary, subject to approval of the Buyer.

Table 100-A. Acceptance Requirements

Inspection & Test	Paragraph Listed in Recommended Sequence
Examination of Product	100.4.2.2.1
Functional & Performance Test	100.4.2.2.2
Insulation Resistance Test	100.4.2.2.2.1
Dielectric Strength Test	100.4.2.2.2.2
Acceptance Vibration Test	100.4.2.2.3
Acceptance Thermal Test	100.4.2.2.4
Acceptance Humidity Test	100.4.2.2.5
Functional & Performance Recheck	100.4.2.2.2

100.4.2.2.1 Examination of Product

The requirements in 4.2.2.1 of the basic specification apply.

100.4.2.2.2 Functional and Performance Tests

The requirements in 4.2.2.2 of the basic specification apply.

100.4.2.2.2.1 Insulation Resistance Test

The requirements in 4.2.2.2.1 of the basic specification apply.

100.4.2.2.2.2 Dielectric Strength Test

The requirements in 4.2.2.2.2 of the basic specification apply.

100.4.2.2.3 Acceptance Vibration Test (AVT)

The requirements in 4.2.2.3 of the basic specification apply.

100.4.2.2.4 Acceptance Thermal Test (ATT)

The requirements in 4.2.2.4 of the basic specification apply.

100.4.2.2.5 Acceptance Humidity Test

The requirements in 4.2.2.5 of the basic specification apply.

100.4.2.3 Assessment

The requirements in 4.2.3 of the basic specification apply.

100.4.2.3.1 Reliability

The requirements in 4.2.3.1 of the basic specification apply.

100.4.2.3.2 Materials and Processes

The requirements in 4.2.3.2 of the basic specification apply.

100.4.2.3.3 Parts Standardization

The requirements in 4.2.3.3 of the basic specification apply.

100.4.2.3.4 Electrical Design Requirements

The requirements in 4.2.3.4 of the basic specification apply.

100.4.2.3.5 Interchangeability

The requirements in 4.2.3.5 of the basic specification apply.

100.4.2.3.6 Human Performance/Human Engineering

The requirements in 4.2.3.6 of the basic specification apply.

100.4.2.3.7 Safety

The requirements in 4.2.3.7 of the basic specification apply.

100.4.2.3.8 Identification and Marking

The requirements in 4.2.3.8 of the basic specification apply.

100.4.2.4 Certification

The requirements in 4.2.4 of the basic specification apply.

100.4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements specified in the performance and design verification matrix of Section 4, Table V shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in Table 100-B.

Table 100-B. Qualification Requirements

Test sequence	Paragraph
Acceptance Test	100.4.2.2
Performance Test	100.4.2.4.1.2
Transportation Test	100.4.2.4.1.11
Power Test	100.4.2.4.1.7
Vibration	100.4.2.4.1.4
Shock	100.4.2.4.1.6
Thermal Vacuum Test	100.4.2.4.1.10
Qualification Humidity Test	100.4.2.4.1.3
* EMC Test	100.4.2.4.1.9
Life Test	100.4.2.4.1.12
Final Performance Test	100.4.2.4.1.2

* Tests and analysis will be conducted and documented by Buyer.

100.4.2.4.1.1 Test Hardware

Qualification-test hardware shall be of the same configuration as flight hardware.

100.4.2.4.1.2 Performance Requirements

The requirements in 4.2.4.1.2 of the basic specification apply.

100.4.2.4.1.3 Qualification Humidity Test

The requirements in 4.2.4.1.3 of the basic specification apply.

100.4.2.4.1.4 Vibration.

100.4.2.4.1.4.1 Qualification - Acceptance Vibration Test (QAVT)

The requirements in 4.2.4.1.4.1 of the basic specification apply.

Deleted

100.4.2.4.1.5 Shock

The requirements in 4.2.4.1.6 of the basic specification apply.

100.4.2.4.1.6 Power Test

The requirements in 4.2.4.1.7 of the basic specification apply. Power tests may be verified as part of the Functional/Performance tests.

100.4.2.4.1.7 Lightning

The requirements in 4.2.4.2.12 of the basic specification apply.

100.4.2.4.1.8 Electromagnetic Compatibility Tests

The requirements in 4.2.4.1.9 of the basic specification apply.

100.4.2.4.1.9 Thermal Vacuum Test

The requirements in 4.2.4.1.10 of the basic specification apply except the minimum pressure shall be 8 psia (413.6 mm Hg).

100.4.2.4.1.10 Transportation Test

The requirements in 4.2.4.1.11 of the basic specification apply.

100.4.2.4.1.11 Operating Life Test

The requirements in 4.2.4.1.12 of the basic specification apply.

100.4.2.4.2 Certification By Analysis

The requirements in 4.2.4.2 of the basic specification apply.

100.4.2.4.2.1 Storage/Operating Life

The requirements in 4.2.4.2.1 of the basic specification apply.

100.4.2.4.2.2 Physical Characteristics

The requirements in 4.2.4.2.2 of the basic specification apply.

100.4.2.4.2.3 Reliability

The requirements in 4.2.4.2.3 of the basic specification apply.

100.4.2.4.2.4 Salt Fog

The requirements in 4.2.4.2.4 of the basic specification apply.

100.4.2.4.2.5 Ozone

The requirements in 4.2.4.2.5 of the basic specification apply.

100.4.2.4.2.6 Fungus

The requirements in 4.2.4.2.6 of the basic specification apply.

100.4.2.4.2.7 Materials and Processes

The requirements in 4.2.4.2.7 of the basic specification apply.

100.4.2.4.2.8 Electromagnetic Compatibility

The requirements in 4.2.4.2.8 of the basic specification apply.

100.4.2.4.2.9 Electrical Design Requirements

The requirements in 4.2.4.2.9 of the basic specification apply.

100.4.2.4.2.10 Safety

The requirements in 4.2.4.2.10 of the basic specification apply.

100.4.2.4.2.11 Sand and Dust

The requirements in 4.2.4.2.11 of the basic specification apply.

100.4.2.4.2.12 Certification by Other Test Data

The requirements in 4.2.4.2.12 of the basic specification apply.

100.4.2.5 Verification Requirements Matrices

The requirements in 4.2.5 of the basic specification apply.

100.5 PREPARATION FOR DELIVERY

The requirements in Section 5 of the basic specification apply.

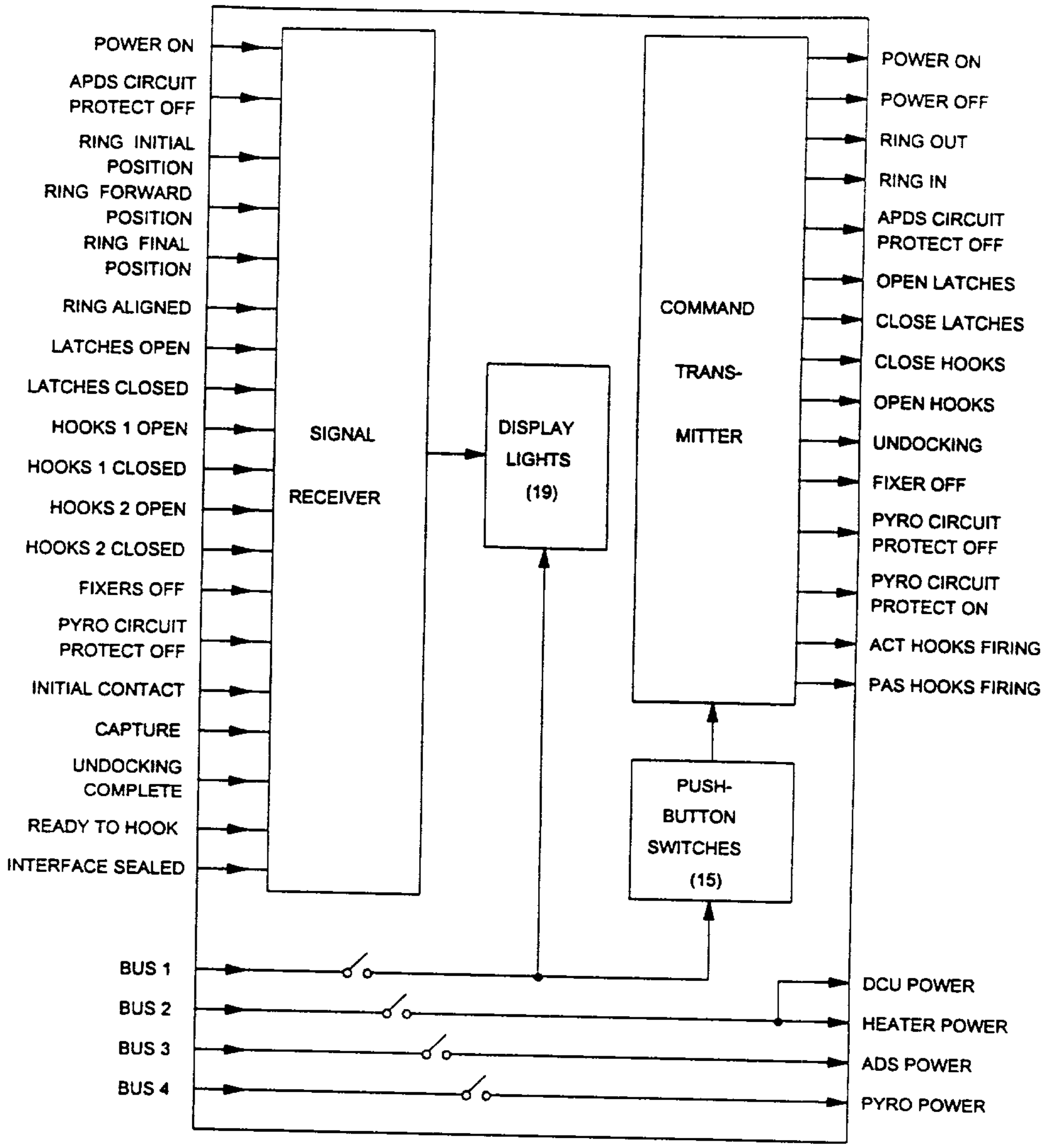

Figure 100-A. A functional block diagram of the DCP

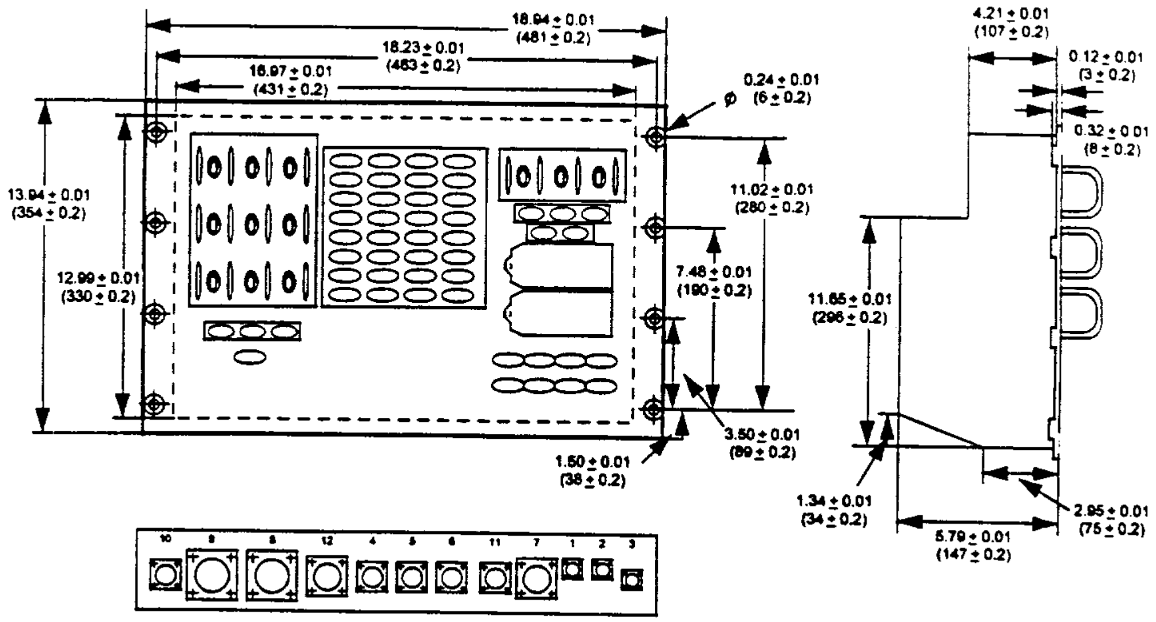

Figure 100-B. DCP Mounting and Connectors Location

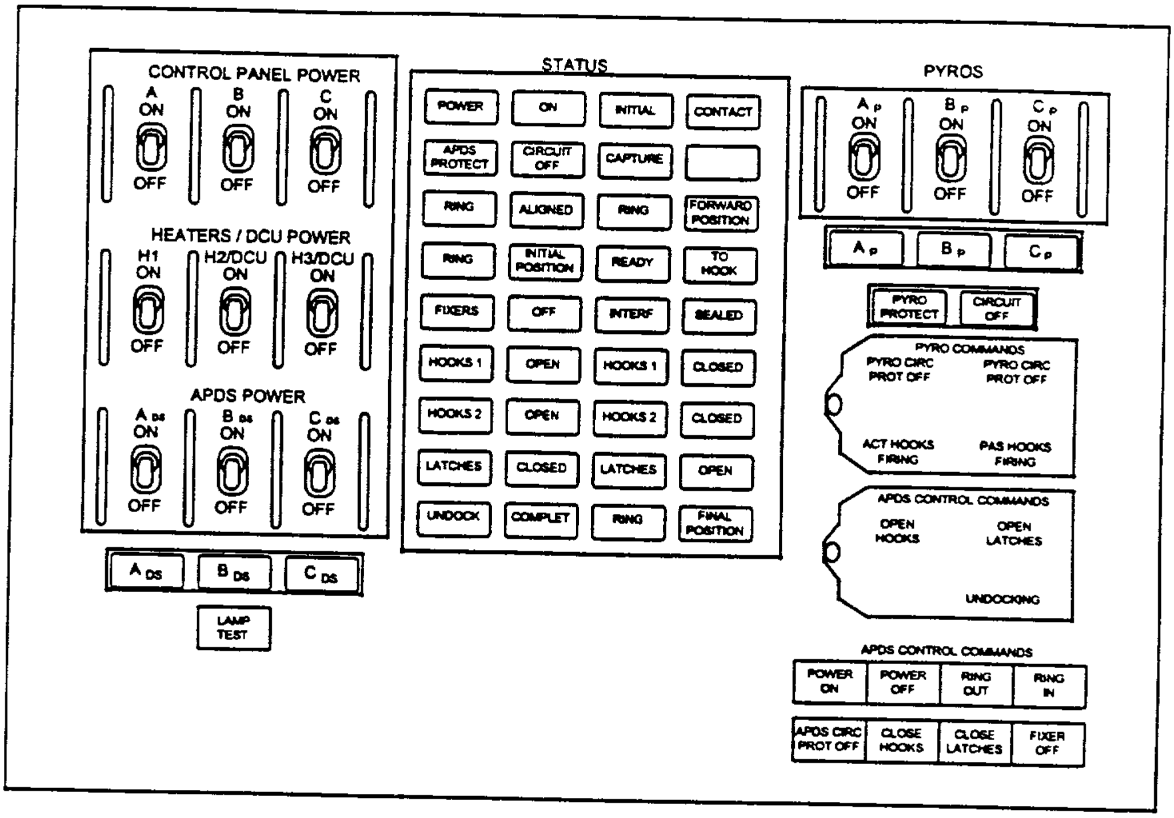

Figure 100-C. Configuration Drawing of the DCP

Table 100-C. DCP Pin Assignments

LRU CONN	LRU PIN NUMBER	FUNCTION
X1	1	Power bus A
	2	Power bus A
	3	Spare
	4	Spare
	5	Spare
	6	Power bus A return
	7	Power bus A return
X2	1	Power Bus B
	2	Power Bus B
	3	Spare
	4	Spare
	5	Spare
	6	Power Bus B return
	7	Power Bus B return
X3	1	Power bus C
	2	Power bus C
	3	Spare
	4	Spare
	5	Spare
	6	Power bus C return
	7	Power bus C return
X4	1	Power bus Ac
	2	Power bus Ac
	3	Spare
	4	Power bus An
	5	Power bus An
	6	Power bus H1
	7	Power bus H1
	8	Power bus H1
	9	Spare
	10	Spare
	11	Spare
	12	Power bus return

Table 100-C. DCP Pin Assignments (Continued)

LRU CONN	LRU PIN NUMBER	FUNCTION
X4	13	Spare
	14	Spare
	15	Power bus return
	16	Power bus return
	17	Power bus return
	18	Power bus return
	19	Power bus return
X5	1	Power bus Bc
	2	Power bus Bc
	3	Spare
	4	Power bus Bn
	5	Power bus Bn
	6	Power bus H2
	7	Spare
	8	Spare
	9	Power bus +T1
	10	Power bus +T1
	11	Spare
	12	Spare
	13	Power bus return
	14	Power bus return
	15	Power bus return
	16	Power bus return
	17	Power bus return
	18	Power bus return
	19	Power bus return
X6	1	Power bus +C
	2	Power bus +C
	3	Spare
	4	Power bus Bn
	5	Power bus Bn
	6	Power bus H3

Table 100-C. DCP Pin Assignments (Continued)

LRU CONN	LRU PIN NUMBER	FUNCTION
	7	Power bus H3
	8	Power bus H3
X6	9	Power bus T2
	10	Power bus T2
	11	Spare
	12	Spare
	13	Power return
	14	Power return
	15	Power return
	16	Power return
	17	Power return
	18	Power return
	19	Power return
X7	1	Pyro circuit protection off command
	2	Pyro circuit protection off command
	3	Pyro circuit protection off command
	4	Pyro circuit protection on command
	5	Pyro circuit protection on command
	6	Pyro circuit protection on command
	7	Active hook fire command
	8	Active hook fire command
	9	Active hook fire command
	10	Active hook fire command
	11	Active hook fire command
	12	Active hook fire command
	13	Passive hook fire command
	14	Passive hook fire command
	15	Passive hook fire command
	16	Passive hook fire command
	17	Passive hook fire command
	18	Passive hook fire command
	19	Spare
	20	Pyro circuit off indication

Table 100-C. DCP Pin Assignments (Continued)

LRU CONN	LRU PIN NUMBER	FUNCTION
	21	Pyro circuit off indication
	22	Pyro circuit off indication
	23	Pyro circuit off indication
X7	24	Spare
	25	Spare
	26	Spare
	27	Spare
	28	Spare
	29	Spare
	30	"-" logic bus
	31	"-" logic bus
	32	Spare
X8	1	"-" logic bus
	2	"-" logic bus
	3	"-" logic bus
	4	Ring initial position indication
	5	Ring initial position indication
	6	Ring initial position indication
	7	Ring final position indication
	8	Ring final position indication
	9	Ring final position indication
	10	Fixers off indication
	11	Fixers off indication
	12	Fixers off indication
	13	Latches open indication
	14	Latches open indication
	15	Latches open indication
	16	Latches closed indication
	17	Latches closed indication
	18	Latches closed indication
	19	Hooks 1 open indication
	20	Hooks 1 open indication
	21	Hooks 1 open indication

Table 100-C. DCP Pin Assignments (Continued)

LRU CONN	LRU PIN NUMBER	FUNCTION
	22	Hooks 1 closed indication
	23	Hooks 1 closed indication
	24	Hooks 1 closed indication
	25	Hooks 2 open indication
X8	26	Hooks 2 open indication
	27	Hooks 2 open indication
	28	Hooks 2 closed indication
	29	Hooks 2 closed indication
	30	Hooks 2 closed indication
	31	"-" logic power bus
	32	"-" logic power bus
	33	"-" logic power bus
	34	Ring forward position indication
	35	Ring forward position indication
	36	Ring forward position indication
	37	Ring aligned indication
	38	Ring aligned indication
	39	Ring aligned indication
	40	Spare
	41	Spare
	42	Spare
	43	Spare
	44	Spare
	45	Spare
	46	Spare
	47	Spare
	48	Spare
	49	Spare
	50	Spare
	1	Open latches command
	2	Open latches command
	3	Open latches command
	4	Close latches command

Table 100-C. DCP Pin Assignments (Continued)

LRU CONN	LRU PIN NUMBER	FUNCTION
X9	5	Close latches command
	6	Close latches command
	7	Open hooks command
	8	Open hooks command
	9	Open hooks command
	10	Close hooks command
	11	Close hooks command
	12	Close hooks command
	13	Fixers off command
	14	Fixers off command
	15	Fixers off command
	16	Open hooks command
	17	Open hooks command
	18	Open hooks command
	19	Close hooks command
	20	Close hooks command
	21	Spare
	22	Spare
	23	Close hooks command
	24	Power on command
X9	25	Power on command
	26	Power on command
	27	Ring in command
	28	Spare
	29	Spare
	30	Spare
	31	Ring out command
	32	Ring out command
	33	Ring out command
	34	Ring in command
	35	Ring in command
	36	Spare
	37	Spare

Table 100-C. DCP Pin Assignments (Continued)

LRU CONN	LRU PIN NUMBER	FUNCTION
	38	Power off command
	39	Power off command
	40	Power off command
	41	Spare
	42	Spare
	43	Spare
X9	44	Spare
	45	Spare
	46	Spare
	47	Spare
	48	Spare
	49	Spare
	50	Spare
X10	1	"-"Control bus
	2	"-"Control bus
	3	"-"Control bus
	4	APDS circuit protectoff command
	5	APDS circuit protectoff command
	6	APDS circuit protectoff command
	7	Undock command
	8	Undock command
	9	Undock command
	10	Spare
	11	"-"Control bus
	12	"-"Control bus
	13	"-"Control bus
	14	Capture indication
	15	Capture indication
	16	Capture indication
	17	Spare
	18	Spare
	19	Spare
	1	Power bus A telemetry

Table 100-C. DCP Pin Assignments (Continued)

LRU CONN	LRU PIN NUMBER	FUNCTION
X11	2	Power bus B telemetry
	3	Power bus C telemetry
	4	Pyro power bus A telemetry
	5	Pyro power bus B telemetry
	6	Pyro power bus C telemetry
	7	Control panel power bus A telemetry
	8	Control panel power bus B telemetry
X11	9	Control panel power bus C telemetry
	10	Heater no. 1 power telemetry
	11	Heater no. 2 power telemetry
	12	Heater no. 3 power telemetry
	13	Spare
	14	Spare
	15	Spare
	16	Spare
	17	Spare
	18	Common return
	19	Common return
X12	1	Spare
	2	Spare
	3	Spare
	4	Spare
	5	Ready to latch indication
	6	Ready to latch indication
	7	Ready to latch indication
	8	Spare
	9	Spare
	10	Interface sealed indication
	11	Interface sealed indication
	12	Interface sealed indication
	13	Spare
	14	Initial contact indication
	15	Initial contact indication

Table 100-C. DCP Pin Assignments (Continued)

LRU CONN	LRU PIN NUMBER	FUNCTION
	16	Initial contact indication
	17	Spare
	18	Power on indication
	19	Power on indication
	20	Power on indication
	21	Spare
	22	Spare
	23	"-" logic bus
X12	24	"-" logic bus
	25	Spare
	26	Spare
	27	Spare
	28	Undock complete indication
	29	Undock complete indication
	30	APDS circuit protect off indication
	31	APDS circuit protect off indication
	32	Spare

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Appendix XI

110. FIELD SUPPORT EQUIPMENT

110.1 SCOPE

This appendix defines the detailed requirements for the Field Support Equipment (FSE).

110.2 APPLICABLE DOCUMENTS

N/A

110.3 REQUIREMENTS.

110.3.1 General

In addition to those articles already supplied under the Multi-Mir program, the Seller shall supply the necessary test fixtures, test consoles, test adapters, loose equipment, and software, if applicable, to exercise, cycle, and troubleshoot the Seller-supplied docking components and control systems both prior to integration with the Orbiter, and post-installation for performance demonstration and verification, as listed in Table 110-A. In cases of commonly available laboratory electronic test equipment, the Seller shall delineate the requirements for test equipment to be provided by the Buyer at each site.

110.3.2 Mechanical FSE

The mechanical FSE shall be provided to perform the following tasks as a minimum:

A. Handle and transport APDA and all mechanical FSE to/from using facilities

B. Install/remove APDA into/from shipping container, external airlock, and supporting structure

C. Support APDA in test/checkout orientation

D. Proof & leak test DM on bench and after installed on docking base

E. Simulate ISS mating tests in Zero-Gravity environment

- Functional testing of capture latches and structure latches
- Docking cycling test
- Simulated ISS mating

F. Protect APDA from damages that might result during manufacturing, checkout, and installation operations.

G. Provide tooling to match-drill docking base with same hole pattern on DM.

110.3.2.1 General Requirements.

English Instruction: All equipment shall be provided with labels and operating instructions in English.

Warnings and Cautions: The design of FSE shall incorporate appropriately located comprehensive and unambiguous cautions and warnings to personnel of potential hazardous characteristics during operation, maintenance, or test functions.

Operational Environment. The following are environmental requirements for sheltered FSE:

- Temperature: +60 °F to +80 °F (15.6 to 26.7 °C) with uncontrolled extremes of +52 °F to +1.5 °F (11.1 to −16.9 °C) for 1 hour
- Pressure: Maximum 15.23 psia (sea level)
- Humidity: 60 ± 10%

Standard Test Conditions: The environmental test conditions shall be

- Temperature: +73 ± 18 °F (22.8 ± 10 °C)
- Pressure: an atmospheric pressure of 28.5 +2, -4.5 in Mercury (Hg)
- Humidity: 50 ± 30%

Mobility: All mobile equipment shall have antiroll and/or antislide devices installed.

Cleanliness: All equipment shall be visibly clean (no trace of corrosion, oil/grease, debris).

Pressure Vessels Material: Shall not be made from T-1 steel or alloy with substantially the same property.

Surface Finishes: All equipment shall not be painted or coated with material subject to chipping, flaking, or scaling. Cadmium plating shall not be used on any surfaces that interface with DM.

Threaded Fasteners:

- All threaded fasteners (internal and external) used for supporting, handling, lifting shall be provided with mating halves designed for each specific ground operations.
- Installation criteria shall consist of torque requirements, proper grip, use of washer . . . etc.
- Design & Construction: The FSE shall be designed with the following safety factors as minimum. Safety factor is defined as (design load)/(max allowable working load)
- Pressure Vessel: Burst = 4.0, Yield = 1.5
- Support Structure: Ultimate = 4.0, Yield = 2.0
- Handling Equipment: Ultimate = 5.0, Yield = 2.0

The design yield load shall be verified.

Welding: Welding of FSE shall be as follows:

- Pressure vessels, structural equipment, handling equipment shall be visually inspected
- Critical weld on handling equipment (single-point-failure mode) shall have weld efficiency in excess of 75%. Weld efficiency is expressed as follows:

Weld efficiency = (Limit load) (Safety Factor) / Allowable Load

- Pressure vessels fabricated by welding shall not be constructed of steel alloys with substantially the same properties as T-1 steel.

Proof Load Test. The design yield load of FSE shall be verified either by proof test or analysis. The following type of FSE shall be verified by proof test:

- Pressure vessel: Proofload at 150% of maximum allowable working pressure
- Support Structure & Handling/Transport Equipment: Seller shall proofload equipment to 200% of safe working load and provide documentation of successful proofload test.

Transportability:

- Containers shall be designed to handle and transport hardware to using facilities without damage or degradation in reliability or performance.
- Container shall protect hardware from natural environment so that loads induced in hardware during transportation will not produce excessive stresses, internal loads, or deflections resulting in damage to hardware.

Weight & size limitation

- Individual weight and size of hardware packaged for shipment shall not exceed the following:

  Weight = 11,000 lbs. (4989.6 kg), Width = 8 ft. (2.44 m), Height = 8 ft. (2.44 m), Length = 32 ft. (9.75 m)

Workmanship: FSE shall be fabricated so that appearance, fit, and adherence to specified dimensions and tolerances are observed. FSE shall be free from burrs or sharp edges that might damage associated equipment or cause injury to personnel.

Identification & Markings:

- Name plate: shall be marked to include: Item part number and name, Buyer model no., Serial no. & Control no., Manufacturer, Date of manufacture.
- Components & Subassemblies. Each fabricated components or assemblies shall be identified with part number.
- Handling & Support Equipment. Limit load shall be identified in a conspicuous place.
- Pressure vessels. Maximum allowable working pressure shall be identified.
- Containers: shall be marked to include: Center of Gravity, Tire pressure (TBS) psig, Empty weight (TBS) pounds, Gross weight (TBS) pounds, Maximum towing speed (TBS) MPH, Appropriate cautions and warnings.

Personnel Lifting Limit. FSE and components/assemblies designed to be lifted, carried, or handled by one man shall be 35 lbs. max. (for 2 men, 70 lbs. max.).

110.3.2.2 Detail Requirements.

Handling Equipment:

- The lifting/handling of the DM shall be through dedicated lifting interface on the DM.
- Handling/lifting operation shall require the use of only one overhead hoist.
- Orientation/rotation data (including limits) and tooling for handling DM shall be provided.
- Loose items of handling equipment shall be tethered to lifting assembly.

Pressure Vessels.

- Shall have design burst pressure 64 psig minimum.
- Shall have yield pressure equals at least 24 psig. The design yield shall be verified by proof pressure test at 24 psig for a minimum of 3 minutes.
- Pressure ports shall be provided for pressurization, pressure monitoring, and pressure relieving with American Standard pipe threads (internal & external threads) per ANSI BI6.5 and BI6.9 (or equivalent).
- Blanking plates for all feed-throughs on DM will be provided.

Mating Test Equipment. Verify that the provided equipment is capable of simulating the ISSA half of DM (passive half) in Zero-Gravity environment to support the following test:

- Functional testing of capture latches and structure latches
- Docking cycling test
- Simulated ISSA mating test
- The Mating Test Equipment shall include as a minimum the following:
- Passive half of DM and lifting attachment
- Own support fixture
- The test configuration of equipment shall have provisions for use with one overhead hoist

DM Protective Cover Set. Verify that protective cover set is capable of protecting DM components from damages that might result from handling or shipping. Protective cover shall be provided for the following as a minimum:

- DM mating seals and sealing surfaces
- Docking guides (3 petals)
- Feed-through opening
- Electrical connectors

110.3.3 Electrical FSE

In general, FSE is used for functional tests, troubleshooting faults in Seller's hardware, and for redundant-path verification. Buyer test equipment and cables supplemented by FSE will be used to perform integrated systems functional tests and evaluation tests. The electrical FSE shall as a minimum provide the capabilities and perform tasks as specified below.

A. Perform fault isolation of the APDS to the Seller's Line Replaceable Unit level.

B. Provide the capability to verify operation of redundant paths in the Seller's electrical systems; e.g., disable one path to verify the functional operation of the other redundant path.

C. Provide the capability to test off nominal conditions and responses, e.g., fault insertions

D. Perform verification of the pyro system using Seller provided pyro monitoring panel with the capability to measure firing circuit resistance for each circuit, measure firing circuit stimulus for each circuit, and measure stray voltage.

E. Provide the capability to perform continuity and insulation resistance tests of all Seller provided harnesses.

F. Provide breakout boxes, breakthrough boxes and adapter cables for verification of all Seller provided Line Replaceable Unit and harness interfaces including those within the APDA. A breakout box is an enclosed box with one connector and a set of test jacks wired to each pin on the connector. The test jacks provide the capability to monitor or inject signals, and apply loads to any wire on the connector. An adapter cable which is wired to every pin on the connector under test is required to mate with the breakout box connector. A break-through box is the same as a breakout box except it provides access to each wire on the connector without interrupting the normal circuit path or operation.

G. Provide capability to interface with Buyer's DITMCO test equipment. Cables and connectors for this purpose are identified in items 78 through 103 of Table 110-A and their application is described in Table 110-B and Figure 110-A.

110.3.3.1 FSE

Field Support Equipment (Electrical and Mechanical) items to be provided are listed in Table 110-A.

110.3.4 Design Considerations

Field Support Equipment shall comply with the following requirements to the extent possible. Deviations shall be analyzed and changes negotiated to comply with the established Space Shuttle Orbiter and support personnel safety practices.

110.3.4.1 FSE Physical Characteristics.

110.3.4.1.1 Weight

The maximum weights of the FSE components are listed in Table 110-A.

110.3.4.2 Power and Grounding.

110.3.4.2.1 Power Cables

Seller shall provide the pigtail power cables listed in Table 110-A to interconnect FSE input power connectors to Buyer facility power services.

110.3.4.2.2 Power Connector

Buyer will terminate the Seller provided power cable pigtails into Buyer provided connectors.

110.3.4.2.3 Main Power Characteristics

Characteristics of the main power available for FSE operation are:

A. a) 120 Vac ± 5 Vac, single phase, 60 Hertz, 30 amps.

B. b) 28 Vdc ± 4 Vdc, 20 amps.

110.3.4.3 Cooling

The FSE shall be designed such that special facility cooling provisions shall be self-contained to operate in the environment specified in 110.3.4.7.1 below.

110.3.4.4 Signal Cables

Seller shall provide signal cables listed in Table 110-A as specified below. All electrical cables and connectors shall be clearly identified in English using accepted equipment marking practices.

A. Signal cables to interconnect FSE and the Seller provided on-board equipment and Line Replaceable Unit test connectors.

B. Pigtailed signal cables to interconnect FSE with Buyer interface connectors. Buyer will terminate the pigtails into Buyer provided connectors.

110.3.4.5 Reliability and Safety.

110.3.4.5.1 Safety

The FSE shall be designed to preclude injury to personnel, or damage to Orbiter, APDS equipment, facilities, and other support equipment.

110.3.4.6 Scheduled Maintenance

If a component of the FSE requires scheduled maintenance, schedules and procedures for the periodic maintenance shall be supplied by the Seller.

110.3.4.7 Environments

The FSE shall be capable of meeting the operating performance requirements in the operational environment specified below.

110.3.4.7.1 OPERATIONAL ENVIRONMENT

Interior controlled environments.

A. Temperature	+15.6 °C (60 °F) to +26.7 °C (80 °F)
B. Pressure	Up to 15.23 psia
C. Humidity	45% to 70%, at 21.1 ± 5 °C (70 ± 10 °F)

110.3.4.8 Transportability

The FSE shall be designed to be handled and transported to using facilities without damage or degradation, using available methods of transportation with the item prepared for shipment in accordance with appropriate shipping practices. The equipment shall be compatible with the planned packaging and transportation system to the extent that loads induced in the equipment during transportation shall not produce excessive stresses, internal loads, or deflections resulting in damage to the equipment.

110.3.5 Design and Construction.

110.3.5.1 Plan

The Seller shall furnish a plan for approval to the Buyer for any new design and construction required to meet the requirements for the FSE.

110.3.5.2 Materials, Processes, and Parts.

110.3.5.2.1 Material Compatibility

Materials and processes used in fabrication of the FSE shall be compatible with the environmental conditions specified in 110.3.4.7.1.

110.3.5.2.2 Parts Standardization

Parts utilization shall be based upon:

A. selection of qualified or suitable parts,

B. proper derating and application,

C. minimization of the number of different types of parts.

110.3.5.2.3 Processes

Processes used in the manufacture of the FSE shall conform to the same methods and standards as required for the flight hardware.

110.3.5.3 General Electrical Design Requirements

General electrical design characteristics shall use best engineering practices as a guideline and also the following paragraphs as applicable.

110.3.5.3.1 Electromagnetic Compatibility (EMC) Design

The design objective shall be to minimize the generation of, and susceptibility to, electromagnetic interference to preclude performance degradation from element within the FSE.

110.3.5.3.2 Bypass Circuits

Bypass circuits, adapters, or special break-out boxes used during checkout or calibration shall not override or defeat electrical or mechanical protective devices.

110.3.5.3.3 Checkout Test Points

The FSE electrical circuits where applicable shall include checkout test points which permit planned checkout and fault isolation tests to be made without disconnection of existing cables/connectors.

110.3.5.3.4 Circuit Protection

The electrical and electronic circuits shall incorporate protection against reverse polarity, excessive currents or voltages, or other improper inputs which can be damaging to existing circuits.

110.3.5.3.5 Connectors

FSE system connectors shall be clearly identified to preclude improper mating of pairs, or cross-connection where in close proximity to similar connectors.

110.3.5.3.6 Electrical Bonding

Electrical bonding posts shall be provided all FSE equipment for facility grounding purposes.

110.3.5.4 Identification and Marking.

110.3.5.4.1 Nameplates

Nameplates shall include (as applicable) item name, Buyer's model number, serial number, and control number; manufacturer, date of manufacture, manufacturer's serial number, part number, and code identification in English. Abbreviations may be used.

110.3.5.5 Identification of Components or Sub-Assemblies

Each fabricated component or subassembly shall be identified with a part number. The same specification or part number shall be used to identify like materials, processes, components, or subassemblies.

110.3.5.6 Interchangeability

Assemblies, components, and parts with the same part number shall be physically and functionally interchangeable.

110.3.5.7 Personnel Lifting and Handling Limits

Handling grips designed to facilitate handling shall be provided on all equipment. The maximum allowable weights for one or two-man lift, carry, or handle is 16 kG (35 pounds) for one person, or 32 kG (70 pounds) for two persons.

Table 110-A. List of Field Support Equipment

Reserved

Table 110-A. List of Field Support Equipment (Continued)

Table 110-A. List of Field Support Equipment (Continued)

Table 110-A. List of Field Support Equipment (Continued)

Table 110-A. List of Field Support Equipment (Concluded)

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Table 110-B. BOB/DITMCO Adapter Cable Matrix

GENERAL NOTE:

1. RUSSIAN CONNECTOR

   AMERICAN CONNECTOR

2. LETTER-NUMBER AT THE RUSSIAN CONNECTOR DENOTE THE COLUMN AND ITEM OF TABLE I
   COLUMN A: BOB ADAPTER CABLES MATE TO RUSSIAN BOXES
   COLUMN B: BOB ADAPTER CABLES MATE TO RUSSIAN PIGTAILS
   COLUMN C: DITMCO ADAPTER CABLE

3. FIGURE 1 REPRESENTS THE MULTI MIR SYSTEM BLOCK DIAGRAM

4. FIGURE 2 REPRESENTS ISSA SYSTEM BLOCK DIAGRAM (TBD)

5. ISSA AND MULTI MIR CONNECTOR DIFFERENCES AT THE ORBITER DOCKING MECHANISM

Connector	ISSA Part No.	Multi Mir Part No.	BOB/DITMCO adapter cable requires for ISSA		
			BOB to Russian box	BOB to Russian Pigtail	DITMCO adapter
X85	ОС2РМТ33Ь 7Щ0А1В	ОСОШ-Ь С-2-50/27-В1-1-В	A25	B25	C15
X100	ОС2РМТ33Ь 7Щ0А1В	ОСОШ-Ь С-2-50/27-В1-1-В	A25	B25	C15
X106	ОСОШ-Ь С-2-19/18-В1-1-В	ОСОШ-Ь С-2-50/27-В2-1-В	A6	B6	C6
X107	ОСОШ-Ь С-2-19/18-В1-1-В	ОСОШ-Ь С-2-50/27-В2-1-В	A6	B6	C6
X111	ОСОШ-Ь С-2-50/27-В1-1-В	ОСОШ-Ь С-2-32/22-В2-1-В	A11	B11	C12

Table 110-B. BOB/DITMCO Adapter Cable Matrix (continued)

Item	Column A BOB Adapter Cable mate to Russian box	Column B BOB Adapter Cable mate to Russian pigtail	Column C DITMCO Adapter Cable
1	11H565.0986 -740	11H565.0986 -730	EN 4206-046.0-10
2	11H565.0986 -160	11H565.0986 -150	EN 4206-046.0-20
3	11H565.0986 -170	11H565.0986 -180	EN 4206-046.0-30
4	11H565.0986A-60	11H565.0986A-50	EN 4206-046.0-40
5	11H565.0987 -1240	11H565.0987 -1210	EN 4206-046.0-50
6	11H565.0987-1300	11H565.0987-1270	EN 4206-046.0-60
7	11H565.0987-1310	11H565.0987-1280	EN 4206-046.0-70
8	11H565.0987-1320	11H565.0987-1290	EN 4206-046.0-80
9	11H565.0987A -100	11H565.0987A -90	EN 4206-046.0-90
10	11H565.0988 -1100	11H565.0988 -1070	EN 4206-046.0-100
11	11H565.0988 -1160	11H565.0988 -1130	EN 4206-046.0-110
12	11H565.0988 -1170	11H565.0988 -1140	EN 4206-046.0-120
13	11H565.0988 -1180	11H565.0988 -1150	EN 4206-046.0-130
14	11H565.0988 -1220	11H565.0988 -1190	EN 4206-046.0-140
15	11H565.0988 -1280	11H565.0988 -1250	EN 4206-046.0-150
16	11H565.0988 -40	11H565.0988 -30	EN 4206-046.0-160
17	11H565.0988-1110	11H565.0988-1080	EN 4206-046.0-170
18	11H565.0989 -20	11H565.0989 -10	EN 4206-046.0-180
19	11H565.0989 -320	11H565.0989 -290	EN 4206-046.0-190
20	11H565.0989 -330	11H565.0989 -300	EN 4206-046.0-200
21	11H565.0989 -40	11H565.0989 -30	MP1-76-1-B (SCAT-307170) *
22	24-A/37-YKP/33-1-1	24-A/35-YKP/37-1-1	MP1-76-2 (SCAT-307171) *
23	32/50-A/37-YKP/33-1-1	32/50-A/35-YKP/37-1-1	ОНЦ-ГЕ-1-7/22-В1-1-В (SCAT-307172) *
24	50-A/37-YKP/33-14-1	50-A/35-YKP/37-14-1	PC 32A (SCAT-307173 & SCAT-301174) *
25	7-A/77-YKP/69-1-1	7-A/71-YKP/77-1-1	ОНЦ-ОМ-1-30/14-В1-1-В (SCAT-307175) *
26	11H565.0988 -1120	11H565.0988 -1090	ОНЦ-ОМ-1-50/18-В1-1-В (SCAT-307176) *
27	11H565.0987 -40	11H565.0987 -30	

Note: * Russian connector was provided instead of pigtail and was made in SCAT cable for DITMCO purposes using American wire.

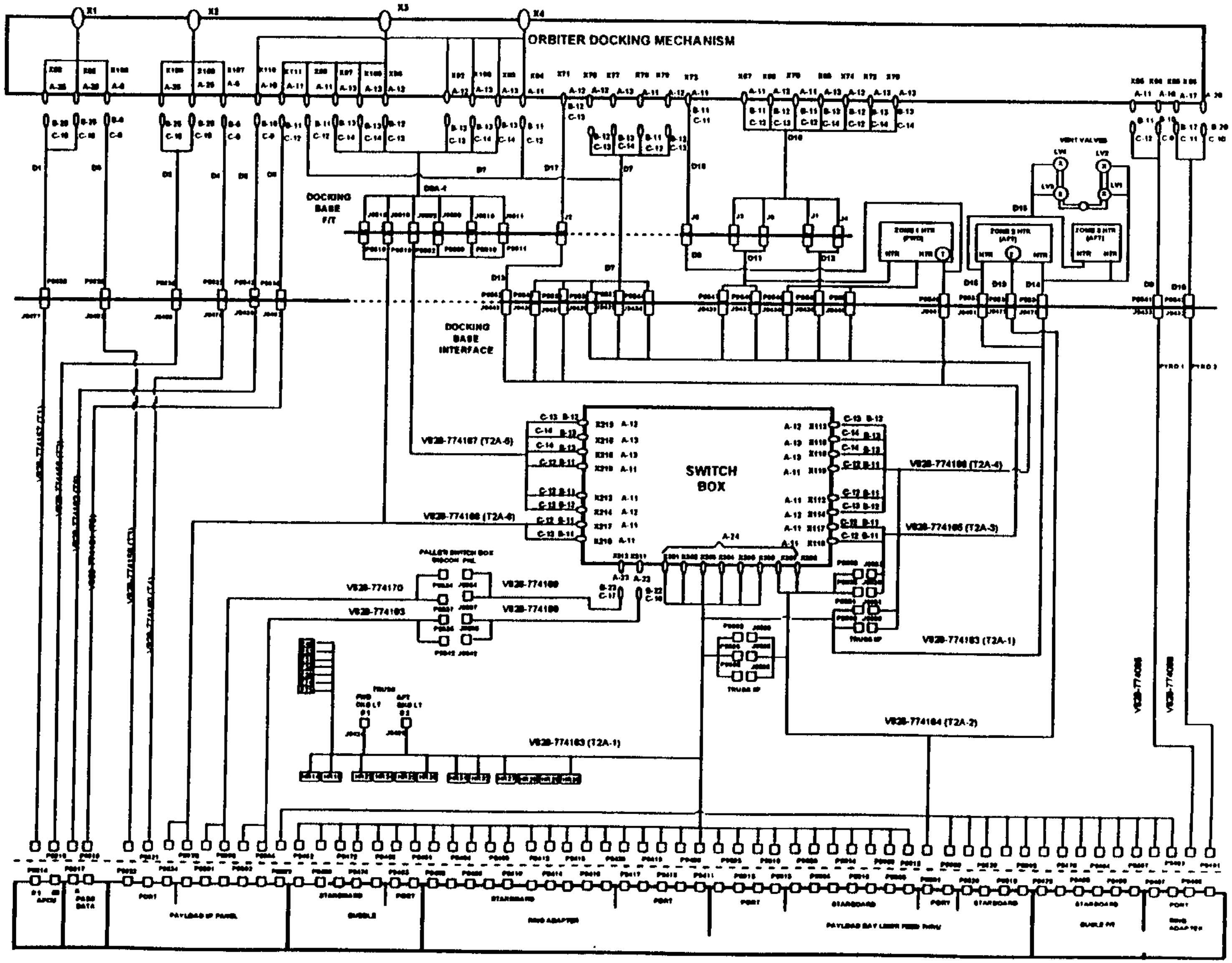


Figure 110-A. ISSA 2A (Truss & DB) System Block Diagram

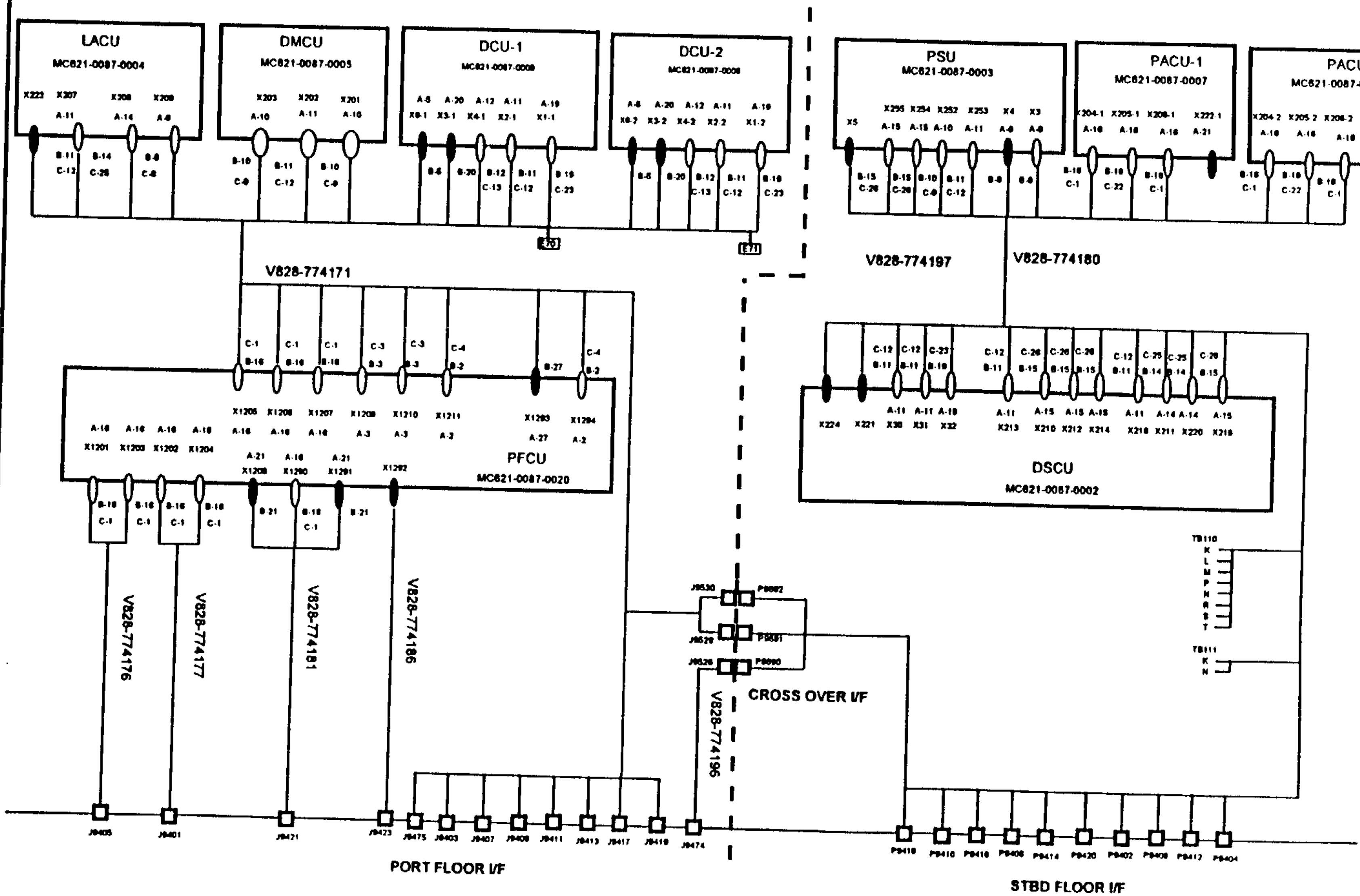


Figure 110-A. ISSA 2A (Pallet) System Block Diagram (continued)

Appendix XII

120. PYROTECHNIC RELEASE DEVICES

120.1 SCOPE

This appendix establishes the performance, design, development, and verification requirements for the Pyrotechnic Release Devices.

120.2 APPLICABLE DOCUMENTS

N/A

120.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

120.3.1 Item Definition

The pyrotechnic subsystem shall be an electrically initiated group of pyrotechnic bolts that provide positive separation between the ISSA and the Orbiter in the event the structural hooks fail to mechanically actuate to release. The pyrotechnic bolt consists of the following:

A. Frangible bolt

B. Electric detonator cartridge

120.3.1.1 Item Diagrams

A schematic block diagram for the pyrotechnic release is shown in Figure 120-A.

120.3.1.2 Interface Definition

The functional and physical interface requirements between the Pyrotechnic Release Devices, the APDS boxes, the structures, and the Orbiter Avionics are defined in the following paragraphs.

120.3.1.2.1 Pyrotechnic Bolt

A pyrotechnic bolt shall be mounted on each of the active and passive hooks of the structural latch mechanisms of the Orbiter APDA. The Pyrotechnic Firing Control Unit will provide signals and power to initiate the pyrotechnic charges; requirements for this unit are in Appendix VII.

120.3.1.2.2 Electric Detonator Cartridges

The electric detonator cartridge shall be installed in the frangible bolt to provide the energy to sever the frangible element.

120.3.1.3 Item Identification

The identification of the pyrotechnic bolt and the detonator cartridge shall be as follows:

Nomenclature	Buyer Control No	Seller Part Number.	Maintenance Level
Pyrotechnic Bolt	MC621-0087-0020	LD34.440.024	SRU

120.3.2 Characteristics

120.3.2.1 Performance Characteristics

After electrical initiation, each pyrotechnic bolt shall sever to provide release of each hook used to join the ISSA and the Orbiter in flight, producing separation of the ISSA and Orbiter.

120.3.2.1.1 Total Useful Life

The pyrotechnic bolt and detonator cartridge shall have a useful life of 19 years minimum which includes a minimum of 33 mission cycles. The useful life shall include a four-year period from date of delivery. During the useful life period, the components shall not deteriorate in performance after being exposed to the qualification environments specified in 120.4.2.4.1.3 thru 120.4.2.4.1.6. The pyrotechnic bolt and detonator cartridge shall have a functional life of one separation mission.

120.3.2.1.2 Pyrotechnic Bolt Performance

The pyrotechnic bolts when installed as a subsystem shall sever in a timely manner to allow separation between the ISSA and Orbiter. Release of shrapnel, debris, and hot gases is acceptable as long as they do not pose hazards to the safety of the ISSA, Orbiter, and crew. Pyrotechnic release of the latch shall not cause the latch to interfere with the separation movement of the Orbiter and the ISSA.

120.3.2.1.3 Retention

The pyrotechnic bolt shall be retained in the unfired position so that after firing, the separated portion of the bolt shall not constitute a hazard to the crew and Orbiter.

120.3.2.1.4 Tensile Capability of Frangible Element

The tensile element of the frangible bolt body shall have a minimum breaking strength of 8,800 pounds (4,000 kgf).

120.3.2.1.5 Bolt Margins and Structural Margin

The electric detonator cartridge when installed on the bolt as part of a subsystem shall move and hold the hooks to the released position to allow separation between the ISSA and the Orbiter at the adverse loading condition when initiated by a cartridge loaded with 85% of the minimum allowable charge weight or with 115% of the maximum allowable charge weight.

120.3.2.1.6 Electric Detonator Cartridge

The detonator cartridge shall utilize redundant electric bridgewires for initiation. The cartridge shall generate enough energy to sever the frangible element of the bolt when loaded at the adverse conditions.

120.3.2.1.7 Single Initiation

The pyrotechnic bolt shall meet the performance requirements herein with the initiation of any one or both of the bridgewires in any dual-bridgewire cartridge.

120.3.2.1.8 Cartridge Mounting Into Frangible Bolt

The mounting of the electric detonator cartridge on the frangible bolt shall not change the electrical characteristics of the detonator cartridge.

120.3.2.1.9 Cartridge Torque

Each electric detonator cartridge shall be capable of withstanding 1.5 times the specified maximum allowable installation torque without physical damage or change in electrical characteristics.

120.3.2.1.10 Auto Ignition

Auto ignition shall not occur when the electric detonator cartridge assembly is exposed for one hour to a stabilized temperature of 235°F. The maximum temperature exposure in the flight application is 185°F (85°C).

120.3.2.1.11 Maximum No Fire

The electric detonator cartridge shall not ignite when the bridgewire is subjected to a dc current of 0.21 ±0.01 ampere for 5 minutes within a temperature range of from +185°F to -85°F. The pyrotechnic bolt shall not degrade after being subjected to the no-fire current.

120.3.2.1.12 All Fire Parameters

The pyrotechnic bolt shall initiate when subjected to current levels of 0.9 to15 amperes from ± 60°C (140°F,-76°F).

120.3.2.2 Physical Characteristics

120.3.2.2.1 Pyrotechnic Bolt

120.3.2.2.1.1 Pyrotechnic Bolt Envelope

The envelope of the pyrotechnic bolt and detonator cartridge assembly is as shown in Figure 120-B.

120.3.2.2.1.2 Weight

The weight of the pyrotechnic bolt shall not exceed 0.165 pound (75 grams).

120.3.2.2.1.3 Helium Leakage

Leakage from the loaded and sealed pyrotechnic bolt shall not exceed 1E-6 standard cubic centimeter of helium per second at a differential of 1.0 plus or minus 0.1 standard atmosphere.

120.3.2.2.1.4 Drop Test

Two pyrotechnic bolts shall survive being dropped along two major axes from a height of six feet plus six inches minus zero inches upon a 0.25-inch minimum thickness steel plate backed by at least three inches of concrete. A new specimen shall be used for each drop. No device shall fire as a result of the drop. The device shall be fired after the drop and shall meet the firing performance characteristics unless obvious damage due to the drop compromises the functional reliability of the device. Obvious damage is any condition which would be identified during normal pre-installation inspection.

120.3.2.2.1.5 Detonator Cartridge Assembly

The detonator cartridge assembly shall be a self-contained unit and shall be provided with a means of attachment to the frangible bolt.

120.3.2.2.2 Cartridge

120.3.2.2.2.1 Pyrotechnic Mix

The detonator cartridge shall use an explosive mix of lead azide, cyclonite, and lead trinitroresorcinate.

120.3.2.2.2.2 Dielectric Strength

The pyrotechnic bolt shall withstand an AC voltage of 200 ± 10 volts rms for 60 seconds between the case and both pins shorted together without breakdown. The detonator cartridge shall not ignite or otherwise be degraded. The detonator cartridge shall be capable of meeting the performance requirement after being subjected to the dielectric strength test.

120.3.2.2.2.3 Continuity Current

The detonator cartridge shall be capable of withstanding 25 applications through the bridgewire of a 50-milliampere pulse having a duration of one minute, without degradation.

120.3.2.2.2.4 Insulation Resistance

The resistance between the body and the bridgewire terminals, and between bridgewire terminals shall be a minimum of 2 megohms when 100 ± 5 % volts direct current is applied for 15 seconds minimum. The pyrotechnic bolt shall be capable of performing its function after being subjected to the insulation resistance test.

120.3.2.2.2.5 Bridgewire Resistance

The bridgewire resistance of the electric detonator cartridge shall be 1 to 2 ohms at ambient temperature when a maximum test current of 50 milliamperes is applied for a maximum of one minute.

120.3.2.2.2.6 Electrostatic Sensitivity

The detonator cartridge shall be capable of performing its function after being subjected to an electrostatic discharge of 25,000 ± 200 volts, applied between shorted pins of each bridgewire and the initiator body, from a 200 ± 20 picofarad capacitor with a 500 ± 50 ohms resistor connected in series with the shorted pins.

120.3.2.2.2.7 Electroexplosive Subsystem Electromagnetic Compatibility

120.3.2.2.2.7.1 Inadvertent Activation

The electroexplosive subsystem shall be designed to limit the power produced at each pyrotechnic bolt by the electromagnetic environment acting on the subsystem to a level at least 20 dB below the maximum pin-to-pin dc no-fire level of the pyrotechnic bolt.

120.3.2.2.2.7.2 Direct Coupling To The Pyrotechnic Bolt and Electroexplosive Subsystem

The pyrotechnic bolt shall not fire in either the pin-to-pin or the pin-to-case mode due to direct coupling of the specified electromagnetic environment into the electroexplosive subsystem.

120.3.2.3 Reliability

The requirements of 3.2.3 of the basic specification apply.

120.3.2.4 Environments

The pyrotechnic bolt and the detonator cartridge assembly shall be capable of operating to the requirements of this appendix after exposure to the environments in 3.2.5.1.3 and 3.2.5.2.3 of the basic specification.

120.3.2.5 Transportability

The pyrotechnic bolt shall be designed to be capable of being handled and transported to using facilities without damage or degradation, utilizing available methods of transport with the item prepared for shipment in accordance with 120.5. The equipment design shall be compatible with the planned packaging and transportation system to the extent that loads induced in the equipment during transportation will not produce stresses, internal loads, or deflections resulting in damage to the equipment.

120.3.2.5.1 Integral Protection Capability

The equipment design shall incorporate one or more of the following provisions for protection of components which are highly vulnerable to damage during transport and associated handling.

A. Provide attach points for installation of temporary protective devices (covers, reinforcing structure, desiccant cartridge, air breather/filter heater, etc.).

B. Make provisions for removal of sensitive component(s) for separate shipment.

C. Provide built-in protective device (e.g., cover, caging of free-moving components, desiccant chamber, heater, etc.).

120.3.3 Design and Construction

The requirements of 3.3 of the basic specification apply except as follows:

120.3.3.1 Materials, Processes and Parts

120.3.3.1.1 Explosive, Propellant and Pyrotechnic Material

Only one lot of each explosive or pyrotechnic material shall be used in the manufacture of any production lot of devices. The use of reclaimed high-explosive materials is prohibited.

120.3.3.1.3.1 Explosive Material Contamination Control

Special precautions shall be taken to ensure that explosive material drawn for production use does not become contaminated. Specific instructions for in-process explosive-material storage and handling shall be incorporated in supplier pyrotechnic device manufacturing procedures. In order to ensure that explosive materials do not become contaminated, special emphasis shall be placed on good housekeeping, container integrity, container placement, and elimination of all contaminant-promoting conditions. Detailed procedures shall be prepared by each pyrotechnic supplier for contamination control of bulk explosive materials.

120.3.3.1.3.2 Explosive Material Compatibility

All materials used in pyrotechnic devices shall be compatible with each other to the extent that no reaction occurs which might adversely affect the component or system performance or safety including transient compounds, liquid or gaseous, generated during curing or storage. Stability and compatibility testing shall be conducted on all explosive/component interfaces, including sealing materials, where test data or analysis for demonstrating stability of materials or compatibility of components is not available.

120.3.3.1.4 Non-acceptable Safing Methods

The non-acceptable methods for safing threaded parts are:

A. Non-metallic inserts where exposed to hot gases such as pressure cartridge threads.

B. Snap rings

C. Tab washers

D. Lock washers

E. Staking

120.3.3.1.5 Liquid Contamination Prevention

To prevent contamination of the explosive material(s) with liquids, the supplier's applicable manufacturing procedures shall specify that each device be completely dry prior to loading and that no liquids be used for cleaning or weld preparation after addition of the explosive materials and prior to hermetic sealing. The procedures shall specify that the immediate area of explosive loading be free of such liquids as methanol, freon, solvents, or alcohol. In the event spillage of explosive material necessitates cleaning of the loading area with liquids, all parts must be removed from the area until after such cleaning is completed, the area is completely dry, and the liquids have been removed.

If liquids are used to clean a loaded unit, after hermetic sealing and prior to leak testing, any unit that fails leak testing shall not be reworked unless a specific rework procedure, that has demonstrated the capability to remove liquid contamination that may have entered the device, is approved by Buyer.

120.3.3.1.6 Production Lot Requirements

The requirements of this paragraph pertain to all lots beginning with the qualification lots of the various devices and assemblies and include all lots intended for manned flight use.

120.3.3.1.6.1 Production Lot

Each piece part, component, subassembly, or device shall be of the same design, construction, material heat or melt lot and heat-treat lot fabricated in one unchanging and essentially continuous manufacturing process and submitted for acceptance at one time. The single-lot control requirements of non-explosive components used in a lot of devices shall be determined, documented, and approved by Buyer. Factors such as component function in end-item performance and effectiveness of destructive tests in screening defective components shall be considered in establishing single-lot control requirements.

120.3.3.1.6.2 Lot Size

Each lot shall be sized to include flight, flight spares, test article, age life samples, and preflight verification-test parts, plus parts necessary for other uses when required.

120.3.3.2 Identification and Marking

The requirements of 3.3.4 of the basic specification apply except as follows:

120.3.3.2.1 Inert Units

Inert units shall have visible marking " YY " on the part.

120.3.3.3 Traceability

All pyrotechnic devices shall be traceable by lot and serial number. Components and materials which are not susceptible to serialization, such as percussion primers, shall be traceable by lot number.

120.3.3.4 Safety

The requirements of 3.3.9 of the basic specification apply, except as follows:

120.3.3.4.1 Yield Factor

The yield factor shall be a minimum of 1.1. applied to the limit load. Components shall have adequate strength to withstand limit loads without loss of operating capability for the life of the component. (This factor is not applicable to the loads generated by the firing of the pyrotechnic charge).

120.3.3.4.2 Design Ultimate Factor of Safety

The design ultimate factor of safety shall be a minimum of 1.4 applied to the limit load. Components shall have adequate strength to withstand ultimate loads without failure. The 1.4 factor is not applicable to loads generated by the firing of the pyrotechnic charge. When the ultimate tensile strength of a selected material is more than 1.4 times the yield strength of the material, the design shall be based on the limit load and the yield strength of the material.

120.4 QUALITY ASSURANCE PROVISIONS

120.4.1 General Requirements

The requirements of 4.1 of the basic specification apply.

120.4.1.1 Destructive Test Sampling

Unless otherwise specified, the number of pyrotechnic bolts to be fired from various lot sizes of loaded Pyrotechnic Devices shall be 10% of the lot or 10 units minimum.

A. Lot size equals number of units presented for lot acceptance tests.

B. Fractional sample sizes below 0.5 shall be rounded downward.

C. Fractional sizes 0.5 and above shall be rounded upward.

Whenever sampling inspection reveals one or more non-conforming items and the sampling plan does not require rejection of the lot, all items in the lot shall be inspected for the identified non-conforming characteristic.

120.4.2 Quality Conformance

The requirements of 4.2 of the basic specification apply except as follows.

120.4.2.1 Development

The requirements of 4.2.1 of the basic specification apply.

120.4.2.2 Acceptance Test

The non-destructive portion of the acceptance test shown in Table 120-2 shall be conducted on all pyrotechnic bolts made from the lot. For a pyrobolt lot which has experienced a design configuration change or a manufacturing process change affecting form, fit, or function of the pyrobolt since any prior production lot acceptance tests, the destructive portion of the acceptance test shall be performed on samples randomly selected from the entire manufactured lot and tested by the sequence shown on Figure 120-C. For pyrobolt lots which are identical in design to the prior production lot and whose manufacturing processes have not changed since the prior production lot, the destructive portion of the acceptance test shall be performed in accordance with Figure

120-D. The Seller shall perform any other test deemed necessary, subject to the approval of Buyer, to assure compliance with the requirements for the end product. The final tests and inspections shall be performed in a manner and under conditions which simulate end use to the highest degree practical without damage to the deliverable units. Any pyrotechnic bolt that fails a non-destructive test shall be rejected. Failure of any pyrotechnic bolt to meet a destructive-test requirement shall cause rejection of the entire lot. Prior to delivery and as a condition of acceptance, the Seller shall conduct the inspection and testing in the sequence shown in Table 120-2 on each pyrobolt.

Table 120-2. Acceptance Tests, Detonator Cartridge/Pyrotechnic Bolt

Inspection and Test	Paragraphs Listed in Recommended Sequence
Examination of Product	120.4.2.2.1
Tensile Test	120.4.2.2.2.2
Electrostatic Discharge Test	120.4.2.2.2.4
Insulation Resistance Test	120.4.2.2.2.5
Bridgewire Resistance Test	120.4.2.2.2.6
X-ray Test	120.4.2.2.1.1
Neutron Radiography Test	120.4.2.2.1.2
Leakage Test	120.4.2.2.2.1
Examination Of Product	120.4.2.2.1
Lot Firing Test	120.4.2.2.2.3
Age Life Certification Test	120.4.2.5.1

120.4.2.2.1 Examination of Product

The requirements of 20.4.2.1.1 of Appendix II apply.

120.4.2.2.1.1 X-ray Test

Each pyrotechnic bolt shall be x-rayed to determine that there are no missing or improperly oriented details, no improperly machined critical cross sections and to verify that there are no foreign objects or materials present.

Individually X-ray each bolt and identify each film with corresponding bolt serial number. Take two views, approximately 90 degrees apart perpendicular to the longitudinal axis. Two negatives shall be made of each view. The Seller shall retain possession of the X-ray film for any future analysis; Seller shall, however, make the film available for review at their facility.

120.4.2.2.1.2 Neutron Radiography Test

Each pyrotechnic bolt shall be subjected to neutron radiography examination in one view to verify that the units meet the following:

A. The pyrotechnic bolt contains the proper explosive loading.

B. The pyrotechnic mixture is present and properly oriented in accordance with the applicable assembly drawing.

C. There are no missing or improperly oriented details.

D. There are no foreign objects or materials present.

E. There are no detectable imperfections.

Cartridges loaded with loose powder shall be N-rayed in the initiation-end-up position with the neutron beam horizontal. All radiography shall be reviewed and anomalies if any shall be resolved prior to subsequent tests. The original neutron radiograph negative shall be submitted to Buyer as part of end-item data; a copy shall be retained in the supplier's permanent files. Each N-ray film shall be identified with pyrobolt part number, lot, and serial number.

120.4.2.2.1.3 Radiography Defects

Radiographs showing identified defects shall be used as inspection aids and criteria in the inspection of radiographic negatives of production parts. As a minimum, the following defects shall be identified and described for inspection of X-radiographs.

A. Missing, partial, and unconsolidated charges

B. Voids and gaps in and between charges

C. Charge density variations

D. Internal foreign material located in charges, flash holes, etc. (Material and size should be identified to determine resolution capabilities.)

E. Out-of-position charges and components

F. Presence of manufacturing liquids and materials

G. Missing components such as O-rings, spacers, and washers

H. Excess materials such as solder, flux, and adhesive

In complying with these requirements, the manufacture of special defective parts is neither required nor desired. "Discovered defects" may be used for personnel training and inspection aids.

120.4.2.2.2 Functional and Performance Tests.

120.4.2.2.2.1 Pyrotechnic Bolt Leakage Test

Each pyrotechnic bolt shall be subjected to a leakage test as follows:

A. Place the pyrotechnic bolts in a vacuum chamber and maintain a minimum vacuum of one inch Mercury absolute for a period of no less than 25 minutes to ensure the removal of air.

B. Fill the chamber with Helium to a pressure of 15 psig (pounds per square inch gage) minimum and allow to soak for a minimum of five minutes.

C. At the completion of the helium soak, wash each bolt with dry nitrogen to remove helium from external surfaces.

D. Within 20 minutes after removal from the helium environment, place each bolt in a leak-detection chamber to record the leak rate in cubic centimeters per second.

E. Failure of any unit to meet the leakage requirements of 120.3.2.2.1.3 shall result in rejection of that unit.

120.4.2.2.2.2 Tensile Test

Prior to acceptance of any inert bolt body, the supplier shall conduct tensile tests on a minimum of 3% of the lot. The acceptance criteria shall be as specified in 120.3.2.1.4. Failure to meet these acceptance criteria shall be cause for rejection of the frangible bolt bodies made from that lot of material.

120.4.2.2.2.3 Lot Firing Test

Random samples of a minimum of ten percent of the lot that have passed the non-destructive tests of Table 120-2 shall be consecutively numbered. The exact quantities required are specified in Figure 120-C for a pyrobolt lot which contains a configuration change in design or manufacturing processes since the last accepted production lot. For a pyrobolt lot which is identical in configuration in both design and manufacturing processes to the last accepted production lot, the destructive quantities are shown in Figure 120-D. The test units shall be exposed to the Shock Test, Random-Vibration Test, Pressure-Cycling Test, and Thermal Vacuum Test identified in Table 120-3 before being fired on test fixtures and test set-ups approved by the Buyer. The firing test distribution is as follows:

A. Low-Temperature Firing I. The samples for low temperature firing per Figures 120-C or -D shall be fired in accordance with the following:

1. The bolts shall be installed in test fixtures. The test fixture shall be stabilized and the pyrobolt fired at a temperature of minus 58°F (± 5°F).

2. For test groups with more than one bolt specimen, initiate by applying firing current to one bridgewire for 50% of the bolt quantity and to both bridgewires simultaneously for the other 50% of bolt quantity.

3. Prior to each firing test, measure and record the firing circuit resistance.

4. During the firing test, measure and record firing current, and time from application of current to initiation with a permanent recording device.

5. Verify complete separation. Inspect and record the condition and engagement of the locking pins of the passive hook and the active hook.

6. Visually inspect and record all findings and conditions of the test items.

7. Photographs shall be made of the test set-up prior to firing. Photographs of the test specimens subsequent to the firing shall be taken if an anomaly is noted during the test to document test results.

B. High-Temperature Firing. The samples for high temperature firing per Figures 120-C or -D shall be fired per 120.4.2.2.2.3 (A) except that the specimen shall be stabilized and fired at a temperature of 122°F (± 5°F).

C. Ambient-Temperature Firing I. The samples for ambient temperature firing per Figures 120-C or -D shall be fired similar to A1, except that the firing shall be at ambient temperature.

D. Underload Firing Test. The underload firing test samples shall be fired per 120.4.2.4.1.7.4.

The Buyer and NASA will identify the disposition on the balance between the ten percent of the lot and fifty-eight units.

120.4.2.2.2.4 Electrostatic Sensitivity Test

Each pyrotechnic bolt shall be subjected to the electrostatic discharge requirement in 120.3.2.2.2.6. The pyrotechnic bolt shall not degrade and shall meet all the performance requirements in this appendix.

120.4.2.2.2.5 Insulation Resistance Test

The resistance between the electroexplosive body and the bridgewire terminals shall be measured and recorded by applying a potential of 100 ± 5% volts direct current for 15 seconds minimum. The measured resistance shall be 2 megohms minimum.

120.4.2.2.2.6 Bridgewire Resistance Test

The bridgewire resistance of each pyrotechnic bolt shall be measured and recorded on the test data sheet. The measured resistance shall be 1 to 2 ohms at laboratory ambient temperature. Test current shall be limited to 50 milliamperes for a maximum of one minute.

120.4.2.4 Certification

The Seller shall certify the requirements of Sections 120.3 and 120.5 by the following methods.

120.4.2.4.1 Qualification Tests

Qualification testing shall be in conformance with the requirements of this paragraph.

120.4.2.4.1.1 Test Hardware

Qualification test hardware shall be of the same lot and configuration as the flight hardware. The requirement to have the same lot can be satisfied if sufficient data from previous certifications shows stable and consistent performance. Qualification-test specimens shall be subjected to the tests specified in Table 120-3. Data from previous tests may be included to the extent that they conform to the test parameters of this specification.

120.4.2.4.1.2 Performance Requirements

The requirements in 4.2.4.1.2 of the basic specification apply.

Table 120-3. Qualification Requirements

Inspection and Test	Paragraphs Listed in Recommended Sequence
Nondestructive Acceptance	120.4.2.2
Shock	120.4.2.4.1.4
Random Vibration	120.4.2.4.1.3
Pressure Cycling	120.4.2.4.1.5
Thermal Cycling	120.4.2.4.1.6
Six-Foot Drop	120.4.2.4.1.4.1
Pyrotechnic Bolt Ambient Firing	120.4.2.4.1.7.1
Pyrotechnic Bolt Low-Temp Firing	120.4.2.4.1.7.2
Pyrotechnic Bolt High-Temp Firing	120.4.2.4.1.7.3
85% Charge Firing	120.4.2.4.1.7.4
D.C. Sensitivity	120.4.2.4.1.7.5
Auto Ignition	120.4.2.4.1.8
Age Life Certification Test	120.4.2.5.1
Pyrotechnic Release Separation	120.4.2.4.1.7.6

120.4.2.4.1.3 Random Vibration

The bolts shall be mounted in a test fixture and torqued to installation-drawing requirements. The mounting plate shall have no resonances in the spectrum tested. The unit shall be subjected to random vibration along each of the three orthogonal axes as follows:

A. The bolts shall be subjected to an acceleration spectral density increasing at the rate of plus 3 dB per octave from 20 to 80 Hz; constant at 0.067 g^2/Hz from 80 to 350 Hz; decreasing at the rate of minus 3 dB per octave from 350 to 2000 Hz. The duration shall be 1020 seconds per axis.

B. After the test, visually inspect and record conditions of the test items.

120.4.2.4.1.4 Shock

The bolts shall be subjected to a Basic Design Shock of 20 g's for a nominal duration of 11 milliseconds in each of three perpendicular directions. The test units shall be subjected to 18 impact shocks of 20g, (three shocks in opposite directions along each of the three mutually perpendicular axes).

120.4.2.4.1.4.1 Six-Foot Drop

Two pyrotechnic bolts (samples 9 and 10) shall be subjected to the Acceptance Tests followed by a six-foot-drop test. One bolt shall be dropped in axis 1, the other bolt in axis 2, of Figure 120-B, one drop per bolt.

A. The bolts shall be dropped from a height of six feet, plus six inches,minus zero inches.

B. The impact surface shall be a steel plate with a minimum thickness of 1/4 inch backed up by a minimum three inch concrete.

C. Drops shall be made from a quick release hook or equivalent and the guided so as to be released and contact in that axis.

D. After the drop test each bolt shall be fired to verify detonation performance.

NOTE: If bolts are deformed or damaged during drop, no firing test is required.

E. Photographs shall be made of the test bolts after the drop and of the firing test set-up.

120.4.2.4.1.5 Pressure Cycling

The bolts shall be subjected to 25 pressure cycles. One pressure cycle shall consist of subjecting the test items to the following:

A. The pressure shall be raised to and held at 14.7 pounds per square inch absolute (psia) pressure for 5 minutes minimum and then reduced to 0.65 psia in less than 15 minutes. Pressure at 0.65 psia shall be held for 25 minutes. The pressure shall be raised back up to 14.7 psia in five minutes.

B. At the end of the last cycle, the test items shall be raised to ambient pressure.

C. After the test, visually inspect and record conditions of the test items.

120.4.2.4.1.6 Thermal Cycle

The bolts shall be subjected to 25 thermal cycles.

A. Mount the bolts on a surface plate and torque to installation-drawing requirements. The temperature of the test items shall be raised to plus 185°F ± 5°F within three hours and maintained at this temperature for 1 hour. The temperature of the test items shall be reduced to and stabilized at minus 85°F ± 5°F within 3 hours and maintained at this temperature for 1 hour. The temperature shall be raised back up to plus 185°F ± 5°F within 3 hours. The change in temperature from high to low to high with prescribed soaking times constitutes one cycle.

B. At the end of the last cycle, the test items shall be conditioned to ambient temperature and pressure within 2 hours.

C. After the test, visually inspect and record conditions of the test items.

120.4.2.4.1.7 Firing Tests

Redundant instrumentation shall be used for sensing all test firing data.

120.4.2.4.1.7.1 Pyrotechnic Bolt Ambient Firing Test

The procedure shall be as follows:

A. The pyrobolts shall be installed in simulator test fixtures approved by the Buyer and allowed to stabilize at ambient laboratory temperature.

B. Prior to each firing test, measure and record the firing-circuit resistance.

C. During the firing test, measure and record firing current, and time from application of current to initiation with a permanent recording device.

D. Verify complete separation. Inspect and record the condition and engagement of the locking pins of the passive hook and the active hook.

E. Visually inspect and record all findings and conditions of the test items.

F. Photographs shall be made of the test set-up prior to firing. Photographs of the test specimens subsequent to the firing shall be taken if any anomalies are observed to document test results.

120.4.2.4.1.7.2 Low-Temperature Firing Test

The low-temperature firing test procedure shall be the same as specified in 120.4.2.4.1.9 except that the specimen shall be stabilized and fired at a temperature of minus 58°F (± 5°F).

120.4.2.4.1.7.3 High-Temperature Firing Test

The high-temperature firing test procedure shall be the same as specified in 120.4.2.4.1.9 except that the specimen shall be stabilized and fired at a temperature of 122°F (± 5°F).

120.4.2.4.1.7.4 85% Charge Firing Test

The test procedure shall be the same as specified in 120.4.2.4.1.7.1 except that the bolt shall be loaded with 85% of its nominal charge loading and only one bridgewire shall be initiated on all 85% charge weight pyrobolt firings.

120.4.2.4.1.7.5 DC Sensitivity Test

120.4.2.4.1.7.5.1 To determine and verify pin-to-pin maximum. "No-fire" level and minimum "All-fire" level for the bolt, using 40 randomly selected serialized pyrotechnic bolts from the lot that have passed the non-destructive tests of Table 120-2, these test units shall be exposed to the Humidity Test, Shock Test, Random-Vibration Test, Pressure-Cycling Test, and Thermal Vacuum Test identified in Table 120-3. These test units shall then be exposed for the second time to X-ray test, Bridgewire Resistance Test, Insulation resistance Test, and Leakage Test identified in Table 120-2 before being fired on test fixtures and test setups approved by Rockwell and NASA.

120.4.2.4.1.7.5.2 All firings shall be at laboratory ambient conditions.

120.4.2.4.1.7.5.3 The firing setup shall be such that the power supply is a 28 Vdc system, and the total resistance R_T is equal to V/I, where I is the current required at the initiator pins and R_T varies according to the test current required for each firing. A constant current power supply may be used to supply the desired input current for this test.

120.4.2.4.1.7.5.4 All specimens shall be initiated using a constant-current pulse stimulus applied to a single bridgewire (pin to pin) for 40 to 50 milliseconds maximum. The specified firing current is at the initiator pins.

120.4.2.4.1.7.5.5 The test-current increments shall be 0.10 amps.

120.4.2.4.1.7.5.6 The first pyrotechnic bolt specimen shall be initiated with 0.6 amps firing current.

120.4.2.4.1.7.5.7 The firing current for the next test shall be:

0.1 ampere below the previous test current if the unit fired.

0.1 ampere above the previous test current if the unit did not fire.

Note: Figure 120-C is a chart of typical sensitivity-test results.

120.4.2.4.1.7.5.8 Prior to each firing, a Bridgewire Resistance and Insulation Resistance test shall be performed on each set of bridgewires of each bolt.

120.4.2.4.1.7.5.9 For each firing, the current and time from application of current to initiation shall be measured and recorded to provide a permanent record, (i.e. oscilloscope picture, digital recording on floppy disk, etc.). These records shall be maintained by the test agency and a copy submitted as part of the test report.

120.4.2.4.1.7.5.10 The 40 bolts shall be subjected to the test while installed in a fixture approved by NASA. In the event of "No-Fire," the pyrobolt shall be disconnected from the test setup, tag-identified as "NO-FIRE at ___ampere" denoting the value of the current applied. NASA will determine the disposition of the "No Fire" test units.

120.4.2.4.1.7.5.11 After testing all 40 bolts, calculate the mean and standard deviation from the resulting firing currents.

120.4.2.4.1.7.6 Pyrotechnic Release Separation Test

A separation test shall be conducted to demonstrate the capability and performance of the pyrotechnic release. A full-up simulated mated separation-system test is required for qualification test. Shock loads at the APDA/docking adapter interface shall be recorded.

120.4.2.4.1.8 Auto Ignition Test

A minimum of four pyrotechnic bolts or two latch assemblies shall be used for this test. The pyrotechnic bolts or latch assemblies shall be exposed to elevated temperatures up to 235°F. The temperature of the pyrotechnic bolt shall be monitored at all times during the test. The rate of temperature change in the test chamber shall not be less than 1 degree Fahrenheit per minute nor more than 4 degrees Fahrenheit per minute. The pyrotechnic bolt temperature shall be stabilized at 235°F for 1 hour. Verify that there is no auto-ignition of the pyrotechnic bolt during the test.

120.4.2.4.2 Certification By Analysis

The following requirements shall be verified by analysis.

120.4.2.4.2.1 Storage/Operating Life

Compliance with storage/operating life requirements of section 120.3 shall be verified by analysis of the drawings and applicable test data.

120.4.2.4.2.2 Factors of Safety

The capability of the pyrotechnic bolt to withstand the factors of safety in accordance with 120.3 shall be verified by analysis of design drawing and test results.

120.4.2.4.2.3 Reliability

Compliance with the reliability requirements of section 120.3 shall be verified by analysis and evaluation of design drawings and test data, as applicable.

120.4.2.4.2.4 Materials and Processes

Compliance with the materials and processes requirements of Section 120.3 which cannot be verified by assessment of design drawings and procedures must be verified by test.

120.4.2.4.2.5 Safety

Compliance with the safety requirements of section 120.3.3.4 shall be verified by analysis and evaluation of design drawings and test data as applicable.

120.4.2.5 Lot Age Certification

The following testing must be conducted to certify the flight lot for continued use.

120.4.2.5.1 Age Life Certification Test

Seven years (para. 120.4.2.5.1.1) and eleven years (para. 120.4.2.5.1.2) after the date of acceptance test, five pyrobolts from the flight lot shall be subjected to the thermal environments specified in paragraph 120.4.2.4.1.6 but at atmospheric pressure rather than vacuum conditions; the pyrobolts shall also be subjected to the random vibration specified in paragraph 120.4.2.4.1.3 and shock spectra as specified in paragraph 120.4.2.4.1.4. The thermal cycling shall preceed the random vibration. The pyrobolts shall then be fired in accordance with paragraph 120.4.2.2.2.3 (c).

120.4.2.5.1.1 Age Life Test I

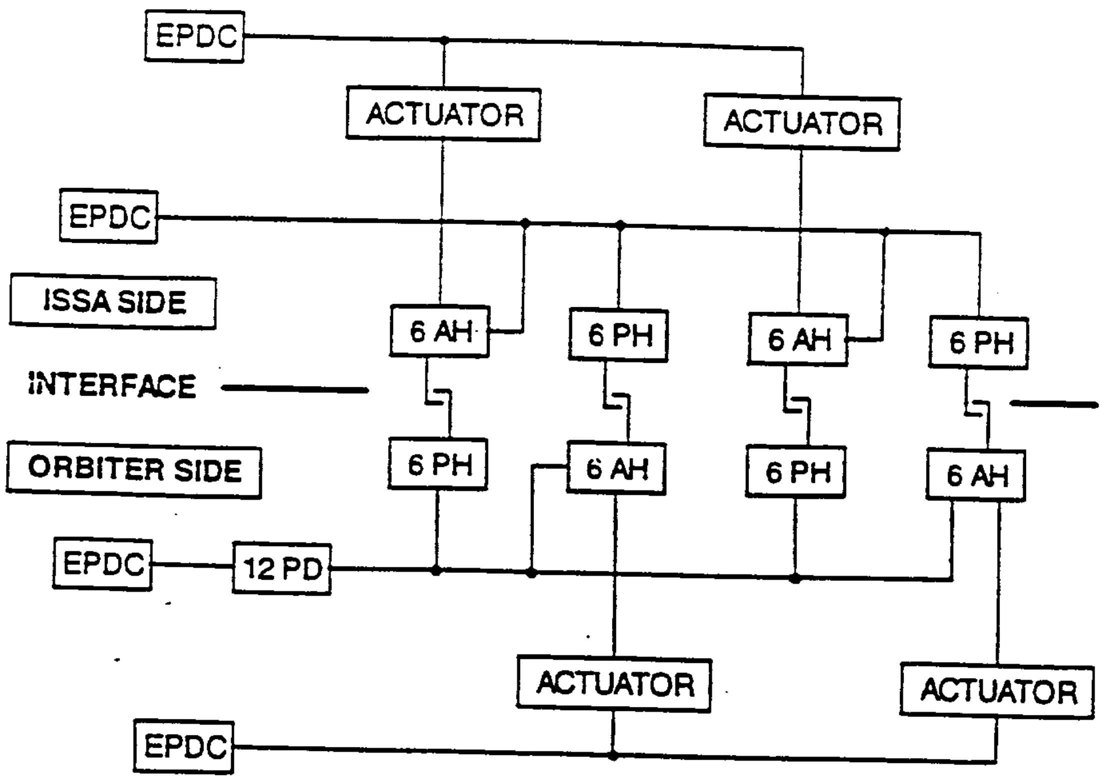
Five samples shall be exposed to the Age Life Test environments per 120.4.2.5.1 seven years after the acceptance test for the pyrobolt lot in question and subsequently fired per 120.4.2.2.2.3(c). Only one bridgewire shall be installed in all five firings. Verify complete separation of the test articles.

120.4.2.5.1.2 Age Life Test II

Five samples shall be exposed to the Age Life Test environments per 120.4.2.5.1 eleven years after the acceptance test for the pyrobolt lot in question and subsequently fired per 120.4.2.2.2.3(c). Only one bridgewire shall be installed in all five firings. Verify complete separation of the test articles.

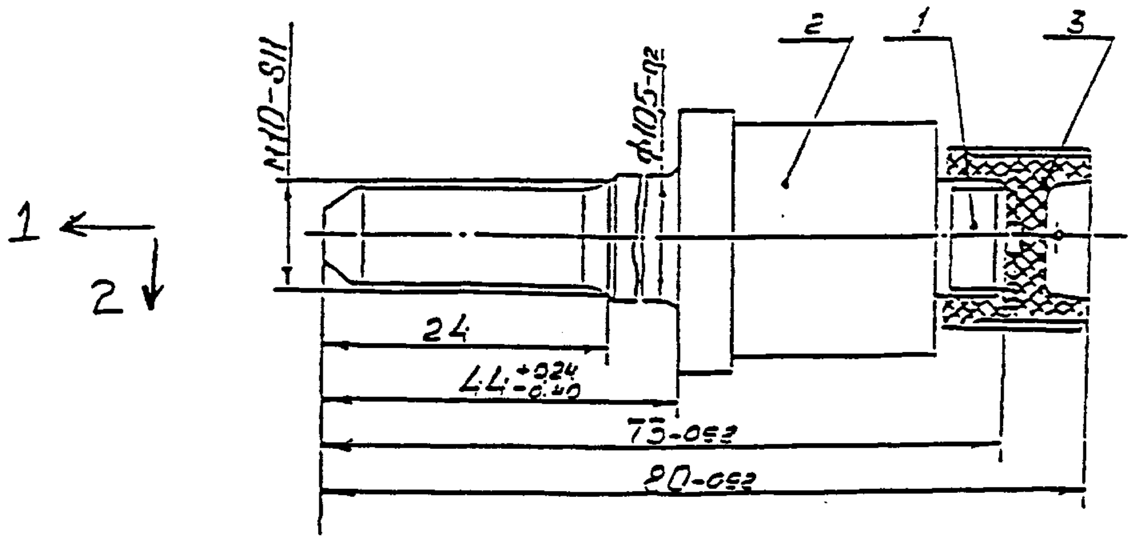
120.5 PREPARATION FOR DELIVERY

The requirements of Section 5 of the basic specification apply.



EPDC: ELEC POWER DISTRIBUTION & CONTROL
AH: ACTIVE HOOK
PH: PASSIVE HOOK
PD: PYRO DEVICE

Figure 120-A. Pyrotechnic Release Block Diagram



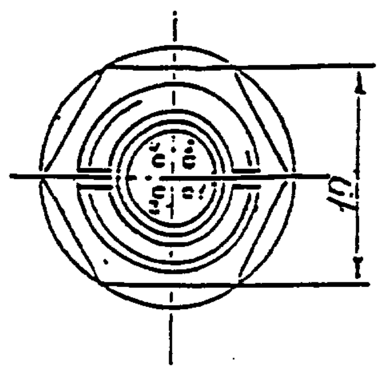


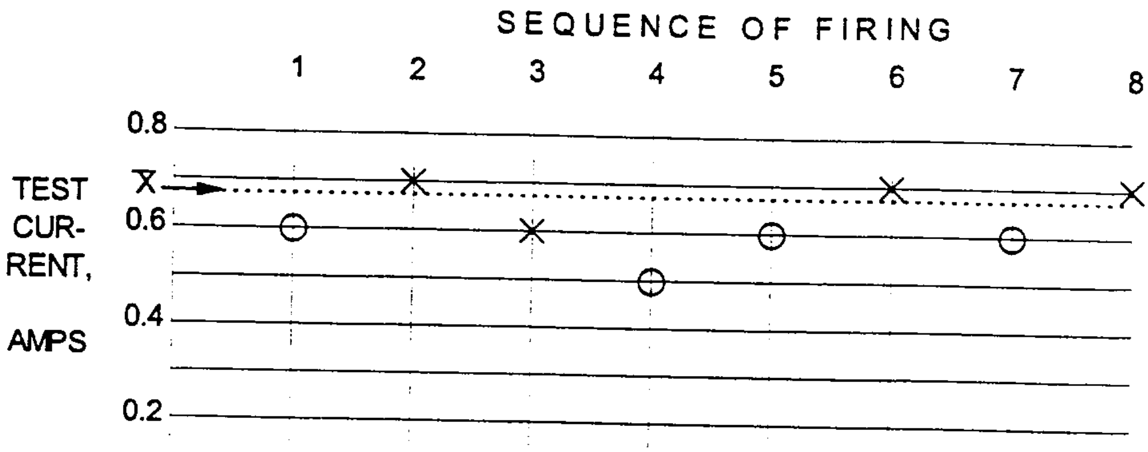
Figure 120-B. Pyrotechnic Bolt Mounting

		DC Sens.	6-Ft Drop	Low Temp Firing	High Temp Firing	Auto Ignition	15% Under load	Age Life	Amb Temp Firing	Flight Units
	Group	A	B	C	D	E	G	H	I	J
	Bolt Qty.	40	2	4	4	4	2	20	24	96
	JSC 26938 PARAGRAPH	SEQUENCE OF TESTS								
EXAMINATION OF PRODUCT	120.4.2.2.1	1	1	1	1	1	1	1	1	1
ELECTROSTATIC DISCHARGE	120.4.2.2.2.4	2	2	2	2	2	2	2	2	2
INSULATION RESISTANCE	120.4.2.2.2.5	3	3	3	3	3	3	3	3	3
BRIDGEWIRE RESISTANCE	120.4.2.2.2.6	4	4	4	4	4	4	4	4	4
X-RAY	120.4.2.2.1.1	5	5	5	5	5	5	5	5	5
N-RAY	120.4.2.2.1.2	6	6	6	6	6	6	6	6	6
HELIUM LEAK TEST	120.4.2.2.2.1	7	7	7	7	7	7	7	7	7
SHOCK	120.4.2.4.1.4			8	8				8	
RANDOM VIBRATION	120.4.2.4.1.3			9	9				9	
PRESSURE CYCLING	120.4.2.4.1.5			10	10				10	
THERMAL CYCLING	120.4.2.4.1.6			11	11				11	
6-FT DROP	120.4.2.4.1.4.1		8							
LOW TEMP FIRING	120.4.2.4.1.7.2			12						
HIGH TEMP FIRING	120.4.2.4.1.7.3				12					
15% UNDERLOAD	120.4.2.4.1.7.4						8			
DC SENSITIVITY	120.4.2.4.1.7.5	8								
AUTO IGNITION	120.4.2.4.1.8					8				
AMBIENT TEMP. FIRING	120.4.2.4.1.7.1		9			9			12	
AGE LIFE TESTING	120.4.2.5.1							8		

Figure 120-C. Destructive Test Matrix for Pyrobolts with a Design or Manufacturing Process Configuration Change

		Low Temp Firing	High Temp Firing	Amb. Temp. Firing	15% Under load	Age Life	Flight Units
	Group	C	D	E	G	H	J
	Bolt Qty.	10	10	5	2	10	100%
	JSC 26938 PARAGRAPH	Sequence of Tests					
EXAMINATION OF PRODUCT	120.4.2.2.1	1	1	1	1	1	1
ELECTROSTATIC DISCHARGE	120.4.2.2.2.4	2	2	2	2	2	2
INSULATION RESISTANCE	120.4.2.2.2.5	3	3	3	3	3	3
BRIDGEWIRE RESISTANCE	120.4.2.2.2.6	4	4	4	4	4	4
X-RAY	120.4.2.2.1.1	5	5	5	5	5	5
N-RAY	120.4.2.2.1.2	6	6	6	6	6	6
HELIUM LEAK TEST	120.4.2.2.2.1	7	7	7	7	7	7
SHOCK	120.4.2.4.1.4	8	8	8			
RANDOM VIBRATION	120.4.2.4.1.3	9	9	9			
PRESSURE CYCLING	120.4.2.4.1.5	10	10	10			
THERMAL CYCLING	120.4.2.4.1.6	11	11	11			
LOW TEMP FIRING	120.4.2.4.1.7.2	12					
HIGH TEMP FIRING	120.4.2.4.1.7.3		12				
15% UNDERLOAD	120.4.2.4.1.7.4				8		
AMBIENT TEMP. FIRING	120.4.2.4.1.7.1			12			
AGE LIFE TESTING	120.4.2.5.1					8	

Figure 120-D. Destructive Test Matrix for Pyrobolts without a Design or Manufacturing Process Configuration Change Since Last Production Lot Acceptance



- O = NO-FIRE
- X = FIRE
- $\overline{X}$ = AVERAGE

$$= \frac{1}{NF}\sum_{j=1}^{NF} IFj$$

where

NF is the number of cases in which firing occurred;
IFj is the magnitude of the jth current for which firing occurred.

Figure 120-E. Example of Charting Results of Sensitivity Test

Appendix XIII

130. INTERCONNECTING WIRING

130.1 SCOPE

This appendix is a description of the wiring interfaces between the APDS and the Orbiter avionics subsystems, including that between the APDS component Line Replaceable Units. This appendix also describes the wiring between the -7001 and -8001 APDAs and ISS.

130.2 APPLICABLE DOCUMENTS

N/A

130.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

130.3.1 Item Definition

The wiring interfaces between the APDS and the Orbiter avionics subsystems (including the interfaces between the APDS Line Replaceable Units), and wiring interfaces between the -7001 and -8001 APDAs and ISS are used to provide transmission of signals and power to all the docking system electrical, electronics, and electromechanical equipment. Also included are the wiring interfaces used for electrical checkout.

130.3.1.1 Item Diagram

Figures 130 A - E are block diagrams showing all pigtail cables to be provided by the seller to configure the Standard Orbiter (Orbiter 103, 104, and 105) and the ISS PMA 1,2,3. Dimensions of the cables depicted in these figures are specifically defined in Tables 130 A - E.

130.3.1.2 Deleted

130.3.1.3 Item Identification

The pigtail cable sets shall be identified as follows. Individual cables making up each of these cable sets are identified in Table 130-F.

Nomenclature	Seller Part No.
Orbiter Cables	SLIYu 374511.010 SLIYu 374511.011 SLIYu 374511.018 SLIYu 374511.019
PMA -2,3 Cables	SLIYu 374511.021
PMA -1 Cables	SLIYu 374511.020

130.3.1.3.1 Cable Set Identification

All cables shall be permanently marked with the Seller's part number and serial number. Each connector reference designator shall be permanently marked on the cable in a location close to the respective connector. All cables shall have the connector and pin number where each wire is terminated permanently marked on each individual pigtail wire. Buyer part number marking on cables is not required.

130.3.2Characteristics

130.3.2.1 Performance Characteristics

The interconnecting wiring shall provide the means to perform the functions allocated to it, in concert with the avionics Line Replaceable Units provided by the Seller, to achieve optimal mating/demating of the ISS with the Orbiter.

130.3.2.1.1 Life

The interconnecting wiring shall have a minimum service life without failure of:

Resource umbilical mate-demate cycles:	100
Other connector mate-demate cycles:	250
Live operation:	15,000 hours

130.3.2.1.2 Design Approach

The requirements in 3.2.1.2 of the basic specification apply.

130.3.2.2 Physical Characteristics

130.3.2.2.1 Envelope

The cables shall have lengths defined in Tables 130 A-E and Figures 130 F-G.

130.3.2.2.2 Weight.

The weight of each of the Interconnecting Wiring cable sets shall not exceed TBD lbs.

130.3.2.3 Reliability

The requirements of 3.2.3 of the basic specification apply

130.3.2.5 Environment

The APDA and airlock floor floor requirements of 3.2.5 the basic specification apply.

130.3.2.6 Transportability

The requirements of 3.2.6 of the basic specification apply.

130.3.3 Design and Construction

The requirements of 3.3 of the basic specification apply.

130.4 QUALITY ASSURANCE PROVISIONS.

130.4.1 General Requirements

The requirements of 4.1 of the basic specification apply.

130.4.2 Quality Conformance

130.4.2.1 Development

The requirements in 4.2.1 of the basic specification apply.

130.4.2.2 Acceptance

Acceptance tests and inspections shall be performed on the interconnecting wiring, to be employed on the delivered units to the Buyer. The minimum number of tests and inspections, and the sequence thereof shall be as specified in Table 130-F. The Seller shall perform any other test deemed necessary, subject to approval of the Buyer.

Table 130-F. Acceptance Requirements

Inspection and Test	Paragraphs Listed in Recommended Sequence
Examination of Product	130.4.2.2.1
Functional & Performance Test	130.4.2.2.2
Insulation Resistance Test	130.4.2.2.2.1
Dielectric Strength Test	130.4.2.2.2.2
Functional & Performance Recheck	130.4.2.2.2

130.4.2.2.1 Examination of Product

The requirements in 4.2.2.1 of the basic specification apply.

130.4.2.2.2 Functional and Performance Tests

The requirements in 4.2.2.2 of the basic specification apply.

130.4.2.2.2.1 Insulation Resistance Test

The requirements in 4.2.2.2.1 of the basic specification apply except resistance shall be no less than 50 Mohms.

130.4.2.2.2.2 Dielectric Strength Test (Vacuum Test only)

The requirements in 4.2.2.2.2 of the basic specification apply except that the test voltage shall be either 355 Vac for 1 minute or 450 Vac for 1 second.

130.4.2.3 Assessment

The requirements in 4.2.3 of the basic specification apply.

130.4.2.3.1 Reliability

The requirements in 4.2.3.1 of the basic specification apply.

130.4.2.3.2 Materials and Processes

The requirements in 4.2.3.2 of the basic specification apply.

130.4.2.3.3 Parts Standardization

The requirements in 4.2.3.3 of the basic specification apply.

130.4.2.3.4 Electrical Design Requirements

The requirements in 4.2.3.4 of the basic specification apply.

130.4.2.3.5 Interchangeability

The requirements in 4.2.3.5 of the basic specification apply.

130.4.2.3.6 Human Performance/Human Engineering

The requirements in 4.2.3.6 of the basic specification apply.

130.4.2.3.7 Safety

The requirements in 4.2.3.7 of the basic specification apply.

130.4.2.3.8 Identification and Marking

The requirements in 4.2.3.8 of the basic specification apply.

130.4.2.4 Certification

The requirements in 4.2.4 of the basic specification apply.

130.4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements in the performance and design verification matrix of Section 4 Table V shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in the sequence shown.

Table 130-G. Qualification Requirements

Suggested Test Sequence	Paragraph Listed in Recommended Sequence
Acceptance Test	130.4.2.2
Performance Test	130.4.2.4.1.2
Transportation Test	130.4.2.4.1.10
Vibration	130.4.2.4.1.4
Shock	130.4.2.4.1.6
Acceleration	130.4.2.4.1.5
Thermal Vacuum Test	130.4.2.4.1.9
Qualification Humidity Test	130.4.2.4.1.3
* EMC Test	130.4.2.4.1.8
Final Performance Test	130.4.2.4.1.2

* Test and analysis will be conducted and documented by Buyer.

130.4.2.4.1.1 Test Hardware

Qualification test hardware shall be of the same configuration as flight hardware.

130.4.2.4.1.2 Performance Requirements

The requirements in 4.2.4.1.2 of the basic specification apply.

130.4.2.4.1.3 Qualification Humidity Test

The requirements in 4.2.4.1.3 of the basic specification apply.

130.4.2.4.1.4 Vibration.

130.4.2.4.1.4.1 Qualification - Acceptance Vibration Test (QAVT)

The Interconnecting Wiring shall be subjected to the qualification random vibration in two mutually perpendicular axes:

Frequency, Hz	Spectral Density, g^2/Hz
20-50	0.1-0.3
50-100	0.3-1.0
100-200	1.0
200-500	1.0
500-1000	1.0-0.5
1000-2000	0.5-0.2

The total duration of the vibration frequencies is 120 sec; (60 sec per axis).

130.4.2.4.1.5 Acceleration

The Interconnecting Wiring shall be subjected to linear acceleration of 50 g's for 10 minutes in each of the two mutually perpendicular axes.

130.4.2.4.1.6 Shock

The Interconnecting Wiring shall be subjected to 20 shock pulses of 100 g's with the pulse duration of 1-5 msec in two mutually perpendicular axes.

130.4.2.4.1.7 Lightning

The requirements in 4.2.4.2.12 of the basic specification apply.

130.4.2.4.1.8 Electromagnetic Compatibility Tests

The requirements in 4.2.4.1.9 of the basic specification apply.

130.4.2.4.1.9 Thermal Vacuum Test

The Interconnecting Wiring shall be subjected to thermal vacuum testing in three phases as follows:

Phase 1 - The Interconnecting Wiring shall be exposed to the maximum and minimum operating temperatures for a duration of not less than 3 hours. Rate of change shall not exceed 240 °F (133.3 °C) per hour, nor be less than 60 °F (33.3 °C) per hour. Selected performance test at the high temperature extreme shall include operation at the maximum heat dissipating mode for a duration consistent with the design capability and sufficient to obtain test data. During the low temperature extremes, the performance test shall include operation at minimum heat dissipating mode for a duration sufficient to verify acceptable performance. The thermal exposure shall be performed by separate tests with a performance test between exposures.

Phase 2 - The Interconnecting Wiring shall be thermally cycled between the maximum and minimum operating temperatures per the requirements specified in Phase 1.

Phase 3 - The Interconnecting Wiring shall be subjected to a vacuum between 10^{-4} and 10^{-5} mm Hg for 24 hours.

130.4.2.4.1.10 Transportation Test

The requirements in 4.2.4.1.11 of the basic specification apply.

130.4.2.4.1.11 Operating Life Test

The requirements in 4.2.4.1.12 of the basic specification apply.

130.4.2.4.2 Certification By Analysis

The requirements in 4.2.4.2 of the basic specification apply.

130.4.2.4.2.1 Storage/Operating Life

The requirements in 4.2.4.2.1 of the basic specification apply.

130.4.2.4.2.2 Physical Characteristics

The requirements in 4.2.4.2.2 of the basic specification apply.

130.4.2.4.2.3 130.4.2.4.2.3 Reliability

The requirements in 4.2.4.2.3 of the basic specification apply.

130.4.2.4.2.4 Salt Fog

The requirements of 4.2.4.2.4 of the basic specification apply.

130.4.2.4.2.5 Ozone

The requirements in 4.2.4.2.5 of the basic specification apply.

130.4.2.4.2.6 Fungus

The requirements in 4.2.4.2.6 of the basic specification apply.

130.4.2.4.2.7 Materials and Processes

The requirements in 4.2.4.2.7 of the basic specification apply.

130.4.2.4.2.8 Electromagnetic Compatibility

The requirements in 4.2.4.2.8 of the basic specification apply.

130.4.2.4.2.9 Electrical Design Requirements

The requirements in 4.2.4.2.9 of the basic specification apply.

130.4.2.4.2.10 Safety

The requirements in 4.2.4.2.10 of the basic specification apply.

130.4.2.4.2.11 Sand and Dust

The requirements in 4.2.4.2.11 of the basic specification apply.

130.4.2.4.2.12 Certification by Other Test Data

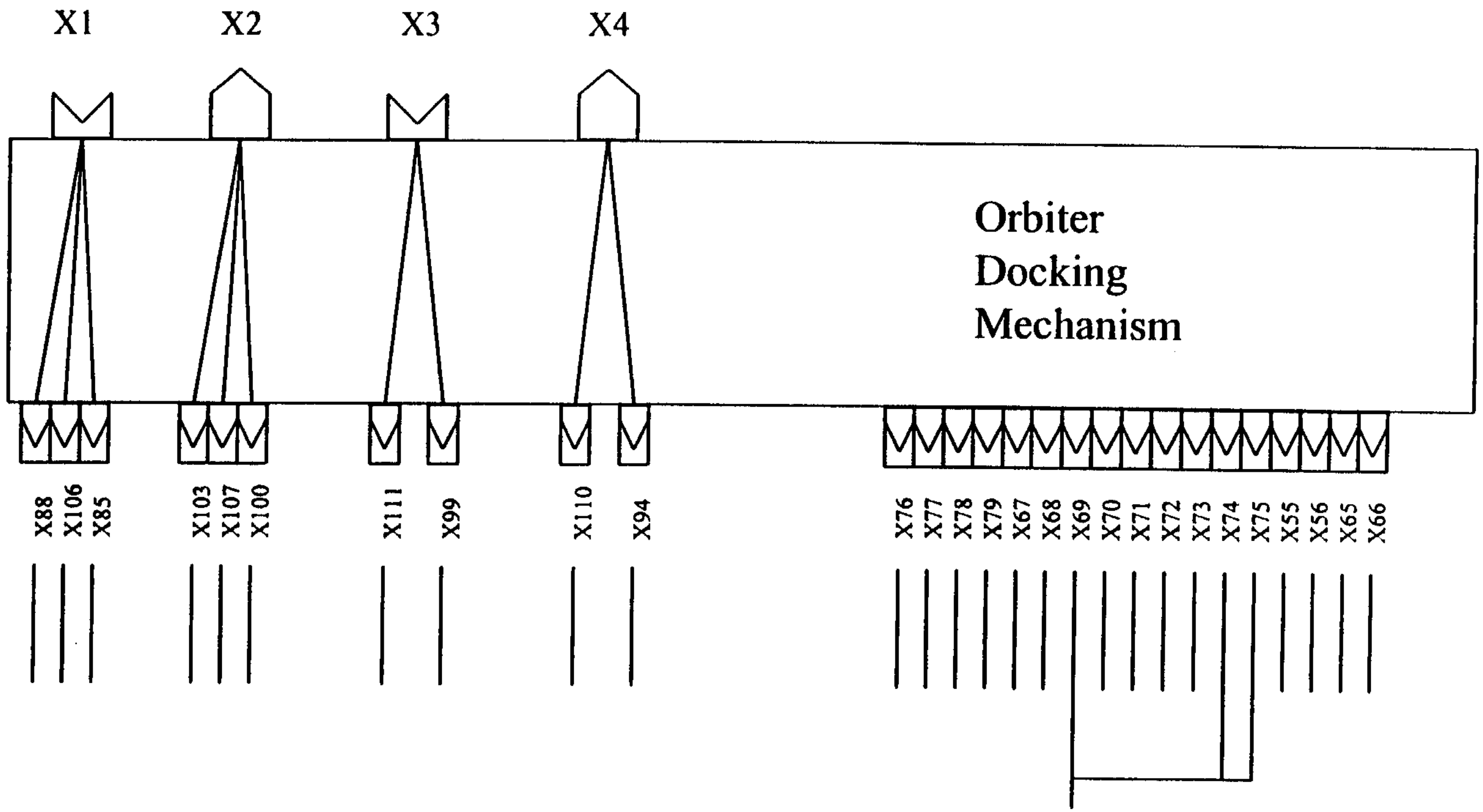
The requirements in 4.2.4.2.12 of the basic specification apply.

130.4.2.5 Verification Requirements Matrices

The requirements in 4.2.5 of the basic specification apply.

130.5 PREPARATION FOR DELIVERY

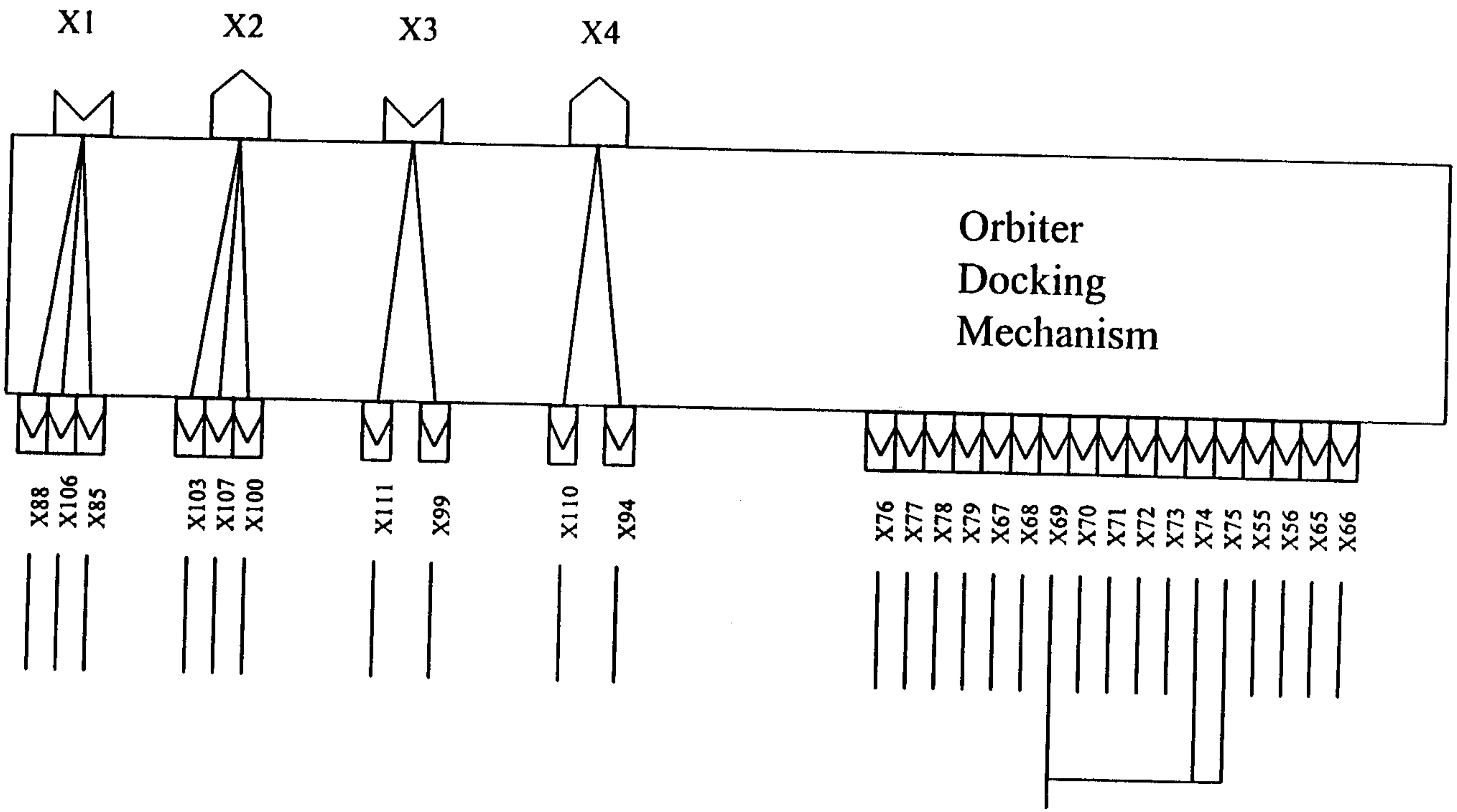
The requirements in Section 5 of the basic specification apply.



Note 1 : Shield ground lug wires not shown on cables x73, x78, x55, x56, x65, x66 x94, x108, x110, x111.

Note 2: X55, X56, X65, and X66 have 90 degree connector backshells oreiented in the direction of theOrbiter airlock.

Figure 130-A. Orbiter APAS Cable Harness Pigtails (-3002 configuration)



Note 1 : Shield ground lug wires not shown on cables x73, x78, x55, x56, x65, x66 x94, x108, x110, x111.

Note 2: X55, X56, X65, and X66 have 90 degree connector backshells oreiented in the direction of theOrbiter airlock.

Figure 130-A.1. Orbiter APAS Cable Harness Pigtails. (-6001 configuration)

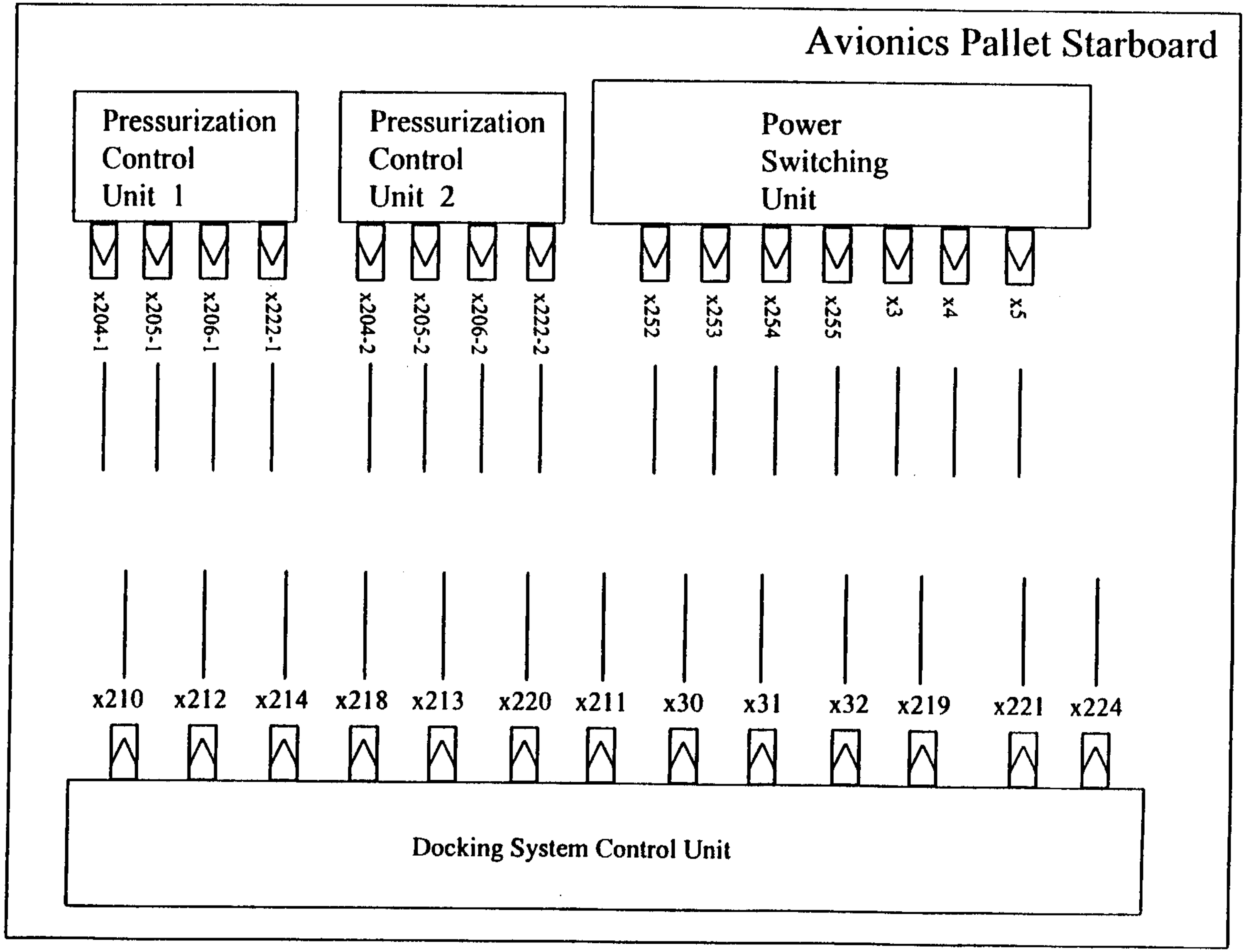


Figure 130-B1. Orbiter Docking System Avionics Starboard Pallet Cable Harness Pigtails.

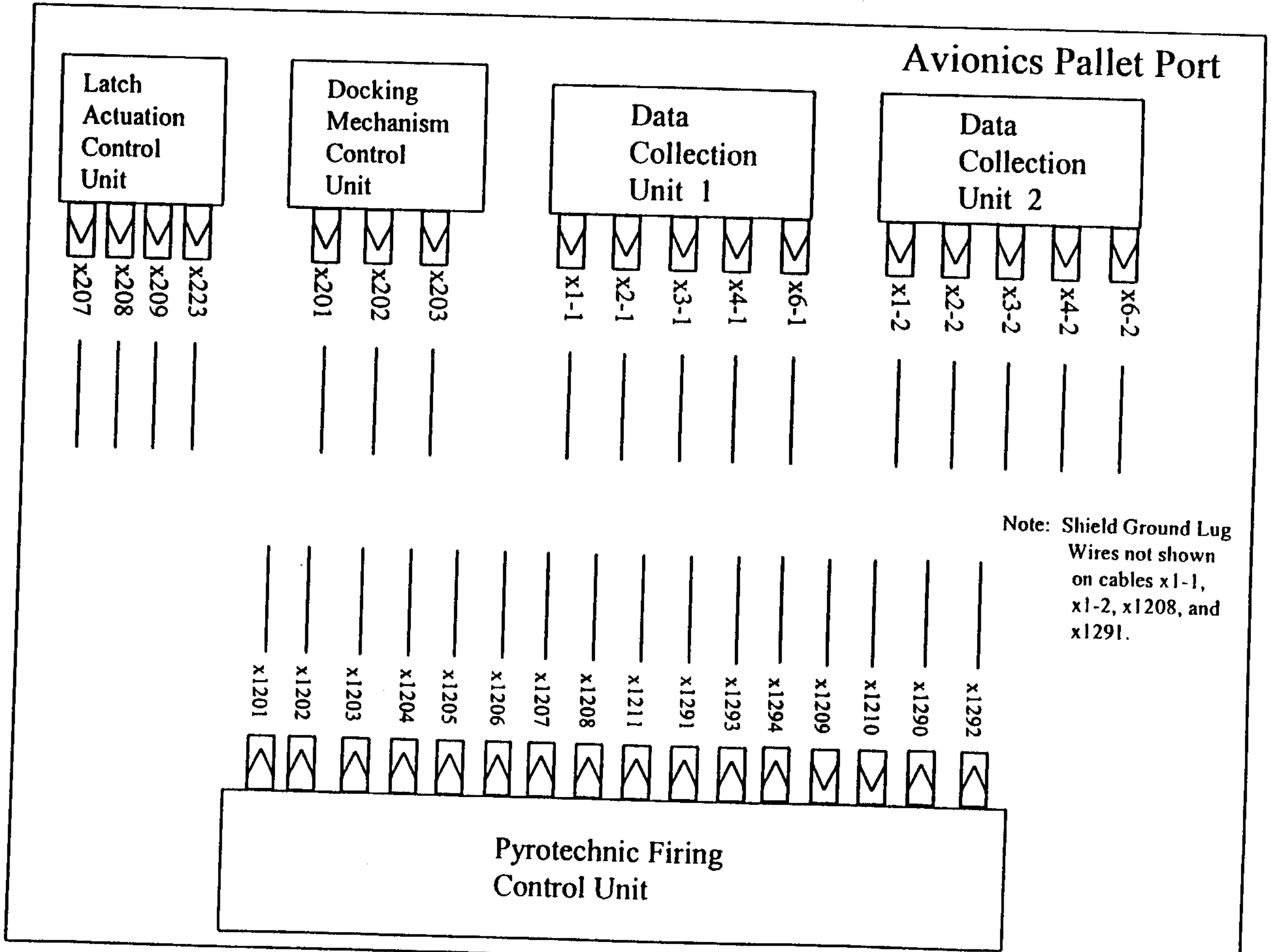


Figure 130-B2. Orbiter Docking System Avionics Port Pallet Cable Harness Pigtails.

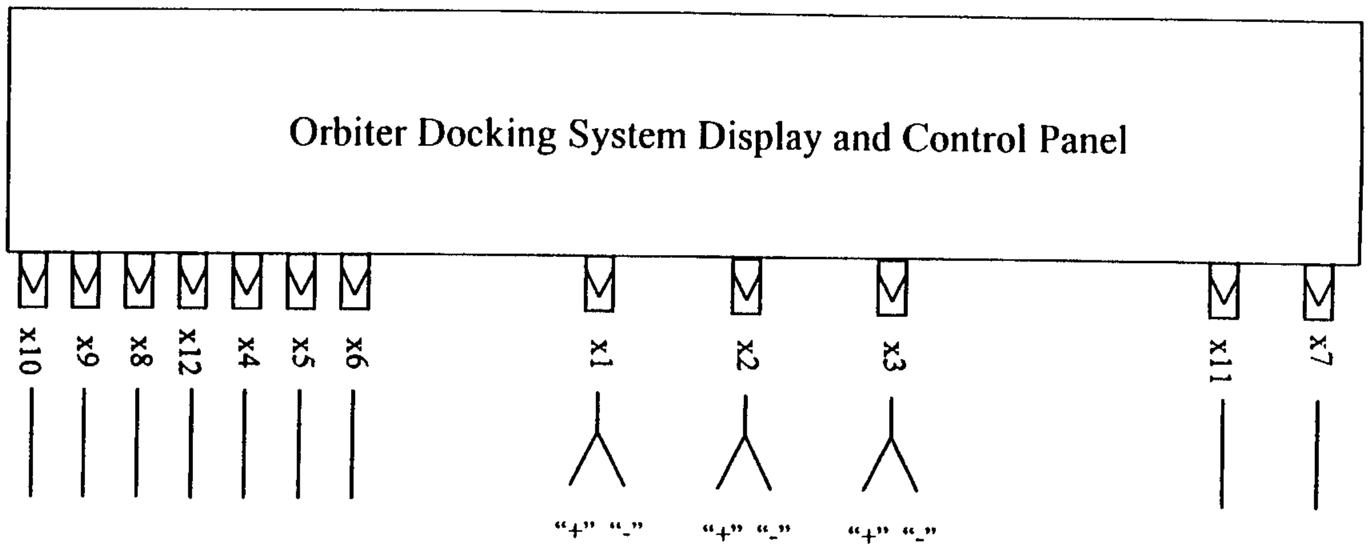
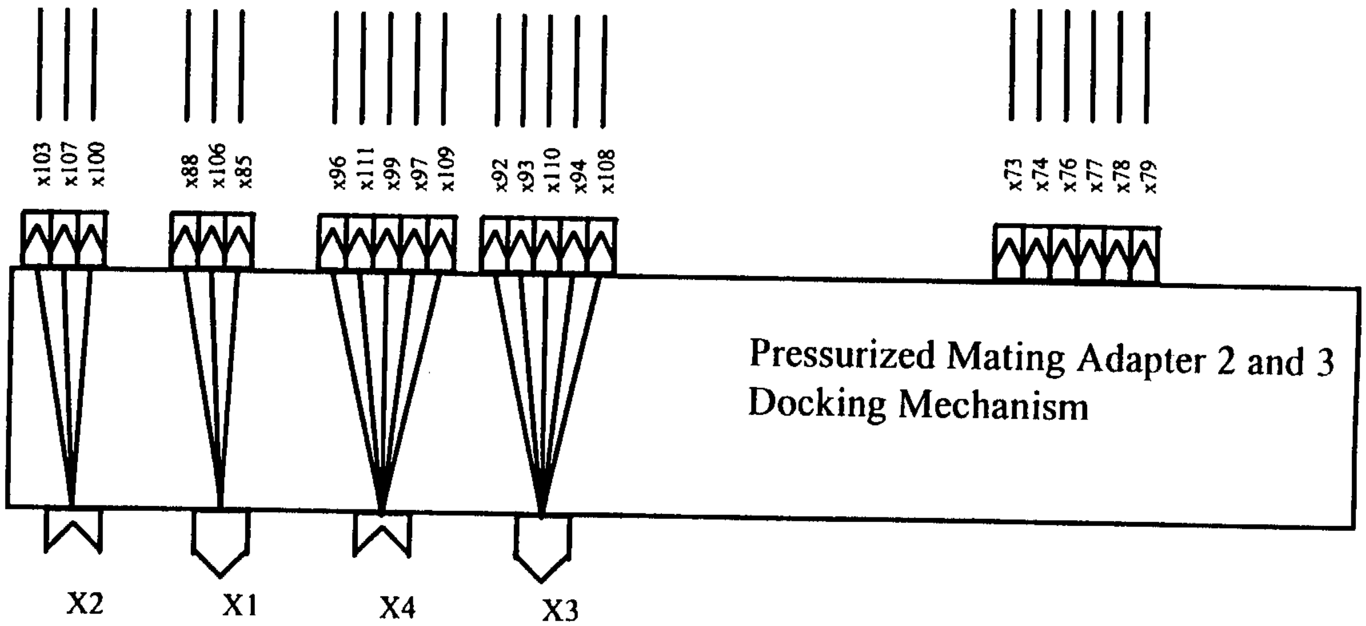
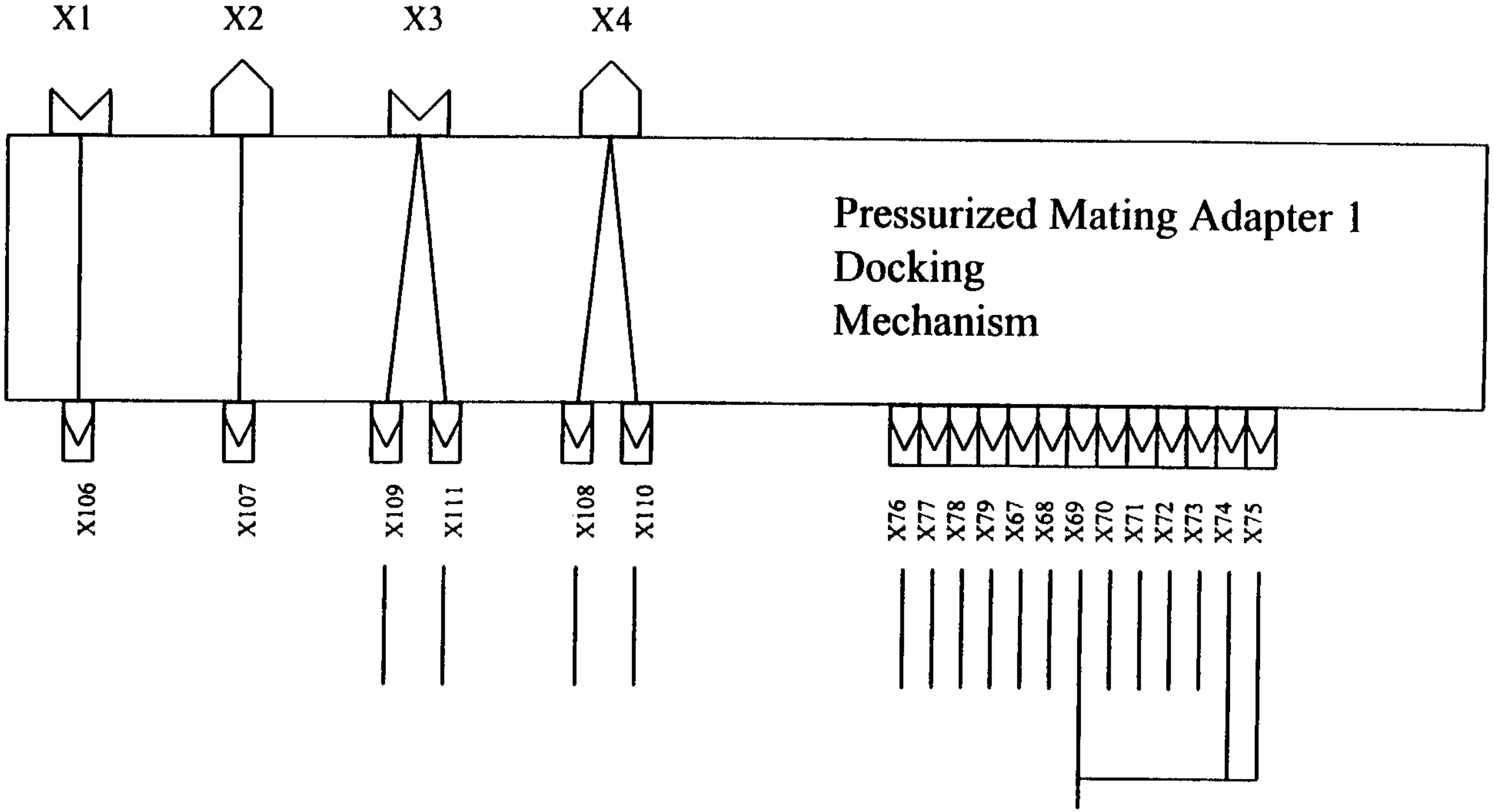


Figure 130-C. Orbiter Display Control Panel Cable Harness Pigtails.



Note: Shield ground lug wires not shown on cables x73, x78, x94, x108, x110, x111

Figure 130-D. Pressurized Mating Adapter 2 and 3 APAS Cable Harness Pigtails.



Note 1 : Shield ground lug wires not shown on cables x73, x78, x108, x110, x109, x111

Note 2: X106 and X107 are for RSC-E ground test only and will be capped for flight.

Note 3: X76 and X77 will have 90 degree connector backshells oriented in the direction of PMA 1.

Figure 130-E. Pressized Mating Adpater 1 APAS Cable Harness Pigtails.

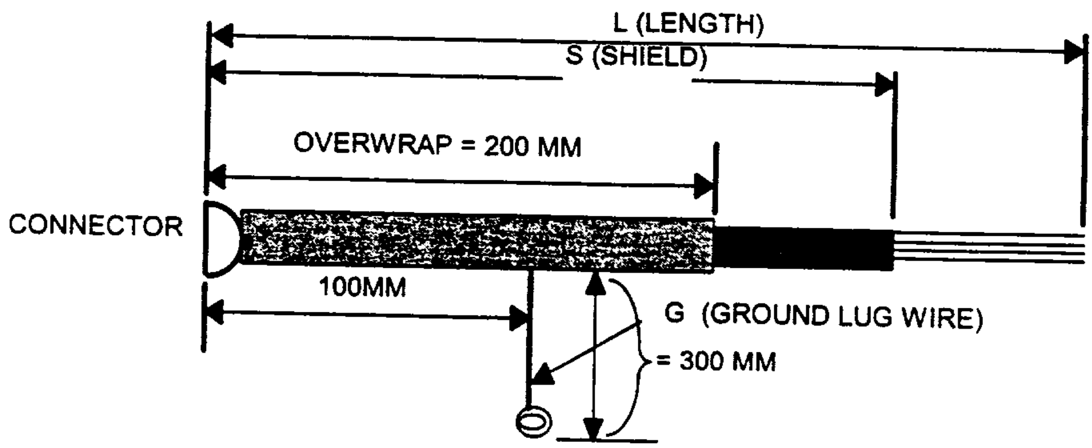


Figure 130-F. Cable Length (Generic)

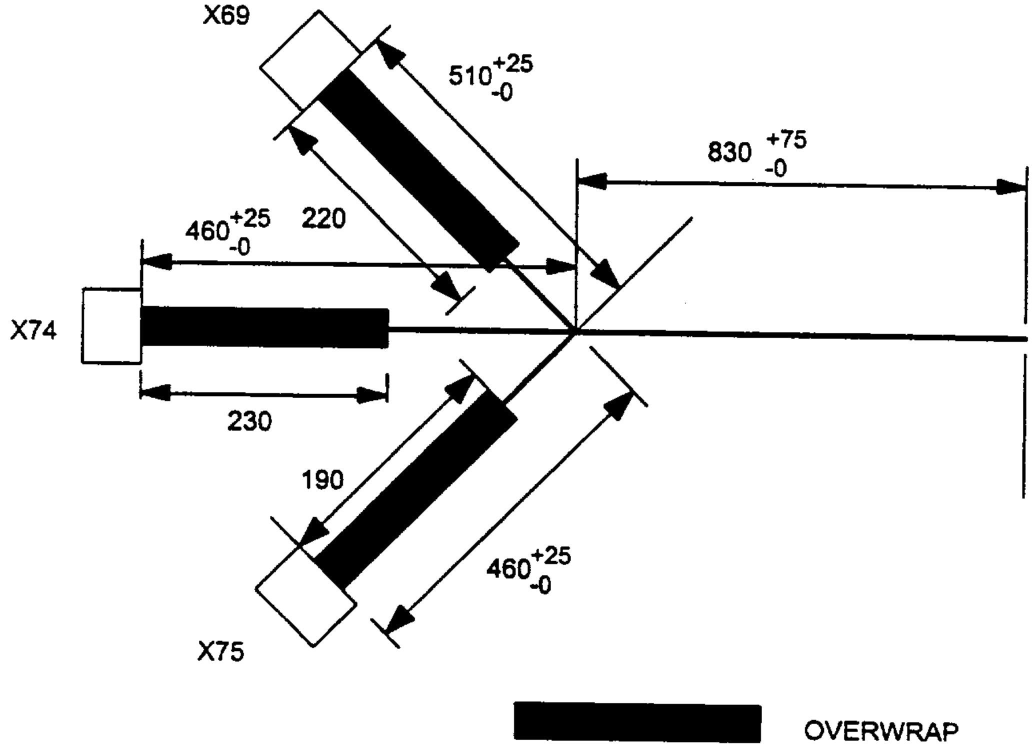


Figure 130-G. Cable Length for X69, X74, and X75 "Pigtails" for Orbiter APDA Cable Harness.

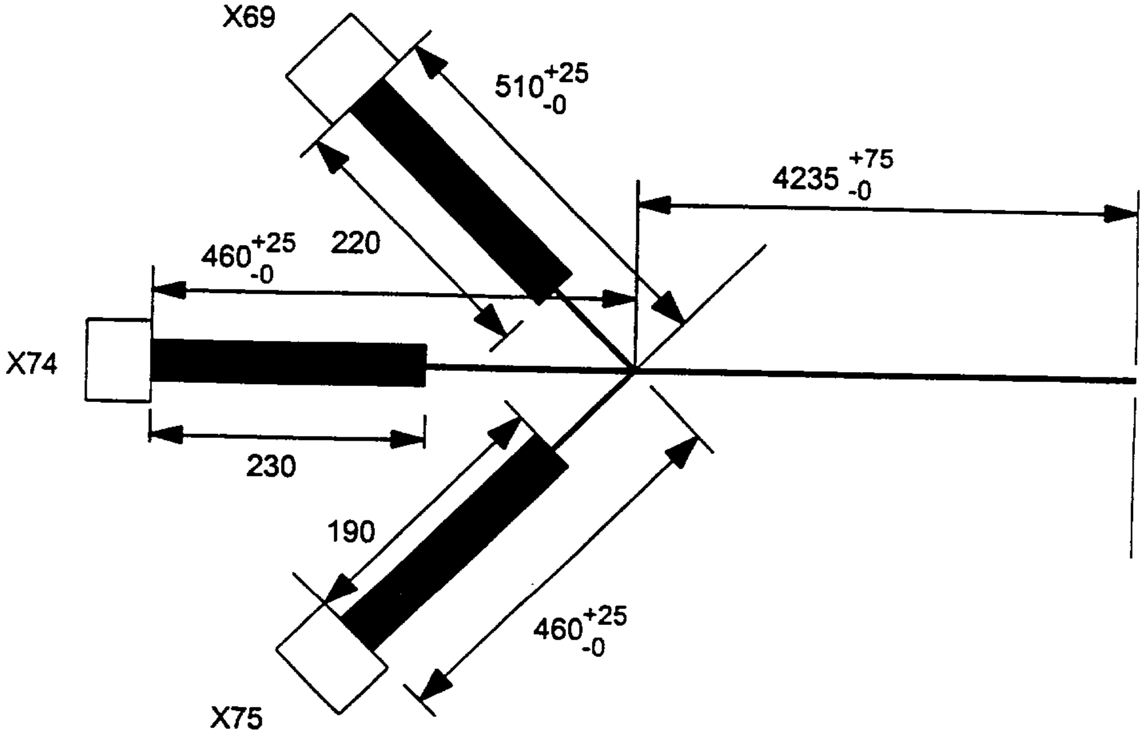


Figure 130-H. Cable Length for X69, X74, and X75 "Pigtails" for ISS PMA2 Cable Harness Pigtails.

Table 130-A. Cable Specifications, Orbiter APDA Cable Harness Pigtails

CONN	LENGTH	TOL.	OVERWRP	TOL.	SHIELD	TOL.	GND W	TOL.	Backshell Config.
X69	See Figure 130-G								Straight
X74	See Figure 130-G								Straight
X75	See Figure 130-G								Straight
X55	1828.8	+25.4,-0	200	±25.4	1524	+25.4,-0	300	±25.4	90° twd Orbiter
X56	1828.8	+25.4,-0	200	±25.4	1524	+25.4,-0	300	±25.4	90° twd Orbiter
X65	1828.8	+25.4,-0	200	±25.4	1524	+25.4,-0	300	±25.4	90° twd Orbiter
X66	1828.8	+25.4,-0	200	±25.4	1524	+25.4,-0	300	±25.4	90° twd Orbiter
All Others	1828.8	+25.4,-0	200	±25.4	1524	+25.4,-0	300	±25.4	Straight
Note: All measurements in Millimeters (mm).									

Table 130-B. Cable Specifications, Orbiter Avionics Pallet Cable Harness Pigtails

CONN	LENGTH	TOL.	OVERWRP	TOL.	SHIELD	TOL.	GND W	TOL.	Backshell Config.
All	2743.2	+25.4,-0	85	±5	2438.4	+25.4,-0	300	±25.4	Straight
Note: All measurements in Millimeters (mm).									

Table 130-C. Cable Specifications, Orbiter Display & Control Panel Cable Harness Pigtails

CONN	LENGTH	TOL.	OVERWRP	TOL.	SHIELD	TOL.	GND W	TOL.	Backshell Config.
X1	730	+50,-0	375	±25.4					
X4	730	+50,-0	375	±25.4					
X2	730	+50,-0	375	±25.4					
X5	750	+50,-0	385	±25.4					
X12	750	+50,-0	315	±25.4					
X8	710	+50,-0	285	±25.4					
X11	800	+50,-0	465	±25.4					
X3	730	±25.4	430	±25.4					
X6	780	+50,-0	425	±25.4					
X10	870	+50,-0	325	±25.4					
X7	980	+50,-0	385	±25.4					
X9	790	+50,-0	305	±25.4					
Note: All measurements in Millimeters(mm).									

Table 130-D. Cable Specifications, ISS PMA 2 & 3 Cable Harness Pigtails

CONN	LENGTH	TOL.	OVERWRP	TOL.	SHIELD	TOL.	GND W	TOL.	Backshell Config.
X55	5855	±25.4	200	±25.4	5550	±25.4	300	±25.4	45° twd PMA
X56	5855	±25.4	200	±25.4	5550	±25.4	300	±25.4	45° twd PMA
X65	5855	±25.4	200	±25.4	5550	±25.4	300	±25.4	45° twd PMA
X66	5855	±25.4	200	±25.4	5550	±25.4	300	±25.4	45° twd PMA
X79-2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Capped
X79-3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Capped
X84-2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Capped
X84-3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Capped
All Other External	5855	±25.4	200	±25.4	5550	±25.4	300	±25.4	Straight
All Internal	4745	±25.4	200	±25.4	4440	±25.4	300	±25.4	Straight
Note: All measurements in Millimeters (mm).									

Table 130-E. Cable Specifications, ISS PMA 1 Cable Harness Pigtails

CONN	LENGTH	TOL.	OVERWRP	TOL.	SHIELD	TOL.	GND W	TOL.	Backshell Config.
X69	See Figure 130-H								Straight
X74	See Figure 130-H								Straight
X75	See Figure 130-H								Straight
X76	5855	±25.4	200	±25.4	5550	±25.4	300	±25.4	90° twd PMA
X77	5855	±25.4	200	±25.4	5550	±25.4	300	±25.4	90° twd PMA
X106	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Capped
X107	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Capped
All Others (External)	5855	±25.4	200	±25.4	5550	±25.4	300	±25.4	Straight
All Others (Internal)	4745	±25.4	200	±25.4	4440	±25.4	300	±25.4	Straight
Note: All measurements in Millimeters (mm).									

Table 130-F.

Cable Set Contents

Cable Set	Individual Cables
SLIYu 374511.010	SLIYu.685611.129 SLIYu.685611.130 SLIYu.685611.131 SLIYu.685611.132 SLIYu.685611.133 SLIYu.685611.134 SLIYu.685611.135 SLIYu.685611.136 SLIYu.685611.137 SLIYu.685612.010 SLIYu.685612.011 SLIYu.685612.012 SLIYu.685611.201
SLIYu 374511.011	SLIYu.685611.150 SLIYu.685611.151
SLIYu 374511.018	SLIYu.685611.216 SLIYu.685611.217 SLIYu.685611.218 SLIYu.685611.219 SLIYu.685611.220 SLIYu.685611.221 SLIYu.685611.222 SLIYu.685611.223 SLIYu.685611.224 SLIYu.685611.225 SLIYu.685611.226 SLIYu.685611.227 SLIYu.685611.228 SLIYu.685611.229 SLIYu.685611.230

Table 130-F.

Cable Set Contents

Cable Set	Individual Cables
SLIYu 374511.018 (cont.)	SLIYu.685611.231
	SLIYu.685611.232
	SLIYu.685611.233
	SLIYu.685611.234
	SLIYu.685611.235
	SLIYu.685611.236
	SLIYu.685611.237
	SLIYu.685611.238
	SLIYu.685611.239
	SLIYu.685611.240
	SLIYu.685611.241
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	SLIYu.685611.251
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	SLIYu.685611.253
	SLIYu.685611.254
	SLIYu.685611.255
	SLIYu.685611.256
	SLIYu.685611.257
	SLIYu.685611.258
	SLIYu.685611.259
	SLIYu.685611.260
	SLIYu.685611.261
	SLIYu.685611.262

Table 130-F.

Cable Set Contents

Cable Set	Individual Cables
SLIYu 374511.018 (cont.)	SLIYu.685611.263 SLIYu.685611.264 SLIYu.685611.265 SLIYu.685611.266 SLIYu.685611.267 SLIYu.685611.268 SLIYu.685615.005 SLIYu.685615.006 SLIYu.685615.015 SLIYu.685615.016
SLIYu 374511.019	SLIYu.685611.269 SLIYu.685611.270 SLIYu.685611.271 SLIYu.685611.272 SLIYu.685611.273 SLIYu.685611.274 SLIYu.685611.275 SLIYu.685611.276 SLIYu.685611.277 SLIYu.685611.278 SLIYu.685611.279 SLIYu.685611.280 SLIYu.685611.281 SLIYu.685611.282 SLIYu.685611.283 SLIYu.685611.284 SLIYu.685611.285 SLIYu.685611.286 SLIYu.685611.287 SLIYu.685611.288

Table 130-F.

Cable Set Contents

Cable Set	Individual Cables
SLIYu 374511.019 (cont.)	SLIYu.685611.289
	SLIYu.685611.290
	SLIYu.685611.291
	SLIYu.685611.292
	SLIYu.685611.293
	SLIYu.685611.294
	SLIYu.685611.295
	SLIYu.685611.296
	SLIYu.685611.297
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	SLIYu.685611.314
	SLIYu.685611.315
	SLIYu.685611.316
	SLIYu.685611.317
	SLIYu.685611.318
	SLIYu.685611.319
	SLIYu.685611.320

Table 130-F.

Cable Set Contents

Cable Set	Individual Cables
SLIYu 374511.019 (cont.)	SLIYu.685611.321 SLIYu.685613.008 SLIYu.685613.009 SLIYu.685613.011 SLIYu.685613.012 SLIYu.685613.013 SLIYu.685613.014
SLIYu 374511.020	SLIYu.685611.334 SLIYu.685611.335 SLIYu.685611.338 SLIYu.685611.339 SLIYu.685611.340 SLIYu.685611.341 SLIYu.685611.342 SLIYu.685611.343 SLIYu.685611.344 SLIYu.685611.345 SLIYu.685611.346 SLIYu.685611.347 SLIYu.685611.348 SLIYu.685611.349 SLIYu.685611.350
SLIYu 374511.021	SLIYu.685611.351 SLIYu.685611.352 SLIYu.685611.353 SLIYu.685611.354 SLIYu.685611.355 SLIYu.685611.355 SLIYu.685611.356 SLIYu.685611.357

Table 130-F.
Cable Set Contents

Cable Set	Individual Cables
SLIYu 374511.021 (cont.)	SLIYu.685611.358
	SLIYu.685611.359
	SLIYu.685611.360
	SLIYu.685611.361
	SLIYu.685611.362
	SLIYu.685611.363
	SLIYu.685611.364
	SLIYu.685611.366
	SLIYu.685611.367
	SLIYu.685611.368
	SLIYu.685611.371
	SLIYu.685611.372
	SLIYu.685615.007
	SLIYu.685615.008
	S_LIYu.685615.009
	SLIYu.685615.010

Table 130-H. Circuit Types

Frequency of Rise and/or Fall Time	Source Impedance (ohms)	Load Impedance (ohms)	Voltage or Sensitivity	Circuit Classification	Wire Type Required	Shield Grouping Required
Analog, Alternating or Direct Current	<100	100-600K	>100mv to ≤6v	ML	TWS	SPG**
		0-200	>6v to ≤40v	HO	TW	NONE
		0-200	>40v	EO	TW	NONE
	≤2.5K	100-600K	≤100mv	ML	TWS	SPG
		>600K			TWDS	SPG
	<100	≥200	>100mv to ≤6v	ML	TWS	SPG
		≥200	>6v to ≤40v	HO	TW	NONE
		≥200	>40v	EO	TW	NONE
≤50 KHz or Rise and Fall Time >10 Microseconds	<100	≥1000	≤6v	ML	TWS	SPG*
		0-200	>6v to ≤40v	HO	TW	NONE
		0-200	>40v	EO	TW	NONE
	≤2.5K	100-600K	≤100mv	ML	TWS	SPG
		>600K			TWDS	SPG
	≥200	>200	>100mv to ≤6v	ML	TWS	SPG
		>200	>6v to ≤40v	HO	TW	NONE
		>200	>40v	EO	TW	NONE
≤50 KHz or Rise and Fall Time <10 Microseconds	ALL	ALL	≤100mv	RF	TWDS*	MPG
		ALL	≤100mv to ≤6v	RF	TWS*	MPG
		<1000	>6v	RF	TWS*	MPG
		>1000			TWDS	MPG
	ALL	ALL	ALL	RF		MPG
TV Video				RF		MPGxxx

Note: This table does not describe those wire types which are permitted to use structure for the circuit return with the exception of the circuit types listed below:

<u>Primary DC Power</u>. A return shall accompany each 28v input wire to individual LRU loads in the distribution of power from the various power control assemblies or panels. Use of vehicle structure as a return path shall be prohibited in the crew module; aft avionics bays, and detachable modules.

<u>Discretes, 28v Single-Ended</u>. Hi-level discretes circuits operating remote power controllers, remote controlled circuit breakers and load control drivers may utilize the 28v power returns in lieu of a wire return path. A return wire path shall be required for flight-critical control functions and in sensitive laod areas, i.e., valves, relays, and etc.

* If the capacitance per foot is critical, controlled impedance wiring should be used.
** If circuit is balanced by transformer, differential, or optical isolation, the shield shall be multipoint grounded to structure.
xxx Distance between shield grounds shall not exceed 18 meters.

<u>Symbols Used</u>

Khz	- Kilohertz	TWDS	- Twisted double shielded	<	- less than
mv	- Millivolts	RF	- Radio frequency	≤	- Less than or equal to
SPG	- Single point ground	TWS	- Twisted shielded	>	- Greater than
MPG	- Multiple point ground	AF	- Audio frequency	≥	- Greater than or equal to
TW	- Twisted				

Table 130-I. Edge-to-Edge Bundle-Separation Requirements

Bundle	Routed Parallel to Bundle	Separation (in inches for parallel runs of D (feet))			
		1' > D	1' ≤ D < 3'	3' ≤ D < 5'	D ≥ 5'
ML	HO	0	1.0	20.0	4.0
	EO	0	1.5	3.0	6.0
	RF	0	2.5	5.0	10.0
HO	EO	0	0.5	1.0	2.0
	RF	0	1.5	2.0	4.0
EO	RF	0	1.0	2.0	4.0

Appendix XIV

140. Androgynous Peripheral Docking System (APDS) Switching System

140.1 SCOPE

This appendix defines the requirements for performance, configuration, design development, and verification of the APDS Switching System, referred to herein as the Switching System (SS). This system is to be used in conjunction with the ISS Node 1, which will be a Orbiter payload and will be connected to the ISS using the Orbiter APDS.

140.2 APPLICABLE DOCUMENTS

N/A

140.3 REQUIREMENTS

The requirements of Section 3 of the basic specification apply, except as follows:

140.3.1 Item Definition

The APDS Switching System consists of the Connector Switch Box (CSB), and unique Avionics cables. This hardware along with other hardware built and delivered in accordance with this specification will provide the capability to control a second active APDA (except for pyro bolts) which is electrically connected to the interfacing connectors. The APDA controlled through the standard connectors shall be referred to as the Orbiter actice APDA (-6001). The active APDA controlled through the interface connectors shall be referred to as the ISS active APDA (-7001). The passive APDA which mates to the -6001 and provides electrical connection to -7001 shall be referred to as ISS passive APDA (-8001).

140.3.1.1 Item Diagram

A simplified diagram of the switching system indicating the functional distribution is shown in Figure 140-A. In the diagram, the SS functions are shown distributed among the -6001, CSB, and Orbiter D&C panel.

140.3.1.2 Interface Definition

The switching system shall be designed to meet the interface requirements shown in Figure 110-A.

140.3.1.2.1 Electrical Power Characteristics

Paragraphs 3.1.2.1 through 3.1.2.1.8.8 of the basic specification apply.

140.3.1.2.1.2 Cold Mating, Demating, and Switching

Power will be removed from the interface cables a) before connectors are mated and demated during docking and undocking, and b) before the switching mechanism is actuated.

140.3.1.2.2 Mechanical Interface.

140.3.1.2.2.1 CSB Mechanical Interface

Provisions for mounting the CSB shall be as shown in Figures 140-C, 140-D, and 140-E.

140.3.1.2.3 Connector Location and Pin Function Assignments.

140.3.1.2.3.1 CSB Connector Location and Pin Function Assignments

The CSB shall have connectors located as shown in Figure 140-D. The CSB pin-function assignments are specified in Tables 140-C, and 140-D.

140.3.1.2.4 Signal Interface Definition. Paragraph 3.1.2.6 of the basic specification apply.

140.3.1.2.4.1.3 CSB Signals.

140.3.1.2.4.1.3.1 CSB Discrete Signals

TBD

140.3.1.2.4.1.3.2 CSB Power Signals

TBD

140.3.1.2.5 Cooling

The CSB shall be passively cooled.

140.3.1.3 Item Identification

The Switching System equipment shall be identified as follows:

Nomenclature	Buyer Control Number MC621-0087	Seller Part Number	Traceability Classification	Maintenance Level
CSB	-0011	SLIYu.642522.001	Ts	LRU

140.3.1.3.1 Cable Set Identification

All cables shall be permanently marked with the Seller's part number and serial number. Each connector reference designator shall be permanently marked on the cable in a location close to the respective connector. In addition, the cables shall have the connector and pin number where each wire is terminated permanently marked on each individual pigtail wire. Buyer part number marking on cables is not required. CSB cable sets are included in the Orbiter cable sets identified in Appendix XIII.

140.3.2 Characteristics.

140.3.2.1 Performance Characteristics

The Switching System shall provide the means to control the -7001 when the -6001 is electrically connected to X3 and X4 of -8001.

140.3.2.1.1 Life.

140.3.2.1.1.1 CSB Life.

140.3.2.1.1.1.1 Operating Life

The CSB shall be capable of performing all operations specified herein for a minimum of 30 switching cycles in space without maintenance. A switching cycle is defined as a complete switching from the Orbiter position to the ISS position and then from the ISS position to the Orbiter position.

140.3.2.1.1.1.2 Service Life. The CSB shall have a functional design life, as follows:

Vacuum cycles:	100
Total cycles:	100

The average orbital mission will be 7 days; the design, however, shall not preclude an orbital stay time up to 30 days.

140.3.2.1.1.2 Cable Life Requirements.

CSB cable life shall be in accordance with the requirements of Appendix XIII.

140.3.2.1.2 CSB Performance Requirements.

140.3.2.1.2.1 Mode Switch

The CSB shall respond to 28-volt power signals from a Displays and Controls Panel to transfer docking controls between the Orbiter and the -7001.

140.3.2.1.2.2 Manual Switching

Manual EVA switching shall be provided by use of a lever with a maximum actuation force of 17.6 lbs (8 kgf). The accessible end of the switching-mechanism shaft shall be configured to mate with a standard tool.

140.3.2.1.2.3 Position Monitor Measurements

The CSB shall provide output-signal voltage measurements to indicate the switch positions (Orbiter or ISS) and Motor-Current status. Measurements shall be provided for the Orbiter/ISS position-status indications through "dry contacts." No single measurement failure shall preclude the ability to provide status of Orbiter and ISS positions.

140.3.2.1.2.4 Motor Drive

The CSB shall be capable of switching to either position using a single motor. A redundant motor shall be provided for backup. The power interface to each motor shall be one-fault-tolerant. Dual motor operation is not allowed.

140.3.2.1.2.5 Voltage Drop

The voltage of any individual 28-volt output signal shall be no less than 0.5 volts lower than the input voltage being switched between Orbiter and ISS positions. The voltage of any individual 5-volt output signal shall be no less than 0.1 volts lower than the input voltage being switched between Orbiter and ISS positions.

140.3.2.1.2.6 Heaters

The CSB shall be designed not to require heaters.

140.3.2.1.2.7 Redundant Electrical Circuits. Wiring of redundant systems, subsystems, or major elements of subsystems shall not be routed in the same bundle or through the same connector along with wiring of any other similar system element such that a single connector demate will cause loss of crew. Where such routing is not feasible, the routing shall be identified by color coding and drawings, with the reason for deviation.

140.3.2.1.3 Cable Performance

The interconnecting cables shall provide the means to distribute power, commands, telemetry, and data between the active APDA, CSB, and Orbiter Avionics pallet.

140.3.2.2 Physical Characteristics.

140.3.2.2.1 Envelope.

140.3.2.2.1.1.1 CSB Envelope

The envelope of the CSB shall not exceed the dimensions shown in Figures 140-C and 140-D.

140.3.2.2.1.1.2 Cable Envelopes

The envelope of the each individual cable of the MC621-0087-0507 cable set shall meet the dimensions shown in Figure 140-F.

140.3.2.2.2 Weight.

140.3.2.2.2.1 CSB Weight

The weight of the CSB shall not exceed 66.1 pounds (30 kg).

140.3.2.2.2.2 Cable Weights

The sum total of all MC621-0087-0507 cable weights shall not exceed 50 pounds (22.7 kg).

140.3.2.3 Reliability

The requirements of 3.2.3.1 through 3.2.3.2 of the basic specification apply.

140.3.2.4 Maintainability

TBD

140.3.2.5 Environments.

140.3.2.5.1 Operating

The CSB and cables shall meet the requirements of 3.2.5.1.3 of the basic specification.

140.3.2.5.2 Non operating

The CSB and cables shall meet the requirements of 3.2.5.2.3 of the basic specification.

140.3.2.6 Transportability. The requirements of 3.2.6 of the basic specification apply.

140.3.3 Design and Construction. The requirements of 3.3 of the basic specification apply except where superseded herein.

140.3.3.1 Materials, Processes, and Parts.

140.3.3.1.1 Materials and Processes

The requirements of 3.3.1.1 of the basic specification apply.

140.3.3.2 Electromagnetic Compatibility and Electrical Design.

140.3.3.2.1 Electromagnetic Compatibility

The requirements of 3.3.3.1 through 3.3.3.1.1.9 of the basic specification apply.

140.3.3.2.2 Electrical Design Requirements.

140.3.3.2.2.1.1 CSB Power Consumption. The CSB shall consume no more than 30 watts.

140.4 QUALITY ASSURANCE PROVISIONS

140.4.1 General Requirements

The requirements of 4.1 through 4.2.5 of the basic specification apply.

140.4.2 Quality Conformance.

140.4.2.1 Development

The requirements of 4.2.1 of the basic specification apply.

140.4.2.2 Acceptance

Acceptance tests and inspections shall be performed on the CSB, to be employed on the units delivered to the Buyer. The minimum number of tests and inspections, and the sequence thereof, shall be as shown in Table 140-A. The Seller shall perform any other test deemed necessary, subject to approval of the Buyer.

140.4.2.2.1 Examination of Product

The requirements of 4.2.2.1 of the basic specification apply.

140.4.2.2.2 Functional and Performance Tests

The requirements of 4.2.2.2 of the basic specification apply.

140.4.2.2.2.1 Insulation Resistance Test

The requirements of 4.2.2.2.1 of the basic specification apply.

140.4.2.2.2.2 Dielectric Strength Test

The requirements of 4.2.2.2.2 of the basic specification apply.

Table 140-A. CSB Acceptance Requirements

Inspection & Test	Paragraph Listed in Recommended Sequence
Examination of Product	140.4.2.2.1
Functional & Performance Test	140.4.2.2.2
Insulation Resistance Test	140.4.2.2.2.1
Dielectric Strength Test	140.4.2.2.2.2
Acceptance Vibration Test	140.4.2.2.3
Acceptance Thermal Test	140.4.2.2.4
Functional & Performance Recheck	140.4.2.2.1

140.4.2.2.3 Acceptance Vibration Test (AVT)

The requirements of 4.2.2.3 of the basic specification apply.

140.4.2.2.4 Acceptance Thermal Test (ATT)

The requirements in 4.2.2.4 of the basic specification apply, except that the CSB shall be exposed to the maximum and minimum operating temperatures for a duration of not less than 3 hours. Rate of change shall not exceed 240°F (133.3°C) per hour, nor be less than 60°F (33.3°C) per hour. The thermal exposure may be performed by cycling from one extreme to the other, or by separate tests with a performance test between exposures.

140.4.2.3 Assessment

The requirements of 4.2.3 of the basic specification apply.

140.4.2.3.1 Reliability

The requirements of 4.2.3.1 of the basic specification apply.

140.4.2.3.2 Materials and Processes

The requirements of 4.2.3.2 of the basic specification apply.

140.4.2.3.3 Parts Standardization

The requirements of 4.2.3.3 of the basic specification apply.

140.4.2.3.4 Electrical Design Requirements

The requirements of 4.2.3.4 of the basic specification apply.

140.4.2.3.5 Interchangeability

The requirements of 4.2.3.5 of the basic specification apply.

140.4.2.3.6 Human Performance/Human Engineering

The requirements of 4.2.3.6 of the basic specification apply.

140.4.2.3.7 Safety

The requirements of 4.2.3.7 of the basic specification apply.

140.4.2.3.8 Identification and Marking

The requirements of 4.2.3.8 of the basic specification apply.

140.4.2.4 Certification

The requirements of 4.2.4 of the basic specification apply.

140.4.2.4.1 Qualification Tests

Qualification testing performed to satisfy the requirements in the performance and design verification matrix of Section 4, Table V of the basic specification shall be in conformance with the requirements of this paragraph. Qualification test specimens shall be subjected to the tests specified in Table 140-B.

Table 140-B. CSB Qualification Requirements

Inspection and Test	Paragraph
Acceptance Test	140.4.2.2
Performance Test	140.4.2.4.1.2
Transportation Test	140.4.2.4.1.11
Power Test	140.4.2.4.1.7
Vibration	140.4.2.4.1.4
Shock	140.4.2.4.1.6
Acceleration	140.4.2.4.1.5
Thermal Vacuum Test	140.4.2.4.1.10
Qualification Humidity Test	140.4.2.4.1.3
*EMC Test	140.4.2.4.1.9
Final Performance Test	140.4.2.4.1.2

*Test and analysis will be conducted and documented by Buyer.

140.4.2.4.1.1 Test Hardware

Qualification test hardware shall be of the same configuration as flight hardware.

140.4.2.4.1.2 Performance Requirements

The requirements of 4.2.4.1.2 of the basic specification apply.

140.4.2.4.1.3 Qualification Humidity Test

The requirements of 4.2.4.1.3 of the basic specification apply.

140.4.2.4.1.4 Vibration.

140.4.2.4.1.4.1 Qualification-Acceptance Vibration Test (QAVT)

The requirements of 4.2.4.1.4.1 of the basic specification apply.

140.4.2.4.1.5 Acceleration

The requirements of 4.2.4.1.5 of the basic specification apply.

140.4.2.4.1.6 Shock

The requirements of 4.2.4.1.6 of the basic specification apply.

140.4.2.4.1.7 Power Test

The requirements of 4.2.4.1.7 of the basic specification apply. Power tests may be part of the Functional/Performance tests.

140.4.2.4.1.8 Lightning

The requirements of 4.2.4.2.12 of the basic specification apply.

140.4.2.4.1.9 Electromagnetic Compatibility Tests

The requirements of 4.2.4.1.9 of the basic specification apply.

140.4.2.4.1.10 Thermal Vacuum Test

The requirements of 4.2.4.1.10 of the basic specification apply.

140.4.2.4.1.11 Transportation Test

The requirements of 4.2.4.1.11 of the basic specification apply.

140.4.2.4.2 Certification By Analysis

The requirements of 4.2.4.2 of the basic specification apply.

140.4.2.4.2.1 Storage/Operating Life

The requirements of 4.2.4.2.1 of the basic specification apply.

140.4.2.4.2.2 Physical Characteristics

The requirements of 4.2.4.2.2 of the basic specification apply.

140.4.2.4.2.3 Reliability

The requirements of 4.2.4.2.3 of the basic specification apply.

140.4.2.4.2.4 Salt Fog

The requirements of 4.2.4.2.4 of the basic specification apply.

140.4.2.4.2.5 Ozone

The requirements of 4.2.4.2.5 of the basic specification apply.

140.4.2.4.2.6 Fungus

The requirements of 4.2.4.2.6 of the basic specification apply.

140.4.2.4.2.7 Materials and Processes

The requirements of 4.2.4.2.7 of the basic specification apply.

140.4.2.4.2.8 Electromagnetic Compatibility

The requirements of 4.2.4.2.8 of the basic specification apply.

140.4.2.4.2.9 Electrical Design Requirements

The requirements of 4.2.4.2.9 of the basic specification apply.

140.4.2.4.2.10 Safety

The requirements of 4.2.4.2.10 of the basic specification apply.

140.4.2.4.2.11 Sand and Dust

The requirements of 4.2.4.2.11 of the basic specification apply.

140.4.2.4.2.12 Certification By Other Test Data

The requirements of 4.2.4.2.12 of the basic specification apply.

140.4.2.5 Verification Requirements Matrices

The requirements of 4.2.5 of the basic specification apply.

140.5 PREPARATION FOR DELIVERY

140.5.1 General Requirements

The requirements of 5.1 through 5.2.7 of the basic specification apply.

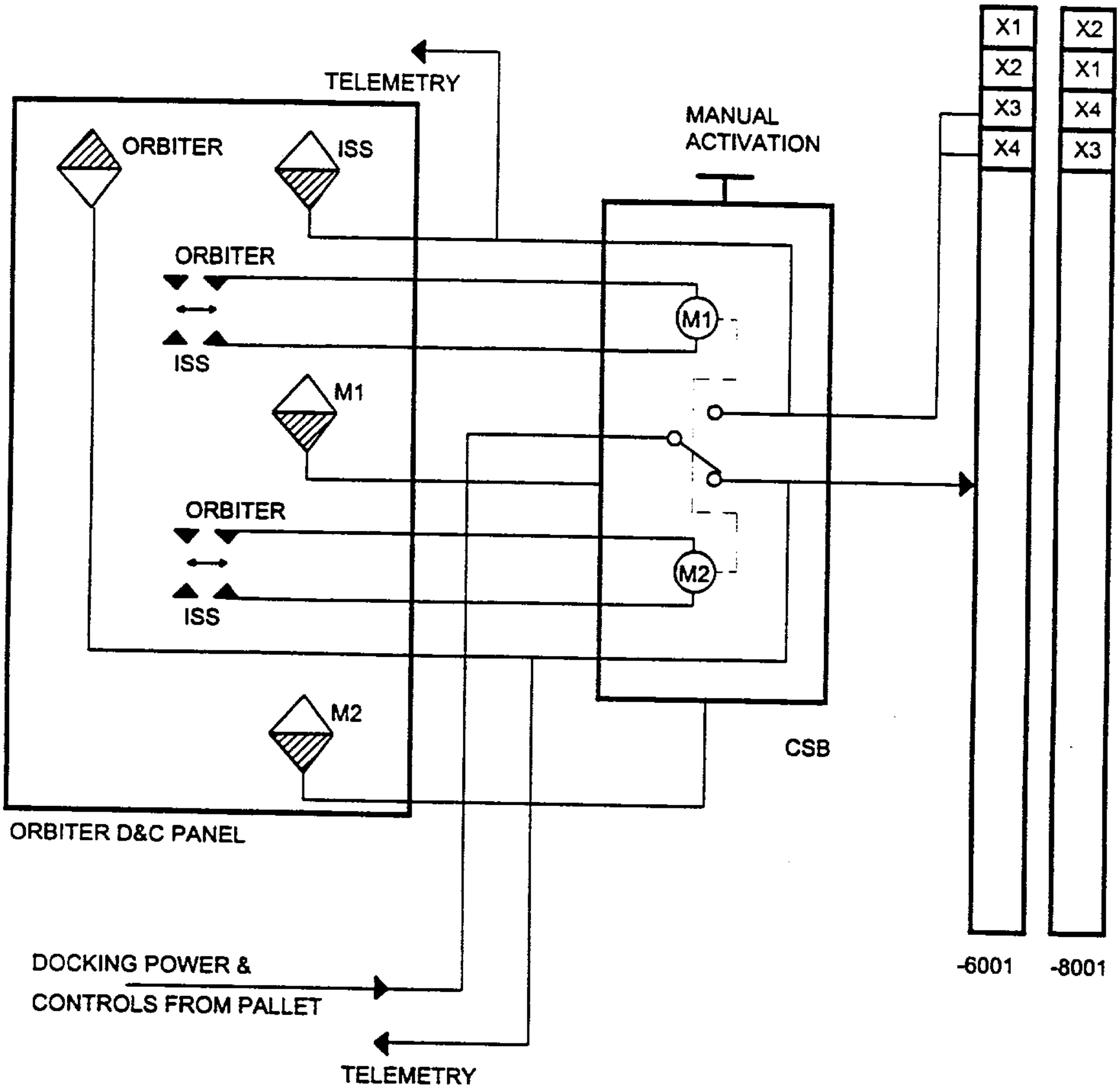
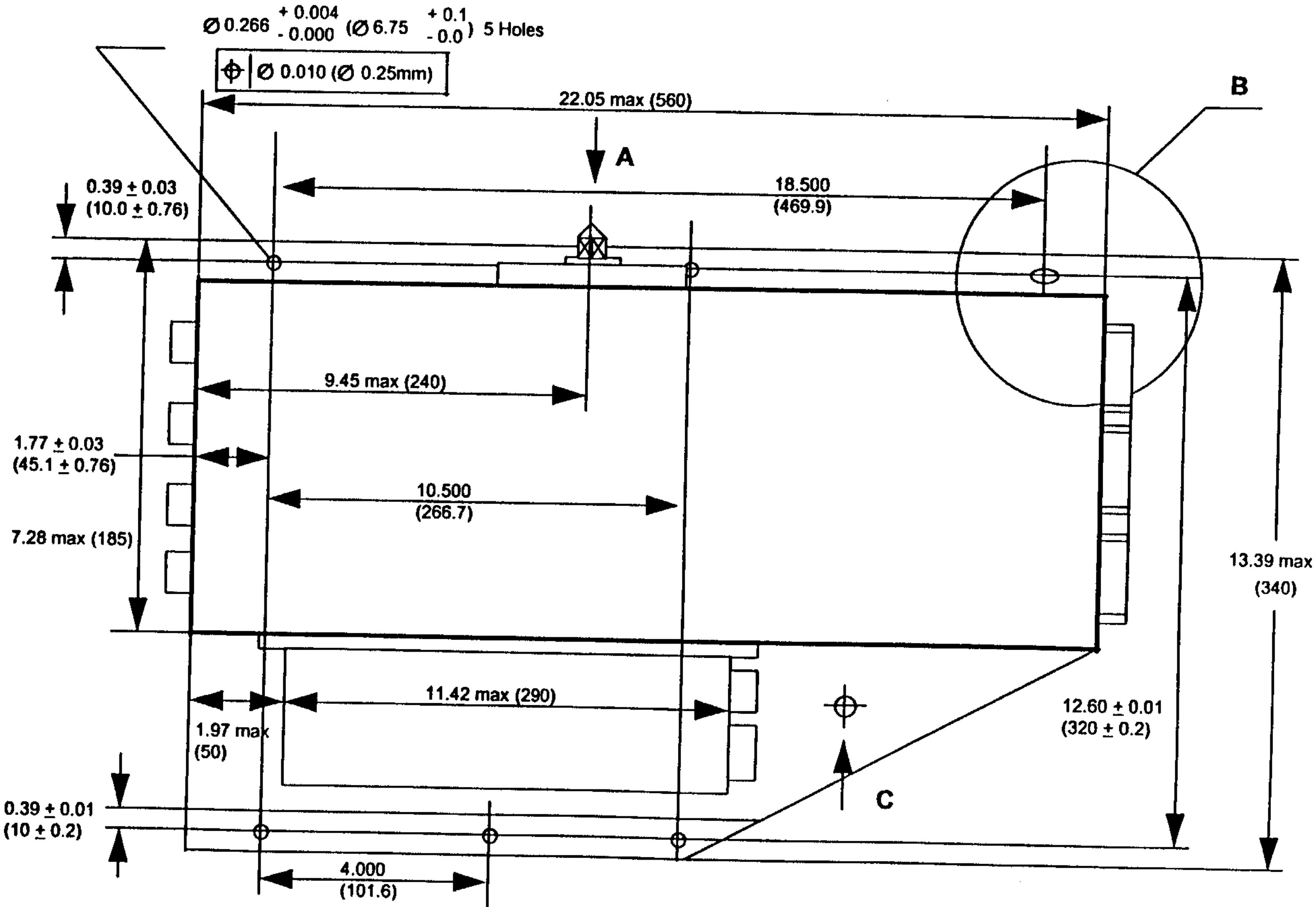


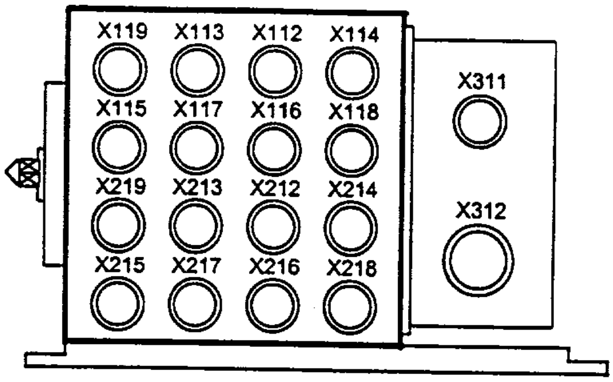
Figure 140-A. Switching System Functional Diagram

Figure 140-B. Deleted



Note: All measurements are in inches with millimeters in parenthesis.

Figure 140-C. Connector Switching Box Mounting and Envelope Configuration



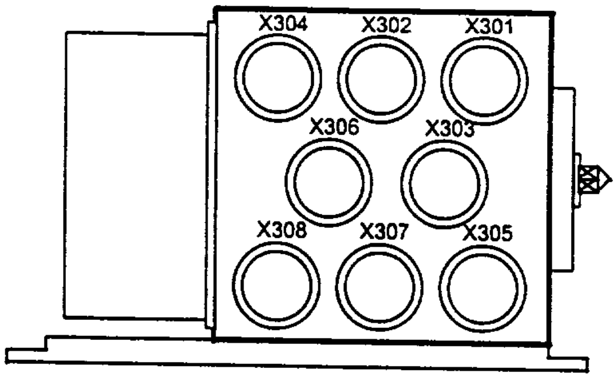
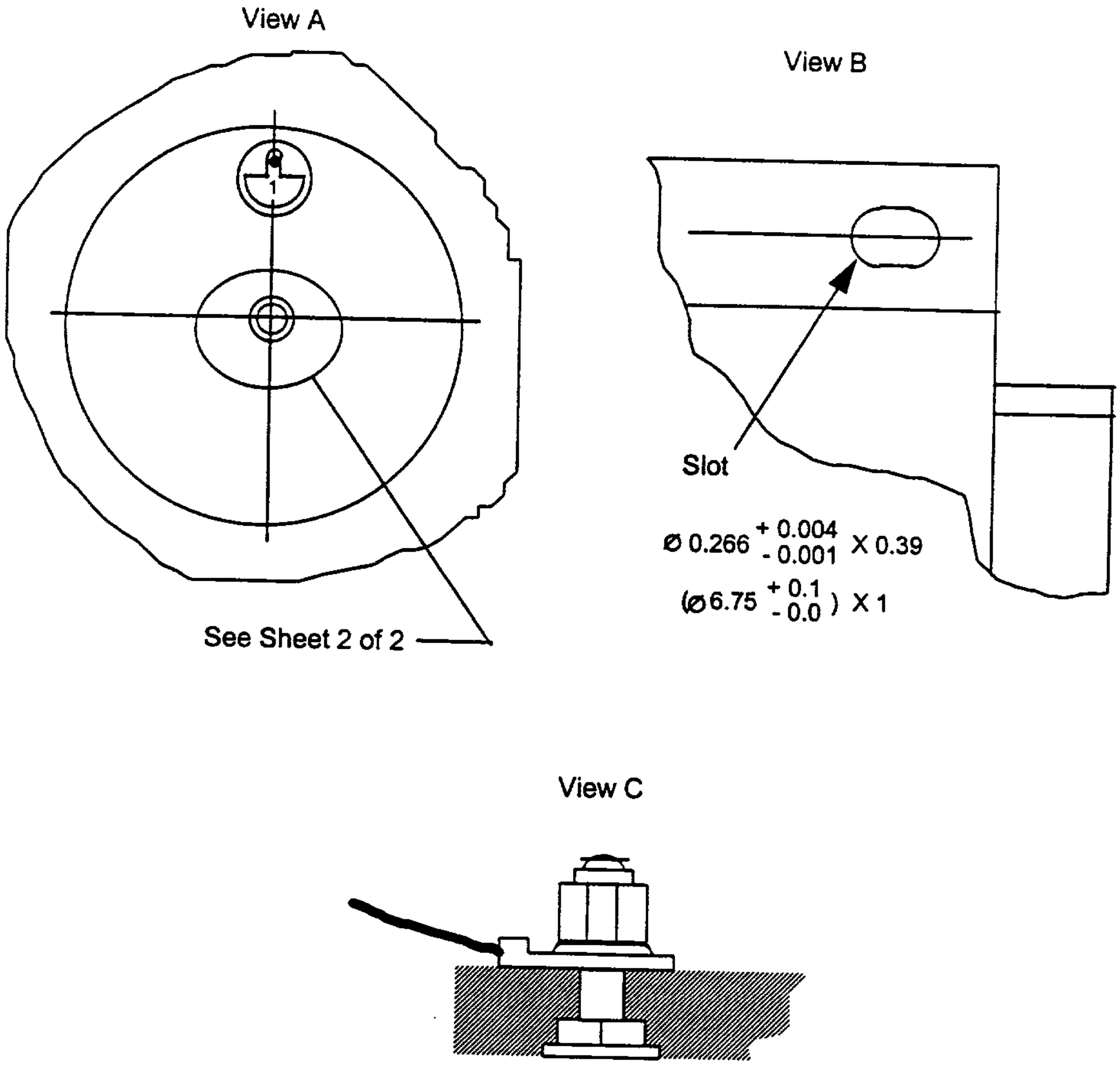
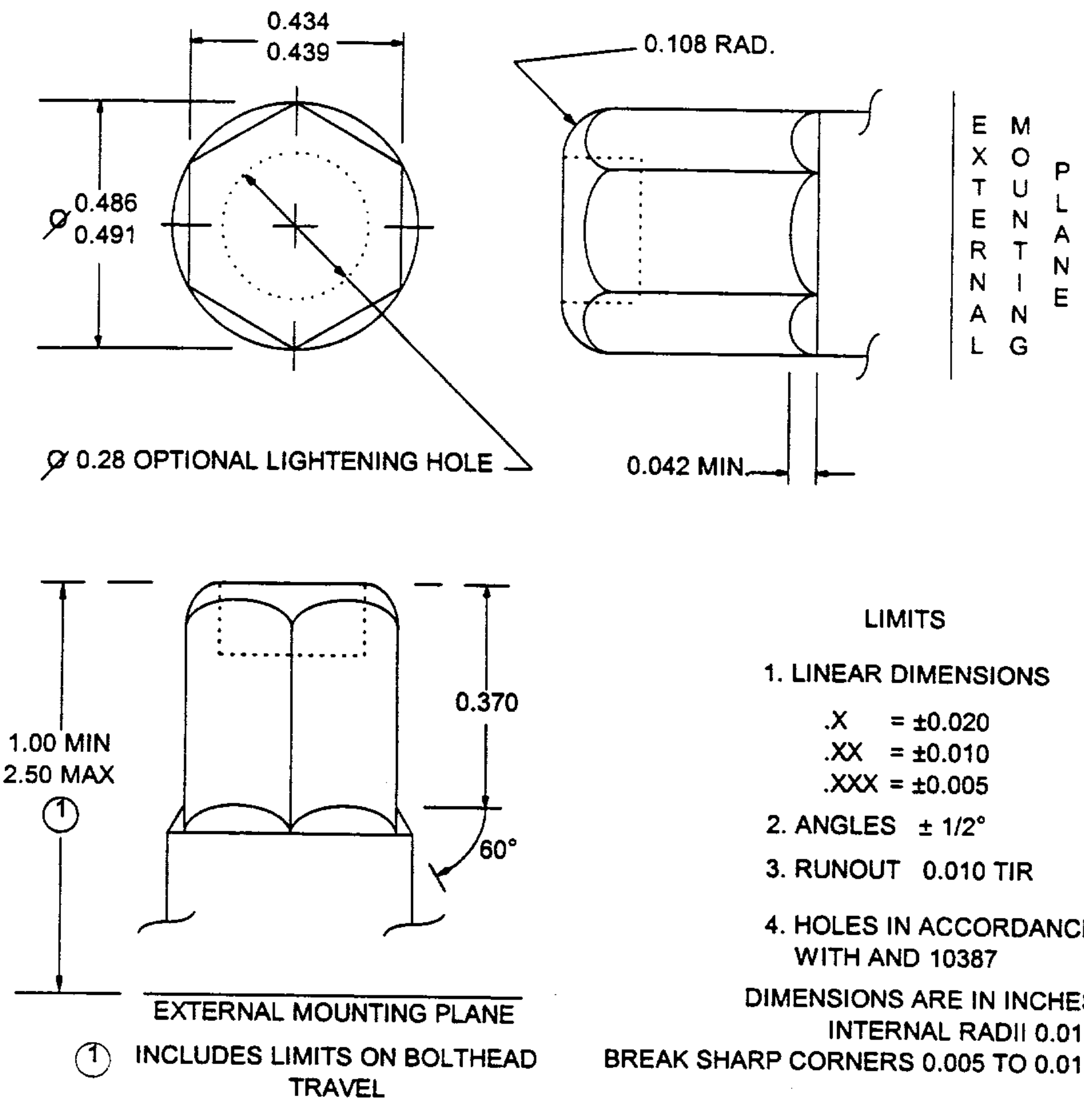


Figure 140-D. CSB Connector Locations



Note: All measurements are in inches with millimeters in parenthesis.

Figure 140-E, Sheet 1 of 2. Connector Switching Box Mounting



LIMITS

1. LINEAR DIMENSIONS

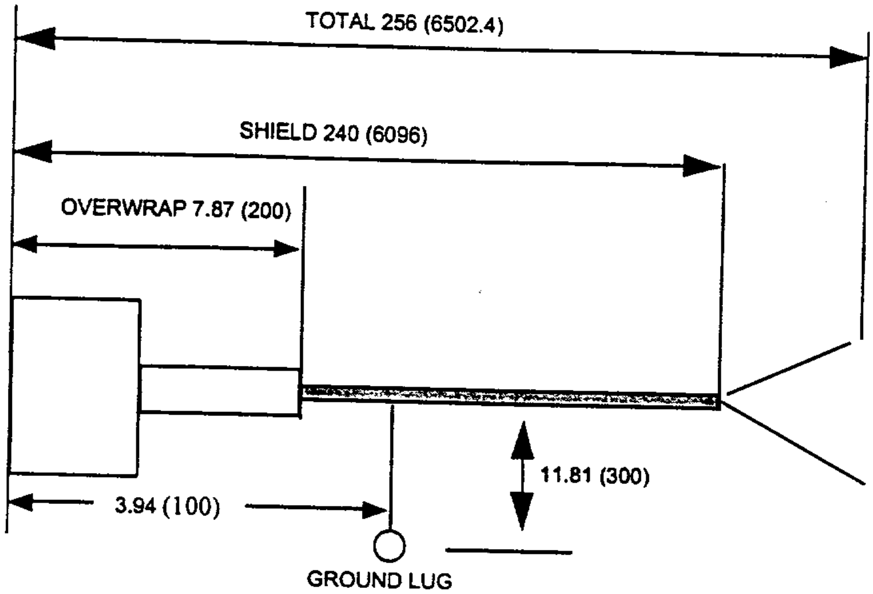
   .X = ±0.020
   .XX = ±0.010
   .XXX = ±0.005

2. ANGLES ± 1/2°
3. RUNOUT 0.010 TIR
4. HOLES IN ACCORDANCE WITH AND 10387

DIMENSIONS ARE IN INCHES
INTERNAL RADII 0.01
BREAK SHARP CORNERS 0.005 TO 0.015

Figure140-E, Sheet 2 of 2. Connector Switching Box Mounting;

7/16-inch Hexagonal EVA-Compatible Bolt



Note: All measurements are in inches with millimeters in parenthesis.

Figure 140-F. Cable Envelope

Table 140-C. Connector Switch Box Switched Docking Functions

Switch Box to Pallet Conn	Pin	Russ Wire Size (mm²)	Shd	Switch Box to ODM (-3002) Conn	Pin	Russ Wire Size (mm²)	ODM (-3002) Conn	Pin	Russ Wire Size (mm²)	Shd	Switch Box to Node 1 (ISS) Conn	Pin	Russ Wire Size (mm²)	Russian Mech Disc Panel Conn	Pin	X3 Pin	X4 Pin	Russ Wire Size (mm²)	Shd	Functions
X304	5	0.35		X114	5	0.35	X68	3	0.35		X214	5	0.35	X92	20		112	0.35		DOCK MECH HEATER (H1-1 +)
X304	23	0.35		X114	23	0.35	X68	48	0.35		X214	23	0.35	X92	21		104	0.35		DOCK MECH HEATER (H1-1 -)
X303	5	0.35		X113	5	0.35	X68	1	0.35		X213	5	0.35	X96	20	89		0.35		DOCK MECH HEATER (H1-2 +)
X303	23	0.35		X113	23	0.35	X68	50	0.35		X213	23	0.35	X96	21	85		0.35		DOCK MECH HEATER (H1-2 -)
X304	6	0.35		X114	6	0.35	X68	9	0.35		X214	6	0.35	X92	22		116	0.35		DOCK MECH HEATER (H1-3 +)
X304	24	0.35		X114	24	0.35	X68	41	0.35		X214	24	0.35	X92	23		110	0.35		DOCK MECH HEATER (H1-3 -)
X303	6	0.35		X113	6	0.35	X68	7	0.35		X213	6	0.35	X96	22	92		0.35		DOCK MECH HEATER (H2-1 +)
X303	24	0.35		X113	24	0.35	X68	44	0.35		X213	24	0.35	X96	23	88		0.35		DOCK MECH HEATER (H2-1 -)
X304	11	0.35		X114	11	0.35	X68	5	0.35		X214	11	0.35	X92	26		113	0.35		DOCK MECH HEATER (H2-2 +)
X304	25	0.35		X114	25	0.35	X68	46	0.35		X214	25	0.35	X92	27		105	0.35		DOCK MECH HEATER (H2-2 -)
X304	12	0.35		X114	12	0.35	X68	17	0.35		X214	12	0.35	X92	28		114	0.35		DOCK MECH HEATER (H2-3 +)
X304	32	0.35		X114	32	0.35	X68	34	0.35		X214	32	0.35	X92	29		106	0.35		DOCK MECH HEATER (H2-3 -)
X304	13	0.35		X114	13	0.35	X68	13	0.35		X214	13	0.35	X92	30		117	0.35		DOCK MECH HEATER (H3-1 +)
X304	33	0.35		X114	33	0.35	X68	38	0.35		X214	33	0.35	X92	31		111	0.35		DOCK MECH HEATER (H3-1 -)
X303	11	0.35		X113	11	0.35	X68	11	0.35		X213	11	0.35	X96	26	91		0.35		DOCK MECH HEATER (H3-2 +)
X303	25	0.35		X113	25	0.35	X68	40	0.35		X213	25	0.35	X96	27	87		0.35		DOCK MECH HEATER (H3-2 -)
X303	12	0.35		X113	12	0.35	X68	24	0.35		X213	12	0.35	X96	28	90		0.35		DOCK MECH HEATER (H3-3 +)
X303	32	0.35		X113	32	0.35	X68	26	0.35		X213	32	0.35	X96	29	86		0.35		DOCK MECH HEATER (H3-3 -)
X306	34	0.35		X116	34	0.35	X74	16	0.2		X216	34	0.35	X92	13		57	0.35		RING ALIGNED
X305	34	0.35		X115	34	0.35	X74	24	0.2		X215	34	0.35	X96	13	40		0.35		RING ALIGNED
X306	35	0.35		X116	35	0.35	X74	25	0.2		X216	35	0.35	X92	14		58	0.35		INITIAL CONTACT
X305	35	0.35		X115	35	0.35	X74	12	0.2		X215	35	0.35	X96	14	41		0.35		INITIAL CONTACT
X306	36	0.35		X116	36	0.35	X74	32	0.35		X216	36	0.35	X92	18		56	0.35		CAPTURE (SHORT)
X305	36	0.35		X115	36	0.35	X74	47	0.35		X215	36	0.35	X96	18	39		0.35		CAPTURE (SHORT)
X306	37	0.35		X116	37	0.35	X74	36	0.2		X216	37	0.35	X92	19		55	0.35		CAPTURE (LONG)
X305	37	0.35		X115	37	0.35	X74	13	0.2		X215	37	0.35	X96	19	38		0.35		CAPTURE (LONG)

Table 140-C. Connector Switch Box Switched Docking Functions (continued)

Switch Box to Pallet		Russ Wire Size		Switch Box to ODM (-3002)		Russ Wire Size	ODM (-3002)		Russ Wire Size		Switch Box to Node 1 (ISS)		Russ Wire Size	Russian Mech Disc Panel		X3	X4	Russ Wire Size		
Conn	Pin	(mm²)	Shd	Conn	Pin	(mm²)	Conn	Pin	(mm²)	Shd	Conn	Pin	(mm²)	Conn	Pin	Pin	Pin	(mm²)	Shd	Functions
X306	26	0.35		X116	26	0.35	X75	10	0.35		X216	26	0.35	X92	1		23	0.35		PWR SUP TO RING MTR (M4)
X306	27	0.35		X116	27	0.35	X75	4	0.35		X216	27	0.35	X92	2		24	0.35		PWR SUP TO RING MTR (M4)
X306	29	0.35		X116	29	0.35	X75	41	0.35		X216	29	0.35	X92	47		5	0.35		PWR SUP TO RING MTR (M4)
X306	30	0.35		X116	30	0.35	X75	50	0.35		X216	30	0.35	X92	48		11	0.35		PWR SUP TO RING MTR (M4)
X305	27	0.35		X115	27	0.35	X75	7	0.35		X215	27	0.35	X96	2	24		0.35		PWR SUP TO RING MTR (M5)
X305	26	0.35		X115	26	0.35	X75	8	0.35		X215	26	0.35	X96	1	23		0.35		PWR SUP TO RING MTR (M5)
X305	30	0.35		X115	30	0.35	X75	47	0.35		X215	30	0.35	X96	48	7		0.35		PWR SUP TO RING MTR (M5)
X305	29	0.35		X115	29	0.35	X75	48	0.35		X215	29	0.35	X96	47	6		0.35		PWR SUP TO RING MTR (M5)
X306	38	0.35		X116	38	0.35	X75	35	0.2		X216	38	0.35	X92	24		61	0.35		RING FINAL POSITION
X305	38	0.35		X115	38	0.35	X75	43	0.35		X215	38	0.35	X96	24	44		0.35		RING FINAL POSITION
X305	10	0.35		X115	10	0.35	X75	22	0.35		X215	10	0.35	X96	46	61		0.35		CONTROL SENSOR RETURN
X306	10	0.35		X116	10	0.35	X75	24	0.2		X216	10	0.35	X92	45		77	0.35		CONTROL SENSOR RETURN
X306	17	0.35		X116	17	0.35	X75	25	0.2		X216	17	0.35	X92	46		78	0.35		CONTROL SENSOR RETURN
X306	39	0.35		X116	39	0.35	X69	34	0.35		X216	39	0.35	X92	3		59	0.35		RING INITIAL POSITION
X305	39	0.35		X115	39	0.35	X69	26	0.35		X215	39	0.35	X96	3	42		0.35		RING INITIAL POSITION
X306	40	0.35		X116	40	0.35	X69	27	0.35		X216	40	0.35	X92	4		60	0.35		RING FORWARD POSITION
X305	40	0.35		X115	40	0.35	X69	28	0.35		X215	40	0.35	X96	4	43		0.35		RING FORWARD POSITION
X306	1	0.35		X116	1	0.35	X69	12	0.35		X216	1	0.35	X92	11		53	0.35		CAPTURE LATCHES OPEN IND
X305	1	0.35		X115	1	0.35	X69	11	0.35		X215	1	0.35	X96	11	36		0.35		CAPTURE LATCHES OPEN IND
X306	2	0.35		X116	2	0.35	X69	4	0.35		X216	2	0.35	X92	12		54	0.35		CAPTURE LATCHES CLOS IND
X305	2	0.35		X115	2	0.35	X69	8	0.35		X215	2	0.35	X96	12	37		0.35		CAPTURE LATCHES CLOS IND
X305	9	0.35		X115	9	0.35	X69	35	0.2											CAPTURE LATCHES IND RTN
X306	9	0.35		X116	9	0.35	X69	36	0.2											CAPTURE LATCHES IND RTN
X305	18	0.35		X115	18	0.35	X72	36	0.35		X215	18	0.35	X96	5	2		0.35		P.S. TO CAP LAT MTR (M1) +
X306	18	0.35		X116	18	0.35	X72	35	0.35		X216	18	0.35	X92	5		1	0.35		P.S. TO CAP LAT MTR (M1) +
X305	22	0.35		X115	22	0.35	X72	2	0.2		X215	22	0.35	X96	41	20		0.35		P.S. TO CAP LAT MTR (M1) -
X306	22	0.35		X116	22	0.35	X72	4	0.2		X216	22	0.35	X92	41		17	0.35		P.S. TO CAP LAT MTR (M1)
X306	3	0.35		X116	3	0.35	X72	11	0.35		X216	3	0.35	X92	8		48	0.35		CAPTURE LATCH NO. 1 CLOS

Table 140-C. Connector Switch Box Switched Docking Functions (continued)

Switch Box to Pallet		Russ Wire Size		Switch Box to ODM (-3002)		Russ Wire Size	ODM (-3002)		Russ Wire Size		Switch Box to Node 1 (ISS)		Russ Wire Size	Russian Mech Disc Panel		X3	X4	Russ Wire Size		
Conn	Pin	(mm^2)	Shd	Conn	Pin	(mm^2)	Conn	Pin	(mm^2)	Shd	Conn	Pin	(mm^2)	Conn	Pin	Pin	Pin	(mm^2)	Shd	Functions
X305	3	0.35		X115	3	0.35	X72	25	0.35		X215	3	0.35	X96	8	31		0.35		CAPTURE LATCH NO. 1 CLOS
X306	4	0.35		X116	4	0.35	X72	32	0.35		X216	4	0.35	X92	15		47	0.35		CAPTURE LATCH NO. 1 OPEN
X305	4	0.35		X115	4	0.35	X72	27	0.35		X215	4	0.35	X96	15	30		0.35		CAPTURE LATCH NO. 1 OPEN
X306	19	0.35		X116	19	0.35	X72	43	0.35		X216	19	0.35	X92	6		2	0.35		P.S. TO CAP LAT MTR (M2) +
X305	19	0.35		X115	19	0.35	X72	42	0.35		X215	19	0.35	X96	6	3		0.35		P.S. TO CAP LAT MTR (M2) +
X305	23	0.35		X115	23	0.35	X72	5	0.2		X215	23	0.35	X96	42	21		0.35		P.S. TO CAP LAT MTR (M2) -
X306	23	0.35		X116	23	0.35	X72	1	0.2		X216	23	0.35	X92	42		20	0.35		P.S. TO CAP LAT MTR (M2) -
X306	5	0.35		X116	5	0.35	X72	24	0.35		X216	5	0.35	X92	9		50	0.35		CAPTURE LATCH NO. 2 CLOS
X305	5	0.35		X115	5	0.35	X72	19	0.35		X215	5	0.35	X96	9	33		0.35		CAPTURE LATCH NO. 2 CLOS
X306	6	0.35		X116	6	0.35	X72	26	0.35		X216	6	0.35	X92	16		49	0.35		CAPTURE LATCH NO. 2 OPEN
X305	6	0.35		X115	6	0.35	X72	40	0.35		X215	6	0.35	X96	16	32		0.35		CAPTURE LATCH NO. 2 OPEN
X306	20	0.35		X116	20	0.35	X72	48	0.35		X216	20	0.35	X92	7		3	0.35		P.S. TO CAP LAT MTR (M3) +
X305	20	0.35		X115	20	0.35	X72	47	0.35		X215	20	0.35	X96	7	4		0.35		P.S. TO CAP LAT MTR (M3) +
X305	24	0.35		X115	24	0.35	X72	9	0.2		X215	24	0.35	X96	43	22		0.35		P.S. TO CAP LAT MTR (M3) -
X306	24	0.35		X116	24	0.35	X72	10	0.2		X216	24	0.35	X92	43		21	0.35		P.S. TO CAP LAT MTR (M3) -
X306	7	0.35		X116	7	0.35	X72	18	0.35		X216	7	0.35	X92	10		52	0.35		CAPTURE LATCH NO. 3 CLOS
X305	7	0.35		X115	7	0.35	X72	33	0.35		X215	7	0.35	X96	10	35		0.35		CAPTURE LATCH NO. 3 CLOS
X306	8	0.35		X116	8	0.35	X72	39	0.35		X216	8	0.35	X92	17		51	0.35		CAPTURE LATCH NO. 3 OPEN
X305	8	0.35		X115	8	0.35	X72	34	0.35		X215	8	0.35	X96	17	34		0.35		CAPTURE LATCH NO. 3 OPEN
X302	11	0.35		X112	11	0.35	X76	4	0.35		X212	11	0.35	X93	1		25	0.35		PWR SUP TO M6 GROUP 1 HOOKS
X302	18	0.35		X112	18	0.35	X76	8	0.35		X212	18	0.35	X93	5		67	0.35		PWR SUP TO M6 GROUP 1 HOOKS
X302	16	0.35		X112	16	0.35	X76	1	0.35		X212	16	0.35	X93	47		12	0.35		PWR SUP TO M6 GROUP 1 HOOKS
X302	24	0.35		X112	24	0.35	X76	5	0.35		X212	24	0.35	X93	48		66	0.35		PWR SUP TO M6 GROUP 1 HOOKS
X301	18	0.35		X119	18	0.35	X76	9	0.35		X219	18	0.35	X97	5	50		0.35		PWR SUP TO M7 GROUP 1 HOOKS
X301	11	0.35		X119	11	0.35	X76	10	0.35		X219	11	0.35	X97	1	25		0.35		PWR SUP TO M7 GROUP 1 HOOKS
X301	16	0.35		X119	16	0.35	X76	11	0.35		X219	16	0.35	X97	47	8		0.35		PWR SUP TO M7 GROUP 1 HOOKS
X301	24	0.35		X119	24	0.35	X76	12	0.35		X219	24	0.35	X97	48	49		0.35		PWR SUP TO M7 GROUP 1 HOOKS

Table 140-C. Connector Switch Box Switched Docking Functions (continued)

Switch Box to Pallet		Russ Wire Size		Switch Box to ODM (-3002)		Russ Wire Size	ODM (-3002)		Russ Wire Size		Switch Box to Node 1 (ISS)		Russ Wire Size	Russian Mech Disc Panel		X3	X4	Russ Wire Size		
Conn	Pin	(mm²)	Shd	Conn	Pin	(mm²)	Conn	Pin	(mm²)	Shd	Conn	Pin	(mm²)	Conn	Pin	Pin	Pin	(mm²)	Shd	Functions
X302	8	0.35		X112	8	0.35	X76	6	0.35		X212	8	0.35	X93	7		63	0.35		GROUP 1 HOOKS CLOSED
X301	8	0.35		X119	8	0.35	X76	20	0.35		X219	8	0.35	X97	7	46		0.35		GROUP 1 HOOKS CLOSED
X302	14	0.35		X112	14	0.35	X76	15	0.35		X212	14	0.35	X93	6		62	0.35		GROUP 1 HOOKS OPEN
X301	14	0.35		X119	14	0.35	X76	22	0.35		X219	14	0.35	X97	6	45		0.35		GROUP 1 HOOKS OPEN
X302	26	0.35		X112	26	0.35	X76	24	0.2											GROUP 1 HOOKS CLOSED RETURN
X301	27	0.35		X119	27	0.35	X76	33	0.2											GROUP 1 HOOKS CLOSED RETURN
X302	27	0.35		X112	27	0.35	X76	32	0.2											GROUP 1 HOOKS OPEN RETURN
X301	26	0.35		X119	26	0.35	X76	30	0.2											GROUP 1 HOOKS OPEN RETURN
X304	1	0.35		X114	1	0.35	X70	4	0.35		X214	1	0.35	X93	18		81	0.35		FIXER 1 (+)
X303	1	0.35		X113	1	0.35	X70	2	0.35		X213	1	0.35	X97	18	64		0.35		FIXER 1 (+)
X304	26	0.35		X114	26	0.35	X70	28	0.35		X214	26	0.35	X93	19		82	0.35		FIXER 1 (-)
X303	26	0.35		X113	26	0.35	X70	31	0.35		X213	26	0.35	X97	19	65		0.35		FIXER 1 (-)
X304	34	0.35		X114	34	0.35	X70	46	0.35		X214	34	0.35	X93	20		83	0.35		FIXER 1 (-)
X303	34	0.35		X113	34	0.35	X70	45	0.35		X213	34	0.35	X97	20	66		0.35		FIXER 1 (-)
X304	2	0.35		X114	2	0.35	X70	10	0.35		X214	2	0.35	X93	21		84	0.35		FIXER 2 (+)
X303	2	0.35		X113	2	0.35	X70	9	0.35		X213	2	0.35	X97	21	67		0.35		FIXER 2 (+)
X304	27	0.35		X114	27	0.35	X70	27	0.35		X214	27	0.35	X93	22		85	0.35		FIXER 2 (-)
X303	27	0.35		X113	27	0.35	X70	26	0.35		X213	27	0.35	X97	22	68		0.35		FIXER 2 (-)
X304	35	0.35		X114	35	0.35	X70	50	0.35		X214	35	0.35	X93	23		86	0.35		FIXER 2 (-)
X303	35	0.35		X113	35	0.35	X70	49	0.35		X213	35	0.35	X97	23	69		0.35		FIXER 2 (-)
X304	3	0.35		X114	3	0.35	X70	8	0.35		X214	3	0.35	X93	24		87	0.35		FIXER 3 (+)
X303	3	0.35		X113	3	0.35	X70	14	0.35		X213	3	0.35	X97	24	70		0.35		FIXER 3 (+)
X304	28	0.35		X114	28	0.35	X70	25	0.35		X214	28	0.35	X93	30		88	0.35		FIXER 3 (-)
X303	28	0.35		X113	28	0.35	X70	24	0.35		X213	28	0.35	X97	30	71		0.35		FIXER 3 (-)
X304	36	0.35		X114	36	0.35	X70	44	0.35		X214	36	0.35	X93	31		89	0.35		FIXER 3 (-)
X303	36	0.35		X113	36	0.35	X70	43	0.35		X213	36	0.35	X97	31	72		0.35		FIXER 3 (-)
X304	4	0.35		X114	4	0.35	X70	13	0.35		X214	4	0.35	X93	16		90	0.35		FIXER 4 (+)
X303	4	0.35		X113	4	0.35	X70	20	0.35		X213	4	0.35	X97	16	73		0.35		FIXER 4 (+)
X304	29	0.35		X114	29	0.35	X70	17	0.35		X214	29	0.35	X93	17		91	0.35		FIXER 4 (-)

Table 140-C. Connector Switch Box Switched Docking Functions (continued)

Switch Box to Pallet		Russ Wire Size		Switch Box to ODM (-3002)		Russ Wire Size	ODM (-3002)		Russ Wire Size		Switch Box to Node 1 (ISS)		Russ Wire Size	Russian Mech Disc Panel		X3	X4	Russ Wire Size		
Conn	Pin	(mm^2)	Shd	Conn	Pin	(mm^2)	Conn	Pin	(mm^2)	Shd	Conn	Pin	(mm^2)	Conn	Pin	Pin	Pin	(mm^2)	Shd	Functions
X303	29	0.35		X113	29	0.35	X70	16	0.35		X213	29	0.35	X97	17	74		0.35		FIXER 4 (-)
X304	37	0.35		X114	37	0.35	X70	48	0.35		X214	37	0.35	X93	25		92	0.35		FIXER 4 (-)
X303	37	0.35		X113	37	0.35	X70	47	0.35		X213	37	0.35	X97	25	75		0.35		FIXER 4 (-)
X304	10	0.35		X114	10	0.35	X70	19	0.35		X214	10	0.35	X93	27		93	0.35		FIXER 5 (+)
X303	10	0.35		X113	10	0.35	X70	18	0.35		X213	10	0.35	X97	27	76		0.35		FIXER 5 (+)
X304	30	0.35		X114	30	0.35	X70	33	0.35		X214	30	0.35	X93	28		94	0.35		FIXER 5 (-)
X303	30	0.35		X113	30	0.35	X70	32	0.35		X213	30	0.35	X97	28	77		0.35		FIXER 5 (-)
X304	38	0.35		X114	38	0.35	X70	42	0.35		X214	38	0.35	X93	29		95	0.35		FIXER 5 (-)
X303	38	0.35		X113	38	0.35	X70	41	0.35		X213	38	0.35	X97	29	78		0.35		FIXER 5 (-)
X304	7	0.35		X114	7	0.35	X67	4	0.2		X214	7	0.35	X93	26		96	0.35		HI-ENERGY DAMPER NO. 1 (+)
X303	7	0.35		X113	7	0.35	X67	3	0.2		X213	7	0.35	X97	26	79		0.35		HI-ENERGY DAMPER NO. 1 (+)
X304	31	0.35		X114	31	0.35	X67	39	0.2		X214	31	0.35	X93	34		97	0.35		HI-ENERGY DAMPER NO. 1 (-)
X303	31	0.35		X113	31	0.35	X67	40	0.2		X213	31	0.35	X97	34	80		0.35		HI-ENERGY DAMPER NO. 1 (-)
X304	8	0.35		X114	8	0.35	X67	17	0.2		X214	8	0.35	X93	35		98	0.35		HI-ENERGY DAMPER NO. 2 (+)**
X303	8	0.35		X113	8	0.35	X67	16	0.2		X213	8	0.35	X97	35	81		0.35		HI-ENERGY DAMPER NO. 2 (+)**
X304	39	0.35		X114	39	0.35	X67	50	0.2		X214	39	0.35	X93	36		99	0.35		HI-ENERGY DAMPER NO. 2 (-)**
X303	39	0.35		X113	39	0.35	X67	49	0.2		X213	39	0.35	X97	36	82		0.35		HI-ENERGY DAMPER NO. 2 (-)**
X304	9	0.35		X114	9	0.35	X67	6	0.2		X214	9	0.35	X93	32		100	0.35		HI-ENERGY DAMPER NO. 3 (+)**
X303	9	0.35		X113	9	0.35	X67	5	0.2		X213	9	0.35	X97	32	83		0.35		HI-ENERGY DAMPER NO. 3 (+)**
X304	40	0.35		X114	40	0.35	X67	35	0.2		X214	40	0.35	X93	33		103	0.35		HI-ENERGY DAMPER NO. 3 (-)**
X303	40	0.35		X113	40	0.35	X67	34	0.2		X213	40	0.35	X97	33	84		0.35		HI-ENERGY DAMPER NO. 3 (-)**
X301	25	0.35		X119	25	0.35	X76	41	0.35		X219	25	0.35	X97	2	9		0.35		PWR SUP TO M9 GROUP 2 HOOKS
X301	17	0.35		X119	17	0.35	X76	42	0.35		X219	17	0.35	X97	3	51		0.35		PWR SUP TO M9 GROUP 2 HOOKS
X301	19	0.35		X119	19	0.35	X76	39	0.35		X219	19	0.35	X97	49	26		0.35		PWR SUP TO M9 GROUP 2 HOOKS
X301	12	0.35		X119	12	0.35	X76	40	0.35		X219	12	0.35	X97	50	52		0.35		PWR SUP TO M9 GROUP 2 HOOKS
X302	25	0.35		X112	25	0.35	X76	47	0.35		X212	25	0.35	X93	2		14	0.35		PWR SUP TO M8 GROUP 2 HOOKS
X302	17	0.35		X112	17	0.35	X76	48	0.35		X212	17	0.35	X93	3		68	0.35		PWR SUP TO M8 GROUP 2 HOOKS
X302	19	0.35		X112	19	0.35	X76	50	0.35		X212	19	0.35	X93	49		29	0.35		PWR SUP TO M8 GROUP 2 HOOKS

Table 140-C. Connector Switch Box Switched Docking Functions (continued)

Switch Box to Pallet		Russ Wire Size		Switch Box to ODM (-3002)		Russ Wire Size	ODM (-3002)		Russ Wire Size		Switch Box to Node 1 (ISS)		Russ Wire Size	Russian Mech Disc Panel		X3	X4	Russ Wire Size		
Conn	Pin	(mm²)	Shd	Conn	Pin	(mm²)	Conn	Pin	(mm²)	Shd	Conn	Pin	(mm²)	Conn	Pin	Pin	Pin	(mm²)	Shd	Functions
X302	12	0.35		X112	12	0.35	X76	46	0.35		X212	12	0.35	X93	50		69	0.35		PWR SUP TO M8 GROUP 2 HOOKS
X302	9	0.35		X112	9	0.35	X76	19	0.35		X212	9	0.35	X93	9		65	0.35		GROUP 2 HOOKS CLOSED
X301	9	0.35		X119	9	0.35	X76	28	0.35		X219	9	0.35	X97	9	48		0.35		GROUP 2 HOOKS CLOSED
X302	15	0.35		X112	15	0.35	X76	18	0.35		X212	15	0.35	X93	8		64	0.35		GROUP 2 HOOKS OPEN
X301	15	0.35		X119	15	0.35	X76	27	0.35		X219	15	0.35	X97	8	47		0.35		GROUP 2 HOOKS OPEN
X302	21	0.35		X112	21	0.35	X77	1	0.35		X212	21	0.35	X93	4		73	0.35		GROUP 1 HOOKS IN-BETWEEN
X301	21	0.35		X119	21	0.35	X77	5	0.35		X219	21	0.35	X97	4	56		0.35		GROUP 1 HOOKS IN-BETWEEN
X301	22	0.35		X119	22	0.35	X77	38	0.35		X219	22	0.35	X97	10	57		0.35		GROUP 2 HOOKS IN-BETWEEN
X302	22	0.35		X112	22	0.35	X77	37	0.35		X212	22	0.35	X93	10		74	0.35		GROUP 2 HOOKS IN-BETWEEN
X302	28	0.35		X112	28	0.35	X77	20	0.2											HOOKS IN-BETWEEN RETURN
X301	28	0.35		X119	28	0.35	X77	28	0.2											HOOKS IN-BETWEEN RETURN
X301	29	0.35		X119	29	0.35	X77	14	0.2											HOOKS IN-BETWEEN RETURN
X302	29	0.35		X112	29	0.35	X77	6	0.2											HOOKS IN-BETWEEN RETURN
X302	30	0.35		X112	30	0.35	X76	36	0.2		X212	30	0.35	X93	46		79	0.35		CONTROL SENSOR RETURN
X302	31	0.35		X112	31	0.35	X76	45	0.2											CONTROL SENSOR RETURN
X301	31	0.35		X119	31	0.35	X76	43	0.2		X219	31	0.35	X97	46	62		0.35		CONTROL SENSOR RETURN
X301	30	0.35		X119	30	0.35	X76	49	0.2											CONTROL SENSOR RETURN
X302	32	0.35		X112	32	0.35	X77	2	0.2		X212	32	0.35	X93	40		80	0.35		CONTROL SENSOR RETURN
X301	33	0.35		X119	33	0.35	X77	3	0.2											CONTROL SENSOR RETURN
X301	34	0.35		X119	34	0.35	X77	8	0.2											CONTROL SENSOR RETURN
X302	13	0.35		X112	13	0.35	X77	45	0.2		X212	13	0.35	X93	11		75	0.35		READY TO HOOK
X301	13	0.35		X119	13	0.35	X77	48	0.2		X219	13	0.35	X97	11	58		0.35		READY TO HOOK
X302	20	0.35		X112	20	0.35	X77	49	0.35		X212	20	0.35	X93	12		76	0.35		UNDOCK COMPLETE
X301	20	0.35		X119	20	0.35	X77	50	0.35		X219	20	0.35	X97	12	59		0.35		UNDOCK COMPLETE
X302	6	0.35		X112	6	0.35	X77	32	0.35		X212	6	0.35	X93	14		71	0.35		INTERFACE SEALED
X301	7	0.35		X119	7	0.35	X77	39	0.35		X219	7	0.35	X97	15	55		0.35		INTERFACE SEALED
X301	5	0.2		X119	5	0.35	X77	24	0.35		X219	5	0.35	X97	13	53		0.35		INTERFACE SEALED

Table 140-C. Connector Switch Box Switched Docking Functions (continued)

Switch Box to Pallet		Russ Wire Size		Switch Box to ODM (-3002)		Russ Wire Size	ODM (-3002)		Russ Wire Size		Switch Box to Node 1 (ISS)		Russ Wire Size	Russian Mech Disc Panel		X3	X4	Russ Wire Size		
Conn	Pin	(mm²)	Shd	Conn	Pin	(mm²)	Conn	Pin	(mm²)	Shd	Conn	Pin	(mm²)	Conn	Pin	Pin	Pin	(mm²)	Shd	Functions
X302	7	0.35									X212	7	0.35	X93	13		70	0.35		INTERFACE SEALED
X301	32	0.35		X119	32	0.35	X77	18	0.2		X219	32	0.35	X97	40	63		0.35		CONTROL SENSOR RETURN
X302	33	0.35		X112	33	0.35	X77	26	0.2											CONTROL SENSOR RETURN
X302	34	0.35		X112	34	0.35	X77	34	0.2											CONTROL SENSOR RETURN
X307	18	0.35		X117	18	0.35	X71	28	0.35		X217	18	0.35	X109	1	10		0.35		BALL SCREW 1 LIN ADV (COM)
X307	26	0.35		X117	26	0.35	X71	23	0.35		X217	26	0.35	X109	2	11		0.35		BALL SCREW 1 LIN ADV (SIG)
X307	34	0.35		X117	34	0.35	X71	40	0.35		X217	34	0.35	X109	3	12		0.35		BALL SCREW 1 LIN ADV (EXC)
X307	19	0.35		X117	19	0.35	X71	27	0.35											BALL SCREW 2 LIN ADV (COM)
X307	27	0.35		X117	27	0.35	X71	24	0.35		X217	27	0.35	X109	4	13		0.35		BALL SCREW 2 LIN ADV (SIG)
X307	35	0.35		X117	35	0.35	X71	39	0.35		X217	35	0.35	X109	19	128		0.35		BALL SCREW 2 LIN ADV (EXC)
X307	20	0.35		X117	20	0.35	X71	26	0.35											BALL SCREW 3 LIN ADV (COM)
X307	28	0.35		X117	28	0.35	X71	25	0.35		X217	28	0.35	X109	5	14		0.35		BALL SCREW 3 LIN ADV (SIG)
X307	36	0.35		X117	36	0.35	X71	45	0.35		X217	36	0.35	X109	21	135		0.35		BALL SCREW 3 LIN ADV (EXC)
X307	21	0.35		X117	21	0.35	X71	35	0.35											BALL SCREW 1 MISALIGN (COM)
X307	29	0.35		X117	29	0.35	X71	18	0.35		X217	29	0.35	X109	6	15		0.35		BALL SCREW 1 MISALIGN (SIG)
X307	37	0.35		X117	37	0.35	X71	50	0.35		X217	37	0.35	X109	22	136		0.35		BALL SCREW 1 MISALIGN (EXC)
X307	22	0.35		X117	22	0.35	X71	36	0.35											BALL SCREW 2 MISALIGN (COM)
X307	30	0.35		X117	30	0.35	X71	19	0.35		X217	30	0.35	X109	7	16		0.35		BALL SCREW 2 MISALIGN (SIG)
X307	38	0.35		X117	38	0.35	X71	49	0.35		X217	38	0.35	X109	23	137		0.35		BALL SCREW 2 MISALIGN (EXC)
X307	23	0.35		X117	23	0.35	X71	34	0.35		X217	23	0.35	X109	8	17		0.35		BALL SCREW 3 MISALIGN (COM)
X307	31	0.35		X117	31	0.35	X71	20	0.35		X217	31	0.35	X109	9	18		0.35		BALL SCREW 3 MISALIGN (SIG)
X307	39	0.35		X117	39	0.35	X71	48	0.35		X217	39	0.35	X109	10	19		0.35		BALL SCREW 3 MISALIGN (EXC)
X307	1	0.35		X117	1	0.35	X71	13	0.35		X217	1	0.35	X109	12	28		0.35		LATCHES MANUAL REL RTN
X307	2	0.35		X117	2	0.35	X71	17	0.35		X217	2	0.35	X109	11	27		0.35		LATCHES MANUAL RELEASE
X307	3	0.35		X117	3	0.35	X71	10	0.35		X217	3	0.35	X109	13	29		0.35		RING FINAL POSITION
X307	4	0.35		X117	4	0.35	X71	31	0.35											RING FINAL POSITION RTN
X307	5	0.35		X117	5	0.35	X73	44	0.35		X217	5	0.35	X109	14	93		0.35		CAPTURE LATCH OPEN
X307	6	0.35		X117	6	0.35	X73	10	0.35											CAPTURE LATCH OPEN RTN

Table 140-C. Connector Switch Box Switched Docking Functions (continued)

Switch Box to Pallet Conn	Pin	Russ Wire Size (mm²)	Shd	Switch Box to ODM (-3002) Conn	Pin	Russ Wire Size (mm²)	ODM (-3002) Conn	Pin	Russ Wire Size (mm²)	Shd	Switch Box to Node 1 (ISS) Conn	Pin	Russ Wire Size (mm²)	Russian Mech Disc Panel. Conn	Pin	X3 Pin	X4 Pin	Russ Wire Size (mm²)	Shd	Functions
X307	7	0.35		X117	7	0.35	X73	43	0.35		X217	7	0.35	X109	15	94		0.35		CAPTURE LATCHES CLOSED
X307	8	0.35		X117	8	0.35	X73	5	0.35											CAPTURE LATCHES CLOS RTN
X307	9	0.35		X117	9	0.35	X73	7	0.35											RING INITIAL POSITION RTN
X307	10	0.35		X117	10	0.35	X73	47	0.35		X217	10	0.35	X109	16	124		0.35		RING INITIAL POSITION
X307	17	0.35		X117	17	0.35	X73	11	0.35											RING FORWARD POSITION RTN
X307	25	0.35		X117	25	0.35	X73	48	0.35		X217	25	0.35	X109	17	125		0.35		RING FORWARD POSITION
X308	19	0.35	3*	X118	19	0.35	X73	21	0.35	2*	X218	19	0.2	X108	1		122	0.35	1*	LWR BALL SCKT 1 TEMP (COM)
X308	27	0.35		X118	27	0.35	X73	20	0.35		X218	27	0.2							LWR BALL SCKT 1 TEMP (SIG)
X308	34	0.35		X118	34	0.35	X73	18	0.35		X218	34	0.35	X108	2		123	0.35		LWR BALL SCKT 1 TEMP (EXC)
X308	20	0.35	3*	X118	20	0.35	X73	28	0.35	2*	X218	20	0.2	X108	3		124	0.35	1*	LWR BALL SCKT 2 TEMP (COM)
X308	28	0.35		X118	28	0.35	X73	27	0.35		X218	28	0.2							LWR BALL SCKT 2 TEMP (SIG)
X308	35	0.35		X118	35	0.35	X73	39	0.35		X218	35	0.35	X108	4		125	0.35		LWR BALL SCKT 2 TEMP (EXC)
X308	21	0.35	3*	X118	21	0.35	X73	37	0.35	2*	X218	21	0.2	X108	5		126	0.35	1*	LWR BALL SCKT 3 TEMP (COM)
X308	29	0.35		X118	29	0.35	X73	36	0.35		X218	29	0.2							LWR BALL SCKT 3 TEMP (SIG)
X308	36	0.35		X118	36	0.35	X73	34	0.35		X218	36	0.35	X108	6		128	0.35		LWR BALL SCKT 3 TEMP (EXC)
X308	22	0.35	3*	X118	22	0.35	X73	17	0.35	2*	X218	22	0.2	X108	7		129	0.35	1*	CAPTURE LATCH 1 TEMP (COM)
X308	30	0.35		X118	30	0.35	X73	16	0.35		X218	30	0.2							CAPTURE LATCH 1 TEMP (SIG)
X308	37	0.35		X118	37	0.35	X73	14	0.35		X218	37	0.35	X108	8		130	0.35		CAPTURE LATCH 1 TEMP (EXC)
X308	23	0.35	3*	X118	23	0.35	X73	25	0.35	2*	X218	23	0.2	X108	9		131	0.35	1*	CAPTURE LATCH 2 TEMP (COM)
X308	31	0.35		X118	31	0.35	X73	24	0.35		X218	31	0.2							CAPTURE LATCH 2 TEMP (SIG)
X308	38	0.35		X118	38	0.35	X73	22	0.35		X218	38	0.35	X108	10		132	0.35		CAPTURE LATCH 2 TEMP (EXC)
X308	24	0.35	3*	X118	24	0.35	X73	33	0.35	2*	X218	24	0.2	X108	11		133	0.35	1*	CAPTURE LATCH 3 TEMP (COM)
X308	32	0.35		X118	32	0.35	X73	32	0.35		X218	32	0.2							CAPTURE LATCH 3 TEMP (SIG)
X308	39	0.35		X118	39	0.35	X73	30	0.35		X218	39	0.35	X108	12		134	0.35		CAPTURE LATCH 3 TEMP (EXC)
X308	18	0.35		X118	18	0.35	X73	6	0.35											SHIELD
X308	25	0.35	3*	X118	25	0.35	X73	29	0.35	2*	X218	25	0.2	X108	13		135	0.35	1*	DCKNG RING DRV TEMP (COM)

Table 140-C. Connector Switch Box Switched Docking Functions (continued)

Switch Box to Pallet Conn	Pin	Russ Wire Size (mm²)	Shd	Switch Box to ODM (-3002) Conn	Pin	Russ Wire Size (mm²)	ODM (-3002) Conn	Pin	Russ Wire Size (mm²)	Shd	Switch Box to Node 1 (ISS) Conn	Pin	Russ Wire Size (mm²)	Russian Mech Disc Panel Conn	Pin	X3 Pin	X4 Pin	Russ Wire Size (mm²)	Shd	Functions
X308	33	0.35		X118	33	0.35	X73	40	0.35		X218	33	0.2							DCKNG RING DRV TEMP (SIG)
X308	40	0.35		X118	40	0.35	X73	45	0.35		X218	40	0.35	X108	14		136	0.35		DCKNG RING DRV TEMP (EXC)
X307	11	0.35		X117	11	0.35	X79	22	0.35		X217	11	0.35	X109	25	143		0.35		UNDOCK COMPLETE
X307	12	0.35		X117	12	0.35	X79	23	0.35											UNDOCK COMPLETE RTN
X307	13	0.35		X117	13	0.35	X79	3	0.35		X217	13	0.35	X109	24	138		0.35		READY TO HOOK
X307	14	0.35		X117	14	0.35	X79	9	0.35		X217	14	0.35	X109	20	132		0.35		CONTROL SENSOR RETURN
X307	15	0.35		X117	15	0.35	X79	26	0.35		X217	15	0.35	X109	28	147		0.35		GROUP 1 HOOKS CLOSED POS
X307	16	0.35		X117	16	0.35	X79	16	0.35											GROUP 1 HOOKS CLOS POS RTN
X307	41	0.35		X117	41	0.35	X79	25	0.35		X217	41	0.35	X109	27	145		0.35		GROUP 2 HOOKS OPEN POSITION
X307	42	0.35		X117	42	0.35	X79	35	0.35											GROUP 2 HOOKS OPEN POS RTN
X307	24	0.35		X117	24	0.35	X79	24	0.35		X217	24	0.35	X109	26	144		0.35		GROUP 1 HOOKS OPEN POSITION
X307	32	0.35		X117	32	0.35	X79	34	0.35											GROUP 1 HOOKS OPEN POS RTN
X307	33	0.35		X117	33	0.35	X79	17	0.35		X217	33	0.35	X109	29	182		0.35		GROUP 2 HOOKS CLOSED POS
X307	40	0.35		X117	40	0.35	X79	27	0.35		X217	40	0.35	X109	18	126		0.35		CONTROL SENSOR RETURN

Table 140-C. Connector Switch Box Switched Docking Functions (concluded)

Switch Box to Pallet Conn	Pin	Russ Wire Size (mm²)	Shd	Switch Box to ODM (-3002) Conn	Pin	Russ Wire Size (mm²)	ODM (-3002) Conn	Pin	Russ Wire Size (mm²)	Shd	Switch Box to Node 1 (ISS) Conn	Pin	Russ Wire Size (mm²)	Russian Mech Disc Panel Conn	Pin	X3 Pin	X4 Pin	Russ Wire Size (mm²)	Shd	Functions
X308	11	0.35		X118	11	0.35	X79	31	0.35		X218	11	0.35	X108	25		148	0.35		GRP 1 HKS LINEAR ADV (EXC)
X308	12	0.35		X118	12	0.35	X79	40	0.35		X218	12	0.35	X108	26		149	0.35		GRP 1 HKS LINEAR ADV (SIG)
X308	26	0.35		X118	26	0.35	X79	50	0.35		X218	26	0.35	X108	27		150	0.35		GRP 1 HKS LINEAR ADV (COM)
X308	41	0.35		X118	41	0.35	X79	30	0.35		X218	41	0.35	X108	28		182	0.35		GRP 2 HKS LINEAR ADV (EXC)
X308	42	0.35		X118	42	0.35	X79	46	0.35		X218	42	0.35	X108	29		183	0.35		GRP 2 HKS LINEAR ADV (SIG)
X308	43	0.35		X118	43	0.35	X79	39	0.35		X218	43	0.35	X108	30		184	0.35		GRP 2 HKS LINEAR ADV (COM)
X308	17	0.35	4*	X118	17	0.35	X78	1	0.35	2*	X218	17	0.2	X108	15		137	0.35	1*	DOCKING I/F TEMP 1 (COM)

Table 140-C. Connector Switch Box Switched Docking Functions (concluded)

X308	10	0.35		X118	10	0.35	X78	2	0.35		X218	10	0.2							DOCKING I/F TEMP 1 (SIG)
X308	4	0.35		X118	4	0.35	X78	4	0.35		X218	4	0.35	X108	16		138	0.35		DOCKING I/F TEMP 1 (EXC)
X308	16	0.35	4*	X118	16	0.35	X78	5	0.35	2*	X218	16	0.2	X108	17		139	0.35	1*	DOCKING I/F TEMP 2 (COM)
X308	9	0.35		X118	9	0.35	X78	6	0.35		X218	9	0.2							DOCKING I/F TEMP 2 (SIG)
X308	3	0.35		X118	3	0.35	X78	8	0.35		X218	3	0.35	X108	18		140	0.35		DOCKING I/F TEMP 2 (EXC)
X308	15	0.35	4*	X118	15	0.35	X78	9	0.35	2*	X218	15	0.2	X108	19		141	0.35	1*	DOCKING I/F TEMP 3 (COM)
X308	8	0.35		X118	8	0.35	X78	10	0.35		X218	8	0.2							DOCKING I/F TEMP 3 (SIG)
X308	2	0.35		X118	2	0.35	X78	12	0.35		X218	2	0.35	X108	20		142	0.35		DOCKING I/F TEMP 3 (EXC)
X308	14	0.35	4*	X118	14	0.35	X78	30	0.35	2*	X218	14	0.2	X108	21		144	0.35	1*	HOOKS DRIVE TEMP 1 (COM)
X308	7	0.35		X118	7	0.35	X78	31	0.35		X218	7	0.2							HOOKS DRIVE TEMP 1 (SIG)
X308	1	0.35		X118	1	0.35	X78	33	0.35		X218	1	0.35	X108	22		145	0.35		HOOKS DRIVE TEMP 1 (EXC)
X308	13	0.35	4*	X118	13	0.35	X78	37	0.35	2*	X218	13	0.2	X108	23		146	0.35	1*	HOOKS DRIVE TEMP 2 (COM)
X308	6	0.35		X118	6	0.35	X78	38	0.35		X218	6	0.2							HOOKS DRIVE TEMP 2 (SIG)
X308	5	0.35		X118	5	0.35	X78	40	0.35		X218	5	0.35	X108	24		147	0.35		HOOKS DRIVE TEMP 2 (EXC)
X308	50	0.35	4*	X118	50	0.35	X78	34	0.35	2*	X218	50	0.35	X108	50		143	0.35	1*	SHD (ALL APDS TEMP MEAS)

NOTES:

1/ ALL 1* SHIELDS (APDS TEMP MEASUREMENTS) TIED TOGETHER THRU SWITCH BOX AT X218-50
X218-50 CAPPED & STOWED (NOT CONNECTED TO PJ9519-23)

2/ ALL 2* SHIELDS (APDS TEMP MEASUREMENTS) TIED TOGETHER THRU SWITCH BOX AT X118-50

3/ ALL 3* SHIELDS (RUN THRU X308 CONNECTOR) TIED TOGETHER THRU SWITCH BOX AT X308-18
X308-18 CAPPED & STOWED (NOT CONNECTED TO P9423-78)

4/ ALL 4* SHIELDS (RUN THRU X308 CONNECTOR) TIED TOGETHER THRU SWITCH BOX AT X308-50

Table 140-D.. Switch-Box Controls

SWITCH BOX I/F CONN	PIN	DOCKING FUNCTION
X311	2	ISS POS TM PWR
X311	3	MOTOR ACTUATION IND (SYS 1)
X311	4	ORBITER MATE DRV PWR (SYS 1)
X311	6	ORBITER MATE DRV PWR (SYS 1)
X311	7	ISS MATE DRV PWR (SYS 1)
X311	8	ISS MATE DRV PWR (SYS 1)
X311	10	ISS POS TM
X311	12	ORBITER POS TM
X311	13	ORBITER POS TM PWR
X311	22	MOTOR PWR RTN A (SYS 1)
X311	23	MOTOR PWR RTN B (SYS 1)
X312	2	ORBITER POS IND PWR
X312	3	MOTOR ACTUATION IND (SYS 2)
X312	4	ORBITER MATE DRV PWR (SYS 2)
X312	6	ORBITER MATE DRV PWR (SYS 2)
X312	7	ISS MATE DRV PWR (SYS 2)
X312	8	ISS MATE DRV PWR (SYS 2)
X312	10	ORBITER POS IND
X312	12	ISS POS IND
X312	13	ISS POS IND PWR
X312	22	MOTOR PWR RTN A (SYS 2)
X312	23	MOTOR PWR RTN B (SYS 2)
X311	11	CSB CONN MATE (XP1) (VOLT)
X311	15	CSB CONN MATE (XP1) (STATUS)
		CSB CONN MATE RTN (VOLT)
X311	9	CSB CONN MATE (XP3) (VOLT)
X311	14	CSB CONN MATE (XP3) (STATUS)
		CSB CONN MATE RTN (STATUS)
		SHD
		SHD
X312	9	CSB CONN MATE (XP2) (VOLT)
X312	15	CSB CONN MATE (XP2) (STATUS)
		CSB CONN MATE RTN (STATUS)
X312	11	CSB CONN MATE (XP4) (VOLT)
X312	14	CSB CONN MATE (XP4) (STATUS)
		CSB CONN MATE RTN (VOLT)
		SHD
		SHD

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Appendix XV

150. DATA REQUIREMENTS

A. This Procurement Data Requirements List (PDRL) delineates the data-submittal requirements required for this procurement.

B. When Buyer approval is required, implementation of documentation shall not proceed until after Buyer approval, or forty-five (45) days after acknowledgment of receipt by Buyer, whichever is earliest, unless disapproved by Buyer.

C. All requested documentation shall be submitted with the following information specified on the data packing sheets and on the outside package label:

NASA/JSC Attention: Jim Nise/OH
NASA Road 1
Houston, Texas 77058

D. Data will be submitted on Seller's format, unless specified otherwise.

E. REPRODUCTION OF DATA - In addition to any other provisions with respect to data contained in this purchase order, Buyer shall have the right to reproduce, in any quantity necessary for efficient performance of its prime contract obligation, any data submitted by Seller without restriction or with restrictive legend authorized by the applicable data use restriction clause.

F. DOCUMENT IDENTIFICATION - All documentation of principal APDS equipment, except drawings and specifications, shall be identified with Seller's document number, revision letter, revision date, Buyer's related control number and Buyer's data item description number. Drawings and specifications shall be identified in accordance with Seller's identification system.

G. DOCUMENTATION QUALITY - Adequate quality assurance provisions shall be implemented and maintained by the Seller to the extent that all documentation submitted is of a standard type and of sufficient quality to reproduce legible copies. The Buyer reserves the right to reject any documentation which does not meet these standards.

H. NUMBER OF COPIES - The Seller shall provide 3 copies of every data submittal, unless otherwise specified.

I. DATA RETENTION - See Data Retention Clause of the applicable Patent and Data Provisions Flysheet of the purchase order.

J. LANGUAGE - All data shall be submitted in both English and when the data was originally prepared in Russian, the source Russian shall also be submitted.

K. DEFINITION OF CODES

DUE DATE:

DDD/C/XXX

DDD = Number of calendar days
C: A = After
P = Prior to
W = Concurrent with
XXX = Event or Milestone

Example:
030/P/CDR 30 days prior to CDR

EVENT OR MILESTONE

ATP	Authority to Proceed
DOR	Determination of Requirements
FPO	Failure/Problem Occurrence
HWD	Hardware Delivery by Seller
IMP	Implementation
NEG	Negotiations with Seller
POC	Purchase Order Close-Out
PRPL	Proposal
QTC	Qualification Test Completion
REL	Release of Data by Seller
REV	Reviews and Meetings
RON	Receipt of Buyer Notification to Submit Data
CDR	Critical Design Review
SCI	Seller Configuration Inspection
PDR	Preliminary Design Review
TBN	To be Negotiated with Seller
TST	Test by Seller

FREQUENCY OF SUBMITTALS

O/TIME	One Time
O/TIME/R	One Time and Revisions
R/ASR	Revisions as Required

APO2 DELETED

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ
CM01	Plan, Configuration Management	45 days after contract go-ahead	Revisions as required	Yes

<u>Scope</u> - This Procurement Data Requirement Description (PDRD) establishes the requirements for preparation and maintenance of a Configuration Management Plan by the Seller.

<u>Content</u> - The Seller's Configuration Management Plan shall include the following:

A. Narrative explanations of the Seller's existing Configuration Management (CM) System intended to be utilized in complying with the requirements imposed in this specification. The explanations shall be in terms of approach and methods to be utilized. Applicable existing Seller-written policies and instructions shall be referenced to selected explanations and documents submitted with the CM Plan.

B. Detailed descriptions of the operation, organization and authority of the Seller's change control system including sample forms and control of Seller's Configuration Baseline Document (SCBD).

C. Relationship between the Seller's configuration status accounting function and configuration verification system, demonstrating how the validity of hardware baseline documentation is assured (as-approved, as-designed, as-built).

D. A description of the format and process with which the Seller will submit an Engineering Design Change Proposal (EDCP). EDCPs must be submitted to obtain Buyer's advance approval of any Class 1 engineering changes. EDCPs shall include a description of and reason for the change, along with descriptions of any impacts to APDS performance, weight, reliability, delivery schedule, and cost. Class I changes as defined in 3.3.6.8.2.

<u>Maintenance</u>. The Plan shall be maintained by page revision or complete reissue, whichever is most cost-effective.

<u>Format</u>. Seller may utilize his own format.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ
CM03	Document, Seller Configuration Baseline (SCBD)	30 days prior to CDR	(a) As Revised after CDR. (b) At Hdwe Del.	Yes

<u>Scope</u> -This Procurement Data Requirement Description (PDRD) establishes the requirement for a data list defining the approved configuration baseline of hardware This list defines each type of Seller End Item (SEI)/major components and assemblies including as a minimum the lowest-level item that is serialized for change effectivity. SCBD's are required for qualified SEI/major components and assemblies.

Note: This document represents the approved baseline for the SEI established by design review, configuration inspection or product audit. Buyer's approval of the SCBD does not constitute a contract change authorization.

Note: One copy shall be furnished in each Acceptance Data Package, PDRL QA12.

Content: The following specific elements of data shall be included:

A. Identification of the SEI/major component and assemblies by Buyer control or part number, item nomenclature, and the Seller's part number.

B. Identification of the contractual documentation used to accept a deliverable SEI/major component:

   1. Buyer procurement technical specification.

   2. Seller's technical documentation:

      a. Released baseline drawings & document list by assembly/subassembly indenture for the deliverable item.

      b. Seller's procurement specification and drawings and subtier-supplier drawings and documents, as applicable.

      c. Seller's Acceptance Test Procedures (ATP).

      d. Selected Seller's Material and Process Specifications essential by the Buyer in consonance with the Seller to be baselined for items to be delivered.

   Note: This document, when baselined, serves as a common reference for control of engineering changes.

Maintenance.The Seller shall prepare the SCBD data in Seller's standard format. a The Seller shall update and resubmit the SCBD to the Buyer in accordance with the following:

A. Subsequent to the Critical Design Review and prior to Buyer approval, the SCBD shall be updated to reflect changes to the listed documentation resultant from the design review.

B. Subsequent to Buyer approval of an incremental design baseline for selected integral assemblies, components or parts of the SEI, the SCBD shall be resubmitted as required to keep Buyer appraised of the release of documents containing changes.

C. Prior to delivery of the first qualifiable or qualified production hardware, submittal of a completed SCBD for the SEI is required to support a Seller Configuration Inspection (SCI). The "as-designed" baseline as identified in the SCBD and approved by the Buyer shall be utilized to assess the readiness of the SEI for delivery to the Buyer.

D. The SCBD approved for SEI shall be utilized as the basis for acceptance of subsequent SEI deliveries. Resubmittal of an SCBD and Buyer reapproval is required for subsequent SEI deliveries only when such items contain engineering changes beyond the baseline shown in an approved SCBD for the SEI.

E. Change authority/remarks shall be provided when changing a line entry during an SCBD revision. The Seller's authority for making a Class I change shall be referenced to the Buyer's Engineering Design Change Proposal (EDCP) and Buyer's Purchase Order Change Notice (POCN).

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ. SUB.	BUYER APPR REQ
CM04	As-Built Configuration Record (ABCR)	Concurrent with hardware delivery	Revisions as required	No

Note: One copy shall be furnished as part of each Acceptance Data Package, PDRL QA12.

Scope - This Procurement Data Requirement Description (PDRD) establishes the requirements for a data list defining the identification and physical description of each SEI/major component and assembly provided by the Seller for acceptance and delivery to Buyer. The document shall consist of an accurate accumulation of data extracted from the fabrication and test records.

Note: Where lot traceability is required, only one ABCR shall be prepared for SEI's comprising a lot.

Content -The following specific elements of data shall be included:

A. Identification of the SEI/major component and assembly by Buyer control number, item nomenclature, Seller part number, and serial/lot number.

B. The contractual documentation, i.e., Buyer Procurement Specification, Buyer approved Acceptance Test Procedure (ATP).

C. The As-Built Configuration Record (ABCR) shall consist of an accurate indentured parts list, including those parts and assemblies baselined in the approved SCBD.

In addition, the ABCR shall include the following:

1. The latest approved document revision letter and engineering change order/notice identifiers to which the part was fabricated.

2. A notation to see PDRD QA12 for Waivers or Deviations against affected parts.

3. Serial/Lot numbers or date codes for all traceable items identified on Seller's drawings or subtier supplier drawings, including all Electrical, Electronic, and Electromechanical (EEE) components.

B. The Seller shall prepare the ABCR data on the Seller's standard form.

CMO5 DELETED

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ. SUB.	BUYER APPR REQ
LS01	Plan, Maintenance Supt	30D/PDR 60D/CDR (Update)		Yes

USE

To describe the Seller's plan for maintenance support of APDS Line Reparable Units (LRU's)

SCOPE - This Procurement Data Requirement Description (PDRD) establishes the requirement for preparation of a Maintenance Support Plan for the Seller's reparable LRU's.

CONTENTS - The Seller's Maintenance Support plan will specify the methods, processes and controls to be utilized to ensure an efficient, cost effective repair program for system LRU's.

The plan shall address as a minimum:

A. Recommended levels of repair and extent of repair at each hardware level.

B. Maintenance concept to include initial testing/fault isolation, repair actions and recommended post maintenance tests (modified ATP) as applicable by type repair, i.e., test to be performed subsequent to replacement of: a plug in module, a soldered in component, etc.

C. Spares lay in requirements.

D. Maintenance of a secured storage area (bonded stores) for spare repair parts if such parts are layed in for future overhaul and repair activities.

E. Provisions for timely response to the Buyer's request for priority repair actions.

F. Provisions for resident quality inspection.

G. Packaging and handling provisions.

H. Delivery of repaired hardware to the Buyer. Utilization of DD Form 250 or DD Form 1149 as applicable.

I. Provisions for response to Buyer's disposition instructions for, and control of, hardware which is beyond economical repair and removed non-reparable component parts.

J. Provisions for submittal of repair cost estimates and estimated completion dates upon receipt of a defective unit.

K. Provisions for subtier supplier repair activities.

FORMAT - Optional

LSO2 DELETED

LSO3 DELETED

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ. SUB.	BUYER APPR REQ
LS04	List, Limited Life, Seller End Item (SEI)	30D/PDR, Update 60D/CDR		Yes

A. To identify the SEI limited-operating-life items and the requirements for inspection, maintenance, and replacement of these items.

B. To identify the SEI limited-shelf-life items and requirements for inspection, maintenance, and replacement of these items.

PREPARATION INFORMATION

SCOPE - Identification of Seller SEI limited-life items.

CONTENT -

A. The SEI limited-operating-life-item action document shall define the criteria for selection of operating-time-significant equipment and establish general requirements for acquisition of data on operating time or cycles. Limited-life items where time or cycles are directly related to the primary cause of failure modes within the life specified in the Buyer procurement specification for the SEI, or where serviceability for such periods requires some action as a function of operating time or cycles, shall be designated as limited-operating-life items. Limited-operating-life-items shall be identified at the Line Replaceable Unit (LRU) level or higher and shall be listed in the SEI Limited-Life List. For each item this list shall identify:

1. Name and part number
2. Operational life limit
3. Life-limiting parameter, part, or material and its function
4. Estimated operational usage prior to delivery to the Buyer
5. Limitations on the number of refurbishments
6. Restrictions related to use, test, handling, and maintenance
7. Rationale for selection

B. The SEI limited shelf life item action document shall define the criteria for selection of limited-shelf-life items and establish general requirements for acquisition of age controlled time data. Limited-life parts and materials which are subject to failure due to aging or environment as a function of time since manufacture and/or installation shall be designated as limited-shelf-life items. The SEI shall have a shelf life that complies with requirements of the procurement specification and the "age-control date" shall be provided at the LRU or higher, for the age-sensitive part or material which must be replaced at the earliest date subsequent to manufacture of the SEI. Limited-shelf-life items shall be identified in the SEI Limited-Life List. For each item this list shall identify:

1. Name and part number
2. Age life limit
3. Life-limiting parameter, part, or material and its function

4. Age limiting environment
5. Limitations on the number of refurbishments
6. Restrictions related to use, test, handling, and maintenance
7. Rationale for selection

FORMAT - Optional. SEI lists for flight and support equipment items shall be separate documents.

LSO5 DELETED

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ. SUB.	BUYER APPR REQ
LS06	Spare Parts Recommendations	30D/PDR Update 60D/CDR		Yes

USE
Content utilized by the Buyer to Evaluate Seller's recommended spares and repair parts in support of deliverable hardware, and to evaluate Seller's recommended changes to spares and repair parts previously recommended.

PREPARATION INFORMATION

SCOPE - The Seller shall recommend spare and repair parts for the support of deliverable hardware.

Design Changes affecting the spares previously recommended shall be documented by submittal of a change SPR.

CONTENTS - The following detailed instructions are provided:

A. The SPR will be prepared listing all spare and repair parts recommendations in a top down breakdown format of the Seller's choosing.

B. For each spare part listed, the SPR shall specify the extent to which and level at which maintenance of the spare is possible and what organization (Buyer or Seller) is authorized to make such repair.

C. For each spare part listed, the SPR shall specify the shelf life, procurement lead time, and total recommednded quantity.

LS08 DELETED

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ
MC02	Material Identifica tion and Usage List	Upon identifica tion of all materials used but not later than45 days prior to delivery of hardware	Revisions in AP02	Yes

Requirements: A list of all materials used in the finished product, including material review actions and material of procured parts and assemblies. The list shall include part number, part title, material specification number, and manufacturer's material designation. For non-metallic materials, material manufacturer and material weight (grams) shall be reported to the nearest 0.001 gram., and material surface area (cm^2) shall be reported to the nearest 0.01 cm^2.

Material applications inside hermetically or environmentally sealed containers, back filled with inert gas, or buried inside potting compounds, with no method of receiving or replenishing a supply of combustion supporting atmosphere, need not be reported. However, the material used for sealing shall be reported.

	DESCRIPTION TITLE	DUE DATE	FREQ. SUB.	BUYER APPR REQ
MP01A	Component Mass Properties Status Report	45 days prior to design release	R/ASR	No

Requirements To provide weight, center of gravity and moment of inertia.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ. SUB.	BUYER APPR REQ
PG01A	Data, Packaging & Transport	Submitted and Approved for Multi-Mir APDS	Update as Required for ISS Shipments	Yes

USE

To provide detailed information of Seller's packaging and transport methods.

PREPARATION INFORMATION

SCOPE - The Seller shall provide engineering documentation for the preservation, packaging and packing for transportation and storage, as required to satisfy the preparation for delivery requirements of the applicable procurement specification, shipping instructions, and purchase order. The types of data to be prepared are described in the following subparagraphs.

Note: Data covering specific parts, i.e., packaging data forms and detail drawings, shall include both the Seller's part number and Buyer Control Number.

CONTENT -

PG01.1 - Packaging Data Form and Supplementary Drawings/Procedures - The specific packaging methods and materials for each item (and a brief description of the item), and supplementary drawings and procedures shall be documented on a Preservation, Packaging and transportation Support Data Form.

Designs and procedures shall be detailed sufficiently to assure initial packaging, subsequent repackaging, container fabrication and special marking, etc., can be properly accomplished by Seller and Buyer personnel ordinarily engaged in performing these operations.

For hazardous items (explosive or radioactive devices, chemicals, solvents, etc.) data shall also include requirements defining as a minimum, the following:

A. Hazardous classification per applicable government or carrier tariffs and regulations for each mode of transportation to be used including applicable transportation tariff or regulation paragraph numbers.

B. Materials, methods or design necessary to assure conformance to packaging requirements specified in the procurement specification, paragraph 5.0, Preparation for Delivery.

C. Department of Transportation Container Requirements.

D. Special hazardous markings and labels.

PG01.6. Report - Packaging and Transport Preliminary Analysis and Concept - This report shall define the conceptual design of packaging/transport equipment and supporting analytical rationale. The following shall be included as applicable:

A. Item configuration information including envelope dimensions, weight, center-of-gravity, shape, support or pickup points, etc. Characteristics of item as related to its susceptibility to damage from natural and induced environments (temperature, pressure, contamination, shock/vibration, etc.).

B. Sketch(es) depicting conceptual design of packaging/transport equipment as planned by Seller to satisfy Buyer's requirements. Sketches shall indicate all significant aspects of the proposed design including, for example, primary materials of construction, applicable government specifications for container(s), etc., methods for supporting/ blocking the item, methods of attenuating transport shock/vibration, methods of corrosion/contamination control, methods of attenuating temperature, pressure, or other environments to which item is sensitive.

C. Recommendations for qualification of packaging and transport methods/equipment by analysis or recommendations for laboratory or over-the-road testing.

D. Capability or limitations of the proposed transport modes (air, highway, rail, water) and specific transport vehicle as may be required.

E. Report coverage shall include all phases of the hardware production and delivery cycle including in-plant storage and handling; local transportation at point of origin; transportation to destination; and receiving, redistribution, handling, and storage at the destination facility.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ. SUB.	BUYER APPR REQ
QA01	Quality Assurance Plan	With proposal	Revisions in AP02	Yes *

Content: Visibility of Seller's quality control system and Qualification test environment specification to demonstrate evidence or compliance with contractual requirements.

QA10 DELETED

QA11 DELETED

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ. SUB.	BUYER APPR REQ
QA12	Acceptance Data Package (ADP)	Concurrent with hardware delivery	Revisions as required	Yes

* One copy shall accompany the hardware. Three copies shall be delivered in accordance with page 1, paragraph 3, of this specification appendix.

Content: Documentation required for the preparation of the ADP shall be compiled from Engineering release drawings, test records, and specifications, as well as verified fabrication and inspection records.

The ADP shall always contain a Title Page, Table of Contents, DD Form 250 or Shipping Document in addition to those elements of data identified in this requirement. The Table of Contents shall account for all items of data included in this requirement.

Each ADP shall be a condition of acceptance for each end item.

Requirements: The documentation indicated below:

I. ADP Data Element Description and Format Requirements

A. A. Title Page - A title page shall be provided for each ADP and shall depict: The Part name;Buyer control number; Buyer specification number, revision letter, amendments incorporated, purchase order number, Seller part number, and end item serial number, and approval signature blocks for Seller's Quality Assurance and NASA Quality Assurance (or NASA designated quality representative).

Format - Seller's format may be used.

B. Table of Contents - A Table of Contents shall be provided at the front of each ADP which includes the Buyer control number and the Seller's part number and end item serial number and provides an inventory of the ADP contents.

Format - Seller's format may be used.

QA12.1 Drawings

Format Type: Per data item SE03

With the first shipment of the end item, the Seller shall provide one top assembly drawing (or drawings) containing sufficient information to conduct a complete identity and damage inspection. When drawing changes occur which affect the end item, the Seller shall provide one new/revised top assembly drawing (or drawings) with the first shipment of the affected end item.

QA12.2 (Reserved)

QA12.3 DD Form 250 Material Inspection and Receiving report

Format Type: Per Figure QA12.3-1

The DD Form 250 shall be prepared for all shipments from Russia, including those that are hand carried. The DD Form 250 is prepared in accordance with instructions provided in the purchase order an/or Statement of Work. A copy of the DD Form 250 shall be included in the ADP for each item or lot delivered.

QA12.4 Shipping Document

Format Type: Seller's format may be used.

Seller's shipping document containing evidence of inspection acceptance for each item delivered shall be prepared when source inspection by the NASA Quality Assurance Representative is not required. A copy of the Seller's shipping document will be included in the ADP for each item or lot delivered and shall itemize the contents of the shipment including Buyer control numbers, and Seller's part names part numbers, and serial numbers.

QA12.5 Operating Time

Format Type: Seller's format may be used

Seller shall provide records of operating time/cycles for items identified as time and/or cycle critical items. The record shall indicate the type of operation, the time and/or cycles of the operation and the total accrued time and/or cycles.

QA12.6 Age-Sensitive Items

Format Type: Seller's format may be used

Seller shall provide age life records for all parts or materials identified as age-sensitive. The record shall include part name, part number, serial number, replacement rationale, cure or manufacture date, installation date, replacement due date, *operation and/or service accomplished date, *operation and/or service due date.

* Operation and/or service accomplished date and Operation and/or service due date shall be used for items that require periodic operation and/or servicing.

QA12.8 Reserved

QA12.9 Weight Record - Seller shall provide a record of the actual weight for each end item. Include as a line item on the shipping document.

QA12.10 Deviation and Waiver Record - Seller shall provide a list of Deviation and Waiver Requests applicable to delivered items per 3.3.6.1.3. A copy of each Deviation or Waiver on the list shall be included in the ADP.

QA12.10.4 Nonstandard Disposition Report - The seller shall provide a report in seller's format describing all instances in which hardware delivered under this contract does not conform to drawing and/or specification requirements (nonconformance). The report shall include a detailed description of each such instance, its location on the hardware, and the rationale by which the decision was made to accept it for delivery.

QA12.11 Record of Material Review Board (MRB) Actions - The seller shall submit copies of material review board policies and procedures including pertinent supporting documentation defining the seller's material review system, which must satisfy the requirements of paragraph 3.4.7 of this specification.

A list of proposed MRB members for quality assurance and engineering, indicating the scope of their material review authority and describing their qualifications (education and experience) shall be provided.

The Seller shall provide a list of material review dispositions applicable to the delivered items or parts/subassemblies installed thereon. Copies of all completed material review board disposition documents, including written descriptions of the non-conformance, the remedial action (disposition), and the corrective action (recurrence prevention), signed by authorized MRB members shall be included in this ADP.

QA12.12 Acceptance Test Data - Seller shall provide acceptance test data sheets reflecting final acceptance test results recorded per the applicable test specification. Acceptance test results shall be reported for each acceptance test required by this procurement specification, and the procurement specification paragraph number for each test shall be clearly linked with the test result. The acceptance data sheets shall reflect quality control verification of all test results recorded, including proof load test results for delivered lifting and handling equipment when applicable.

QA12.13 Notes and Comments - When other sections do not normally provide for such reporting, the Seller shall prepare notes and comments annotating events or requirements. Anomalous conditions encountered during acceptance testing, special instructions, advice or warning for personnel safety, shall be included.

QA12.15 Operating (Handling/Maintenance) Instructions. Set of instructions to allow operation written to the level of understanding of a skilled technician. Instructions shall be provided for the APDA and other complex hardware, including field support equipment, which require detailed procedures for operation.

QA12.19 Reserved

QA12.21 Reserved

QA12.22 Non-destructive Evaluation Data (NDE) - The seller shall provide copies of reports in seller's format describing results of any ultrasonic, dye penetrant, X-Rays and/or eddy-current inspections performed on hardware delivered under the-contract delivered items or on parts, subassemblies installed thereon.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ
QA15A	Data, Pyrotechnic			
	Paragraph 1 -	015/A/ATP or 014/A/CDR	0/TIME/R	Yes (Note 1)
	Paragraph 2 -	(Note 2)	R/ASR	Yes
	Paragraph 3 -	005/A/RON	R/ASR	Yes

Requirement.

1. Control Documentation

   a. Drawings - all, including packaging, bomb and tooling

   b. Procedures - qualification, acceptance and Quality Plan

   c. Instructions: manufacturing, inspection, and processing

   d. Specifications: procurement, special process, material, etc.

   e. Parts List:: include items a, b, c, and d with revisions

2. Acceptance Data Package

   a. Certified acceptance reports

   b. Certified list of detail parts

   c. One set of X-ray negatives of each part and X-ray certification

   d. One set of N-ray negatives of each part and N-ray certification

   e. One copy of the following as applicable:

      1) pressure-vs-time curves

      2) dent tests

      3) delay time and ignition time

      4) function

      5) detonation velocity

6) leak test

f. Certification of tensile test of body materials and proof pressure test of bodies

g. Certification that the formula for Pyrotechinc mix is the same as the mix used in qualification test

h. Marriage records recording assembly of components with traceability

i. Weight data

j. Final inspection record

3. Lot Acceptance Data

a. records of material traceability

b. Operational and manufacturing records

c. Rework information and inspection records

d. Operating time logs

e. Seller specification and drawings

f. Buyer specification and drawings

g. Approved changes pertinent to drawings and specifications

h. Assembly drawings

i. Acceptance test procedures

j. Any other information which may be used for the assessment of the quality and reliability of the pyrotechnic devices prior to flight certification.

Notes: 1. In addition to the three copies submitted, three copies shall be available at Seller's facility for Buyer's "Preproduction Source Review (Phase II)" conducted prior to explosive loading.

2. All data applicable to Non-Destructive Evaluation (NDE) shall be submitted upon completion of NDE (N-Rays and X-Rays: One copy each; certification, etc.: Four copies each). All other data shall be furnished in each Acceptance Data Package, PDRL QA12, upon certification of hardware.

QA19 DELETED

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ
RA01	Reliability Analysis Report	Initial: 030/P/PDR Final: 030/P/CDR	R/ASR 1	Yes

Requirement. Implementation of this data requirement shall be to the extent shown for the following categories of hardware:

A. New Design -- full application of all provisions.

B. Modified Design -- evaluation to the extent those modifications result in specific reliability analysis impact.

C. Unmodified Design -- use of previous data with review and incorporation of any potential interface or application changes or newly acquired data which would change prior analysis.

The Seller shall perform reliability analysis on all electrical and mechanical elements to show compliance with the useful life requirements specified in the procurement specification. The analysis shall take into account the equipment operating modes, parts derating (electrical elements only), mission phases, and environmental factors. If available, standby (non-operating) failure rates for electrical and mechanical elements shall be provided. The operating temperature, for purposes of the reliability analysis, shall be the nominal operating temperature. Failure predictions that are based on actual failure history and operating times shall be current and shall include all failures relevant to the electrical or mechanical element under analysis.

Content. The reliability analysis shall, as a minimum, provide the following:

A. Definition of Product by purpose, performance, constraints, and failure definition.

B. Reliability model, consisting of logic and mathematical representations of operations and non-operations for each major application made to the functional group level, and reliability block diagrams. (A functional group is a set of electrical or mechanical elements performing a required and relatively independent function within a component, such as command decode logic, power switching, pyro firing logic, or differential assembly.)

C. Piece part data for each item tabulated on data sheets and listing the electrical or mechanical elements for each functional block, stress factors for each electrical element, and predicted failure rates and failure rate sources.

D. Reliability analysis summary to include a discussion of analysis results, identified problem areas, and planned actions to control or eliminate the noted problems. The analysis techniques and models utilized shall be fully described.

FORMAT: Subcontractor's format is acceptable.

Maintenance. All information shall be kept current.

Note 1: Final data item shall be submitted 30 days prior to critical design review or upon 90% completion of design for subsequent submittals.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ
RA-19	Analysis Data Energia EEE Part, Application	CDR	0/TIME/R	Yes

Requirement: The Seller shall provide an analysis to verify that all Electrical, Electronic, and Electromechanical (EEE) parts are not overstressed in worst case environments, operating conditions, and duty cycles.

MDU EEE Part Application Analysis Data

Module Name: POWER SUPPLY CCA Date: Nov 29, 1993 Updated: Aug 12, 1994

Schematic No: 8263326 Prepared By: J. Krywalski By: L. Musil

Circuit Symbol	Part Number	Type	Description	Parameter	Max Rated	Actual	Units	Ratio	Requirement	Comments
Q10	8263107-604	2N2907A	Transistor, PNP	Vce	30	16.000	Volts	0.533	0.700	
				Vcb	60	16.0	Volts	0.267	0.700	
				Veb	5	0.600	Volts	0.120	0.700	
				Ic	0.80	0.002	Amps	0.003	0.750	
				Pd	1.8	0.002	Watts	0.001	0.500	
				Tj	200	102	Deg C	0.510	1.000	
T2(A2), T3 (A2)	8263431-301	XFMR	Transformer	Vbr case	500	200	Volts	0.400		
				Vpin-pin	500	200	Volts	0.400		
				Tr	30	11.0	Deg C	0.367	1.000	< 30 Deg
VR200	JNXV1N4479 US	1N4479	Diode, Zener	Pd	1.0	0.000	Watts	0.000	0.500	
				Iz	0.037	0.000	Amps	0.000	0.750	
				Tj	150	84.300	Deg C	0.967	1.000	<30 Deg C
CR20	8263437-401	SDRIj	Diode, Rect	Pd	0.850	0.396	Watts	0.466	0.500	
				Irect	1.000	0.081	Amps	0.081	0.700	
				Isurge	25	6.000	Amps	0.240	0.750	
				Vr	600	342.60	Volts	0.571	0.700	
				Tj	175	98.200	Deg C	0.561	1.000	

RA-19 EXAMPLE

RA20 Deleted

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ
RA22	Report, Failure Mode and Effects Analysis (FMEA) and Single Failure Point Summary (SFPS)	030/P/PDR	R/ASR	Yes

Requirement. A document that reflects how the redundancy requirements of the APDS hardware and equipment were met, or identifies where they are not met along with an explanation or rationale why.

In addition to functional effects of failures, the analysis shall identify the effects of individual hardware failures on the function. Data elements required for individual FMEA analyses are defined in Table RA22.

Table RA22. FMEA Data Elements.

1. FMEA Identification Number
2. Subsystem Name
3. Line Replaceable Unit (LRU) Name
4. LRU Part Number
5. Description of Part Under Analysis
6. Reference Designators
7. Quantity of Like Items
8. Hardware Item Function Description
9. Reference Documents
10. Failure Mode
11. Mission Phase
12. Failure Mode Cause(s)
13. Failure Detection Method
14. Correcting Action
15. Failure Effects On:
    a. Subsystem

b. Interfacing Subsystem

c. Mission

d. Crew, Vehicle, and Elements

e. Functional Criticality Effects

16. Approval Signatures

The Seller shall determine, and the Buyer shall approve, the functional criticality from Table RA22A, and the hardware criticality from table RA22B. The Seller shall provide the following additional data items described in RA22C for hardware items which are considered critical.

RA22 (Continued)

Table RA22A. Functional Criticality Definitions for Flight Hardware

Criticality	Potential Effect or Failure
1	Single failure which could result in loss of life or vehicle.
1R	Redundant hardware item(s), all of which if failed, could cause loss of life or vehicle.
2	Single failure which could result in loss of mission.
2R	Redundant hardware item(s), all of which if failed, could cause loss of mission.
3	All others.

Table RA22B. Hardware Criticality Definitions for Flight Hardware

Criticality	Potential Effect or Failure
1	Loss of life or vehicle.
2	Loss of mission or next failure of any redundant item could cause loss of life or vehicle.
3	All others.

Table RA22C. Additional FMEA Data Elements.

1. Design - Identify design features which minimize the probability of occurrence of the failure mode and cause.

2. Test - Identify specific test accomplished to detect failure mode and causes during acceptance test and certification tests.
3. Inspection - Identify specific inspection points that are included to determine that specific failure modes causes are not inadvertently manufactured into the hardware.
4. Failure History - Provide information relative to the performance history of the hardware item's failure mode.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ. SUB.	BUYER APPR REQ
RA24	Failure/Problem, Analysis and Corrective Action Report	1) Telephone report within 24 hrs. A/FPO 2) 010/A/FPO	As required	No Yes

Requirement. A document that provides a detailed description of any failure or problem that has occurred once formal Acceptance testing has started. The report shall include a description of how the failure or problem was isolated to the root cause. The report shall include a recommended corrective action to preclude recurrence along with a failure-effect assessment and recommendation concerning hardware already fabricated.

Once formal acceptance testing is started, the Seller is required to issue an initial problem notification by telephone to the Buyer within 24 Hours of occurrence.This notification is to include identification of the item which failed, the nature and symptoms of that failure, and the test underway at the time.

Upon evaluation by the Buyer, the Seller will be directed to proceed with failure analysis or hardware disposition, or both. If hardware analysis is required, written 10 day reports are required. Data Elements required for these reports are defined in Table RA24.

A final report is to include updates of the 10-day report information, along with the test history of the failed item, a description of the failure analysis employed, conclusions drawn from these analyses, and final corrective action plans.

The following shall also be included in the final report to meet contract requirements:

1) A description of the analysis methods, test equipment, and laboratory techniques employed.

2) Illustrations and photographs as appropriate.

3) Conclusions drawn from the analysis, including, where applicable, identification of piece parts which accounted for the cause of problem in the higher assembly.

4) Corrective action, including references to appropriate drawings and specifications.

Problem notification and reporting shall be submitted through the following:

Reports shall be sent to:	JSC PRACA Center NASA/JSC NS43/Bldg 17 Houston, Texas 77058	
voice:	Primary Secondary	713-244-1937 713-244-1941
facsimile mail:	Primary Secondary	713-244-1848 713-244-1849
hours of operation:	8:00 a.m. - 4:30 p.m. Central, Monday thru Friday	

Table RA24. Problem Report Data Elements

		24 Hrs. (telecon)	10 day report
1.	Report number and date of Initiation	x	x
2.	Date of problem detection.	x	x
3.	Item under test/operation at time or detection (system, type, model) drawing number, nomenclature, serial number, and manufacturer.	x	x
4.	Non-conforming time (lowest assembly level to which the problem is attributable) part or model) number, nomenclature, and manufacturer.	x	x
5.	Test/operation being performed at time of detection including manufacturing or test document number.	x	x
6.	Type of problem; i.e., failure or unsatisfactory condition.	x	x
7.	If failure - Type; i.e., primary or secondary	x	x
8.	Symptom	x	x
9.	Brief description of problem, including how the problem occurred and comparison of expected events with detail events (or results)	x	x
10.	Location of item at time of problem detection (facility, work center, etc.)		x
11.	Identification of the next higher subassembly of the time under test at time of detection (part number or model number, nomenclature, and manufacturer)		x
12.	Operational usage at time of problem detection (total time/cycle/miles).		x
13.	Effect of problem in terms of (1) the performance of the next higher subassembly and (2) in terms of hazard potential		x
14.	Test history describing the various test conducted on the item before and after the problem occurred. Prior problem history shall also be included.		

Note: I = If Available

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ
SA05	Plan, System Safety	CDR	0/TIME/R	Yes

Requirement. This System Safety Plan shall define the Seller's safety tasks required to support the Buyer's certification to NASA that the APDS is safe to fly on the Orbiter for use in performing the ISSA Missions. These tasks shall include safety design requirements development/imposition, hazard analysis/risk assessment and hazard control requirements development, Fault Tree Analysis, verification of requirements implementation, design review, test and evaluation support, and reporting and documentation.

Reporting shall include any:

1. discrepancies found in design compliance with safety requirements,
2. status in the APDS Program Monthly Progress Report, PDRL AP02,
3. briefing the status of safety tasks and of APDS safety/hazards at major Design Reviews,
4. utilizing the reporting system specified in PDRL RA24 or its equivalent to report mishaps in which APDS hardware is damaged.

Documentation shall include delivering to the Buyer, as part of PDRL SA07, documents and data on any safety risk and hazard analysis/assessment and hazard reporting performed on APDA/APDS, both prior to and during the NASA/RSA contract.

The Plan shall describe how a safety-dedicated, single point-of-contact shall be responsible for acquiring, compiling, and sending safety documentation, safety task status, and status of hardware compliance with all safety provisions and requirements, and for performing communications with his counterpart at the Buyer's facility.

The Plan shall describe the schedule of the safety tasks and their integration with tasks of other functions.

The Plan shall describe the Seller's methods to assure identification, elimination and/or control of potential hazards which may lead to injury or loss of personnel and/or damage or loss of flight equipment, or of mission-related field support equipment, throughout the complete cycle of the program.

An example of what is expected in a System Safety Plan is attached.

EXAMPLE OUTLINE OF A SYSTEM SAFETY PLAN

1.0 Purpose and Scope

1.1 Purpose
1.2 Scope

2.0 Applicable Documents

3.0 Safety Tasks Management

3.1 Planning and Management of Safety Tasks
3.2 Safety Organization
3.3 Safety Interface Coordination

4.0 Safety Task Requirements (Tasks to be Completed and Processes to be Used)

4.1 Development and Imposition of Safety-Design Requirements
4.2 Fault Tree Analysis
4.3 Hazard Analysis and Risk Assessment
4.4 Hazard Resolution (Development and Approval of Hazard-Control Requirements)
4.5 Verification of Requirements Implementation
4.6 Design and Program Review
4.7 Test and Evaluation Support
4.7.1 Testing of Critical Equipment
4.7.2 Hazardous or High-Cost Tests and Operations
4.8 Reporting and Documentation

5.0 Schedule for Task Completion

6.0 Definitions

Note: The intent of this PDRD can be met by delivering Volume I - Safety Plan of RSM-06, Safety & Mission Assurance Plans which are contained in the data requirements section (J-2) of the NASA/RSA Contract NAS15-10110.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ
SA07	Report, Risk Assessment	Initial: 030/P/PDR Final: 030/P/CDR	R/ASR	Yes

Requirement. A Risk Assessment Report (RAR) shall be prepared and submitted in accordance with the above schedule. This report content and format shall conform to the attached sample Table of Contents. This report shall include documentation and data on all design-to safety requirements and hazard control requirements levied on APDA/APDS, both prior to and during the NASA/RSA contract. This report shall also include documentation and data in matrix format on all verification of implementation of these requirements on APDA/APDS, both prior to and during the NASA/RSA contract.

This report shall include the results of all hazard analyses conducted to determine the existence, severity and impact of specific safety risks to personnel and other systems caused by the APDS hardware, and associated equipment , during all ground, transportation, ferry flight, assembly, testing, movement, storage, maintenance, and/or operation of the APDS. All hazards, including those resulting from failures, regardless of system or component redundancy, shall be analyzed. In addition to hazards resulting from failures, those emanating from normal or emergency equipment operations, environment, personnel error, design characteristics, and credible accident scenarios shall be analyzed. Hazards resulting from failure to meet program requirements and Single Failure Points (SFPs) shall be identified. The analyses shall identify the necessary actions to eliminate or control any failures or malfunctions that could independently or collectively present a hazard to interfacing hardware (e.g. ODS Airlock, Orbiter, ISSA). All individual causes shall be listed along with the controls which are applied to those causes. Controls and the methods of verifying the controls shall include sufficient detail and explanation of design features, procedures, testing, inspection, and/or analysis to clearly reflect critical controls which mitigate the hazard and support rationale for hazard closure or acceptance of risk. All hazardous functions shall be identified and analyzed to ensure that the system operates at an acceptable risk level. Worksheets documenting and summarizing these hazard analyses shall be prepared in accordance with the attached Sample Hazard Analysis Worksheets, and shall be included in the RAR.

This report shall include documentation and data on any safety risk and hazard assessments and hazard reporting performed on APDA/APDS, both prior to and during the NASA/RSA contract. The corrective action taken or planned to eliminate or mitigate each risk shall be described.

SAMPLE TABLE OF CONTENTS

SECTION PAGE

SAMPLE TABLE OF CONTENTS (Continued)

APPENDICES PAGE

SAMPLE LIST OF FIGURES

SAMPLE HAZARD ANALYSIS WORKSHEETS

SS/MIR DOCKING SAMPLE HAZARD ANALYSIS (OHA)

OHA #	DM1OHA08(F)	**Rev**	Original Issue		
Operation	Undocking	**Safety Engineer**	H. R. Hildreth	**Sign.**	
Task	Perform Rapid ODS Isolation	**Project Engineer**	K. J. Kelly	**Sign.**	
Subtask	Close/Seal Hatches	**Date**	11.15.94	**Page**	1of 4
Orbiter Mission	STS - 71				

Hazard: Loss of Ability to Isolate the ODS

Hazard Description: In the event of a contingency/emergency undocking, loss of pressurization in the ISSA/ODS/Spacelab/tunnels, or other off-nominal situation requiring rapid closure/sealing of the ODS hatches, drag-through hardware, including air ducts and television camera cables, will have to be removed to permit hatch closure/sealing and prevent loss of pressurization in the ISSA/ODS/Spacelab/crew cabin and loss of habitable atmosphere.

Potential Causes:

- 1. Failure to follow procedures
- 2. Inability to rapidly remove hatch drag-through hardware.
- 3. Inability to close/seal hatches.

Recommended Actions:

- NASA develop and document training procedures to ensure that flight crew personnel will adhere strictly to approved, safe procedures while executing rapid isolation of the ODS from the ISSA/Spacelab/tunnels/crew cabin

- NASA develop and document operational procedures for flight crew personnel to rapidly isolate the ODS from the ISSA/Spacelab/tunnels/crew cabin.

SS/MIR DOCKING OPERATING HAZARD ANALYSIS (OHA)

OHA #	DM1OHA08(F)	**Rev**	Original Issue		
Operation	Undocking	**Safety Engineer**	H. R. Hildreth	**Sign.**	
Task	Perform Rapid ODS Isolation	**Project Engineer**	K. J. Kelly	**Sign.**	
Subtask	Close/Seal Hatches	**Date**	11.15.94	**Page**	2 of 4
Orbiter Mission	STS - 71				

HAZARD	CAUSE	EFFECT	SEVERITY	SAFETY RQMTS	CONTROL	VERIFICATION	LIKELIHOOD
Loss of Ability to Isolate the ODS	1. Failure to follow procedures	1. Loss of crew resulting from loss of pressurization in the ISSA/ODS/Spacelab/crew cabin and loss of habitable atmosphere	1.Catastrophic	1. SSD92D0551, ODS DRS: - Paragraph 6.3.4.1.1 "Safety"	1.a Provide training procedures to ensure that flight crew personnel will adhere strictly to approved, safe procedures while executing rapid isolation of the ODS form the ISSA/Spacelab/ tunnels/crew cabin. 1.b Provide operational procedures for rapid isolation of the ODS form the ISSA/Spacelab/ tunnels/crew cabin.	1.a Analysis and approval of training procedures and simulations. 1.b Analysis and approval of operational procedures.	1. Improbable

SS/MIR DOCKING OPERATING HAZARD ANALYSIS (OHA)

OHA # DM1OHA08(F) **Rev** Original Issue
Operation Undocking **Safety Engineer** H. R. Hildreth **Sign.**
Task Perform Rapid ODS Isolation **Project Engineer** K. J. Kelly **Sign.**
Subtask Close/Seal Hatches **Date** 11.15.94 **Page** 3 of 4
Orbiter Mission STS - 71

HAZARD	CAUSE	EFFECT	SEVERITY	SAFETY RQMTS	CONTROL	VERIFICATION	LIKELIHOOD
Loss of Ability to Isolate the ODS	2. Inability to rapidly remove hatch drag-through hardware. (Ref. Integration Hazard Report SS-10)	2. Loss of crew resulting from loss of pressurization in the ISSA/ODS/Spacelab/crew cabin and loss of habitable atmosphere	2.Catastrophic	2. SSD92D0551, ODS DRS: - Paragraph 3.2.4.2 "Quick-Disconnect Capability" 6.3.4.1.1 "Safety"	2. Design to prevent hazards by providing quick-disconnect capability for all hatch drag-through ducts and cables.	2. Review/analysis of design drawing # TBD.	2. Remote

SS/MIR DOCKING OPERATING HAZARD ANALYSIS (OHA)

OHA #	DM1OHA08(F)	**Rev**	Original Issue		
Operation	Undocking	**Safety Engineer**	H. R. Hildreth	**Sign.**	
Task	Perform Rapid ODS Isolation	**Project Engineer**	K. J. Kelly	**Sign.**	
Subtask	Close/Seal Hatches	**Date**	11.15.94	**Page**	4 of 4
Orbiter Mission	STS - 71				

HAZARD	CAUSE	EFFECT	SEVERITY	SAFETY RQMTS	CONTROL	VERIFICATION	LIKELI-HOOD
Loss of Ability to Isolate the ODS	3. Inability to close/seal hatches. (Ref. Integration Hazard Report SS-10)	3. Loss of crew resulting from loss of pressurization in the ISSA/ODS/Spacelab/crew cabin and loss of habitable atmosphere	3. Catastrophic	3. SSD92D055 1, ODS DRS: - Paragraph 3.3.1.3.8/ 6.3.3.1.3.11 "Seals and Sealing Devices" 6.3.4.1.1 "Safety"	3.a Design to prevent hazards. Factor of safety for hatch mechanisms is 1.4 or greater. 3.b Provide failure tolerance through redundancy. 3.c Select material to prevent galling 3.d Periodic inspection per OMRSD.	3.a Review/analysis of design drawing # TBD. Perform load analysis. 3.b Review of failure history, failure tolerance analysis, and FMEA. 3.c Review and approval of material selection and application, inspection by Materials Branch. 3.d Review of OMRSD inspection reports. (Ref. ORBI-269, Crew Module Seal External Leakage)	3. Improbable

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
SA20	Report, Fault Tree Analysis	1 June, 1995	Quarterly (every 3 months)	Yes

Requirement. A document that depicts in a qualitative graphical and logical representation, the various combinations of possible events, both fault and normal, which can occur in the APDS and which can cause a pre-defined undesired event. An undesired event is any event which is identified as objectionable and unwanted, such as a potential accident, hazardous condition, or undesired failure mode. These events shall include but not be limited to: (1) inability to perform docking, (2) potential collision between the Orbiter and ISS during docking, (3) inability to separate Orbiter from ISS, and (4) loss of habitable environmental pressuring during IVA. This graphic presentation exposes the interrelationships of system events and their dependence upon each other, which may result in the occurrence of the undesired event. The fault tree shall be developed using formalized deductive logic and to the lowest level required to adequately define the undesired event.

The seller shall utilize the Fault Tree Analysis software and key provided by NASA to develop the required fault tree.

Fault Tree Analysis shall address differences by mission due to:

1) Hardware differences

2) Operations differences.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
SE03	Drawings and Associated Lists			
(a)	Preliminary Design Drawings including Schematics and Drawing Tree	014/P/PDR 014/P/CDR (Note 1)	R/ASR	No
(b)	Hardware Product Drawings including Schematics/ Assembly Level	000/W/REL (Note 2)	R/ASR	No
(c)	Below Assembly Level Detail Drawings including Schematics	72 hrs/A/RON (Note 3)	As required	No

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
(d)	Revision History File	010/A/RON	R/ASR	No
(e)	Box to Box Interface diagram showing all I/F Pins	15 days after contract go-ahead		Yes
(f)	Preliminary system Level Schematics	15 days after Contract go-ahead		Yes
(g)	Update System Level Schematics	at PDR		Yes
(h)	Final System Level Schematics	60 days prior to CDR		Yes
(i)	Retrofit Kit Drawings/ Instructions	000/W/REL	R/ASR	No
(j)	Illustrated Parts Breakdown (IPB)	000/W/REL (Note 4)	R/ASR	Yes
(k)	Geometric Math Model	at PDR	R/ASR	Yes

(These data items shall be made available to Buyer prior to kit delivery for acceptance.)

Requirement. The Seller shall prepare engineering data in forms suitable for recording designs developed for this specification for flight hardware, brassboard hardware, and the FSE defined in Appendix XI.

Notes
1. Drawing Tree - A drawing tree so arranged that the next lower assembly or part drawings are identified.
2. Limited indentured levels of Product Drawings shall be delivered to the Buyer as specified in Buyer's approved SCBD (reference CM03) subsequent to baseline/release and prior to item delivery.
3. Drawings below the assembly level and not listed in CM03 shall be required upon request only (Type III data). Under emergency conditions, Seller shall submit all required drawings within 72 hours.
4. Requirements for the IPB shall be identified and validated through maintenance analysis conducted by the Buyer.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
SEO6A	Structural Analysis and Fracture Mechanics Analysis Report	45 days prior to design release	R/ASR	No

Requirements To identify structural component margins of safety, fracture critical candidates and critical design conditions on the end item.

Notes: The report shall include as a minimum:

1. A display of the stress margin of safety summarized for the end item.

2. Analysis data for each structural component including a sketch of the component, descriptions of the critical load condition and the analysis method, margin of safety, and identification of the criterion condition.

3. The fracture-mechanics analysis shall include the anticipated load history, the loads spectra, the material crack-propagation-rate data, the stress-intensity relationship which describes the local stress field, crack size, crack morphology, and the geometry of the structure.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
SE08	Electrical Power Requirements Data	(Note)	R/ASR	Yes

Requirement. The seller shall prepare electrical power requirements data for every component furnished in accordance with this specification.

Notes: 1. Electrical power consumption of each item of flight hardware of this contract, including individual interface pins are required by the Seller. The specific function of individual interface pins shall also be identified.

2. 000/W/PRPL, 014/P/CDR, and 030/A/TST. When program does not require CDR, submittal dates will be 000/W/PRPL, 060 days prior to release of production design, and 030/A/TST.

SE10 Deleted

SE23 DELETED

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ. SUB.	BUYER APPR REQ
TM02	Certification Plan	Initial: 030/P/PDR Final: 030/P/CDR	R/ASR	Yes *

* Buyer will approve or disapprove within 45 days after authority to proceed or 45 days after receipt of revision notification.

Content - The Seller shall provide the following data in the Certification Plan:

1. Design Certification Matrix. Data to be provided by the Seller on the matrix is:

   a. All applicable APDS mechanical and avionics hardware as identified in Section 3 of the basic specification.

   b. All applicable environmental parameters from Section 3 of the basic specification identified by specification paragraph number.

   c. Summary of the available data, used to satisfy certification requirements, that exists for the hardware being procured, including test levels, duration, measured or monitored parameters.

   d. A description, by specification paragraph number, of how the available data satisfies the Section 3 requirements, or the action suggested or recommended in order for the hardware to meet the specified requirements.

2. The plan shall provide detail description of all certification activities which include qualification tests, analysis and simulations planned. The plan shall define the logic and approach and schedules planned for satisfying the certification requirements.

3. The plan shall provide a description of the Seller's traceability activities. Traceability shall be accomplished by assigning a traceability identification to traceable items and major components as identified in the Section 3 of the basic specification and by providing a means of correlating each to its historical records. Conversely, the records must be traceable to each item/major component.

4. The plan shall address the following certification/reliability programmatic requirements:

   4.1 Reliability Design Requirements. Provide documentation including numerical studies to identify the APDS processes that verify that the reliability of the APDS hardware meets the reliability requirements of this specification.

   4.2 Problem Reporting And Corrective Action System. Provide documentation to make known the APDS reliability process for control, reporting, analysis, correction, and prevention of APDS hardware failures and deliverable items during and subsequent to acceptance testing.

4.2.1 Problem Analysis. Provide documentation to make known the APDS reliability process for failure analysis and problem correction.

4.2.2 Corrective Action. The APDS program shall implement corrective action to prevent recurrence of failures when the analysis reveals the causes to be within its control. A problem report shall be considered closed when corrective action has been implemented. Notification of corrective action for all failures and problems shall be on a close-out Problems Analysis Report. Corrective actions which result in a change to configuration baseline documentation shall be processed in accordance with the configuration management system.

4.2.3 Electrical And Mechanical Parts Control. Provide documentation to make known the APDS process for controlling selection, reduction in number of types, specification, application reviews, analyzing failures, stocking and handling methods, installation procedures, and establishing reliability and quality requirements of electrical and mechanical parts.

MAINTENANCE. The plan shall be maintained current by page revision or complete re-issue, whichever is most effective, to reflect all approved program changes.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
TM06	Reports, Test and Analysis(Certification) (6-27-73)	030/A/TST (Test) 030/P/CDR (Analysis)	R/ASR	Yes

Requirement. (a) For each LRU there shall be an Acceptance Test Procedure that describes what tests are to be accomplished, the test sequence, how each paragraph of the AT requirements of the specification will be satisfied, and how the test is to be set up and accomplished, along with the parameters to be monitored or measured, with pass-fail criteria.

(b) There shall be a Qualification Test Procedure for each LRU to be subjected to a Qualification test. The procedure shall outline what tests are to be accomplished, the test sequence, how each paragraphs of the qualification test requirements of the specification will be satisfied, and a description of how the test is to be set up and accomplished, along with the parameters to be monitored or measured, with pass/fail criteria.

(c) There shall be a Qualification Test Report for each item that was subjected to a formal Qualification test sequence. This report shall provide a summary of the tests performed, their results, and identification by specification paragraph number of which qualification requirements of the specification have been satisfied. The report shall also include the detailed test data with a Qualify Control or Inspection buy-off stamp.

TM09 DELETED

TM10 DELETED

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
TM11	Procedures, Qualification, Acceptance Test	030/P/TST	R/ASR	Yes

Requirement. The Seller shall provide information to evaluate Seller's acceptance test procedures and qualification test procedures.

Appendix XVI

160. ANDROGYNOUS PERIPHERAL DOCKING ASSEMBLIES FOR INTERIM CONTROL MODULE

160.1 SCOPE

This appendix defines requirements for an active and a passive Androgynous Peripheral Docking Assembly (APDA) and other elements of an Androgynous Peripheral Docking System (APDS) for use with the Interim Control Module (ICM) in the International Space Station (ISS) program for docking to FGB. Also defined herein are requirements for testing and for data submittal.

160.2 APPLICABLE DOCUMENTS. The requirements of Section 2 apply.

160.3 REQUIREMENTS. The requirements of Section 3 apply, except as follows:

160.3.1 Item Definition.

Figure 1 is an illustration of the flight configuration showing the ICM berthed with the Orbiter. The central volume of the ICM is unpressurized; each APDA has a dome and seals to provide pressure integrity from the Orbiter airlock through the passive APDA to its dome and from the FGB through the active APDA to its dome. The following elements in this configuration are covered by this appendix:

(1)	MC621-0087-7002 33U.6201.008-11	Androgynous Peripheral Docking Assembly (active)
	MC621-0087-8002 33U.6201.008-12	Androgynous Peripheral Docking Assembly (passive)
(2)	MC621-0087-0020	Pyrotechnic Release Devices
(3)	SLIYu 374511.022	ICM Pigtail Cables

APDA -7002 (Active) shall include the structure and guide ring; and the capture-latch, structural-hook and extend/retract/attenuation mechanisms. This active APDA shall be capable of providing structural compliance with six degrees of freedom and shall have pyrotechnic release devices for the structural hooks. Figure 160-2 shows the configuration of APDA -7002.

APDA -8002 (Passive) shall include the structure and stationary guide ring, and the passive structural-hook mechanism. The -8002 APDA shall not have pyrotechnic release devices for the structural hooks. Figure 160-3 shows the configuration of APDA -8002.

HANISM STRUCTURE

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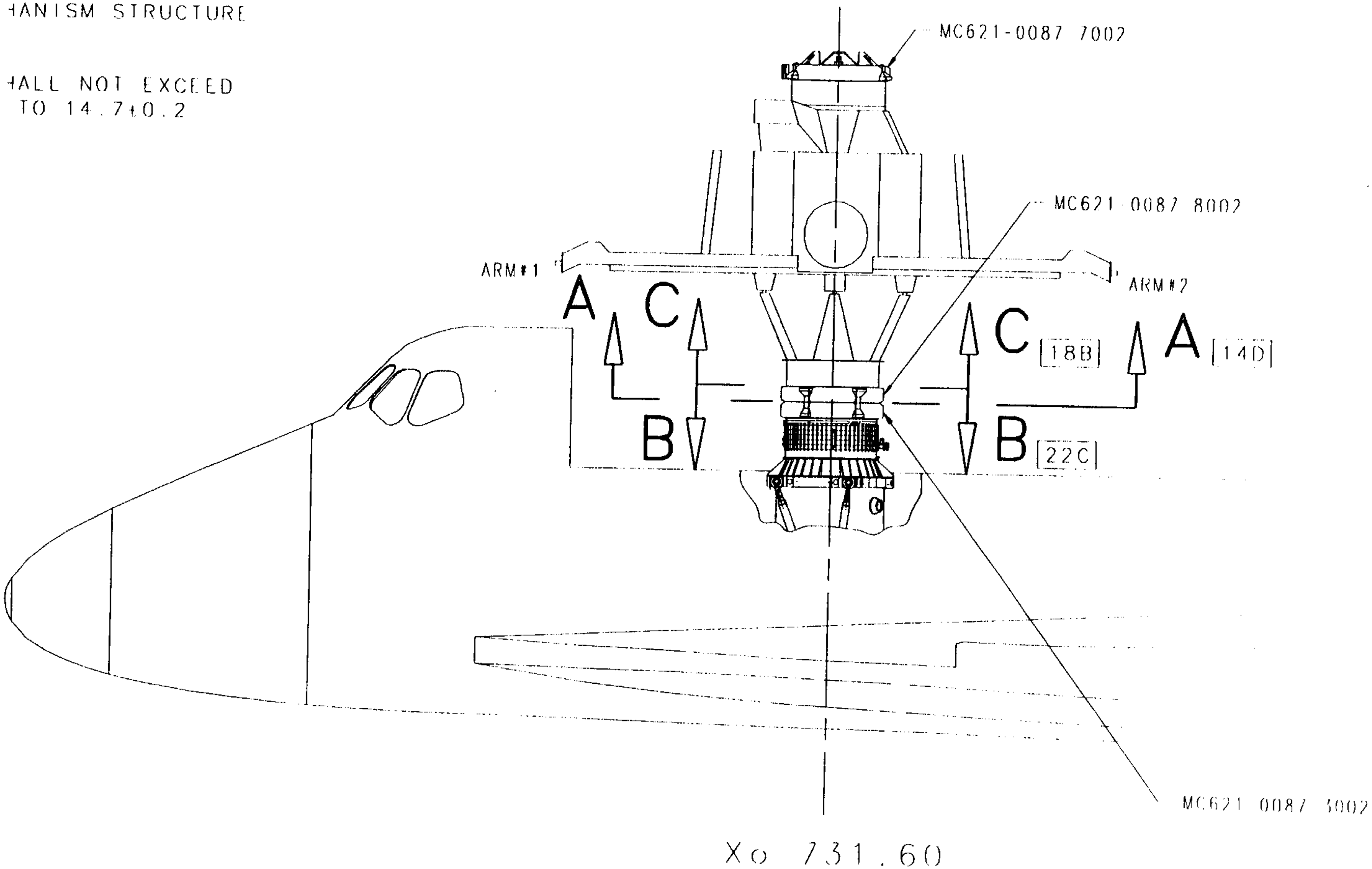

Figure 160-1. Active APDA -7002 and Passive APDA -8002 Mounted on Interim Control Module Berthed with Orbiter

160.3.1.1 Subsystem Definition

The APDAs consist of the following subsystems and features:

a. APDA -7002 (reference Figure 160-2)
   1. Structural Hook Mechanism with both active and passive hooks.
   2. Structure (Base with Interface Seals, and Guide Ring)
   3. Resource Electrical Connectors (X3 and X4 operational, X1 and X2 not operational but with metal caps)
   4. Indicators, Undocking Sensors, Temperature Sensors, Hook-Status Sensors, Capture Sensors, Ready-to-Hook Sensors, and Pressure Sensors
   5. Heaters
   6. Pushers
   7. Capture-Latch Mechanism
   8. Mechanism for extension and retraction of the ring and attenuation of loads
   9. Pressure Dome with Seals
   10. Pyrotechnic Release Device for Active Hooks
       The pyrotechnic release device is addressed as a separate Line Replaceable Unit in Appendix XII.
   11. Provisions for mounting two TV cameras and two lights
   12. Feedthrough connectors for cameras and lights
   13. Provisions for mounting Crosshair Target for TV Camera Alignment

b. APDA -8002 (reference Figure 160-3)
   1. Structural Hook Mechanism with only Passive Hooks
   2. Structure (Base with Seals, and Stationary Guide Ring)
   3. Resource Electrical Connectors (X3 and X4 operational, X1 and X2 not operational but with metal caps)
   4. Pushers
   5. Docking Target
   6. Pressure Dome with Seals
   7. No sensors required.

160.3.1.1.1 Functional Definition.

a. APDA -7002 shall:
   1. Capture the passive APDA body-mounted capture latches.
   2. Attenuate docking loads during capture and attenuation, and limit the relative vehicle motions.
   3. Align, structurally attach, and seal the active to passive APDAs.
   4. Allow for termination of docking operations and separation of vehicles at any point in the docking process, and not prevent the remating of the vehicles during the same mission.
   5. Allow for resource transfer between vehicles.
   6. Provide for the demating of the spacecrafts.

b. APDA -8002 shall:
   1. Align and allow structural attachment of the active to passive APDAs.
   2. Seal active and passive APDAs by use of passive hooks.
   3. Allow for resource transfer between vehicles.

160.3.1.2 Interface Definition

160.3.1.2.1 Electrical Power Characteristics. The requirements of paragraph 3.1.2.1 apply except as follows:

160.3.1.2.1.1 Electrical Interface and Connectors. The electrical interfaces to the ICM APDA -7002 shall be in accordance with Figures 160-2 and 160-3. Connectors and pin assignments at these interfaces are shown in Tables 160-9 and 160-10.

160.3.1.2.1.2 Resource-Transfer Umbilicals.

160.3.1.2.1.2.1 Mounting and Pin Assignments. The four resource-transfer umbilicals X1 through X4 shall be mounted along the external surface of the APDA structure (base) per Figures 160-2 and 160-3. The resource-transfer pin assignments and functions for the -7002 and -8002 APDAs shall be as shown in Tables 160-11, 160-12, 160-13 and 160-13a. The power transfer design requirements of X1 and X2 shall be in accordance with Figure 20-D, E for -8002.

160.3.1.2.1.2.2 Engagement and Disengagement. The connectors shall be engaged and disengaged by operation of the mechanism. The pins shall be disengaged prior to completion of structural-hook opening.

160.3.1.2.2 Mounting. The mounting provisions of the APDAs shall be as shown in Figures 160-2 and 160-3.

160.3.1.2.3 -8002 APDA-to-ICM Interface. The interfacing of the -8002 APDA and the ICM shall be in accordance with Figure 160-3.

160.3.1.2.4 -7002 APDA-to-FGB Interface. The interfacing of the -7002 APDA and the ICM shall be in accordance with Figure 160-2.

160.3.1.2.5 Active-APDA-to-Passive-APDA Interface. The active and passive APDAs shall be designed to mate under the loads, relative velocities, and relative misalignments of Tables 160-4 and 160-5.

160.3.1.2.6 Pressure. The requirements of 20.3.1.2.6 apply except that the articles here include pressure-dome seals rather than hatch seals:

a. APDA -7002:
   1. pressure-dome interface seals
   2. mating seals
b. APDA -8002:
   1. pressure-dome interface seals
   2. mating seals

160.3.1.3 Item Identification. The APDA and pyrotechnic subassembly shall be identified as follows:

Nomenclature	Buyer Part No.	Seller Part No.	Maint. Level
Active APDA	MC621-0087-7002	33U.6201.008-11	LRU
Passive APDA	MC621-0087-8002	33U.6201.008-12	LRU
Pigtail Cables		SLIYu 374511.022	
Pyrotechnic Release Device	(See Appendix XII)		

160.3.1.3.1 Cable Set Identification. The requirements of 130.3.1.3.1 apply.

160.3.2 Characteristics

160.3.2.1 Performance Characteristics

The ISS 2A.1 mission is defined as: The ICM is launched as a payload in the Orbiter. The ICM is removed from the payload bay by the Remote Manipulator System (RMS) and is berthed to the ODS. After structural attachment to the ODS is achieved, the APDS Switching System (reference Appendix 14) is placed in the ICM position to control the active -7002 APDA on the ICM. The ODS/ICM stack is then docked to the aft axial port of the FGB. After ICM to FGB structural attachment is achieved, the APDS Switching System is placed back to the ODS position. The ODS is then undocked from the ICM and the Orbiter maneuvers to dock with PMA 2. After structural attachment with PMA 2, the Orbiter's crew ingress's the ISS assembly to the ICM -7002 and retrieves the docking camera/lights.

The ICM is then ready to perform the required operations, and upon completion of the ICM design tasks, the ICM undocks from the ISS and de-orbits. The following are detailed performance requirements of the ICM docking system.

a. The APDA functions shall provide the means to connect and disconnect the active and passive docking mechanisms.
b. APDA-7002 shall provide the ability to transmit data from the ICM to the FGB. APDA - 8002 shall provide the ability to transmit video from the Orbiter to the ICM.
c. Sequencing of APDA functions may be automated from initial contact until full dock; the automated sequence, however, shall be able to be interrupted at any point. Subsequent to interruption, the sequence shall be able to be completed manually or terminated manually. Interruption of the automated sequence shall not prevent remating to the FGB.
d. Means shall be provided to monitor operations and safety-critical functions and to check out and verify systems. The resulting data shall be available for use by both flight crew and ground operations.
e. APDA -7002 active hooks shall be capable of being controlled OPEN and CLOSED from the ICM avionics, only for undocking from the FGB (reference Figure 160-4). Telemetry will be provided from the -7002 to indicate the actuator CLOSED discrete status.
f. APDA -7002 pyrotechnic bolts of the active hooks shall have the capability of being initiated from the ICM avionics (reference Figure 160-4). The bolts will be fired six at a time, with a maximum of 100 milliseconds between firings. The total time required for firings is less than 150 milliseconds. Each firing command shall initiate two separate pryotechnic bolt bridgewires in parallel (reference Figure 160-6).

160.3.2.1.1 Life

160.3.2.1.1.1 Operating Life

a. -7002 APDA The -7002 APDA shall be capable of performing all of the applicable operations specified herein with maintenance for a minimum of the following cycles. Interface seals may be replaced after each mission.

On-Orbit Vacuum Cycles	3
Ground No-Load Cycles	9
Ground Load Cycles	2

b. -8002 APDA. The -8002 APDA shall be capable of performing all of the applicable operations specified herein with maintenance for a minimum of the following cycles.

On-Orbit Vacuum Cycles	30
Ground No-Load Cycles	9
Ground Load Cycles	2

The hardware to which this requirement applies is that used for a nominal docking, including the passive structural hooks, the structure (base with seals and stationary guide ring), the resource electrical connectors, and pushers.

c. Pigtail Cables. The requirements of 130.3.2.1.1 apply.

160.3.2.1.1.2 Useful Life. The APDA shall have a minimum useful life of the operating cycles specified in 3.2.1.1.1 which are equivalent to the following.

a. -7002 APDA Three Orbiter missions in a five-year life without maintenance.
b. -8002 APDA Three Orbiter missions in a five-year life without maintenance.

An Orbiter mission is defined as including all applicable operations and environments including launch, on-orbit, and landing phases.

160.3.2.1.1.3 Shelf Life. The APDAs shall be capable of operating in accordance with the requirements herein any time within a period of five years from the date of delivery when exposed to the applicable environments of 160.3.2.5.

160.3.2.1.1.4 Pyrotechnic Release Devices. Unique service-life requirements for pyrotechnic release devices are given in Appendix XII.

160.3.2.1.2 CG and Moment of Inertia. The center of gravity (CG) of the mechanisms shall be determined in three axes from a defined reference datum shown in Figures 160-2 and 160-3. The moments of inertia shall be calculated about the CG of the APDA.

160.3.2.1.3 Forces, Moments and Dynamic Excursion Limit. The APDA shall limit the mating forces, moments and dynamic excursions at the interface to those defined in Table 160-4 with the spacecraft mass properties defined in Tables 160-6 and 160-7.

160.3.2.1.4 Vehicle Undocking. The four separation plungers (two on each system) shall induce an initial separation force of 250 kgf (551 lbs) minimum and 270 kgf (595 lbs) maximum. To demate, the work (energy) applied shall be between 4.0 kgf-m (28.9 ft-lbs) and 4.3 kgf-m (31.1 ft-lbs).

160.3.2.2 Physical Characteristics. The requirements of 20.3.2.2 apply except as follows:

160.3.2.2.1 Envelopes. The envelope of the APDAs shall not exceed the dimensions shown in Figures 160-2 and 160-3.

160.3.2.2.1.1 Interface Hardware

160.3.2.2.1.1.1 Resource-Transfer Umbilicals. The envelope of the resource-transfer umbilicals shall not exceed the dimensions shown in Figures 160-2 and 160-3.

160.3.2.2.1.1.2 Laser Reflector. Deleted.

160.3.2.2.1.1.3 Docking Target. The envelope of the -8002 APDA Docking Target shall be as shown in Figure 160-3.

160.3.2.2.1.1.4 Pigtail Cables. The envelope dimensions shall be as shown on Figure 160-5.

160.3.2.2.2 Weight. The weight of the resource-transfer umbilicals, panels, and mounting hardware shall not exceed 9.1 kgf (20 lbs). The weight of the APDAs, not including the resource-transfer umbilicals, shall not exceed the following:

a. -7002 APDA: 310.0 kg
b. -8002 APDA: 210.0 kg

160.3.2.2.3 Strength. The APDA shall have adequate strength and stiffness at the design temperature to withstand limit loads and pressures without detrimental yielding and ultimate loads and pressures without failure. The load combinations are defined in Table 160-4. The APDA shall exhibit a minimum margin of safety equal to zero.

160.3.2.2.4 Factors of Safety. The requirements of 20.3.2.2.4 apply.

160.3.2.2.5 Fracture Control. The requirements of 20.3.2.2.5 apply.

160.3.2.2.6 Fatigue. The requirements of 20.3.2.2.6 apply.

160.3.2.2.7 Creep. The requirements of 20.3.2.2.7 apply.

160.3.2.2.8 Insulation Resistance. The requirements of 20.3.2.2.8 apply.

160.3.2.2.9 Dielectric Strength. The APDA shall be capable of withstanding 200 Vac between any isolated circuit and the case or enclosure for one second. There shall be no arc-over or leakage greater than 100 milliamperes. The Seller's installation drawing and other applicable documents shall include any necessary caution notes regarding dielectric or other test voltages with regard to connected terminals, terminals across capacitors, integrated circuits, semiconductors and other polarity sensitive devices. Buyer must approve any variation with this requirement.

160.3.2.2.10 Exterior Surface Finish. The requirements of 20.3.2.2.10 apply.

160.3.2.2.11 Cycle Definition. For purposes of life certification, as defined in 20.3.2.1.1, one APDA cycle is defined to include one capture latch operational cycle (per 20.3.2.2.12.1.6), one structural hook operational cycle (per 20.3.2.2.12.2.8), and one attenuation mechanism operational cycle (per 20.3.2.2.12.3.12).

160.3.2.2.12 Subsystem Requirements. The following sections describe the requirements of each mechanical subsystem as an installed subsystem of the APDA.

160.3.2.2.12.1 Capture-Latch Mechanism of APDA -7002. The requirements of 20.3.2.2.12.1 apply, for APDA -7002 only.

160.3.2.2.12.2 Structural Hook Mechanism.

a. -7002 APDA
Each of 12 hook locations shall have a passive and an active hook. The structural hook mechanism shall consist of twelve hooks driven in two sets of six hooks comprising alternate hooks. Each set is driven with an actuator with redundant motors powered through a pulley and cable system to the hooks. Each actuator shall consist of redundant motors driving the output through a reduction unit. The redundant motors shall operate concurrently and failure of either motor shall not affect the output torque or the operation of the remaining motor, but the actuator rate may be reduced by 50%. APDA -7002 only shall have the capability to release only active hooks pyrotechnically (Reference Appendix XII). Each active hook shall be equipped with a micro switch capable of indicating the closed position of the hook.

b. -8002 APDA
Each of 12 hook locations shall have one passive hook. The -8002 APDA shall have no pyrotechnic devices and no sensors of any kind.

160.3.2.2.12.2.1 Load/Stroke. The requirements of 20.3.2.2.12.2.1 apply to APDA -7002/-8002, with mated loads as shown in Table 160-5.

160.3.2.2.12.2.2 Limit Load. The requirements of 20.3.2.2.12.2.2 apply to APDA -7002/-8002 with mated loads as shown in Table 160-5.

160.3.2.2.12.2.3 Ultimate Load. The requirements of 20.3.2.2.12.2.3 apply to APDAs -7002 and -8002.

160.3.2.2.12.2.4 Stall/Maximum Load. The requirements of 20.3.2.2.12.2.4 apply to APDA -7002.

160.3.2.2.12.2.5 Aiding Loads. The requirements of 20.3.2.2.12.2.5 apply to APDA -7002.

160.3.2.2.12.2.6 Irreversibility. The requirements of 20.3.2.2.12.2.6 apply to APDA -7002.

160.3.2.2.12.2.7 Speed/Rate. The requirements of 20.3.2.2.12.2.7 apply to APDA -7002.

160.3.2.2.12.2.8 Operational Cycles. The requirements of 20.3.2.2.12.2.8 apply to APDA -7002.

160.3.2.2.12.2.9 Mechanical Stops. The requirements of 20.3.2.2.12.2.9 apply to APDA -7002.

160.3.2.2.12.2.10 Pyrodevices. APDA -7002 shall be equipped with pyrodevices. Pyrodevices shall assure emergency undocking for all 12 active hooks. Reference requirements of Appendix XII.

160.3.2.2.12.3 Extend/Retract and Attenuation Mechanisms. The requirements on APDA - 7001 in 20.3.2.2.12.3 apply to APDA -7002 here.

160.3.2.2.12.3.1 System Stiffness and Damping Characteristics. The requirements of 20.3.2.2.12.3.1 apply, with the performance requirements of Table 160-4 here.

160.3.2.2.12.3.1.1 Axial Slip Clutch. The requirements of 20.3.2.2.12.3.1.1B apply.

160.3.2.2.12.3.1.2 Shock Spring. The requirements of 20.3.2.2.12.3.1.2 apply.

160.3.2.2.12.3.1.3 Deleted.

160.3.2.2.12.3.1.4 Initial Position. The initial position of the -7002 APDA shall meet the requirements of Figure 160-2.

160.3.2.2.12.3.1.5 Guide Ring Dampers. The requirements of 20.3.2.2.12.3.1.5B apply.

160.3.2.2.12.3.1.6 Guide Ring Centering Spring. The requirements of 20.3.2.2.12.3.1.6B apply.

160.3.2.2.12.3.1.7 High Energy Dampers. The requirements of 20.3.2.2.12.3.1.6B apply.

160.3.2.2.12.3.2 Load/Stroke. The requirements of 20.3.2.2.12.3.2 apply, under the nominal operating loads of Table 160-4 here.

160.3.2.2.12.3.3 Maximum Angle of Rotation. The requirements of 20.3.2.2.12.3.3 apply.

160.3.2.2.12.3.4 Rotational Applied Contact and Return Moments. The requirements of 20.3.2.2.12.3.4B apply.

160.3.2.2.12.3.5 Parallel Applied Contact and Return Forces. Contact and return forces parallel to the interface surfaces shall be:

Guide Ring Displacement	Direction of Y_T axis		Direction of Z_T axis	
	Applied Contact Force kgf	Return Force kgf	Applied Contact Force kgf	Return Force kgf
Prior to Sensor Initiation *	55±25	50±15	55±15	50±15
50 mm	110±30	90±25	110±30	90±25
100 mm	190±50	160±50	180±50	160±40

* Note: Sensor initiation to be at 8 mm maximum

160.3.2.2.12.3.6 Limit Load. The requirements of 20.3.2.2.12.3.6 apply, using the velocities and misalignments of Table 160-4 here.

160.3.2.2.12.3.7 Ultimate Load. The requirements of 20.3.2.2.12.3.7 apply.

160.3.2.2.12.3.8 Stall/Maximum Load. The requirements of 20.3.2.2.12.3.8 apply.

160.3.2.2.12.3.9 Aiding Loads. The requirements of 20.3.2.2.12.3.9 apply.

160.3.2.2.12.3.10 Irreversibility. The requirements of 20.3.2.2.12.3.10 apply.

160.3.2.2.12.3.11 Speed/Rate. The requirements of 20.3.2.2.12.3.11B apply.

160.3.2.2.12.3.12 Operational Cycles. The requirements of 20.3.2.2.12.3.12 apply.

160.3.2.2.12.3.13 Mechanical Stops. The requirements of 20.3.2.2.12.3.13 apply.

160.3.2.2.12.3.14 Ring Rotation Moment. The requirements of 20.3.2.2.12.3.14 apply.

160.3.2.2.12.3.15 Fixers. The requirements of 20.3.2.2.12.3.15 apply.

160.3.2.2.13 Commands and Indications. The APDAs shall be designed to respond to the commands in Table 160-1.APDA -7002 shall be designed to provide the position indications listed in Table 160-1.

160.3.2.2.15 Deleted.

160.3.2.2.16 Optical Properties. The requirements of 20.3.2.2.16 apply.

160.3.2.2.17 Capture-Latch Heaters. The requirements of 20.3.2.2.17 apply to APDA -7002.

160.3.2.3 Reliability. The requirements of 3.2.3 apply except that for the ICM the APDAs shall be single-failure-tolerant for both docking and undocking.

160.3.2.4 Maintainability. The requirements of 3.2.4 apply.

Table 160-1. Command and Indication Requirements for APDA -7002

COMMAND	EVENT
Ring Out	Extend capture ring to initial position or final position
Ring In	Retract capture ring to final position
Open Hooks	Open structural hooks (System 1 & 2)
Close Hooks	Latch structural hooks (System 1 & 2)
Open Latches	Open capture latches to release position
Close Latches	Latch capture latches to ready-to-capture position
Fixer Off	Unlock fixers (five ballscrew-and-nut differentials)
Active Hooks Fire	Initiates pyros for 12 active hooks
INDICATION	**EVENT**
Ring Initial Position	Capture ring ready to dock
Ring Final Position	Capture ring retracted. Final position sensors shall initiate if interface surface of ring is 4.5 + 3 mm lower than seal interface of assembly.
Ring Aligned	Capture ring centered (five sensors aligned) An 8 mm deflection or 1°18' rotation of the guide ring from the initial position, fixers off, parallel to the seal interface in any direction shall actuate one of the misalignment sensors.
Ring Forward Position	Capture ring extended
Hooks 1 Open	Structural hooks open (System 1, six hooks)
Hooks 1 Closed	Structural hooks closed (System 1, six hooks)
Hooks 2 Open	Structural hooks open (System 2, six hooks)
Hooks 2 Closed	Structural hooks closed (System 2, six hooks)
Hook Closed Position Indicator	Verifies closure of each active structural hook
Latches Retracted	Capture latches ready to capture (three latches)
Latches Extended	Capture latches released (three latches)
Latches Extended (Manual)	Capture latches manually released
Fixer Off	Fixers (five ballscrew-&-nut differentials) unlocked
Ready To Hook	Seal interface within reach of structural hooks
Undocking Complete	Undocking Complete
Interface Sealed	Structural seal compressed
Initial Contact	Signal from any one of five alignment sensors
Capture	Contact sensors on ring actuated
Linear Translation	Linear translation of guide ring
Temperature Sensors	Monitor temperature of various components

160.3.2.5 Environments. APDA requirements of 3.2.5 apply, with the following correspondences:

Requirements on -7001 in JSC 26938 apply to -7002 here.
Requirements on -8001 in JSC 26938 apply to -8002 here.

160.3.2.6 Transportability. The requirements of 3.2.6 apply.

160.3.3 Design and Construction. The requirements of 3.3 apply.

160.4. QUALITY ASSURANCE PROVISIONS

160.4.1 General Requirements. The requirements of 4.1 apply.

160.4.2 Quality Conformance. The requirements of 4.2 apply.

160.4.2.1 Development. The requirements of 4.2.1 apply.

160.4.2.2 Acceptance.

a. APDA. The requirements of 20.4.2.2 apply, with the inspections and tests of Table 160-2 here.

b. Pigtail Cables. The requirements of 130.4.2.2 apply.

c. Pyrotechnic Release Devices. The requirements of 120.4.2.2 apply.

160.4.2.2.1 Examination of Product. The requirements of 20.4.2.2.1 apply.

160.4.2.2.2 Electrical Circuit Verification Test. The requirements of 20.4.2.2.2 apply.

160.4.2.2.3 Electrical Insulation Resistance Test. The requirements of 20.4.2.2.3 apply.

160.4.2.2.4 Dielectric Strength Test. Test each electromechanical device at the component level (subassembly level testing is acceptable) to 200 Vac from case or enclosure to any circuit and between mutually insulated parts for one second. Verify no arc-over or leakage greater than 100 milliamperes.

160.4.2.2.5 Functional Performance Tests

160.4.2.2.5.1 Guide Ring Test. The requirements on APDA -7001 in 20.4.2.2.5.1 apply to APDA -7002 here.

160.4.2.2.5.1.1 No Back Functional. The requirements of 20.4.2.2.5.1.1 apply to APDA -7002 here.

160.4.2.2.5.2 Fixer Test. The requirements of 20.4.2.2.5.2 apply to APDA -7002.

160.4.2.2.5.3 Interface Sensor Test. The requirements of 20.4.2.2.5.3A apply to APDA -7002.

160.4.2.2.5.4 Structural Hook Test. The requirements of 20.4.2.2.5.4 apply to APDA -7002.

Table 160-2. APDA Acceptance Requirements

Inspection and Test	Sequence	APDA -7002	APDA -8002
Examination of Product	160.4.2.2.1	x	x
Electrical Circuit Verification	160.4.2.2.2	x	x
Electrical Insulation Resistance	160.4.2.2.3	x	x
Dielectric Strength	160.4.2.2.4	x	
Functional Performance Tests			
Guide Ring	160.4.2.2.5.1	x	
Fixer	160.4.2.2.5.2	x	
Interface Sensor	160.4.2.2.5.3	x	
Structural Hook	160.4.2.2.5.4	x	
Capture Latch	160.4.2.2.5.5	x	
Heater	160.4.2.2.5.6	x	
High-energy damper	160.4.2.2.5.7	x	
Instrumentation Calibration	160.4.2.2.5.8	x	
Acceptance Vibration	160.4.2.2.6	x	x
Loads			
Axial Stiffness in Initial Position	160.4.2.2.7.1	x	
Retraction Force	160.4.2.2.7.2	x	
Restraining Force	160.4.2.2.7.3	x	
Body Latch Load	160.4.2.2.7.4		x
Capture Latch Force	160.4.2.2.7.5	x	
Capture Latch Unlatch Force	160.4.2.2.7.6	x	
Translation Capability, Y_T & Z_T axes	160.4.2.2.7.7	x	
Rotational Capability, Y_T & Z_T axes	160.4.2.2.7.8	x	
Rotational Capability, X_T axis	160.4.2.2.7.9	x	
Acceptance Thermal Vacuum	160.4.2.2.8	x	
APDA Body Component Proof Pressure	160.4.2.2.10	x	x
Optical Properties	160.4.2.2.13	x	x
Weight Measurement	160.4.2.2.14	x	x

160.4.2.2.5.5 Capture-Latch Test. The requirements of 20.4.2.2.5.5 apply to APDA -7002.

160.4.2.2.5.6 Heater Test. The requirements of 20.4.2.2.5.6 apply.

160.4.2.2.5.7 Damper Tests. The requirements of 20.4.2.2.5.7 apply to APDA -7002.

160.4.2.2.5.8 Instrumentation Calibration Tests. The requirements of 20.4.2.2.5.8 apply to APDA -7002.

160.4.2.2.6 Acceptance Vibration Tests. The requirements of 20.4.2.2.6 apply.

160.4.2.2.7 Loads Tests

160.4.2.2.7.1 Test of Axial Stiffness in Initial Position. The requirements of 20.4.2.2.7.1 apply to APDA -7002.

160.4.2.2.7.2 Retraction Force Test. The requirements of 20.4.2.2.7.2 apply to APDA -7002.

160.4.2.2.7.3 Restraining Force Test. The requirements of 20.4.2.2.7.3 apply to APDA -7002.

160.4.2.2.7.4 Body Latch Load Test. The requirements of 20.4.2.2.7.4 apply to APDA -8002.

160.4.2.2.7.5 Capture Latch Latching-Force Test. The requirements of 20.4.2.2.7.5 apply to APDA -7002.

160.4.2.2.7.6 Capture Latch Unlatching-Force Test. The requirements of 20.4.2.2.7.6 apply to APDA -7002.

With the Capture Latches open, measure the force required to release the Capture Latches using a counterbalanced test ring to simulate undocking. Force to release open latches shall not exceed 12 kgf.

160.4.2.2.7.7 Translation Capability Test (Y_T & Z_T axes). The requirements of 20.4.2.2.7.7(B) apply to APDA -7002.

160.4.2.2.7.8 Rotational Capability Test (Y_T & Z_T axes). The requirements of 20.4.2.2.7.8(B) apply to APDA -7002.

160.4.2.2.7.9 Rotational Capability Test About X_T axis. The requirements of 20.4.2.2.7.9(B) apply to APDA -7002.

160.4.2.2.8 Acceptance Thermal Vacuum Test. The requirements of 20.4.2.2.8 apply.

160.4.2.2.9 Deleted.

160.4.2.2.10 APDA Body-Component Proof-Pressure Test. The requirements of 20.4.2.2.10 apply to the body components of APDAs -7002 and -8002.

160.4.2.2.11 Deleted.

160.4.2.2.12 Deleted.

160.4.2.2.13 Optical-Properties Test. The requirements of 20.4.2.2.13 apply.

160.4.2.2.14 Weight Measurement. The requirements of 20.4.2.2.14 apply.

160.4.2.3 Assessment. The requirements of 4.2.3 apply.

160.4.2.4 Certification. The requirements of 20.4.2.4 apply.

160.4.2.4.1 Qualification Tests.

a. APDA. Qualification testing shall be in conformance with the requirements of this paragraph. Where and to the extent qualification is accomplished by test, qualification-test specimens shall be subjected to the tests specified in Table 160-3.1 in the sequence shown. Qualification test hardware shall be of the same configuration as APDA -7002 flight hardware.

b. Pigtail Cables. The requirements of 130.4.2.4.1 apply.

160.4.2.4.1.1 Examination of Product. The requirements of 20.4.2.4.1.1 apply.

160.4.2.4.1.2 Transportation-Strength Test. The requirements of 20.4.2.4.1.2 apply.

160.4.2.4.1.3 Qualification Vibration Test. The requirements on APDAs -7001 and -8001 of 20.4.2.4.1.3 apply to APDA -7002 here.

160.4.2.4.1.4 Shock-Basic Design Test. The requirements on APDAs -7001 and -8001 of 20.4.2.4.1.4 apply to APDA -7002 here.

160.4.2.4.1.5 Acoustic Noise Test. The requirements on APDAs -7001 and -8001 of 20.4.2.4.1.5 apply to APDA -7002 here.

Table 160-3.1. APDA Qualification Requirements

Inspection and Test	Sequence	APDA -7002
Acceptance (Examination of Product, Dome Lest Test only)	160.4.2.2	x
Examination of Product	160.4.2.4.1.1	x
Transportation Strength	160.4.2.4.1.2	x
Qualification Vibration	160.4.2.4.1.3	x
Shock-Basic Design	160.4.2.4.1.4	x
Acoustic Noise	160.4.2.4.1.5	x
Disassembly Inspection	160.4.2.4.1.14	x

160.4.2.4.1.6 Deleted.

160.4.2.4.1.7 Deleted.

160.4.2.4.1.8 Deleted.

160.4.2.4.1.9 Deleted.

160.4.2.4.1.10 Deleted

160.4.2.4.1.11 Deleted

160.4.2.4.1.11.5 Deleted.

160.4.2.4.1.11.6 Deleted.

160.4.2.4.1.11.7 Deleted.

160.4.2.4.1.11.8 Deleted.

160.4.2.4.1.11.9 Deleted.

160.4.2.4.1.12 Deleted.

160.4.2.4.1.13 Deleted.

160.4.2.1.14 Disassembly Inspection. The requirements of 20.4.2.4.1.14 apply.

160.4.2.4.2 Certification by Analysis. The requirements of 20.4.2.4 apply. Seller shall provide data in a report to demonstrate certification of the following requirements by analysis:

Table 160-3.2. Analysis Requirements

Analysis	Paragraph	APDA -7002	APDA -8002
Qualification Thermal Vacuum	20.4.2.4.1.7	x	x
Six Degree of Freedom (Modeling)	20.4.2.4.1.9	x	
Service Life	20.4.2.4.1.10	x	x
Loads	20.4.2.4.1.11		
Extend/Retract Mechanism Limit Load	20.4.2.4.1.11.1	x	
Extend/Retract Mechanism Ultimate Load	20.4.2.4.1.11.2	x	
Capture and Body Latch Ultimate Load	20.4.2.4.1.11.3	x	x
Simultaneous Loads	20.4.2.4.1.11.4	x	x
Structural Hook Component Loads	20.4.2.4.1.11.5	x	x
Ultimate Translational Load	20.4.2.4.1.11.6	x	
Ultimate Rotational Load	20.4.2.4.1.11.7	x	
Fixer Limit Load	20.4.2.4.1.11.8	x	
Fixer Ultimate Load	20.4.2.4.1.11.9	x	
Pyrotechnic Shock	20.4.2.4.1.12	x	
Pressure	20.4.2.4.1.13	x	x

160.4.2.5 Verification Requirements Matrices. The Seller's verification program shall satisfy the performance and design verification requirements specified in Table 160-3.3.

Table 160 -3.3 Performance and Design Verification Matrix

VERIFICATION METHOD

1. Analysis
2. Assessment
   a. Inspection
   b. Review of Design
3. Test
   a. Development
   b. Qualification
   c. Acceptance

N/A - Not Applicable

Section 160.3 and 160.5 Requirement No.	Requirements	Verification Method							Related Section 160.4 Reqmnt No.
			1	2		3			
		N/A		a	b	a	b	c	
160.3	REQUIREMENTS	X							
160.3.1	Item Definition	X							
160.3.1.1	Subsystem Definition			X	X				160.4.2.2.1
160.3.1.1.1	Functional Definition							X	160.4.2.2.2
160.3.1.2	Interface Definition	X							
160.3.1.2.1	Electrical Power Characteristics			X	X				160.4.2.2.1
160.3.1.2.1.1	Electrical Interface and Connectors			X	X				160.4.2.2.1
160.3.1.2.1.2	Resource-Transfer Umbilicals	X							
160.3.1.2.1.2.1	Mounting and Pin Assignments			X	X				160.4.2.2.1
160.3.1.2.1.2.2	Engagement and Disengagement							X	160.4.2.2.2
160.3.1.2.2	Mounting			X	X				160.4.2.2.1
160.3.1.2.3	-8002 APDA-to-ICM Interface			X	X				160.4.2.2.1
160.3.1.2.4	-7002 APDA-to-FGB Interface			X	X				160.4.2.2.1
160.3.1.2.5	Active-APDA-to-Passive-APDA Interface		X						160.4.2.4.2
160.3.1.2.6	Pressure		X						160.4.2.4.2
160.3.1.3	Item Identification			X					160.4.2.2.1
160.3.1.3.1	Cable Set Identification			X					160.4.2.2.1
160.3.2	Characteristics	X							
160.3.2.1	Performance Characteristics				X				160.4.2.2.1
160.3.2.1.1	Life	X							
160.3.2.1.1.1	Operating Life		X						160.4.2.4.2

Table 160 -3.3 Performance and Design Verification Matrix (Cont'd)

Section 160.3 and 160.5 Requirement No.	Requirements	Verification Method							Related Section 160.4 Reqmnt No.
			1	2		3			
		N/A		a	b	a	b	c	
160.3.2.1.1.2	Useful Life		X						160.4.2.4.2
160.3.2.1.1.3	Shelf Life		X						160.4.2.4.2
160.3.2.1.1.4	Pyrotechnic Release Devices		X						160.4.2.4.2
160.3.2.1.2	CG and Moment of Inertia		X						160.4.2.4.2
160.3.2.1.3	Forces, Moments and Dynamic Excursion Limit		X						160.4.2.4.2
160.3.2.1.4	Vehicle Undocking							X	160.4.2.2.2
160.3.2.2	Physical Characteristics.		X						160.4.2.4.2
160.3.2.2.1	Envelopes.			X					160.4.2.2.1
160.3.2.2.1.1	Interface Hardware	X							
160.3.2.2.1.1.1	Resource-Transfer Umbilicals			X					160.4.2.2.1
160.3.2.2.1.1.3	Docking Target			X					160.4.2.2.1
160.3.2.2.1.1.4	Pigtail Cables			X					160.4.2.2.1
160.3.2.2.2	Weight.							X	160.4.2.2
160.3.2.2.3	Strength		X						160.4.2.4.2
160.3.2.2.4	Factors of Safety		X						160.4.2.4.2
160.3.2.2.5	Fracture Control		X						160.4.2.4.2
160.3.2.2.6	Fatigue		X						160.4.2.4.2
160.3.2.2.7	Creep		X						160.4.2.4.2
160.3.2.2.8	Insulation Resistance							X	160.4.2.2.3
160.3.2.2.9	Dielectric Strength							X	160.4.2.2.4
160.3.2.2.10	Exterior Surface Finish		X						160.4.2.4.2
160.3.2.2.11	Cycle Definition	X							
160.3.2.2.12	Subsystem Requirements	X							
160.3.2.2.12.1	Capture-Latch Mechanism of APDA -7002							X	160.4.2.2
160.3.2.2.12.2	Structural Hook Mechanism							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.2.1	Load/Stroke							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.2.2	Limit Load							X	160.4.2.2
160.3.2.2.12.2.3	Ultimate load		X						160.4.2.2

Table 160 -3.3 Performance and Design Verification Matrix (Cont'd)

Section 160.3 and 160.5 Requirement No.	Requirements	Verification Method							Related Section 160.4 Reqmnt No.
			1	2		3			
		N/A		a	b	a	b	c	
160.3.2.2.12.2.4	Stall/Maximum Load							X	160.4.2.2
160.3.2.2.12.2.5	Aiding Loads							X	160.4.2.2
160.3.2.2.12.2.6	Irreversibility							X	160.4.2.2
160.3.2.2.12.2.7	Speed/Rate							X	160.4.2.2
160.3.2.2.12.2.8	Operational Cycles							X	160.4.2.2
160.3.2.2.12.2.9	Mechanical Stops							X	160.4.2.2
160.3.2.2.12.2.10	Pyrodevices			X					160.4.2.2
160.3.2.2.12.3	Extend/Retract and Attenuation Mechanisms							X	160.4.2.2
160.3.2.2.12.3.1	System Stiffness and Damping Characteristics							X	160.4.2.2
160.3.2.2.12.3.1.1	Axial Slip Clutch							X	160.4.2.2
160.3.2.2.12.3.1.2	Shock Spring							X	160.4.2.2
160.3.2.2.12.3.1.4	Initial Position							X	160.4.2.2
160.3.2.2.12.3.1.5	Guide Ring Dampers							X	160.4.2.2, 160.4.2.2.5.1
160.3.2.2.12.3.1.6	Guide Ring Centering Spring							X	160.4.2.2
160.3.2.2.12.3.1.7	High Energy Dampers							X	160.4.2.2
160.3.2.2.12.3.2	Load/Stroke							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.3.3	Maximum Angle of Rotation							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.3.4	Rotational Applied Contact and Return Moments							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.3.5	Parallel Applied Contact and Return Forces							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.3.6	Limit Load							X	160.4.2.2
160.3.2.2.12.3.7	Ultimate Load							X	160.4.2.2
160.3.2.2.12.3.8	Stall/Maximum Load							X	160.4.2.2
160.3.2.2.12.3.9	Aiding Loads							X	160.4.2.2
160.3.2.2.12.3.10	Irreversibility							X	160.4.2.2
160.3.2.2.12.3.11	Speed/Rate							X	160.4.2.2

Table 160 -3.3 Performance and Design Verification Matrix (Cont'd)

Section 160.3 and 160.5 Requirement No.	Requirements	Verification Method							Related Section 160.4 Reqmnt No.
			1	2		3			
		N/A		a	b	a	b	c	
160.3.2.2.12.3.12	Operational Cycles							X	160.4.2.2
160.3.2.2.12.3.13	Mechanical Stops							X	160.4.2.2
160.3.2.2.12.3.14	Ring Rotation Moment							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.3.15	Fixers							X	160.4.2.2, 160.4.2.2.5.2
160.3.2.2.13	Commands and Indications							X	160.4.2.2
160.3.2.2.16	Optical Properties							X	160.4.2.2
160.3.2.2.17	Capture-Latch Heaters							X	160.4.2.2, 160.4.2.2.5.6
160.3.2.3	Reliability		X						160.4.2.4.2
160.3.2.4	Maintainability		X						160.4.2.4.2
160.3.2.5	Environments							X	160.4.2.2
160.3.2.6	Transportability		X						160.4.2.4.2
160.3.3	Design and Construction		X						160.4.2.4.2
5	Preparation for Delivery			X					

160.5 PREPARATION FOR DELIVERY. The requirements of Section 5 apply.

160.6 NOTES. The requirements of Section 6 apply.

160.7 FIELD SUPPORT EQUIPMENT

The following field support equipment is a part of the deliverable hardware covered by this specification:

1. Carriage	VK.7809-2006	1
2. Carriage	VK.7809-1424 AM	1
3. Ring with attachment hardware	11N565.1762-11	2
4. Strut with attachment hardware	11N565.1762-19	6

5. Test cables for the -7002 X3 and X4 connectors to simulate the FGB side of the interface

160.8 SPARES AND GROUND PROCESSING

160.8.1 Spares. Spares, such as seals, grease, and other consumable, as required to support processing of the APDAs at NRL and KSC, shall be provided with the delivery of the APDAs.

160.8.2 Ground Processing. Requirements for maintenance and support of the APDAs for ground processing shall be defined in the Operations Manual, paragraph 12.15 of QA 12.

160.9 DOCUMENTATION FOR ICM APDA

160.9.1 The following documents shall be updated and resubmitted to include the work required by this Appendix XVI.

CM 04	As-Built Configuration Record
QA 12	Acceptance Data Package
RA 22	Failure Modes and Effects Analysis/Critical Items List (Appendix)
RA 24	Problem Reporting and Corrective Action
SA 07	Risk Assessment Report (Appendix)
SE 03	Drawings and Associated Lists (Envelope/Assembly drawings, Parts Lists, Engineering Changes, Schematics)
TM 06	Test and Analysis Reports
TM 11	Qualification and Acceptance Test Procedures
QA 15A	Pyrotechnic Data

160.9.2 The following documents need not be updated, but are applicable to the work performed by this Appendix XVI:

CM 01	Configuration Management Plan
PG 01A	Packaging and Transport Data
QA 01	Quality Assurance Plan
SA 05	System Safety Plan

Table 160-4. Forces, Moments and Dynamic-Excursion Limits
APDA -7002 PERFORMANCE REQUIREMENTS

a. Capture and attenuate with the following mass properties
Orbiter see Table 160-6 FGB see Table 160-7

b. Contact Condition Limits (10)

Axial Velocity	0.0 to 0.2 ft/sec (0.0 to 70.0 mm/sec)
Lateral Velocity	0±0.15 ft/sec (radial)
Angular Velocity	0±0.20 deg/sec/axis
Lateral Misalignment (8)	0±4.2 in (radial)
Angular Misalignment	0±4.0 deg/axis(2) About X_T: 0±4.0 deg

c. APDA Mating and Demating Forces and Moments

	Docking		Extension at Mechanical Stop		Retraction at Mechanical Stop	
Load	-7002	-8002	-7002	-8002	-7002	-8002
Tension	1000 kgf	1000±50 kgf	n/a	n/a	2200 kgf *	2200 kgf *
Compression (Static)	1000 kgf	1000±50 kgf	1000 kgf *	n/a	n/a	n/a
Compression (Dynamic - < 0.1 sec.)	1900 kgf	1900 kgf	n/a	n/a	n/a	n/a
Shear (7)	±500 kgf	±500 kgf	n/a	n/a	n/a	n/a
Bending (7)	±500 kgf-m	±500 kgf-m	±500 kgf-m	±500 kgf-m	n/a	n/a
Torsion	±300 kgf-m	±300 kgf-m	±300 kgf-m	±300 kgf-m	n/a	n/a

* = APDA internal loads not transmitted to FGB

d. Vehicle Relative Dynamic Rotation Limits During Mating (6)

$\theta_{x,y}$ 13°
θ_z 13°

e. Undocking Separation Conditions (3) e
In accordance with 3.2.1.4

Table 160-5. Forces, Moments and Dynamic Excursion Limits

MATED DESIGN LIMIT LOADS (1) (4) (5) (9)

APDA -7002/-8002

(12 Structural Hooks Engaged)

	CASE 1	CASE 2	CASE 3	CASE 4(-8002 only)
Axial	±500 kgf (1100 lbs)	±500 kgf (1100 lbs)	±1800 kgf (3970 lbs)	±1360 kgf (3000 lbs)
Shear (7)	±500 kgf (1100 lbs)	± 500 kgf (1100 lbs)	±1360 kgf (3000 lbs)	±1820 kgf (4000 lbs)
Bending (7)	±4000 kgf-m (346,800 in-lbs)	±6650 kgf-m (577,000 in-lbs)	±4000 kgf-m (346,800 in-lbs)	±4960 kgf-m (430,000 in-lbs)
Torsion	±6650 kgf-m (577,000 in-lbs)	±4000 kgf-m (346,800 in-lbs)	±4000 kgf-m (346,800 in-lbs)	±690 kgf-m (60,000 in-lbs)

Notes for Tables 160-4 and 160-5.

(1) These values are 3s maxima and shall be applied simultaneously in a statistically appropriate manner, provided that the reach capability of the internal petals is not exceeded

(2) 4 deg. about any axis within the Orbiter x-y (Y_T - Z_T) plane.

(3) Impulse shall be applied at the center of the docking interface and along the mechanism X_T axis.

(4) For design purposes, the loads and moments shall apply simultaneously. Loads shall be applied at the center of the docking interface.

(5) These are maximum case-consistent loads.

(6) These can be simultaneous dynamic rotations.

(7) Value is a vector sum

(8) Lateral misalignment is defined as the minimum distance between the center of the active ring of the APDA and the longitudinal axis of the capture ring of the passive APDA at the moment of first contact between the guide petals.

(9) Loads (Table 160-5) and Fatigue Load Spectrum (Table 160-8) are given on the basis of load carrying capacity of the docking assembly and does not exceed the confirmed scope of tests for APDAs -6001, -7001, or -8001.

(10) Orbiter RCS jets will be used during docking to assist capture dynamics. Two nose, F1D and F2D, and two tail, L3D and R3D, jets will be operated from first contact to capture. A 1.0 second pilot reaction time, starting from first contact, is assumed before the PRCS jets are activated. Post Contact Thrusting (PCT) shall consists of three 80 millisecond nose and tail jet firings with 160 millisecond delay between them, a 1.0 second wait, and finally four 160 millisecond nose and tail firings with 80 millisecond delay between them. Each RCS pulse for docking operation, has a ramp-up time of 0.01 seconds to the maximum forces or moments shown in Table 160-5.1. Forces/Moments stay at the specified levels for 0.070 seconds for the first phase of firing, and for 0.150 seconds for the second phase of firing. The ramp-down time from the maximum value to zero is also 0.010 seconds.

Table 160-5.1. RCS Forces and Moments

Fxo	=	-152.28	kg
Fyo	=	0	
Fzo	=	1113.85	kg
Mxo	=	16.933	kg-m
Myo	=	5026.63	kg-m
Mzo	=	2.31	kg-m

Table 160-6. Orbiter Mass Properties

WEIGHT (lbs)	C.G. (in)			MOMENT OF INERTIA (slug-ft^2 x 10^5)			PRODUCT OF INERTIA (slug-ft^2 x 10^5)		
	X_0	Y_0	Z_0	I_{xx}	I_{yy}	I_{zz}	P_{xy}	P_{xz}	P_{yz}
247983 (high)	1092.7	-0.2	375.7	10.98	75.62	77.54	7.62	2499.06	-81.96
205713 (low)	1102.1	-0.15	372.24	10.57	75.76	75.72	18.55	2568.18	77.36

Table 160-7. ICM/ISSMass Properties

	ICM Attachment To Orbiter	ISS 2A.1 Assembly Stage
Weight (kg)	9182	56985
Moment of Inertia (kg-m^2)		
Ixx	17749	7566793
Iyy	17129	7467926
Izz	17924	232051
Products of Inertia (kg-m^2)		
Ixy	+1124	-13
Iyz	-52	-3082
Ixz	-105	-140534
c.g. offset from docking I/F (m)		
X	0.00	-0.081
Y	0.00	0.0
Z	2.41	21.39
RELATIVE ALIGNMENT IN ORBITER STRUCTURAL AXIS	SPACE STATION AXIS OF ALIGNMENT	
X	Positive X	Negative Z
Y	Positive Y	Negative Y
Z	Positive Z	Negative X

Mass properties are in the orbiter structural coordinate system. All products of inertia are negative integrals.

Table 160-8. Fatigue Load Spectrum

Amplitude Tier Percent of Limit Load	-7002/-8002 APDA Cycle Count
90-100	10
80-90	50
70-80	100
60-70	700
50-60	1,000
40-50	4,000
30-40	22,000
20-30	50,000
15-20	50,000
10-15	400,000
5-10	5,000,000
2.5-5	5,000,000

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
SA20	Report, Fault Tree Analysis	1 June, 1995	Quarterly (every 3 months)	Yes

Requirement. A document that depicts in a qualitative graphical and logical representation, the various combinations of possible events, both fault and normal, which can occur in the APDS and which can cause a pre-defined undesired event. An undesired event is any event which is identified as objectionable and unwanted, such as a potential accident, hazardous condition, or undesired failure mode. These events shall include but not be limited to: (1) inability to perform docking, (2) potential collision between the Orbiter and ISS during docking, (3) inability to separate Orbiter from ISS, and (4) loss of habitable environmental pressuring during IVA. This graphic presentation exposes the interrelationships of system events and their dependence upon each other, which may result in the occurrence of the undesired event. The fault tree shall be developed using formalized deductive logic and to the lowest level required to adequately define the undesired event.

The seller shall utilize the Fault Tree Analysis software and key provided by NASA to develop the required fault tree.

Fault Tree Analysis shall address differences by mission due to:

1) Hardware differences

2) Operations differences.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
SE03	Drawings and Associated Lists			
(a)	Preliminary Design Drawings including Schematics and Drawing Tree	014/P/PDR 014/P/CDR (Note 1)	R/ASR	No
(b)	Hardware Product Drawings including Schematics/ Assembly Level	000/W/REL (Note 2)	R/ASR	No
(c)	Below Assembly Level Detail Drawings including Schematics	72 hrs/A/RON (Note 3)	As required	No

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
(d)	Revision History File	010/A/RON	R/ASR	No
(e)	Box to Box Interface diagram showing all I/F Pins	15 days after contract go-ahead		Yes
(f)	Preliminary system Level Schematics	15 days after Contract go-ahead		Yes
(g)	Update System Level Schematics	at PDR		Yes
(h)	Final System Level Schematics	60 days prior to CDR		Yes
(i)	Retrofit Kit Drawings/ Instructions	000/W/REL	R/ASR	No
(j)	Illustrated Parts Breakdown (IPB)	000/W/REL (Note 4)	R/ASR	Yes
(k)	Geometric Math Model	at PDR	R/ASR	Yes

(These data items shall be made available to Buyer prior to kit delivery for acceptance.)

Requirement. The Seller shall prepare engineering data in forms suitable for recording designs developed for this specification for flight hardware, brassboard hardware, and the FSE defined in Appendix XI.

Notes

1. Drawing Tree - A drawing tree so arranged that the next lower assembly or part drawings are identified.
2. Limited indentured levels of Product Drawings shall be delivered to the Buyer as specified in Buyer's approved SCBD (reference CM03) subsequent to baseline/release and prior to item delivery.
3. Drawings below the assembly level and not listed in CM03 shall be required upon request only (Type III data). Under emergency conditions, Seller shall submit all required drawings within 72 hours.
4. Requirements for the IPB shall be identified and validated through maintenance analysis conducted by the Buyer.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
SEO6A	Structural Analysis and Fracture Mechanics Analysis Report	45 days prior to design release	R/ASR	No

Requirements To identify structural component margins of safety, fracture critical candidates and critical design conditions on the end item.

Notes: The report shall include as a minimum:

1. A display of the stress margin of safety summarized for the end item.

2. Analysis data for each structural component including a sketch of the component, descriptions of the critical load condition and the analysis method, margin of safety, and identification of the criterion condition.

3. The fracture-mechanics analysis shall include the anticipated load history, the loads spectra, the material crack-propagation-rate data, the stress-intensity relationship which describes the local stress field, crack size, crack morphology, and the geometry of the structure.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
SE08	Electrical Power Requirements Data	(Note)	R/ASR	Yes

Requirement. The seller shall prepare electrical power requirements data for every component furnished in accordance with this specification.

Notes: 1. Electrical power consumption of each item of flight hardware of this contract, including individual interface pins are required by the Seller. The specific function of individual interface pins shall also be identified.

2. 000/W/PRPL, 014/P/CDR, and 030/A/TST. When program does not require CDR, submittal dates will be 000/W/PRPL, 060 days prior to release of production design, and 030/A/TST.

SE10 Deleted

SE23 DELETED

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ. SUB.	BUYER APPR REQ
TM02	Certification Plan	Initial: 030/P/PDR Final: 030/P/CDR	R/ASR	Yes *

* Buyer will approve or disapprove within 45 days after authority to proceed or 45 days after receipt of revision notification.

Content - The Seller shall provide the following data in the Certification Plan:

1. Design Certification Matrix. Data to be provided by the Seller on the matrix is:

   a. All applicable APDS mechanical and avionics hardware as identified in Section 3 of the basic specification.

   b. All applicable environmental parameters from Section 3 of the basic specification identified by specification paragraph number.

   c. Summary of the available data, used to satisfy certification requirements, that exists for the hardware being procured, including test levels, duration, measured or monitored parameters.

   d. A description, by specification paragraph number, of how the available data satisfies the Section 3 requirements, or the action suggested or recommended in order for the hardware to meet the specified requirements.

2. The plan shall provide detail description of all certification activities which include qualification tests, analysis and simulations planned. The plan shall define the logic and approach and schedules planned for satisfying the certification requirements.

3. The plan shall provide a description of the Seller's traceability activities. Traceability shall be accomplished by assigning a traceability identification to traceable items and major components as identified in the Section 3 of the basic specification and by providing a means of correlating each to its historical records. Conversely, the records must be traceable to each item/major component.

4. The plan shall address the following certification/reliability programmatic requirements:

   4.1 Reliability Design Requirements. Provide documentation including numerical studies to identify the APDS processes that verify that the reliability of the APDS hardware meets the reliability requirements of this specification.

   4.2 Problem Reporting And Corrective Action System. Provide documentation to make known the APDS reliability process for control, reporting, analysis, correction, and prevention of APDS hardware failures and deliverable items during and subsequent to acceptance testing.

4.2.1 Problem Analysis. Provide documentation to make known the APDS reliability process for failure analysis and problem correction.

4.2.2 Corrective Action. The APDS program shall implement corrective action to prevent recurrence of failures when the analysis reveals the causes to be within its control. A problem report shall be considered closed when corrective action has been implemented. Notification of corrective action for all failures and problems shall be on a close-out Problems Analysis Report. Corrective actions which result in a change to configuration baseline documentation shall be processed in accordance with the configuration management system.

4.2.3 Electrical And Mechanical Parts Control. Provide documentation to make known the APDS process for controlling selection, reduction in number of types, specification, application reviews, analyzing failures, stocking and handling methods, installation procedures, and establishing reliability and quality requirements of electrical and mechanical parts.

MAINTENANCE. The plan shall be maintained current by page revision or complete re-issue, whichever is most effective, to reflect all approved program changes.

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
TM06	Reports, Test and Analysis(Certification) (6-27-73)	030/A/TST (Test) 030/P/CDR (Analysis)	R/ASR	Yes

Requirement. (a) For each LRU there shall be an Acceptance Test Procedure that describes what tests are to be accomplished, the test sequence, how each paragraph of the AT requirements of the specification will be satisfied, and how the test is to be set up and accomplished, along with the parameters to be monitored or measured, with pass-fail criteria.

(b) There shall be a Qualification Test Procedure for each LRU to be subjected to a Qualification test. The procedure shall outline what tests are to be accomplished, the test sequence, how each paragraphs of the qualification test requirements of the specification will be satisfied, and a description of how the test is to be set up and accomplished, along with the parameters to be monitored or measured, with pass/fail criteria.

(c) There shall be a Qualification Test Report for each item that was subjected to a formal Qualification test sequence. This report shall provide a summary of the tests performed, their results, and identification by specification paragraph number of which qualification requirements of the specification have been satisfied. The report shall also include the detailed test data with a Qualify Control or Inspection buy-off stamp.

TM09 DELETED

TM10 DELETED

PDRD NO.	DESCRIPTION TITLE	DUE DATE	FREQ SUB.	BUYER APPR REQ'D
TM11	Procedures, Qualification, Acceptance Test	030/P/TST	R/ASR	Yes

Requirement. The Seller shall provide information to evaluate Seller's acceptance test procedures and qualification test procedures.

Appendix XVI

160. ANDROGYNOUS PERIPHERAL DOCKING ASSEMBLIES FOR INTERIM CONTROL MODULE

160.1 SCOPE

This appendix defines requirements for an active and a passive Androgynous Peripheral Docking Assembly (APDA) and other elements of an Androgynous Peripheral Docking System (APDS) for use with the Interim Control Module (ICM) in the International Space Station (ISS) program for docking to FGB. Also defined herein are requirements for testing and for data submittal.

160.2 APPLICABLE DOCUMENTS. The requirements of Section 2 apply.

160.3 REQUIREMENTS. The requirements of Section 3 apply, except as follows:

160.3.1 Item Definition.

Figure 1 is an illustration of the flight configuration showing the ICM berthed with the Orbiter. The central volume of the ICM is unpressurized; each APDA has a dome and seals to provide pressure integrity from the Orbiter airlock through the passive APDA to its dome and from the FGB through the active APDA to its dome. The following elements in this configuration are covered by this appendix:

(1)	MC621-0087-7002 33U.6201.008-11	Androgynous Peripheral Docking Assembly (active)
	MC621-0087-8002 33U.6201.008-12	Androgynous Peripheral Docking Assembly (passive)
(2)	MC621-0087-0020	Pyrotechnic Release Devices
(3)	SLIYu 374511.022	ICM Pigtail Cables

APDA -7002 (Active) shall include the structure and guide ring; and the capture-latch, structural-hook and extend/retract/attenuation mechanisms. This active APDA shall be capable of providing structural compliance with six degrees of freedom and shall have pyrotechnic release devices for the structural hooks. Figure 160-2 shows the configuration of APDA -7002.

APDA -8002 (Passive) shall include the structure and stationary guide ring, and the passive structural-hook mechanism. The -8002 APDA shall not have pyrotechnic release devices for the structural hooks. Figure 160-3 shows the configuration of APDA -8002.

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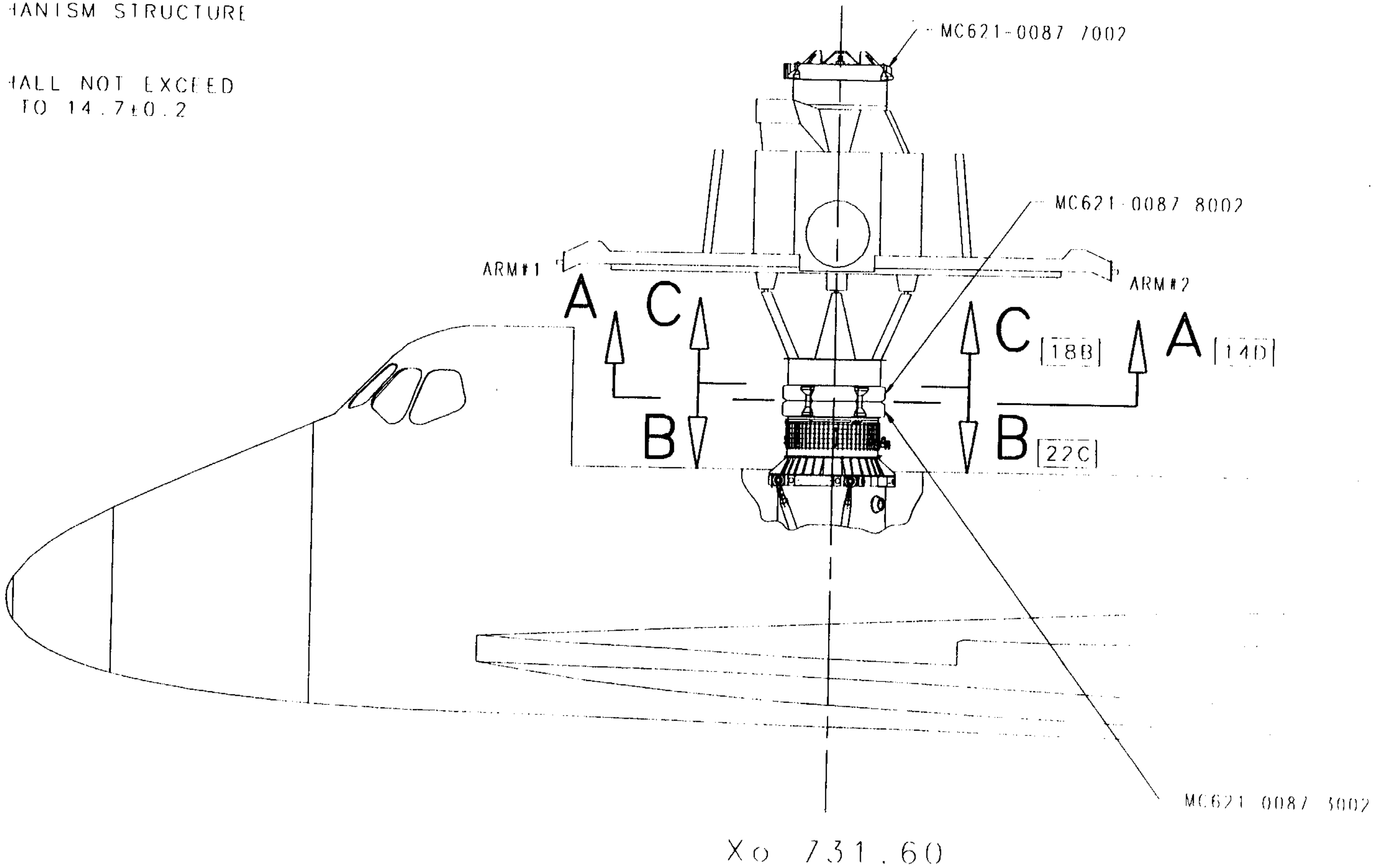


Figure 160-1. Active APDA -7002 and Passive APDA -8002 Mounted on Interim Control Module Berthed with Orbiter

160.3.1.1 Subsystem Definition

The APDAs consist of the following subsystems and features:

a. APDA -7002 (reference Figure 160-2)
   1. Structural Hook Mechanism with both active and passive hooks.
   2. Structure (Base with Interface Seals, and Guide Ring)
   3. Resource Electrical Connectors (X3 and X4 operational, X1 and X2 not operational but with metal caps)
   4. Indicators, Undocking Sensors, Temperature Sensors, Hook-Status Sensors, Capture Sensors, Ready-to-Hook Sensors, and Pressure Sensors
   5. Heaters
   6. Pushers
   7. Capture-Latch Mechanism
   8. Mechanism for extension and retraction of the ring and attenuation of loads
   9. Pressure Dome with Seals
   10. Pyrotechnic Release Device for Active Hooks
       The pyrotechnic release device is addressed as a separate Line Replaceable Unit in Appendix XII.
   11. Provisions for mounting two TV cameras and two lights
   12. Feedthrough connectors for cameras and lights
   13. Provisions for mounting Crosshair Target for TV Camera Alignment

b. APDA -8002 (reference Figure 160-3)
   1. Structural Hook Mechanism with only Passive Hooks
   2. Structure (Base with Seals, and Stationary Guide Ring)
   3. Resource Electrical Connectors (X3 and X4 operational, X1 and X2 not operational but with metal caps)
   4. Pushers
   5. Docking Target
   6. Pressure Dome with Seals
   7. No sensors required.

160.3.1.1.1 Functional Definition.

a. APDA -7002 shall:
   1. Capture the passive APDA body-mounted capture latches.
   2. Attenuate docking loads during capture and attenuation, and limit the relative vehicle motions.
   3. Align, structurally attach, and seal the active to passive APDAs.
   4. Allow for termination of docking operations and separation of vehicles at any point in the docking process, and not prevent the remating of the vehicles during the same mission.
   5. Allow for resource transfer between vehicles.
   6. Provide for the demating of the spacecrafts.

b. APDA -8002 shall:
   1. Align and allow structural attachment of the active to passive APDAs.
   2. Seal active and passive APDAs by use of passive hooks.
   3. Allow for resource transfer between vehicles.

160.3.1.2 Interface Definition

160.3.1.2.1 Electrical Power Characteristics. The requirements of paragraph 3.1.2.1 apply except as follows:

160.3.1.2.1.1 Electrical Interface and Connectors. The electrical interfaces to the ICM APDA -7002 shall be in accordance with Figures 160-2 and 160-3. Connectors and pin assignments at these interfaces are shown in Tables 160-9 and 160-10.

160.3.1.2.1.2 Resource-Transfer Umbilicals.

160.3.1.2.1.2.1 Mounting and Pin Assignments. The four resource-transfer umbilicals X1 through X4 shall be mounted along the external surface of the APDA structure (base) per Figures 160-2 and 160-3. The resource-transfer pin assignments and functions for the -7002 and -8002 APDAs shall be as shown in Tables 160-11, 160-12, 160-13 and 160-13a. The power transfer design requirements of X1 and X2 shall be in accordance with Figure 20-D, E for -8002.

160.3.1.2.1.2.2 Engagement and Disengagement. The connectors shall be engaged and disengaged by operation of the mechanism. The pins shall be disengaged prior to completion of structural-hook opening.

160.3.1.2.2 Mounting. The mounting provisions of the APDAs shall be as shown in Figures 160-2 and 160-3.

160.3.1.2.3 -8002 APDA-to-ICM Interface. The interfacing of the -8002 APDA and the ICM shall be in accordance with Figure 160-3.

160.3.1.2.4 -7002 APDA-to-FGB Interface. The interfacing of the -7002 APDA and the ICM shall be in accordance with Figure 160-2.

160.3.1.2.5 Active-APDA-to-Passive-APDA Interface. The active and passive APDAs shall be designed to mate under the loads, relative velocities, and relative misalignments of Tables 160-4 and 160-5.

160.3.1.2.6 Pressure. The requirements of 20.3.1.2.6 apply except that the articles here include pressure-dome seals rather than hatch seals:

a. APDA -7002:
    1. pressure-dome interface seals
    2. mating seals
b. APDA -8002:
    1. pressure-dome interface seals
    2. mating seals

160.3.1.3 Item Identification. The APDA and pyrotechnic subassembly shall be identified as follows:

Nomenclature	Buyer Part No.	Seller Part No.	Maint. Level
Active APDA	MC621-0087-7002	33U.6201.008-11	LRU
Passive APDA	MC621-0087-8002	33U.6201.008-12	LRU
Pigtail Cables		SLIYu 374511.022	
Pyrotechnic Release Device		(See Appendix XII)	

160.3.1.3.1 Cable Set Identification. The requirements of 130.3.1.3.1 apply.

160.3.2 Characteristics

160.3.2.1 Performance Characteristics

The ISS 2A.1 mission is defined as: The ICM is launched as a payload in the Orbiter. The ICM is removed from the payload bay by the Remote Manipulator System (RMS) and is berthed to the ODS. After structural attachment to the ODS is achieved, the APDS Switching System (reference Appendix 14) is placed in the ICM position to control the active -7002 APDA on the ICM. The ODS/ICM stack is then docked to the aft axial port of the FGB. After ICM to FGB structural attachment is achieved, the APDS Switching System is placed back to the ODS position. The ODS is then undocked from the ICM and the Orbiter maneuvers to dock with PMA 2. After structural attachment with PMA 2, the Orbiter's crew ingress's the ISS assembly to the ICM -7002 and retrieves the docking camera/lights.

The ICM is then ready to perform the required operations, and upon completion of the ICM design tasks, the ICM undocks from the ISS and de-orbits. The following are detailed performance requirements of the ICM docking system.

a. The APDA functions shall provide the means to connect and disconnect the active and passive docking mechanisms.
b. APDA-7002 shall provide the ability to transmit data from the ICM to the FGB. APDA - 8002 shall provide the ability to transmit video from the Orbiter to the ICM.
c. Sequencing of APDA functions may be automated from initial contact until full dock; the automated sequence, however, shall be able to be interrupted at any point. Subsequent to interruption, the sequence shall be able to be completed manually or terminated manually. Interruption of the automated sequence shall not prevent remating to the FGB.
d. Means shall be provided to monitor operations and safety-critical functions and to check out and verify systems. The resulting data shall be available for use by both flight crew and ground operations.
e. APDA -7002 active hooks shall be capable of being controlled OPEN and CLOSED from the ICM avionics, only for undocking from the FGB (reference Figure 160-4). Telemetry will be provided from the -7002 to indicate the actuator CLOSED discrete status.
f. APDA -7002 pyrotechnic bolts of the active hooks shall have the capability of being initiated from the ICM avionics (reference Figure 160-4). The bolts will be fired six at a time, with a maximum of 100 milliseconds between firings. The total time required for firings is less than 150 milliseconds. Each firing command shall initiate two separate pryotechnic bolt bridgewires in parallel (reference Figure 160-6).

160.3.2.1.1 Life

160.3.2.1.1.1 Operating Life

a. -7002 APDA The -7002 APDA shall be capable of performing all of the applicable operations specified herein with maintenance for a minimum of the following cycles. Interface seals may be replaced after each mission.

On-Orbit Vacuum Cycles	3
Ground No-Load Cycles	9
Ground Load Cycles	2

b. -8002 APDA. The -8002 APDA shall be capable of performing all of the applicable operations specified herein with maintenance for a minimum of the following cycles.

On-Orbit Vacuum Cycles	30
Ground No-Load Cycles	9
Ground Load Cycles	2

The hardware to which this requirement applies is that used for a nominal docking, including the passive structural hooks, the structure (base with seals and stationary guide ring), the resource electrical connectors, and pushers.

c. Pigtail Cables. The requirements of 130.3.2.1.1 apply.

160.3.2.1.1.2 Useful Life. The APDA shall have a minimum useful life of the operating cycles specified in 3.2.1.1.1 which are equivalent to the following.

a. -7002 APDA Three Orbiter missions in a five-year life without maintenance.
b. -8002 APDA Three Orbiter missions in a five-year life without maintenance.

An Orbiter mission is defined as including all applicable operations and environments including launch, on-orbit, and landing phases.

160.3.2.1.1.3 Shelf Life. The APDAs shall be capable of operating in accordance with the requirements herein any time within a period of five years from the date of delivery when exposed to the applicable environments of 160.3.2.5.

160.3.2.1.1.4 Pyrotechnic Release Devices. Unique service-life requirements for pyrotechnic release devices are given in Appendix XII.

160.3.2.1.2 CG and Moment of Inertia. The center of gravity (CG) of the mechanisms shall be determined in three axes from a defined reference datum shown in Figures 160-2 and 160-3. The moments of inertia shall be calculated about the CG of the APDA.

160.3.2.1.3 Forces, Moments and Dynamic Excursion Limit. The APDA shall limit the mating forces, moments and dynamic excursions at the interface to those defined in Table 160-4 with the spacecraft mass properties defined in Tables 160-6 and 160-7.

160.3.2.1.4 Vehicle Undocking. The four separation plungers (two on each system) shall induce an initial separation force of 250 kgf (551 lbs) minimum and 270 kgf (595 lbs) maximum. To demate, the work (energy) applied shall be between 4.0 kgf-m (28.9 ft-lbs) and 4.3 kgf-m (31.1 ft-lbs).

160.3.2.2 Physical Characteristics. The requirements of 20.3.2.2 apply except as follows:

160.3.2.2.1 Envelopes. The envelope of the APDAs shall not exceed the dimensions shown in Figures 160-2 and 160-3.

160.3.2.2.1.1 Interface Hardware

160.3.2.2.1.1.1 Resource-Transfer Umbilicals. The envelope of the resource-transfer umbilicals shall not exceed the dimensions shown in Figures 160-2 and 160-3.

160.3.2.2.1.1.2 Laser Reflector. Deleted.

160.3.2.2.1.1.3 Docking Target. The envelope of the -8002 APDA Docking Target shall be as shown in Figure 160-3.

160.3.2.2.1.1.4 Pigtail Cables. The envelope dimensions shall be as shown on Figure 160-5.

160.3.2.2.2 Weight. The weight of the resource-transfer umbilicals, panels, and mounting hardware shall not exceed 9.1 kgf (20 lbs). The weight of the APDAs, not including the resource-transfer umbilicals, shall not exceed the following:

a. -7002 APDA: 310.0 kg
b. -8002 APDA: 210.0 kg

160.3.2.2.3 Strength. The APDA shall have adequate strength and stiffness at the design temperature to withstand limit loads and pressures without detrimental yielding and ultimate loads and pressures without failure. The load combinations are defined in Table 160-4. The APDA shall exhibit a minimum margin of safety equal to zero.

160.3.2.2.4 Factors of Safety. The requirements of 20.3.2.2.4 apply.

160.3.2.2.5 Fracture Control. The requirements of 20.3.2.2.5 apply.

160.3.2.2.6 Fatigue. The requirements of 20.3.2.2.6 apply.

160.3.2.2.7 Creep. The requirements of 20.3.2.2.7 apply.

160.3.2.2.8 Insulation Resistance. The requirements of 20.3.2.2.8 apply.

160.3.2.2.9 Dielectric Strength. The APDA shall be capable of withstanding 200 Vac between any isolated circuit and the case or enclosure for one second. There shall be no arc-over or leakage greater than 100 milliamperes. The Seller's installation drawing and other applicable documents shall include any necessary caution notes regarding dielectric or other test voltages with regard to connected terminals, terminals across capacitors, integrated circuits, semiconductors and other polarity sensitive devices. Buyer must approve any variation with this requirement.

160.3.2.2.10 Exterior Surface Finish. The requirements of 20.3.2.2.10 apply.

160.3.2.2.11 Cycle Definition. For purposes of life certification, as defined in 20.3.2.1.1, one APDA cycle is defined to include one capture latch operational cycle (per 20.3.2.2.12.1.6), one structural hook operational cycle (per 20.3.2.2.12.2.8), and one attenuation mechanism operational cycle (per 20.3.2.2.12.3.12).

160.3.2.2.12 Subsystem Requirements. The following sections describe the requirements of each mechanical subsystem as an installed subsystem of the APDA.

160.3.2.2.12.1 Capture-Latch Mechanism of APDA -7002. The requirements of 20.3.2.2.12.1 apply, for APDA -7002 only.

160.3.2.2.12.2 Structural Hook Mechanism.

a. -7002 APDA
Each of 12 hook locations shall have a passive and an active hook. The structural hook mechanism shall consist of twelve hooks driven in two sets of six hooks comprising alternate hooks. Each set is driven with an actuator with redundant motors powered through a pulley and cable system to the hooks. Each actuator shall consist of redundant motors driving the output through a reduction unit. The redundant motors shall operate concurrently and failure of either motor shall not affect the output torque or the operation of the remaining motor, but the actuator rate may be reduced by 50%. APDA -7002 only shall have the capability to release only active hooks pyrotechnically (Reference Appendix XII). Each active hook shall be equipped with a micro switch capable of indicating the closed position of the hook.

b. -8002 APDA
Each of 12 hook locations shall have one passive hook. The -8002 APDA shall have no pyrotechnic devices and no sensors of any kind.

160.3.2.2.12.2.1 Load/Stroke. The requirements of 20.3.2.2.12.2.1 apply to APDA -7002/-8002, with mated loads as shown in Table 160-5.

160.3.2.2.12.2.2 Limit Load. The requirements of 20.3.2.2.12.2.2 apply to APDA -7002/-8002 with mated loads as shown in Table 160-5.

160.3.2.2.12.2.3 Ultimate Load. The requirements of 20.3.2.2.12.2.3 apply to APDAs -7002 and -8002.

160.3.2.2.12.2.4 Stall/Maximum Load. The requirements of 20.3.2.2.12.2.4 apply to APDA -7002.

160.3.2.2.12.2.5 Aiding Loads. The requirements of 20.3.2.2.12.2.5 apply to APDA -7002.

160.3.2.2.12.2.6 Irreversibility. The requirements of 20.3.2.2.12.2.6 apply to APDA -7002.

160.3.2.2.12.2.7 Speed/Rate. The requirements of 20.3.2.2.12.2.7 apply to APDA -7002.

160.3.2.2.12.2.8 Operational Cycles. The requirements of 20.3.2.2.12.2.8 apply to APDA -7002.

160.3.2.2.12.2.9 Mechanical Stops. The requirements of 20.3.2.2.12.2.9 apply to APDA -7002.

160.3.2.2.12.2.10 Pyrodevices. APDA -7002 shall be equipped with pyrodevices. Pyrodevices shall assure emergency undocking for all 12 active hooks. Reference requirements of Appendix XII.

160.3.2.2.12.3 Extend/Retract and Attenuation Mechanisms. The requirements on APDA -7001 in 20.3.2.2.12.3 apply to APDA -7002 here.

160.3.2.2.12.3.1 System Stiffness and Damping Characteristics. The requirements of 20.3.2.2.12.3.1 apply, with the performance requirements of Table 160-4 here.

160.3.2.2.12.3.1.1 Axial Slip Clutch. The requirements of 20.3.2.2.12.3.1.1B apply.

160.3.2.2.12.3.1.2 Shock Spring. The requirements of 20.3.2.2.12.3.1.2 apply.

160.3.2.2.12.3.1.3 Deleted.

160.3.2.2.12.3.1.4 Initial Position. The initial position of the -7002 APDA shall meet the requirements of Figure 160-2.

160.3.2.2.12.3.1.5 Guide Ring Dampers. The requirements of 20.3.2.2.12.3.1.5B apply.

160.3.2.2.12.3.1.6 Guide Ring Centering Spring. The requirements of 20.3.2.2.12.3.1.6B apply.

160.3.2.2.12.3.1.7 High Energy Dampers. The requirements of 20.3.2.2.12.3.1.6B apply.

160.3.2.2.12.3.2 Load/Stroke. The requirements of 20.3.2.2.12.3.2 apply, under the nominal operating loads of Table 160-4 here.

160.3.2.2.12.3.3 Maximum Angle of Rotation. The requirements of 20.3.2.2.12.3.3 apply.

160.3.2.2.12.3.4 Rotational Applied Contact and Return Moments. The requirements of 20.3.2.2.12.3.4B apply.

160.3.2.2.12.3.5 Parallel Applied Contact and Return Forces. Contact and return forces parallel to the interface surfaces shall be:

Guide Ring Displacement	Direction of Y_T axis		Direction of Z_T axis	
	Applied Contact Force kgf	Return Force kgf	Applied Contact Force kgf	Return Force kgf
Prior to Sensor Initiation *	55±25	50±15	55±15	50±15
50 mm	110±30	90±25	110±30	90±25
100 mm	190±50	160±50	180±50	160±40

* Note: Sensor initiation to be at 8 mm maximum

160.3.2.2.12.3.6 Limit Load. The requirements of 20.3.2.2.12.3.6 apply, using the velocities and misalignments of Table 160-4 here.

160.3.2.2.12.3.7 Ultimate Load. The requirements of 20.3.2.2.12.3.7 apply.

160.3.2.2.12.3.8 Stall/Maximum Load. The requirements of 20.3.2.2.12.3.8 apply.

160.3.2.2.12.3.9 Aiding Loads. The requirements of 20.3.2.2.12.3.9 apply.

160.3.2.2.12.3.10 Irreversibility. The requirements of 20.3.2.2.12.3.10 apply.

160.3.2.2.12.3.11 Speed/Rate. The requirements of 20.3.2.2.12.3.11B apply.

160.3.2.2.12.3.12 Operational Cycles. The requirements of 20.3.2.2.12.3.12 apply.

160.3.2.2.12.3.13 Mechanical Stops. The requirements of 20.3.2.2.12.3.13 apply.

160.3.2.2.12.3.14 Ring Rotation Moment. The requirements of 20.3.2.2.12.3.14 apply.

160.3.2.2.12.3.15 Fixers. The requirements of 20.3.2.2.12.3.15 apply.

160.3.2.2.13 Commands and Indications. The APDAs shall be designed to respond to the commands in Table 160-1.APDA -7002 shall be designed to provide the position indications listed in Table 160-1.

160.3.2.2.15 Deleted.

160.3.2.2.16 Optical Properties. The requirements of 20.3.2.2.16 apply.

160.3.2.2.17 Capture-Latch Heaters. The requirements of 20.3.2.2.17 apply to APDA -7002.

160.3.2.3 Reliability. The requirements of 3.2.3 apply except that for the ICM the APDAs shall be single-failure-tolerant for both docking and undocking.

160.3.2.4 Maintainability. The requirements of 3.2.4 apply.

Table 160-1. Command and Indication Requirements for APDA -7002

COMMAND	EVENT
Ring Out	Extend capture ring to initial position or final position
Ring In	Retract capture ring to final position
Open Hooks	Open structural hooks (System 1 & 2)
Close Hooks	Latch structural hooks (System 1 & 2)
Open Latches	Open capture latches to release position
Close Latches	Latch capture latches to ready-to-capture position
Fixer Off	Unlock fixers (five ballscrew-and-nut differentials)
Active Hooks Fire	Initiates pyros for 12 active hooks
INDICATION	EVENT
Ring Initial Position	Capture ring ready to dock
Ring Final Position	Capture ring retracted. Final position sensors shall initiate if interface surface of ring is 4.5 + 3 mm lower than seal interface of assembly.
Ring Aligned	Capture ring centered (five sensors aligned) An 8 mm deflection or 1°18' rotation of the guide ring from the initial position, fixers off, parallel to the seal interface in any direction shall actuate one of the misalignment sensors.
Ring Forward Position	Capture ring extended
Hooks 1 Open	Structural hooks open (System 1, six hooks)
Hooks 1 Closed	Structural hooks closed (System 1, six hooks)
Hooks 2 Open	Structural hooks open (System 2, six hooks)
Hooks 2 Closed	Structural hooks closed (System 2, six hooks)
Hook Closed Position Indicator	Verifies closure of each active structural hook
Latches Retracted	Capture latches ready to capture (three latches)
Latches Extended	Capture latches released (three latches)
Latches Extended (Manual)	Capture latches manually released
Fixer Off	Fixers (five ballscrew-&-nut differentials) unlocked
Ready To Hook	Seal interface within reach of structural hooks
Undocking Complete	Undocking Complete
Interface Sealed	Structural seal compressed
Initial Contact	Signal from any one of five alignment sensors
Capture	Contact sensors on ring actuated
Linear Translation	Linear translation of guide ring
Temperature Sensors	Monitor temperature of various components

160.3.2.5 Environments. APDA requirements of 3.2.5 apply, with the following correspondences:

Requirements on -7001 in JSC 26938 apply to -7002 here.
Requirements on -8001 in JSC 26938 apply to -8002 here.

160.3.2.6 Transportability. The requirements of 3.2.6 apply.

160.3.3 Design and Construction. The requirements of 3.3 apply.

160.4. QUALITY ASSURANCE PROVISIONS

160.4.1 General Requirements. The requirements of 4.1 apply.

160.4.2 Quality Conformance. The requirements of 4.2 apply.

160.4.2.1 Development. The requirements of 4.2.1 apply.

160.4.2.2 Acceptance.

a. APDA. The requirements of 20.4.2.2 apply, with the inspections and tests of Table 160-2 here.

b. Pigtail Cables. The requirements of 130.4.2.2 apply.

c. Pyrotechnic Release Devices. The requirements of 120.4.2.2 apply.

160.4.2.2.1 Examination of Product. The requirements of 20.4.2.2.1 apply.

160.4.2.2.2 Electrical Circuit Verification Test. The requirements of 20.4.2.2.2 apply.

160.4.2.2.3 Electrical Insulation Resistance Test. The requirements of 20.4.2.2.3 apply.

160.4.2.2.4 Dielectric Strength Test. Test each electromechanical device at the component level (subassembly level testing is acceptable) to 200 Vac from case or enclosure to any circuit and between mutually insulated parts for one second. Verify no arc-over or leakage greater than 100 milliamperes.

160.4.2.2.5 Functional Performance Tests

160.4.2.2.5.1 Guide Ring Test. The requirements on APDA -7001 in 20.4.2.2.5.1 apply to APDA -7002 here.

160.4.2.2.5.1.1 No Back Functional. The requirements of 20.4.2.2.5.1.1 apply to APDA -7002 here.

160.4.2.2.5.2 Fixer Test. The requirements of 20.4.2.2.5.2 apply to APDA -7002.

160.4.2.2.5.3 Interface Sensor Test. The requirements of 20.4.2.2.5.3A apply to APDA -7002.

160.4.2.2.5.4 Structural Hook Test. The requirements of 20.4.2.2.5.4 apply to APDA -7002.

Table 160-2. APDA Acceptance Requirements

Inspection and Test	Sequence	APDA -7002	APDA -8002
Examination of Product	160.4.2.2.1	x	x
Electrical Circuit Verification	160.4.2.2.2	x	x
Electrical Insulation Resistance	160.4.2.2.3	x	x
Dielectric Strength	160.4.2.2.4	x	
Functional Performance Tests			
Guide Ring	160.4.2.2.5.1	x	
Fixer	160.4.2.2.5.2	x	
Interface Sensor	160.4.2.2.5.3	x	
Structural Hook	160.4.2.2.5.4	x	
Capture Latch	160.4.2.2.5.5	x	
Heater	160.4.2.2.5.6	x	
High-energy damper	160.4.2.2.5.7	x	
Instrumentation Calibration	160.4.2.2.5.8	x	
Acceptance Vibration	160.4.2.2.6	x	x
Loads			
Axial Stiffness in Initial Position	160.4.2.2.7.1	x	
Retraction Force	160.4.2.2.7.2	x	
Restraining Force	160.4.2.2.7.3	x	
Body Latch Load	160.4.2.2.7.4		x
Capture Latch Force	160.4.2.2.7.5	x	
Capture Latch Unlatch Force	160.4.2.2.7.6	x	
Translation Capability, Y_T & Z_T axes	160.4.2.2.7.7	x	
Rotational Capability, Y_T & Z_T axes	160.4.2.2.7.8	x	
Rotational Capability, X_T axis	160.4.2.2.7.9	x	
Acceptance Thermal Vacuum	160.4.2.2.8	x	
APDA Body Component Proof Pressure	160.4.2.2.10	x	x
Optical Properties	160.4.2.2.13	x	x
Weight Measurement	160.4.2.2.14	x	x

160.4.2.2.5.5 Capture-Latch Test. The requirements of 20.4.2.2.5.5 apply to APDA -7002.

160.4.2.2.5.6 Heater Test. The requirements of 20.4.2.2.5.6 apply.

160.4.2.2.5.7 Damper Tests. The requirements of 20.4.2.2.5.7 apply to APDA -7002.

160.4.2.2.5.8 Instrumentation Calibration Tests. The requirements of 20.4.2.2.5.8 apply to APDA -7002.

160.4.2.2.6 Acceptance Vibration Tests. The requirements of 20.4.2.2.6 apply.

160.4.2.2.7 Loads Tests

160.4.2.2.7.1 Test of Axial Stiffness in Initial Position. The requirements of 20.4.2.2.7.1 apply to APDA -7002.

160.4.2.2.7.2 Retraction Force Test. The requirements of 20.4.2.2.7.2 apply to APDA -7002.

160.4.2.2.7.3 Restraining Force Test. The requirements of 20.4.2.2.7.3 apply to APDA -7002.

160.4.2.2.7.4 Body Latch Load Test. The requirements of 20.4.2.2.7.4 apply to APDA -8002.

160.4.2.2.7.5 Capture Latch Latching-Force Test. The requirements of 20.4.2.2.7.5 apply to APDA -7002.

160.4.2.2.7.6 Capture Latch Unlatching-Force Test. The requirements of 20.4.2.2.7.6 apply to APDA -7002.

With the Capture Latches open, measure the force required to release the Capture Latches using a counterbalanced test ring to simulate undocking. Force to release open latches shall not exceed 12 kgf.

160.4.2.2.7.7 Translation Capability Test (Y_T & Z_T axes). The requirements of 20.4.2.2.7.7(B) apply to APDA -7002.

160.4.2.2.7.8 Rotational Capability Test (Y_T & Z_T axes). The requirements of 20.4.2.2.7.8(B) apply to APDA -7002.

160.4.2.2.7.9 Rotational Capability Test About X_T axis. The requirements of 20.4.2.2.7.9(B) apply to APDA -7002.

160.4.2.2.8 Acceptance Thermal Vacuum Test. The requirements of 20.4.2.2.8 apply.

160.4.2.2.9 Deleted.

160.4.2.2.10 APDA Body-Component Proof-Pressure Test. The requirements of 20.4.2.2.10 apply to the body components of APDAs -7002 and -8002.

160.4.2.2.11 Deleted.

160.4.2.2.12 Deleted.

160.4.2.2.13 Optical-Properties Test. The requirements of 20.4.2.2.13 apply.

160.4.2.2.14 Weight Measurement. The requirements of 20.4.2.2.14 apply.

160.4.2.3 Assessment. The requirements of 4.2.3 apply.

160.4.2.4 Certification. The requirements of 20.4.2.4 apply.

160.4.2.4.1 Qualification Tests.

a. APDA. Qualification testing shall be in conformance with the requirements of this paragraph. Where and to the extent qualification is accomplished by test, qualification-test specimens shall be subjected to the tests specified in Table 160-3.1 in the sequence shown. Qualification test hardware shall be of the same configuration as APDA -7002 flight hardware.

b. Pigtail Cables. The requirements of 130.4.2.4.1 apply.

160.4.2.4.1.1 Examination of Product. The requirements of 20.4.2.4.1.1 apply.

160.4.2.4.1.2 Transportation-Strength Test. The requirements of 20.4.2.4.1.2 apply.

160.4.2.4.1.3 Qualification Vibration Test. The requirements on APDAs -7001 and -8001 of 20.4.2.4.1.3 apply to APDA -7002 here.

160.4.2.4.1.4 Shock-Basic Design Test. The requirements on APDAs -7001 and -8001 of 20.4.2.4.1.4 apply to APDA -7002 here.

160.4.2.4.1.5 Acoustic Noise Test. The requirements on APDAs -7001 and -8001 of 20.4.2.4.1.5 apply to APDA -7002 here.

Table 160-3.1. APDA Qualification Requirements

Inspection and Test	Sequence	APDA -7002
Acceptance (Examination of Product, Dome Lest Test only)	160.4.2.2	x
Examination of Product	160.4.2.4.1.1	x
Transportation Strength	160.4.2.4.1.2	x
Qualification Vibration	160.4.2.4.1.3	x
Shock-Basic Design	160.4.2.4.1.4	x
Acoustic Noise	160.4.2.4.1.5	x
Disassembly Inspection	160.4.2.4.1.14	x

160.4.2.4.1.6 Deleted.

160.4.2.4.1.7 Deleted.

160.4.2.4.1.8 Deleted.

160.4.2.4.1.9 Deleted.

160.4.2.4.1.10 Deleted

160.4.2.4.1.11 Deleted

160.4.2.4.1.11.5 Deleted.

160.4.2.4.1.11.6 Deleted.

160.4.2.4.1.11.7 Deleted.

160.4.2.4.1.11.8 Deleted.

160.4.2.4.1.11.9 Deleted.

160.4.2.4.1.12 Deleted.

160.4.2.4.1.13 Deleted.

160.4.2.1.14 Disassembly Inspection. The requirements of 20.4.2.4.1.14 apply.

160.4.2.4.2 Certification by Analysis. The requirements of 20.4.2.4 apply. Seller shall provide data in a report to demonstrate certification of the following requirements by analysis:

Table 160-3.2. Analysis Requirements

Analysis	Paragraph	APDA -7002	APDA -8002
Qualification Thermal Vacuum	20.4.2.4.1.7	x	x
Six Degree of Freedom (Modeling)	20.4.2.4.1.9	x	
Service Life	20.4.2.4.1.10	x	x
Loads	20.4.2.4.1.11		
Extend/Retract Mechanism Limit Load	20.4.2.4.1.11.1	x	
Extend/Retract Mechanism Ultimate Load	20.4.2.4.1.11.2	x	
Capture and Body Latch Ultimate Load	20.4.2.4.1.11.3	x	x
Simultaneous Loads	20.4.2.4.1.11.4	x	x
Structural Hook Component Loads	20.4.2.4.1.11.5	x	x
Ultimate Translational Load	20.4.2.4.1.11.6	x	
Ultimate Rotational Load	20.4.2.4.1.11.7	x	
Fixer Limit Load	20.4.2.4.1.11.8	x	
Fixer Ultimate Load	20.4.2.4.1.11.9	x	
Pyrotechnic Shock	20.4.2.4.1.12	x	
Pressure	20.4.2.4.1.13	x	x

160.4.2.5 Verification Requirements Matrices. The Seller's verification program shall satisfy the performance and design verification requirements specified in Table 160-3.3.

Table 160 -3.3 Performance and Design Verification Matrix

VERIFICATION METHOD

1. Analysis
2. Assessment
   a. Inspection
   b. Review of Design
3. Test
   a. Development
   b. Qualification
   c. Acceptance

N/A - Not Applicable

Section 160.3 and 160.5 Requirement No.	Requirements	Verification Method							Related Section 160.4 Reqmnt No.
			1	2		3			
		N/A		a	b	a	b	c	
160.3	REQUIREMENTS	X							
160.3.1	Item Definition	X							
160.3.1.1	Subsystem Definition			X	X				160.4.2.2.1
160.3.1.1.1	Functional Definition							X	160.4.2.2.2
160.3.1.2	Interface Definition	X							
160.3.1.2.1	Electrical Power Characteristics			X	X				160.4.2.2.1
160.3.1.2.1.1	Electrical Interface and Connectors			X	X				160.4.2.2.1
160.3.1.2.1.2	Resource-Transfer Umbilicals	X							
160.3.1.2.1.2.1	Mounting and Pin Assignments			X	X				160.4.2.2.1
160.3.1.2.1.2.2	Engagement and Disengagement							X	160.4.2.2.2
160.3.1.2.2	Mounting			X	X				160.4.2.2.1
160.3.1.2.3	-8002 APDA-to-ICM Interface			X	X				160.4.2.2.1
160.3.1.2.4	-7002 APDA-to-FGB Interface			X	X				160.4.2.2.1
160.3.1.2.5	Active-APDA-to-Passive-APDA Interface		X						160.4.2.4.2
160.3.1.2.6	Pressure		X						160.4.2.4.2
160.3.1.3	Item Identification			X					160.4.2.2.1
160.3.1.3.1	Cable Set Identification			X					160.4.2.2.1
160.3.2	Characteristics	X							
160.3.2.1	Performance Characteristics				X				160.4.2.2.1
160.3.2.1.1	Life	X							
160.3.2.1.1.1	Operating Life		X						160.4.2.4.2

Table 160 -3.3 Performance and Design Verification Matrix (Cont'd)

Section 160.3 and 160.5 Requirement No.	Requirements	Verification Method							Related Section 160.4 Reqmnt No.
			1	2		3			
		N/A		a	b	a	b	c	
160.3.2.1.1.2	Useful Life		X						160.4.2.4.2
160.3.2.1.1.3	Shelf Life		X						160.4.2.4.2
160.3.2.1.1.4	Pyrotechnic Release Devices		X						160.4.2.4.2
160.3.2.1.2	CG and Moment of Inertia		X						160.4.2.4.2
160.3.2.1.3	Forces, Moments and Dynamic Excursion Limit		X						160.4.2.4.2
160.3.2.1.4	Vehicle Undocking							X	160.4.2.2.2
160.3.2.2	Physical Characteristics.		X						160.4.2.4.2
160.3.2.2.1	Envelopes.			X					160.4.2.2.1
160.3.2.2.1.1	Interface Hardware	X							
160.3.2.2.1.1.1	Resource-Transfer Umbilicals			X					160.4.2.2.1
160.3.2.2.1.1.3	Docking Target			X					160.4.2.2.1
160.3.2.2.1.1.4	Pigtail Cables			X					160.4.2.2.1
160.3.2.2.2	Weight.							X	160.4.2.2
160.3.2.2.3	Strength		X						160.4.2.4.2
160.3.2.2.4	Factors of Safety		X						160.4.2.4.2
160.3.2.2.5	Fracture Control		X						160.4.2.4.2
160.3.2.2.6	Fatigue		X						160.4.2.4.2
160.3.2.2.7	Creep		X						160.4.2.4.2
160.3.2.2.8	Insulation Resistance							X	160.4.2.2.3
160.3.2.2.9	Dielectric Strength							X	160.4.2.2.4
160.3.2.2.10	Exterior Surface Finish		X						160.4.2.4.2
160.3.2.2.11	Cycle Definition	X							
160.3.2.2.12	Subsystem Requirements	X							
160.3.2.2.12.1	Capture-Latch Mechanism of APDA -7002							X	160.4.2.2
160.3.2.2.12.2	Structural Hook Mechanism							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.2.1	Load/Stroke							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.2.2	Limit Load							X	160.4.2.2
160.3.2.2.12.2.3	Ultimate load		X						160.4.2.2

Table 160 -3.3 Performance and Design Verification Matrix (Cont'd)

Section 160.3 and 160.5 Requirement No.	Requirements	Verification Method N/A	1	2 a	2 b	3 a	3 b	3 c	Related Section 160.4 Reqmnt No.
160.3.2.2.12.2.4	Stall/Maximum Load							X	160.4.2.2
160.3.2.2.12.2.5	Aiding Loads							X	160.4.2.2
160.3.2.2.12.2.6	Irreversibility							X	160.4.2.2
160.3.2.2.12.2.7	Speed/Rate							X	160.4.2.2
160.3.2.2.12.2.8	Operational Cycles							X	160.4.2.2
160.3.2.2.12.2.9	Mechanical Stops							X	160.4.2.2
160.3.2.2.12.2.10	Pyrodevices			X					160.4.2.2
160.3.2.2.12.3	Extend/Retract and Attenuation Mechanisms							X	160.4.2.2
160.3.2.2.12.3.1	System Stiffness and Damping Characteristics							X	160.4.2.2
160.3.2.2.12.3.1.1	Axial Slip Clutch							X	160.4.2.2
160.3.2.2.12.3.1.2	Shock Spring							X	160.4.2.2
160.3.2.2.12.3.1.4	Initial Position							X	160.4.2.2
160.3.2.2.12.3.1.5	Guide Ring Dampers							X	160.4.2.2, 160.4.2.2.5.1
160.3.2.2.12.3.1.6	Guide Ring Centering Spring							X	160.4.2.2
160.3.2.2.12.3.1.7	High Energy Dampers							X	160.4.2.2
160.3.2.2.12.3.2	Load/Stroke							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.3.3	Maximum Angle of Rotation							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.3.4	Rotational Applied Contact and Return Moments							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.3.5	Parallel Applied Contact and Return Forces							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.3.6	Limit Load							X	160.4.2.2
160.3.2.2.12.3.7	Ultimate Load							X	160.4.2.2
160.3.2.2.12.3.8	Stall/Maximum Load							X	160.4.2.2
160.3.2.2.12.3.9	Aiding Loads							X	160.4.2.2
160.3.2.2.12.3.10	Irreversibility							X	160.4.2.2
160.3.2.2.12.3.11	Speed/Rate							X	160.4.2.2

Table 160 -3.3 Performance and Design Verification Matrix (Cont'd)

Section 160.3 and 160.5 Requirement No.	Requirements	Verification Method							Related Section 160.4 Reqmnt No.
			1	2		3			
		N/A		a	b	a	b	c	
160.3.2.2.12.3.12	Operational Cycles							X	160.4.2.2
160.3.2.2.12.3.13	Mechanical Stops							X	160.4.2.2
160.3.2.2.12.3.14	Ring Rotation Moment							X	160.4.2.2, 160.4.2.2.7
160.3.2.2.12.3.15	Fixers							X	160.4.2.2, 160.4.2.2.5.2
160.3.2.2.13	Commands and Indications							X	160.4.2.2
160.3.2.2.16	Optical Properties							X	160.4.2.2
160.3.2.2.17	Capture-Latch Heaters							X	160.4.2.2, 160.4.2.2.5.6
160.3.2.3	Reliability		X						160.4.2.4.2
160.3.2.4	Maintainability		X						160.4.2.4.2
160.3.2.5	Environments							X	160.4.2.2
160.3.2.6	Transportability		X						160.4.2.4.2
160.3.3	Design and Construction		X						160.4.2.4.2
5	Preparation for Delivery			X					

160.5 PREPARATION FOR DELIVERY. The requirements of Section 5 apply.

160.6 NOTES. The requirements of Section 6 apply.

160.7 FIELD SUPPORT EQUIPMENT

The following field support equipment is a part of the deliverable hardware covered by this specification:

1. Carriage	VK.7809-2006	1
2. Carriage	VK.7809-1424 AM	1
3. Ring with attachment hardware	11N565.1762-11	2
4. Strut with attachment hardware	11N565.1762-19	6

5. Test cables for the -7002 X3 and X4 connectors to simulate the FGB side of the interface

160.8 SPARES AND GROUND PROCESSING

160.8.1 Spares. Spares, such as seals, grease, and other consumable, as required to support processing of the APDAs at NRL and KSC, shall be provided with the delivery of the APDAs.

160.8.2 Ground Processing. Requirements for maintenance and support of the APDAs for ground processing shall be defined in the Operations Manual, paragraph 12.15 of QA 12.

160.9 DOCUMENTATION FOR ICM APDA

160.9.1 The following documents shall be updated and resubmitted to include the work required by this Appendix XVI.

CM 04	As-Built Configuration Record
QA 12	Acceptance Data Package
RA 22	Failure Modes and Effects Analysis/Critical Items List (Appendix)
RA 24	Problem Reporting and Corrective Action
SA 07	Risk Assessment Report (Appendix)
SE 03	Drawings and Associated Lists (Envelope/Assembly drawings, Parts Lists, Engineering Changes, Schematics)
TM 06	Test and Analysis Reports
TM 11	Qualification and Acceptance Test Procedures
QA 15A	Pyrotechnic Data

160.9.2 The following documents need not be updated, but are applicable to the work performed by this Appendix XVI:

CM 01	Configuration Management Plan
PG 01A	Packaging and Transport Data
QA 01	Quality Assurance Plan
SA 05	System Safety Plan

Table 160-4. Forces, Moments and Dynamic-Excursion Limits
APDA -7002 PERFORMANCE REQUIREMENTS

a. Capture and attenuate with the following mass properties
Orbiter see Table 160-6 FGB see Table 160-7

b. Contact Condition Limits (10)

Axial Velocity	0.0 to 0.2 ft/sec (0.0 to 70.0 mm/sec)
Lateral Velocity	0±0.15 ft/sec (radial)
Angular Velocity	0±0.20 deg/sec/axis
Lateral Misalignment (8)	0±4.2 in (radial)
Angular Misalignment	0±4.0 deg/axis(2) About X_T: 0±4.0 deg

c. APDA Mating and Demating Forces and Moments

	Docking		Extension at Mechanical Stop		Retraction at Mechanical Stop	
Load	-7002	-8002	-7002	-8002	-7002	-8002
Tension	1000 kgf	1000±50 kgf	n/a	n/a	2200 kgf *	2200 kgf *
Compression (Static)	1000 kgf	1000±50 kgf	1000 kgf *	n/a	n/a	n/a
Compression (Dynamic - < 0.1 sec.)	1900 kgf	1900 kgf	n/a	n/a	n/a	n/a
Shear (7)	±500 kgf	±500 kgf	n/a	n/a	n/a	n/a
Bending (7)	±500 kgf-m	±500 kgf-m	±500 kgf-m	±500 kgf-m	n/a	n/a
Torsion	±300 kgf-m	±300 kgf-m	±300 kgf-m	±300 kgf-m	n/a	n/a

* = APDA internal loads not transmitted to FGB

d. Vehicle Relative Dynamic Rotation Limits During Mating (6)

$\theta_{x,y}$ 13°
θ_z 13°

e. Undocking Separation Conditions (3) e
In accordance with 3.2.1.4

Table 160-5. Forces, Moments and Dynamic Excursion Limits

MATED DESIGN LIMIT LOADS (1) (4) (5) (9)

APDA -7002/-8002

(12 Structural Hooks Engaged)

	CASE 1	CASE 2	CASE 3	CASE 4(-8002 only)
Axial	±500 kgf (1100 lbs)	±500 kgf (1100 lbs)	±1800 kgf (3970 lbs)	±1360 kgf (3000 lbs)
Shear (7)	±500 kgf (1100 lbs)	± 500 kgf (1100 lbs)	±1360 kgf (3000 lbs)	±1820 kgf (4000 lbs)
Bending (7)	±4000 kgf-m (346,800 in-lbs)	±6650 kgf-m (577,000 in-lbs)	±4000 kgf-m (346,800 in-lbs)	±4960 kgf-m (430,000 in-lbs)
Torsion	±6650 kgf-m (577,000 in-lbs)	±4000 kgf-m (346,800 in-lbs)	±4000 kgf-m (346,800 in-lbs)	±690 kgf-m (60,000 in-lbs)

Notes for Tables 160-4 and 160-5.

(1) These values are 3s maxima and shall be applied simultaneously in a statistically appropriate manner, provided that the reach capability of the internal petals is not exceeded

(2) 4 deg. about any axis within the Orbiter x-y (Y_T - Z_T) plane.

(3) Impulse shall be applied at the center of the docking interface and along the mechanism X_T axis.

(4) For design purposes, the loads and moments shall apply simultaneously. Loads shall be applied at the center of the docking interface.

(5) These are maximum case-consistent loads.

(6) These can be simultaneous dynamic rotations.

(7) Value is a vector sum

(8) Lateral misalignment is defined as the minimum distance between the center of the active ring of the APDA and the longitudinal axis of the capture ring of the passive APDA at the moment of first contact between the guide petals.

(9) Loads (Table 160-5) and Fatigue Load Spectrum (Table 160-8) are given on the basis of load carrying capacity of the docking assembly and does not exceed the confirmed scope of tests for APDAs -6001, -7001, or -8001.

(10) Orbiter RCS jets will be used during docking to assist capture dynamics. Two nose, F1D and F2D, and two tail, L3D and R3D, jets will be operated from first contact to capture. A 1.0 second pilot reaction time, starting from first contact, is assumed before the PRCS jets are activated. Post Contact Thrusting (PCT) shall consists of three 80 millisecond nose and tail jet firings with 160 millisecond delay between them, a 1.0 second wait, and finally four 160 millisecond nose and tail firings with 80 millisecond delay between them. Each RCS pulse for docking operation, has a ramp-up time of 0.01 seconds to the maximum forces or moments shown in Table 160-5.1. Forces/Moments stay at the specified levels for 0.070 seconds for the first phase of firing, and for 0.150 seconds for the second phase of firing. The ramp-down time from the maximum value to zero is also 0.010 seconds.

Table 160-5.1. RCS Forces and Moments

Fxo	=	-152.28	kg
Fyo	=	0	
Fzo	=	1113.85	kg
Mxo	=	16.933	kg-m
Myo	=	5026.63	kg-m
Mzo	=	2.31	kg-m

Table 160-6. Orbiter Mass Properties

WEIGHT (lbs)	C.G. (in)			MOMENT OF INERTIA (slug-ft^2 x 10^5)			PRODUCT OF INERTIA (slug-ft^2 x 10^5)		
	X_0	Y_0	Z_0	I_{xx}	I_{yy}	I_{zz}	P_{xy}	P_{xz}	P_{yz}
247983 (high)	1092.7	-0.2	375.7	10.98	75.62	77.54	7.62	2499.06	-81.96
205713 (low)	1102.1	-0.15	372.24	10.57	75.76	75.72	18.55	2568.18	77.36

Table 160-7. ICM/ISSMass Properties

	ICM Attachment To Orbiter	ISS 2A.1 Assembly Stage
Weight (kg)	9182	56985
Moment of Inertia (kg-m^2)		
Ixx	17749	7566793
Iyy	17129	7467926
Izz	17924	232051
Products of Inertia (kg-m^2)		
Ixy	+1124	-13
Iyz	-52	-3082
Ixz	-105	-140534
c.g. offset from docking I/F (m)		
X	0.00	-0.081
Y	0.00	0.0
Z	2.41	21.39
RELATIVE ALIGNMENT IN ORBITER STRUCTURAL AXIS	SPACE STATION AXIS OF ALIGNMENT	
X	Positive X	Negative Z
Y	Positive Y	Negative Y
Z	Positive Z	Negative X

Mass properties are in the orbiter structural coordinate system. All products of inertia are negative integrals.

Table 160-8. Fatigue Load Spectrum

Amplitude Tier Percent of Limit Load	-7002/-8002 APDA Cycle Count
90-100	10
80-90	50
70-80	100
60-70	700
50-60	1,000
40-50	4,000
30-40	22,000
20-30	50,000
15-20	50,000
10-15	400,000
5-10	5,000,000
2.5-5	5,000,000

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	D	REVISED 07/29/98 BY C. KATAKIA		R.AJEMIAN

NOTES:

1. DIMENSIONS SHOWN XXX ARE IN US STANDARD (INCHES)
   (XXX) ARE IN METRIC (MM)

(1) 2. U.S.A. SHALL PROVIDE 2 GROUNDING STRAPS BETWEEN DOCKING MECHANISM AND BASE AND 2 ATTACH LOCATIONS AS SHOWN ON SHEET 4. RSC-E SHALL PROVIDE 2 GROUNDING LOCATIONS AS SHOWN ON SHEET 4 AND 2 BOLTS.

3. FOR APDA INTERCONNECTING ELECTRICAL CABLES SEE TABLE TBD XIV OF THIS SPECIFICATION.

(2) 4. SEAL : MATERIAL 51-1567 TY38-40595-72
   SHORE HARDNESS 50-65
   COMPRESS LOAD 28.54 - 39.95 LB/INCH (5-7 N/mm)

(3) 5. BOLT: M10-8g: MATERIAL: STAINLESS 07Ch16N6
   FINISH : PASSIVATE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	166.9(1150)	137.9(950)	9
AXIAL	174.2(1200)	145.1(1000)	12
RADIAL	152.4(1050)	130.6(900)	6

(4) 6. RSC-E BASE MATERIAL: AL ALLOY AMr6.M
   FINISH : CHEM FILM ANODIZE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	42.1(290)	17.4(120)	11
AXIAL	42.1(290)	17.4(120)	11
RADIAL	42.1(290)	17.4(120)	11

(5) 7. ALIGNMENT PIN MATERIAL: TITANIUM BT-14
   FINISH: NONE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	137.9(950)	123.4(850)	10%
AXIAL	137.9(950)	123.4(850)	10%
RADIAL	137.9(950)	123.4(850)	10%

(6) 8. THESE BOLTS TO BE TORQUED TO 364.0±9.0 IN-LBS (4.0±0.1 KGF M) LOCKWIRE BOLTS IN PAIRS USING .020 DIA LOCKWIRE.

(7) 9. FACILITY GROUND STUD. FACILITY GROUNDING CABLE MUST BE ATTACHED AT THIS LOCATION AT ALL TIME

(8) 10. PROVIDED BY RSC-E

(9) 11. CONNECTOR KEYWAYS AS SHOWN

(10) 12. Xt, Yt, Zt DENOTE MECHANISM TEST AXIS

13. ICM:
   MATERIAL: ALUMINUM ALLOY 6061-T651
   FINISH: CHEM FILM PER MIL-C-5541, CLASS 3

(11) 14. LEAKAGE OF SEALING SURFACE ACROSS EACH INTERFACE CODED (11) SHALL NOT EXCEED 0.08 LBS/DAY(36g/DAY) WHEN INTERIOR IS PRESSURIZED TO 14.7±0.2 PSI(760 ±10 mmHG) IN THE DOCKED OR MATED MODE

(12) 15. RSC-E SHALL DESIGN THE EXTERNAL THERMAL BLANKETS TO BE REMOVABLE AND RE-INSTALLABLE WITHOUT DAMAGE. RSC-E SHALL DELIVER THE EXTERNAL THERMAL BLANKET AS LOOSE EQUIPMENT. THE X1 THRU X4 CONNECTORS AND THE EXTERNAL METAL COVERS SHALL BE TEMPORARILY INSTALLED ON THE MECHANISM, FASTENERS TO BE HAND TIGHT ONLY.

(13) 16. THESE CONNECTORS SHALL BE FURNISHED WITH SHORTING PLUGS.

(14) 17. USA WILL PROVIDE AND INSTALL THE CAMERA ALIGNMENT CROSS HAIR ASSEMBLY

(15) 18. DRILL PLATE TO BE PROVIDED BY RSC-E.

(16) 19. USA TO PROVIDE KNCML-4 X 0.75 INSERTS, QTY. 120 FOR INSTALLING EXTERNAL METAL COVERS AND KNML-10 X 1.5SP INSERTS, QTY 8, FOR ATTACHMENT OF CAMERA AND LIGHT MOUNTING ASSY.

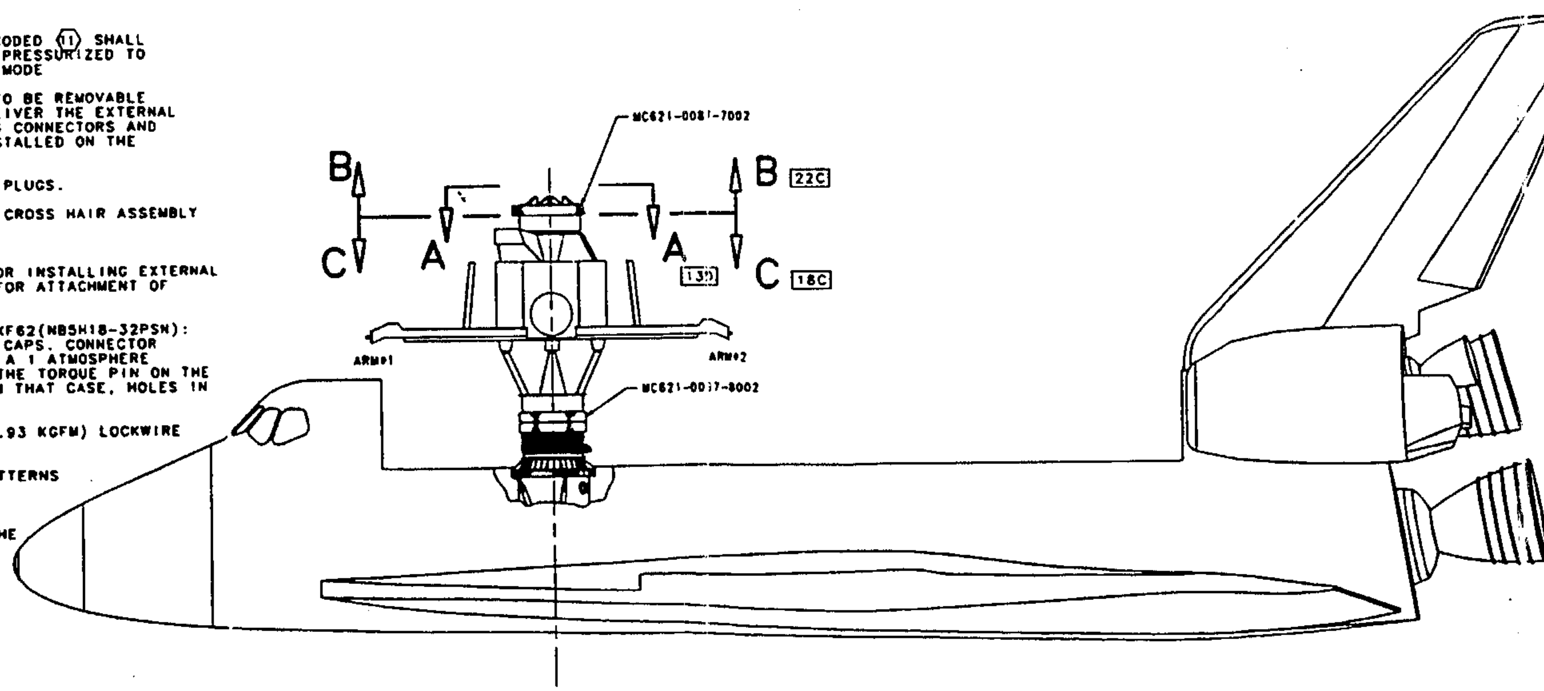
(17) 20. USA TO PROVIDE CONNECTORS XF61(NB5H18-32PSW) AND XF62(NB5H18-32PSN): PROVIDED CONNECTORS WILL INCLUDE: SEALS, NUTS AND CAPS. CONNECTOR MAX PRESSURE LEAK RATE IS 1 X 10^{-4} CM^3 PER SEC. AT A 1 ATMOSPHERE DIFFERENTIAL PRESSURE. IT IS ALLOWED TO FILE OFF THE TORQUE PIN ON THE FLANGE OF THE CONNECTORS PRIOR TO INSTALLATION, IN THAT CASE, HOLES IN THE STRUCTURE IS NOT REQUIRED

(18) 21. TORQUE CONNECTOR JAM NUTS TO 80-85 IN/LBS (0.88-0.93 KGFM) LOCKWIRE NUTS TO EACH OTHER.

(19) 22. THE TOLERANCE OF MOUNTING PADS AND THEIR HOLE PATTERNS AS RELATED TO THE MECHANISM AXIS TO BE ±1°

(20) 23. U.S.A WILL PROVIDE AND INSTALL BUSHINGS INTO THE MECHANISM STRUCTURE PRIOR TO ITS MOUNTING ONTO THE AIRLOCK BASE.

(21) 24. ALL ENVELOPE DIMENSIONS, WHERE APPLICABLE, DO NOT INCLUDE THERMAL BLANKET THICKNESS. THICKNESS OF BLANKET WALL IS:
   .19-.40(5-10 MM)- ON THE GROUND
   .78(20 MM) MAX, UNRESTRICTED- ON ORBIT



ICM CONFIGURATION
SCALE: NONE

MC621-0087-7002 CONFIGURATION
(33Y.6201.008-11)

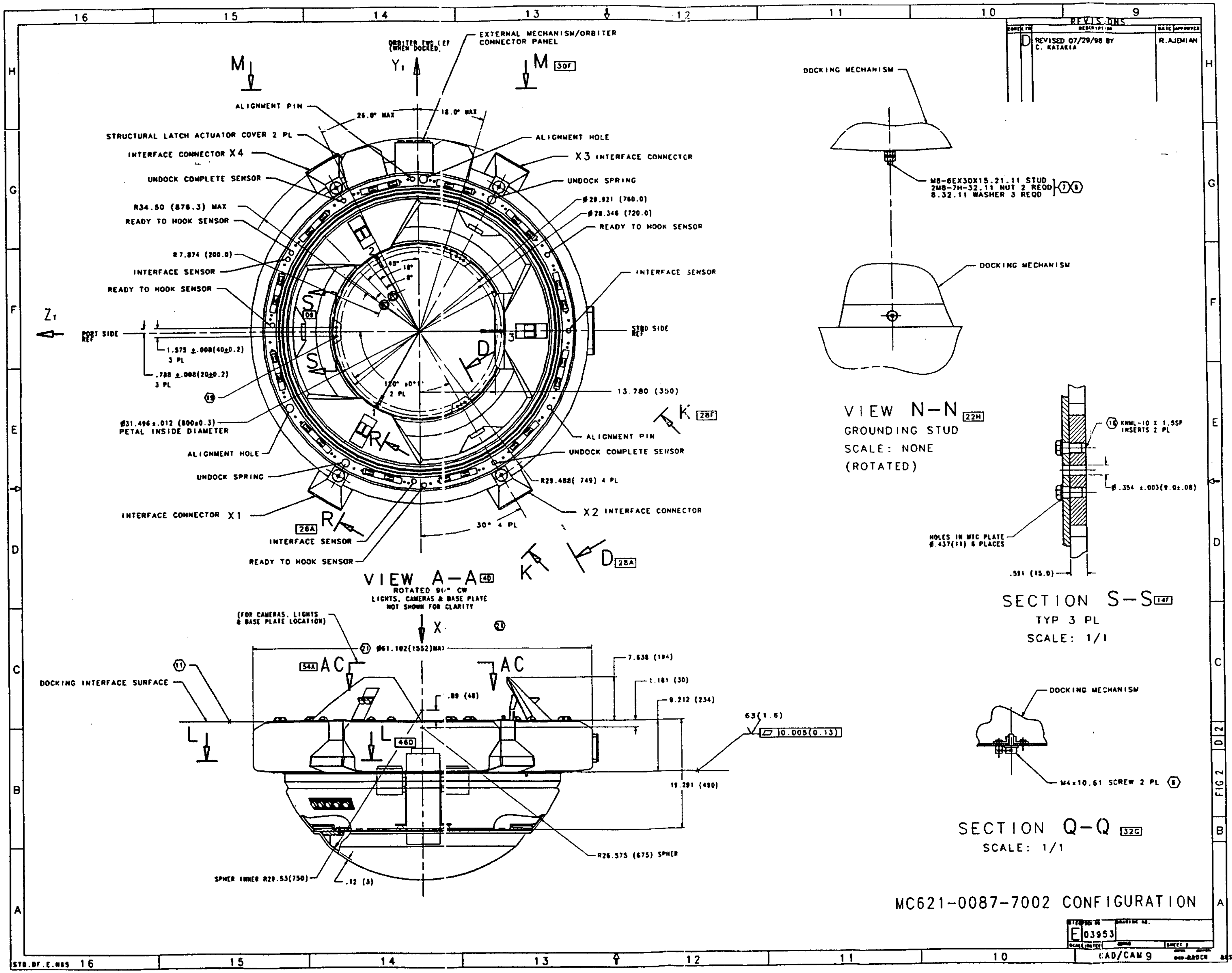
SPEC CONTROL DRAWING - ISSA DOCKING MECHANISM INTEIFACE REQUIREMENTS

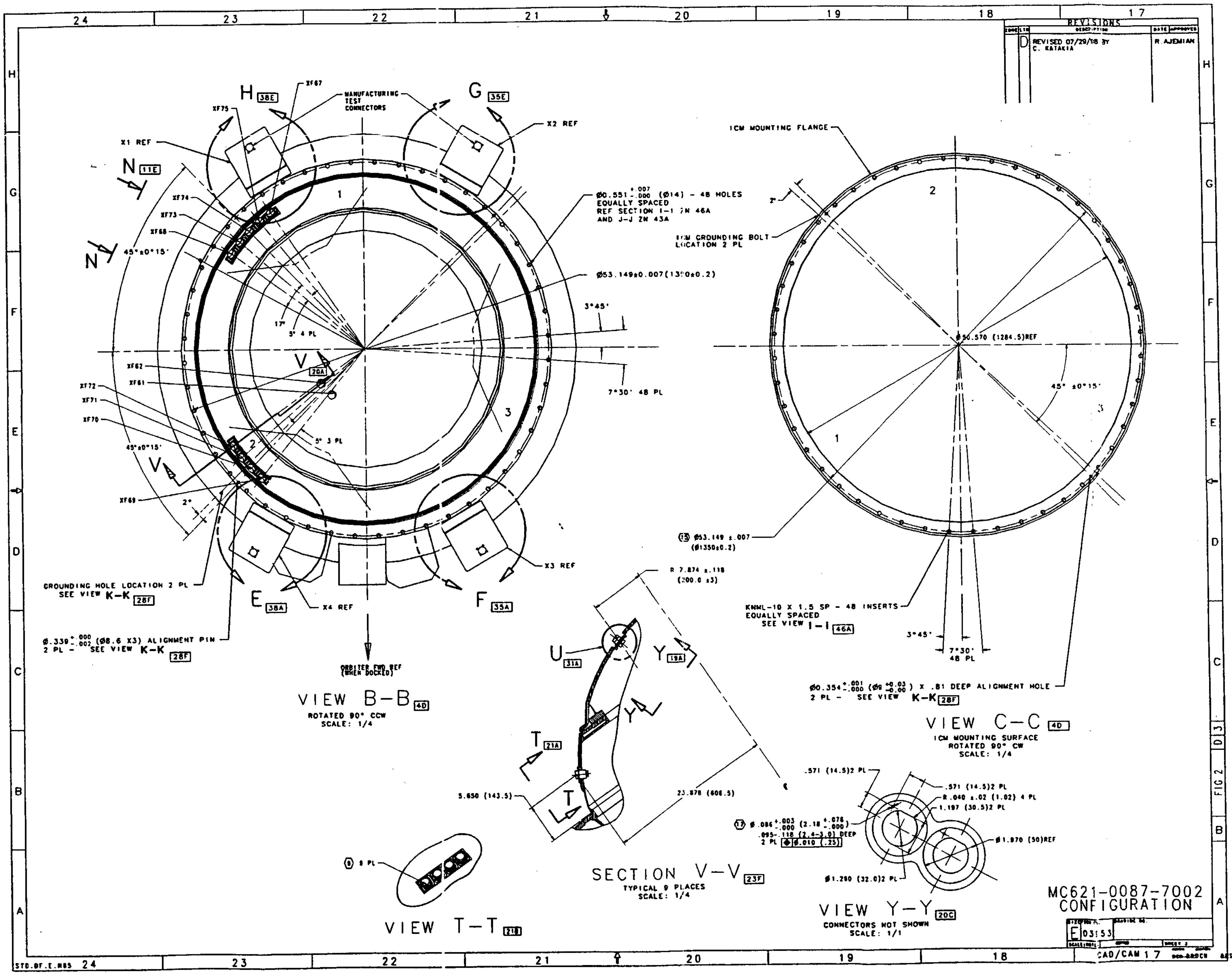
E 03953 FIG 160-2

CAD/CAM 1

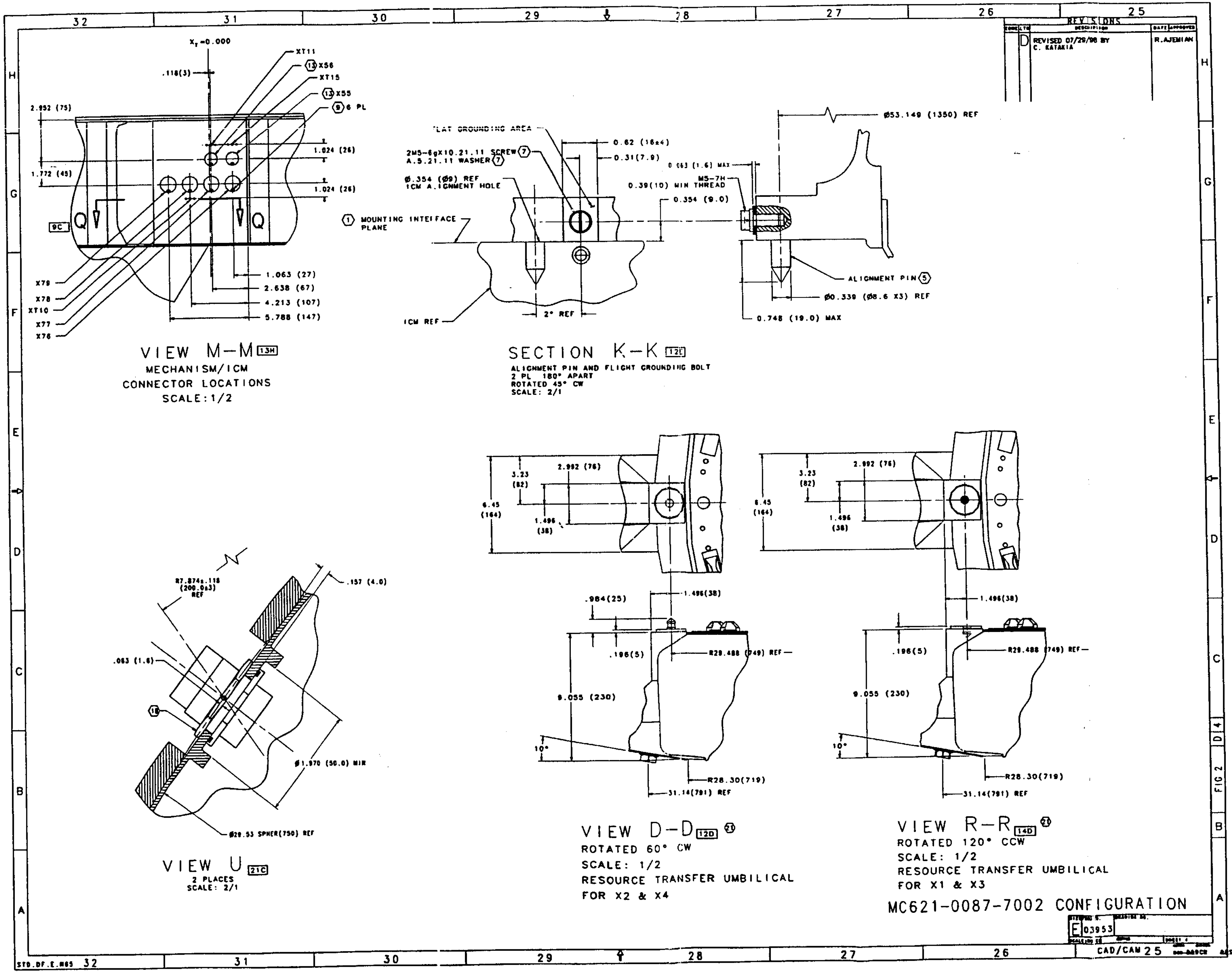
STD.DF.E.N67

glThu Jul 30 15:30:48 PDT 1998




REVISIONS
D REVISED 07/29/98 BY C. KATAKIA
R. AJEMIAN
MANUFACTURING TEST CONNECTORS
X1 REF
X2 REF
X3 REF
X4 REF
ICM MOUNTING FLANGE
Ø53.149±0.007
ICM GROUNDING BOLT LOCATION 2 PL
3°45'
7°30' 48 PL
45°±0°15'
GROUNDING HOLE LOCATION 2 PL SEE VIEW K-K
ORBITER FWD REF (WHEN DOCKED)
VIEW B-B
ROTATED 90° CCW
SCALE: 1/4
VIEW C-C
ICM MOUNTING SURFACE
ROTATED 90° CW
SCALE: 1/4
SECTION V-V
TYPICAL 9 PLACES
SCALE: 1/4
VIEW T-T
VIEW Y-Y
CONNECTORS NOT SHOWN
SCALE: 1/1
MC621-0087-7002
CONFIGURATION
CAD/CAM

gITue Aug 11 10:27:52 PDT 1998



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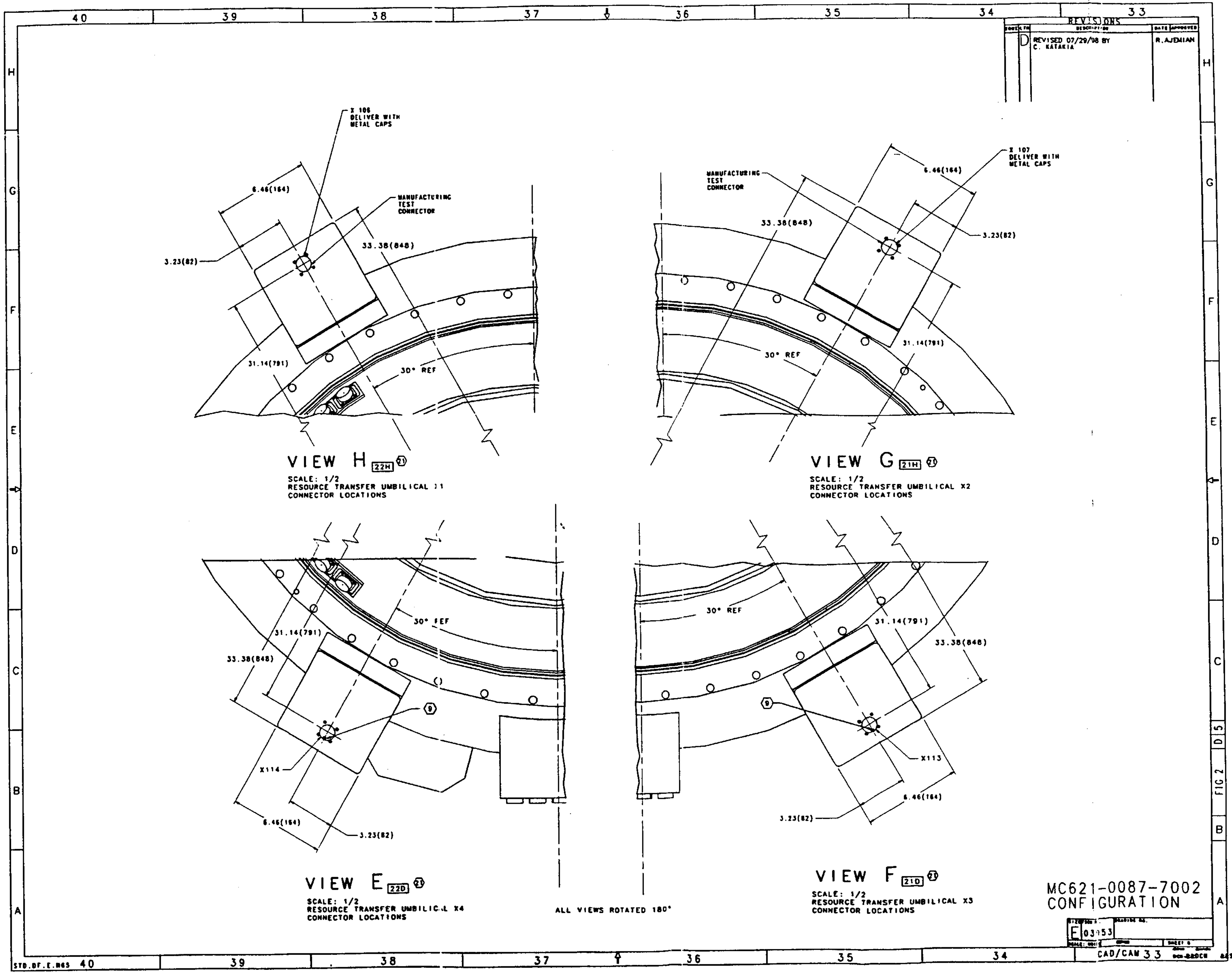

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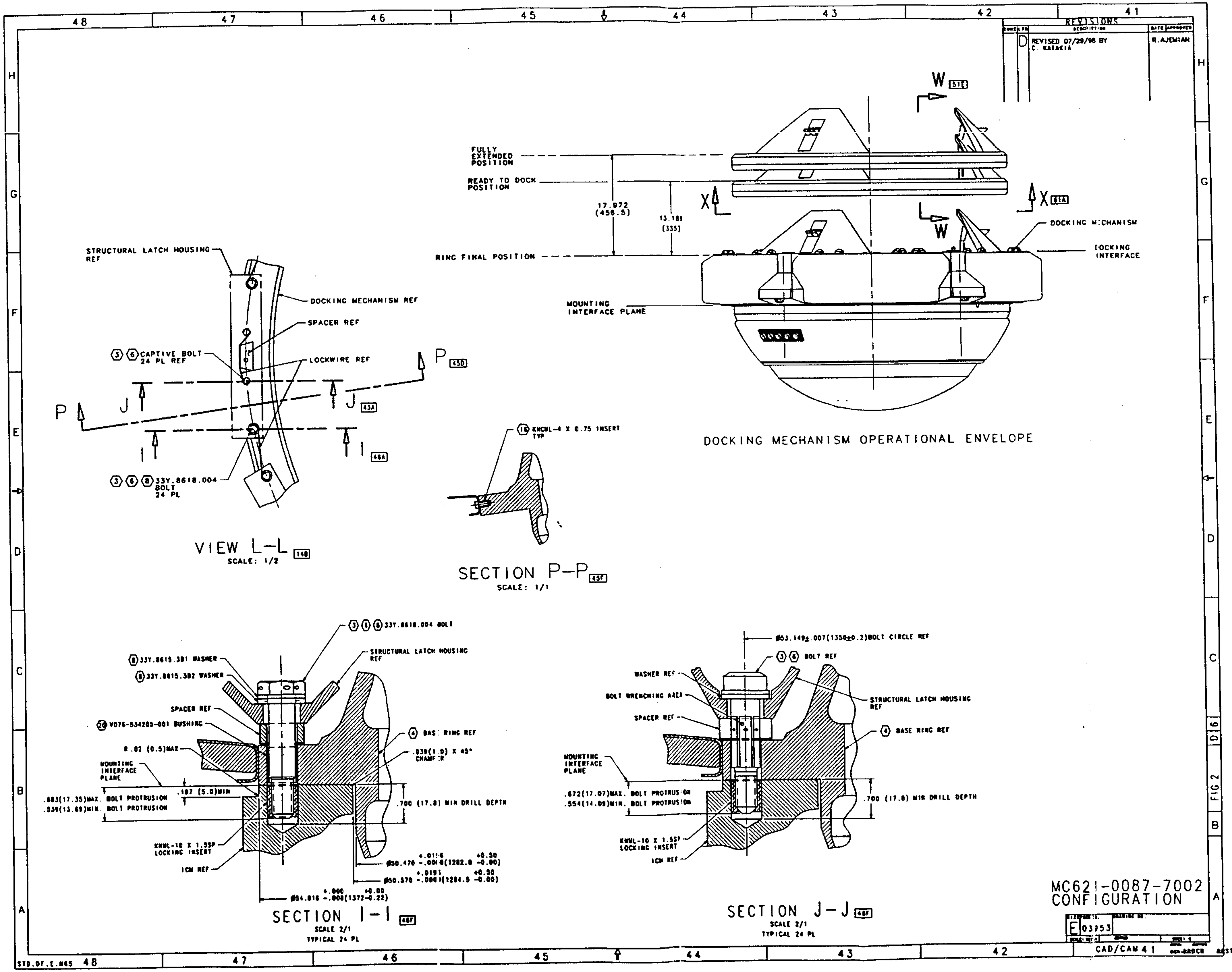

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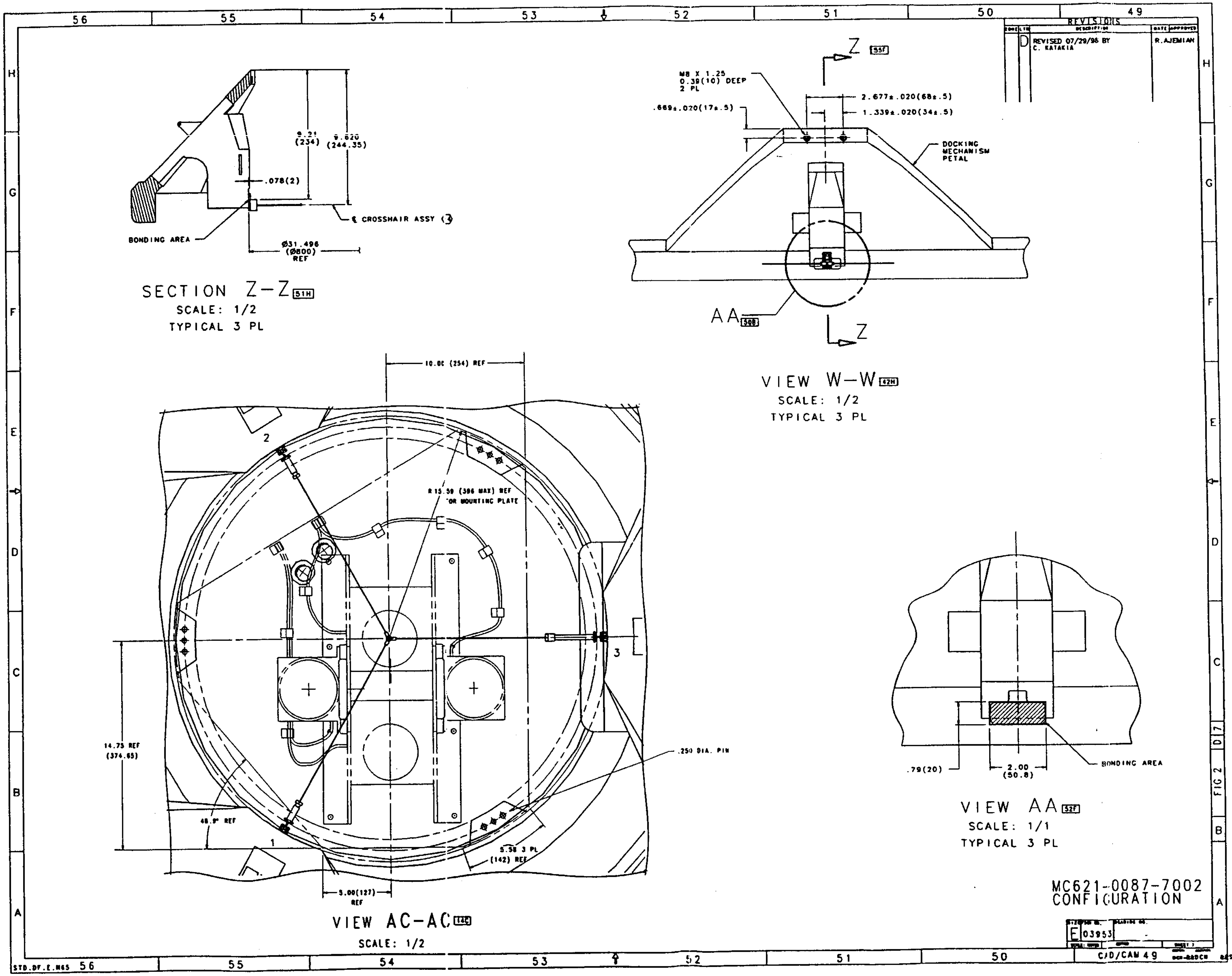
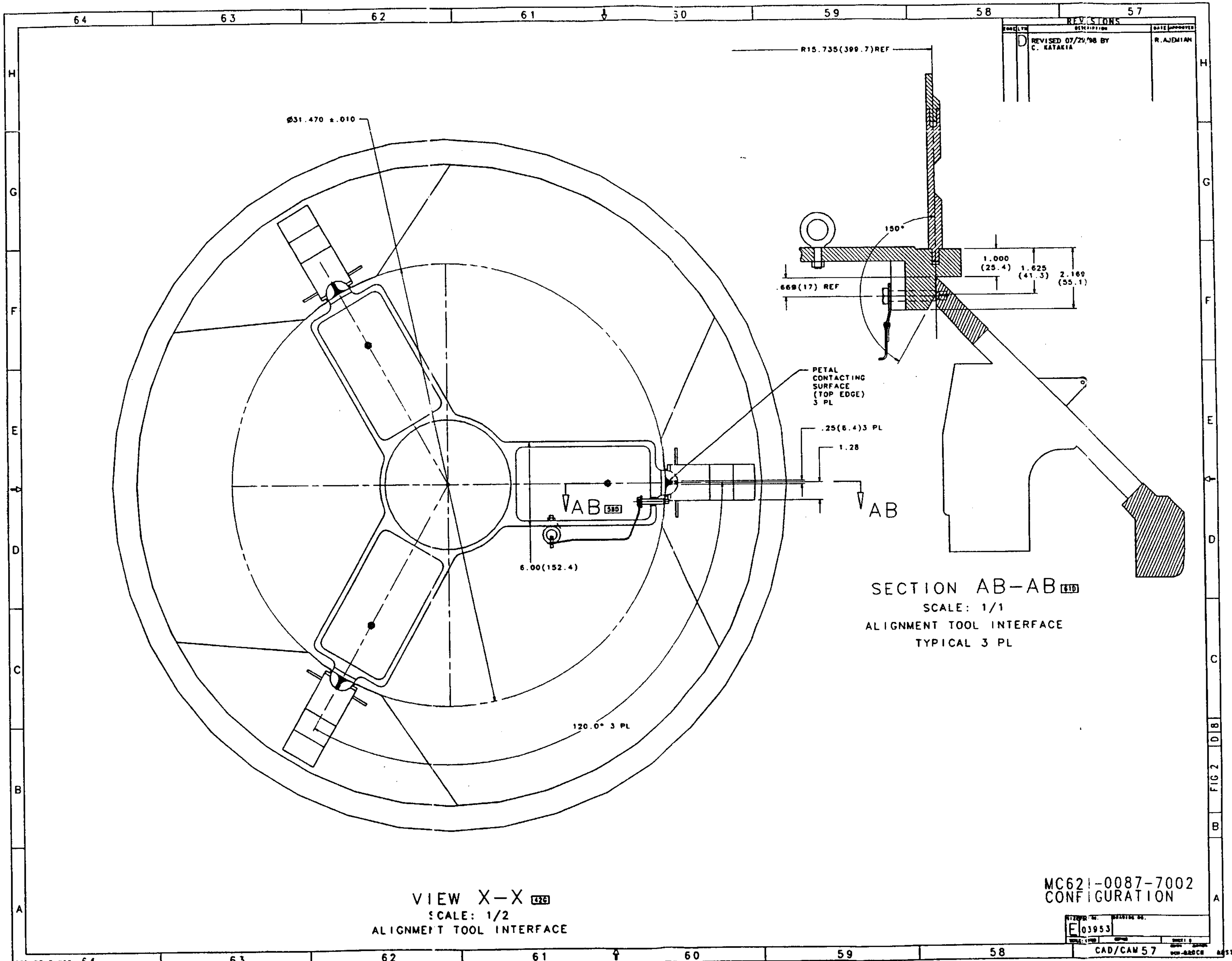
gThu Jul 30 13:20:40 PDT 1998




REVISIONS
D REVISED 07/29/98 BY C. KATAKIA
R.AJEMIAN
R15.735(399.7)REF
Ø31.470 ±.010
150°
1.000 (25.4)
1.625 (41.3)
2.169 (55.1)
.669(17) REF
PETAL CONTACTING SURFACE (TOP EDGE) 3 PL
.25(6.4)3 PL
1.28
AB
AB
6.00(152.4)
120.0° 3 PL
SECTION AB-AB
SCALE: 1/1
ALIGNMENT TOOL INTERFACE
TYPICAL 3 PL
VIEW X-X
SCALE: 1/2
ALIGNMENT TOOL INTERFACE
MC621-0087-7002
CONFIGURATION
E 03953
CAD/CAM
FIG 2
STD.DF.E.865

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	D	REVISED 07/30/98 BY C. KATAKIA		R. AJEMIAN 07/30/98

NOTES:

1. DIMENSIONS SHOWN XXX ARE IN US STANDARD (INCHES) (XXX) ARE IN METRIC (MM)

(1) 2. USA PROVIDES 2 GROUNDING STRAPS BETWEEN DOCKING MECHANISM AND THE ICM RSC-E PROVIDES 2 GROUNDING LOCATIONS AS SHOWN ON SHEET 4 AND 2 BOLTS

3. FOR APDA INTERCONNECTING ELECTRICAL CABLES SEE TABLE TBD OF THIS SPECIFICATION.

(2) 4. SEAL : MATERIAL 51-1567 TY38-40595-72
~~SHORE HARDNESS 50-65~~
COMPRESS LOAD 28.54 - 39.95 LB/INCH (5-7 N/mm)

(3) 5. BOLT: M10-8g: MATERIAL: STAINLESS 07Ch18N6
FINISH : PASSIVATE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	166.9(1150)	137.9(950)	9
AXIAL	174.2(1200)	145.1(1000)	12
RADIAL	152.4(1050)	130.6(900)	6

(4) 6. RSC-E BASE MATERIAL: AL ALLOY AMr6.M
FINISH : CHEM FILM ANODIZE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	42.1(290)	17.4(120)	11
AXIAL	42.1(290)	17.4(120)	11
RADIAL	42.1(290)	17.4(120)	11

(5) 7. ALIGNMENT PIN MATERIAL: TITANIUM BT-14
FINISH: NONE

MECHANICAL PROPERTIES:	Ftu KSI(N/mm2)	Fty KSI(N/mm2)	EL(%)
TANGENTIAL	137.9(950)	123.4(850)	10%
AXIAL	137.9(950)	123.4(850)	10%
RADIAL	137.9(950)	123.4(850)	10%

(6) 8. THESE BOLTS TO BE TORQUED TO 364.0±9.0 IN-LBS (4.0±.1 KGF M) LOCKWIRE BOLTS IN PAIRS USING .020 DIA LOCKWIRE.

(7) 9. PROVIDED BY RSC-E

(8) 10. CONNECTOR KEYWAYS AS SHOWN

11. Xt, Yt, Zt DENOTE MECHANISM TEST AXIS

12. ICM INTERFACE MATERIAL:
MATERIAL: ALUMINUM ALLOY 6061-T651
FINISH: CHEM FILM PER MIL-C-5541, CLASS 3

(9) 13. DRILL PLATE PROVIDED BY RSC-E

14. THIS MECHANISM INTERFACES WITH MC621-0087-3002 MECHANISM ON THE ORBITER

15. RSC-E SHALL DESIGN THE EXTERNAL THERMAL BLANKET TO BE REMOVABLE AND RE-INSTALLABLE WITHOUT DAMAGE. RSC-E SHALL DELIVER THE EXTERNAL THERMAL BLANKET AS LOOSE EQUIPMENT. THE X1 THRU X4 CONNECTORS AND THE EXTERNAL METAL COVERS SHALL BE TEMPORARILY INSTALLED ON THE MECHANISM. FASTENERS TO BE HAND TIGHT ONLY.

(10) 16. USA PROVIDES THE TARGET ASSY, MOUNTING PLATE AND ATTACHING HARDWARE

(11) 17. LEAKAGE OF SEALING SURFACE ACROSS EACH INTERFACE CODED (11) SHALL NOT EXCEED 0.08 LBS/DAY(36g/DAY) WHEN INTERIOR IS PRESSURIZED TO 14.7±0.2 PSI(760±10mmHg) IN THE DOCKED OR MATED MODE

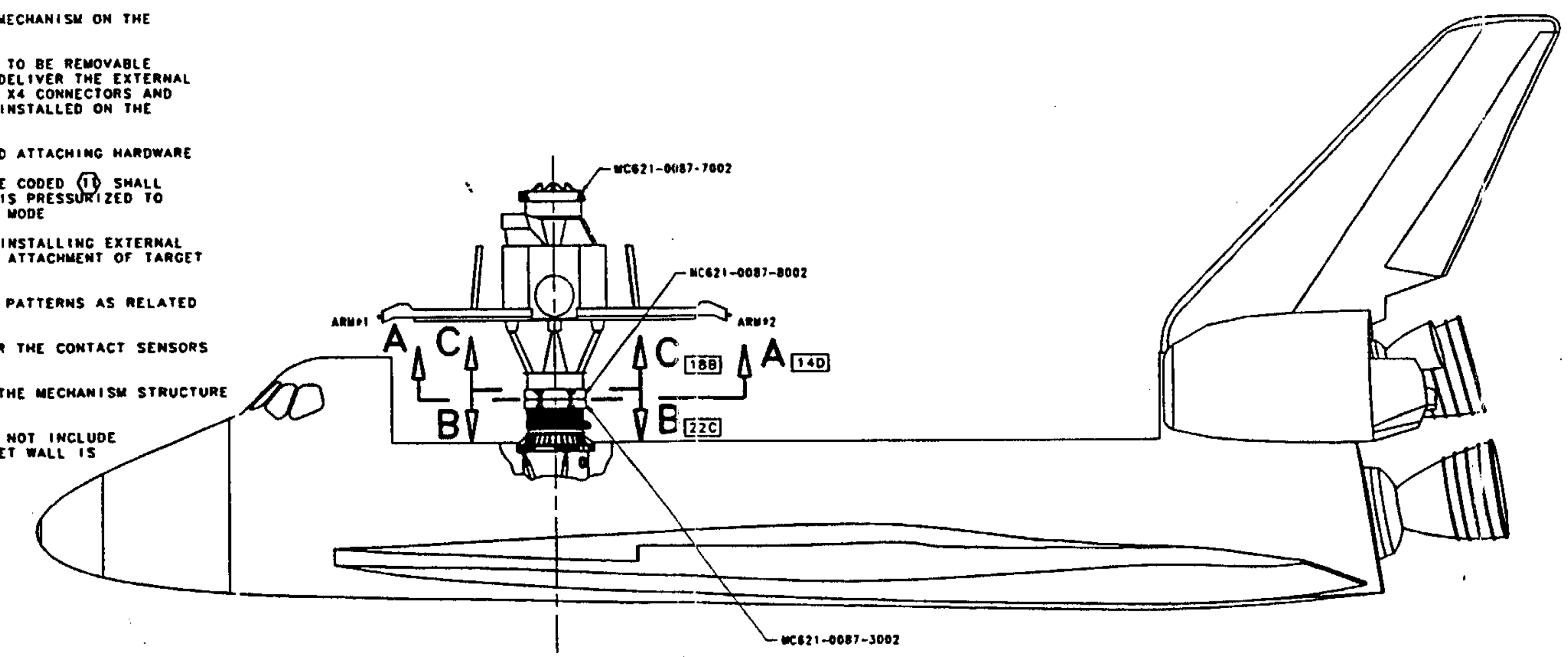
(12) 18. USA TO PROVIDE (120)KNCML-4 X 0.75 INSERTS FOR INSTALLING EXTERNAL METAL COVERS AND (8)KNML-10 X 1.5SP INSERTS FOR ATTACHMENT OF TARGET MOUNTING PLATE.

(13) 19. THE TOLERANCE OF MOUNTING PADS AND THEIR HOLE PATTERNS AS RELATED TO MECHANISM AXIS TO BE ±1°

(14) 20. THE HOLES DRILLED ON THE INTERFACE SURFACE FOR THE CONTACT SENSORS WHICH ARE NOT USED, NEED NOT BE PLUGGED.

(15) 21. U.S.A WILL PROVIDE AND INSTALL BUSHINGS INTO THE MECHANISM STRUCTURE PRIOR TO ITS MOUNTING ONTO THE AIRLOCK BASE.

(16) 22. ALL ENVELOPE DIMENSIONS, WHERE APPLICABLE, DO NOT INCLUDE THERMAL BLANKET THICKNESS. THICKNESS OF BLANKET WALL IS
.19-.40(5-10 MM)- ON THE GROUND
.78(20 MM) MAX, UNRESTRICTED- ON ORBIT



Xo 731.60

ICM CONFIGURATION

SCALE: NONE

MC621-0087-8002 CONFIGURATION
(33Y.6201.008-12)

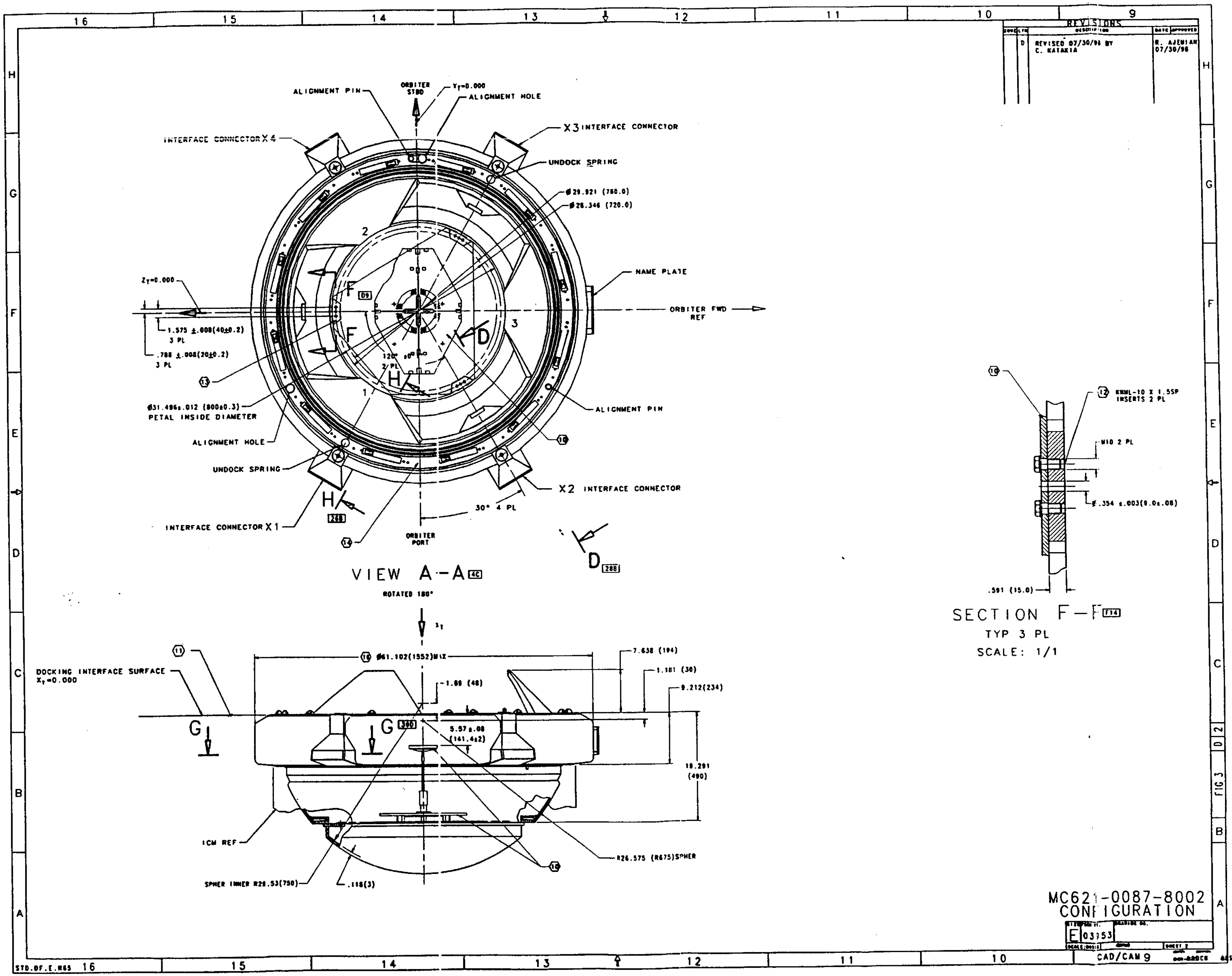
SPEC CONTROL DRAWING - ISSA, DOCKING MECHANISM INTERFACE REQUIREMENTS

E 03953 FIG 160-3

CAD/CAM 1

STD.DF.E.#67

623



MC621-0087-8002
CONFIGURATION

E 03353

CAD/CAM 9

STD.DF.E.R65

FIG 3 D 2

Fri Jul 31 07:32:34 PDT 1998

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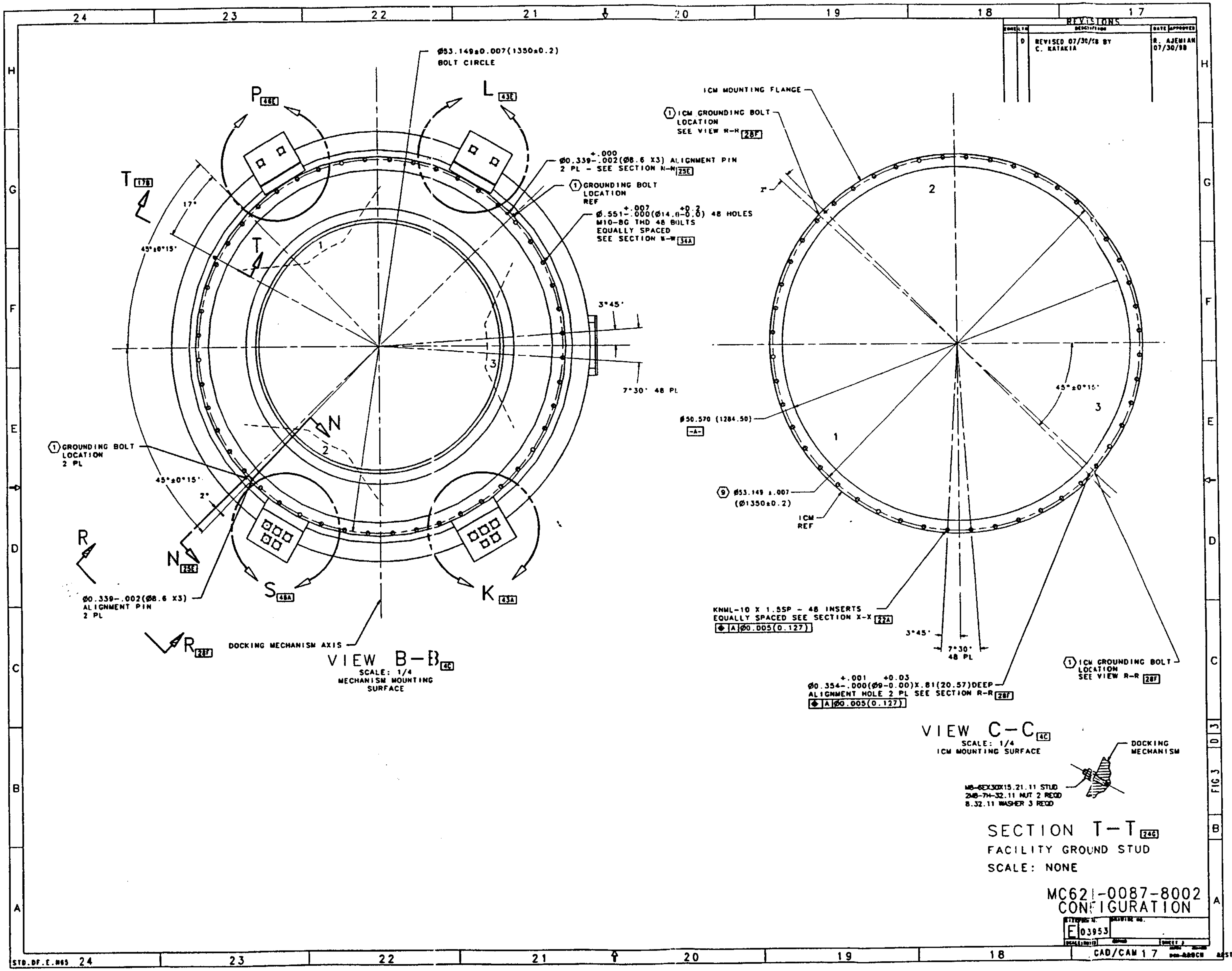
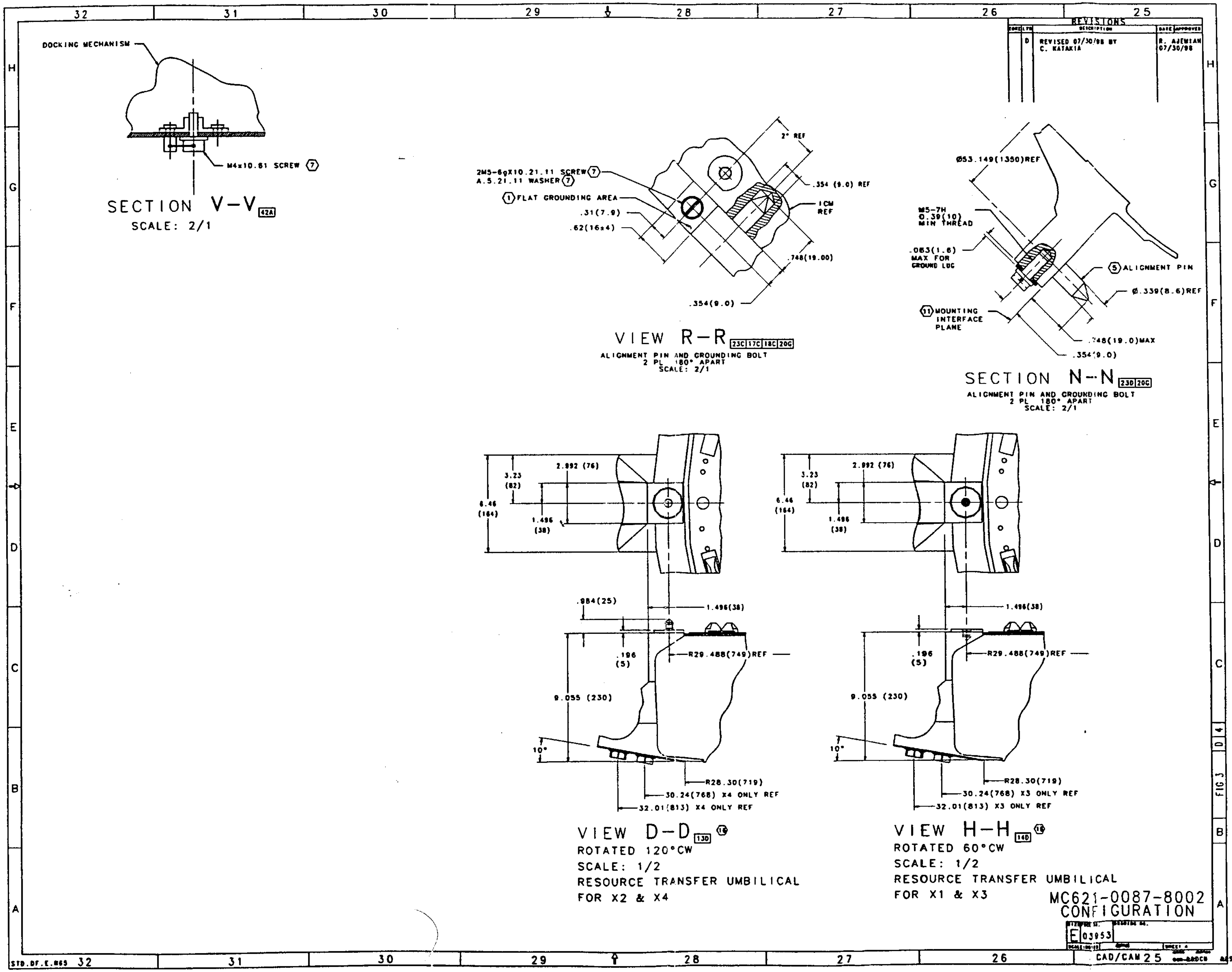
Thu Jul 30 13:27:16 PDT 1998



Thu Jul 30 13:29:05 PDT 1998



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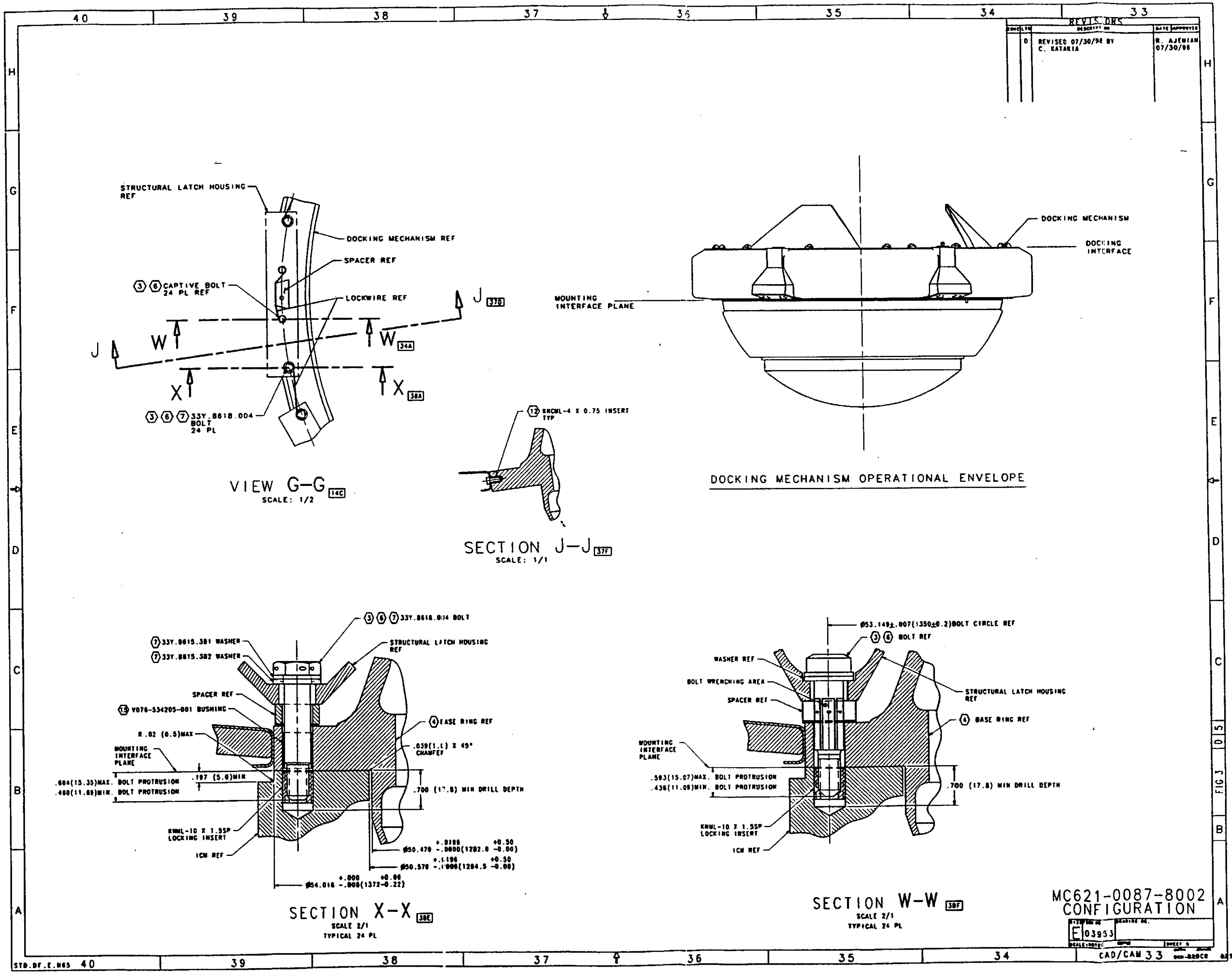

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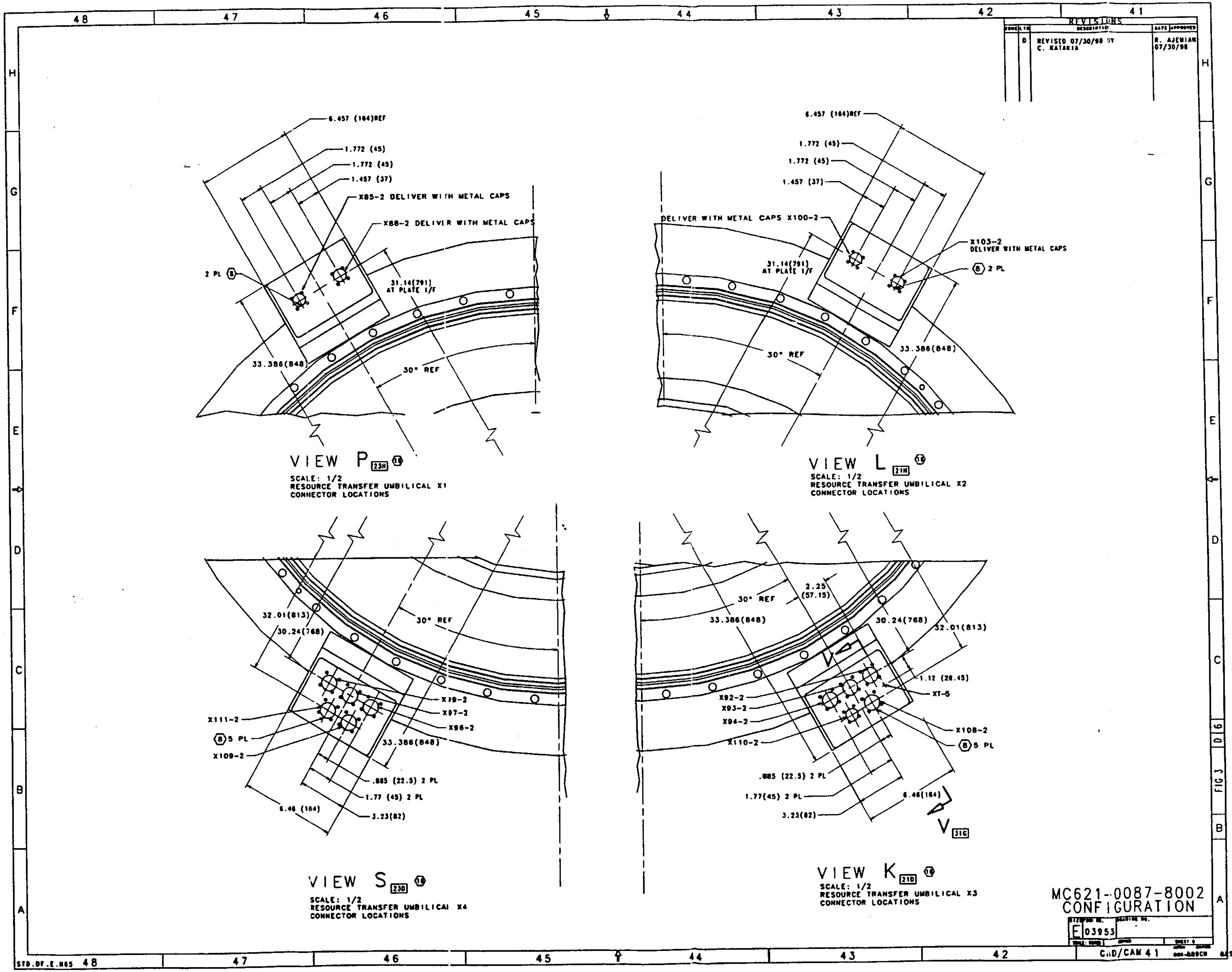


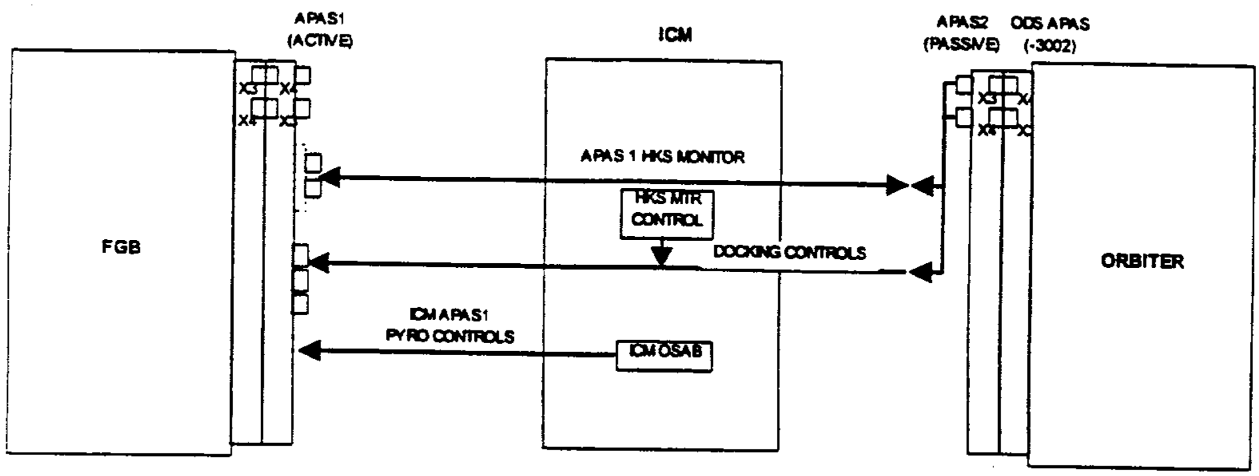
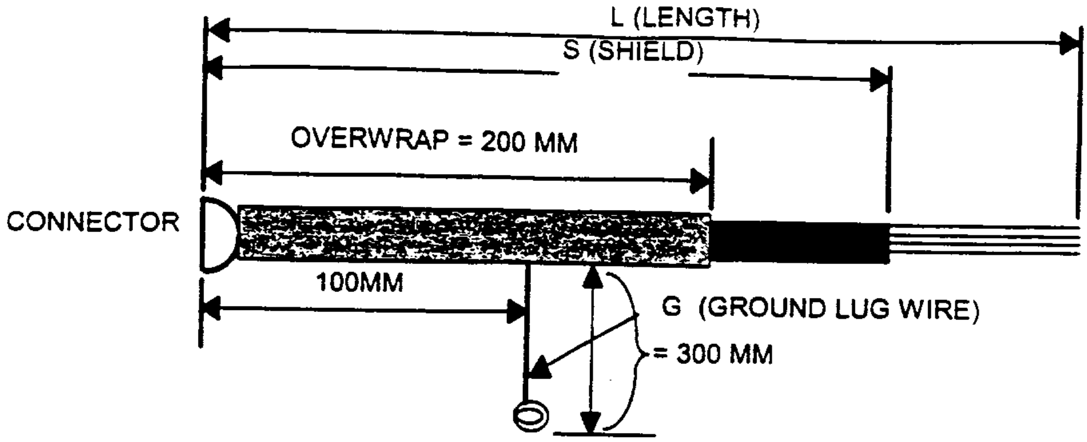
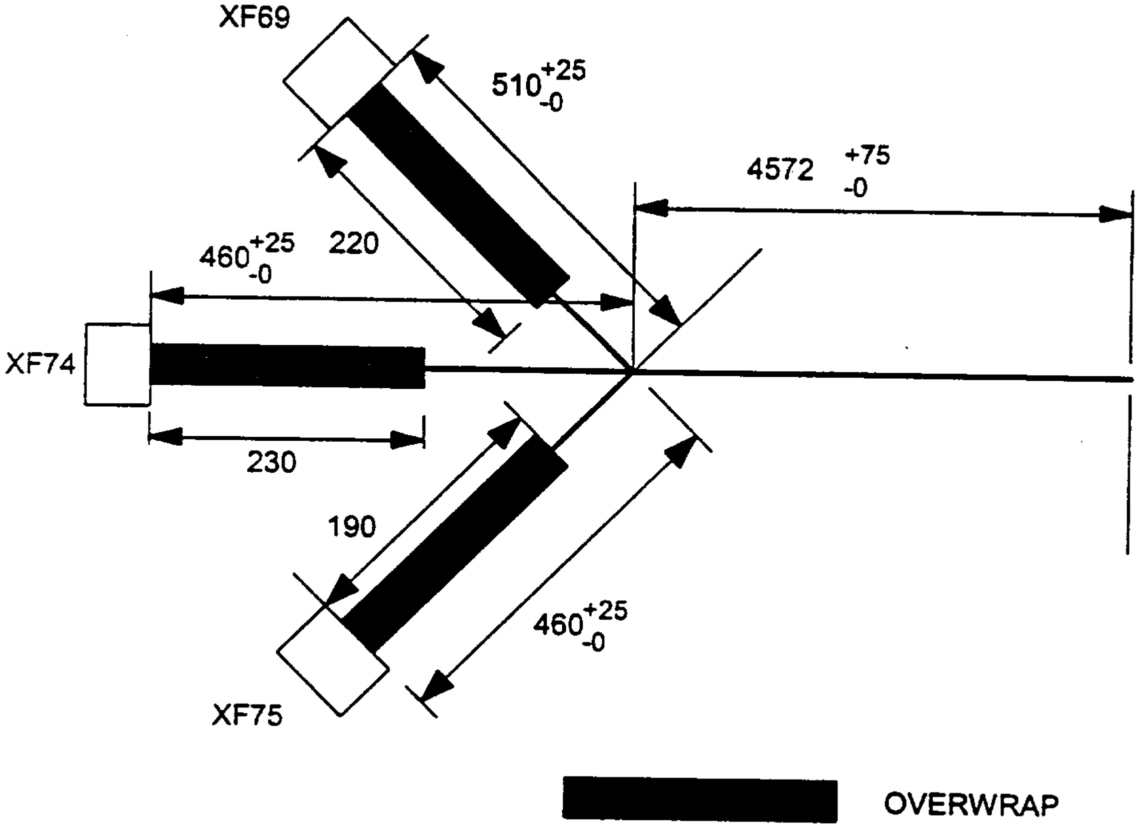


Figure 160-4. Interface Diagram of Hooks/Pyro Control From ICM



Note: For all cables except as indicated below:
L = 4572 +75, -0 millimeters
S = 4267.2 +75, -0 millimeters



Note: All dimensions are in millimeters.

Figure 160-5. Cable Envelopes

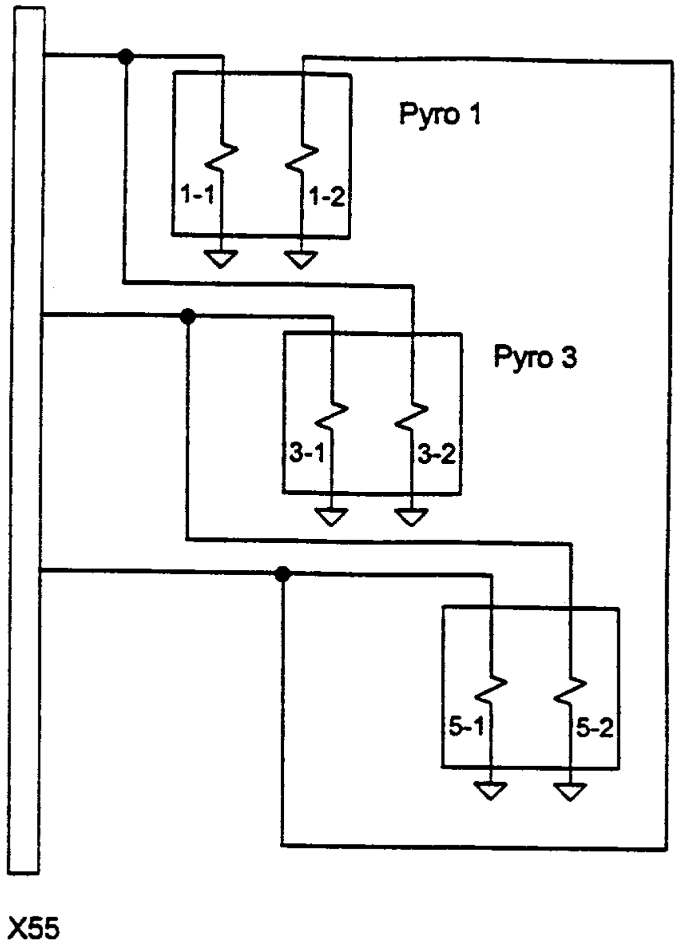


Figure 160-6. Typical Parallel Circuit For Pyrotechnic Bolt Bridgewires

Table 160-9. Electrical Interface Connections to ICM and APDA 7002

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F		FUNCTION
		CONN	PIN	
ML1	0.35	X55	31	PYRO 1-1/3-2 ACTIVE HOOK ASSY (+)
ML1	0.35	X55	1	PYRO 1-1/3-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X56	1	PYRO 7-1/9-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X56	21	PYRO 7-1/9-2 ACTIVE HOOK ASSY (+)
ML1	0.35	X55	35	PYRO 5-1/1-2 ACTIVE HOOK ASSY (+)
ML1	0.35	X55	5	PYRO 5-1/1-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X56	5	PYRO 11-1/7-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X56	25	PYRO 11-1/7-2 ACTIVE HOOK ASSY (+)
ML1	0.35	X56	23	PYRO 9-1/11-2 ACTIVE HOOK ASSY (+)
ML1	0.35	X56	3	PYRO 9-1/11-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X55	3	PYRO 3-1/5-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X55	33	PYRO 3-1/5-2 ACTIVE HOOK ASSY (+)
ML1	0.35	X55	32	PYRO 2-1/4-2 ACTIVE HOOK ASSY (+)
ML1	0.35	X55	2	PYRO 2-1/4-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X56	2	PYRO 8-1/10-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X56	22	PYRO 8-1/10-2 ACTIVE HOOK ASSY (+)
ML1	0.35	X55	36	PYRO 6-1/2-2 ACTIVE HOOK ASSY (+)
ML1	0.35	X55	6	PYRO 6-1/2-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X56	6	PYRO 12-1/8-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X56	26	PYRO 12-1/8-2 ACTIVE HOOK ASSY (+)
ML1	0.35	X56	24	PYRO 10-1/12-2 ACTIVE HOOK ASSY (+)
ML1	0.35	X56	4	PYRO 10-1/12-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X55	4	PYRO 4-1/6-2 ACTIVE HOOK ASSY (-)
ML1	0.35	X55	34	PYRO 4-1/6-2 ACTIVE HOOK ASSY (+)
HO1	0.35	XF68	3	DOCK MECH HEATER (H1-1 +)
HO1	0.35	XF68	48	DOCK MECH HEATER (H1-1 -)
HO2	0.35	XF68	1	DOCK MECH HEATER (H1-2 +)
HO2	0.35	XF68	50	DOCK MECH HEATER (H1-2 -)

Table 160-9. Electrical Interface Connections to ICM and APDA 7002 (Continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO3	0.35	XF68	9	DOCK MECH HEATER (H1-3 +)
HO3	0.35	XF68	41	DOCK MECH HEATER (H1-3 -)
HO3	0.35	XF68	7	DOCK MECH HEATER (H2-1 +)
HO3	0.35	XF68	44	DOCK MECH HEATER (H2-1 -)
HO1	0.35	XF68	5	DOCK MECH HEATER (H2-2 +)
HO1	0.35	XF68	46	DOCK MECH HEATER (H2-2 -)
HO2	0.35	XF68	17	DOCK MECH HEATER (H2-3 +)
HO2	0.35	XF68	34	DOCK MECH HEATER (H2-3 -)
HO3	0.35	XF68	13	DOCK MECH HEATER (H3-1 +)
HO3	0.35	XF68	38	DOCK MECH HEATER (H3-1 -)
HO2	0.35	XF68	11	DOCK MECH HEATER (H3-2 +)
HO2	0.35	XF68	40	DOCK MECH HEATER (H3-2 -)
HO1	0.35	XF68	24	DOCK MECH HEATER (H3-3 +)
HO1	0.35	XF68	26	DOCK MECH HEATER (H3-3 -)
HO1	0.35	XF74	16	RING ALIGNED
HO2	0.35	XF74	24	RING ALIGNED
HO1	0.35	XF74	25	INITIAL CONTACT
HO2	0.35	XF74	12	INITIAL CONTACT
HO1	0.35	XF74	32	CAPTURE (SHORT)
HO2	0.35	XF74	47	CAPTURE (SHORT)
HO1	0.35	XF74	36	CAPTURE (LONG)
HO2	0.35	XF74	13	CAPTURE (LONG)
HO1	0.35	XF75	10	PWR SUP TO RING MTR (M4)
HO1	0.35	XF75	4	PWR SUP TO RING MTR (M4)
HO1	0.35	XF75	41	PWR SUP TO RING MTR (M4)
HO1	0.35	XF75	50	PWR SUP TO RING MTR (M4)
HO2	0.35	XF75	7	PWR SUP TO RING MTR (M5)

Table 160-9. Electrical Interface Connections to ICM and APDA 7002 (Continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO2	0.35	XF75	8	PWR SUP TO RING MTR (M5)
HO2	0.35	XF75	47	PWR SUP TO RING MTR (M5)
HO2	0.35	XF75	48	PWR SUP TO RING MTR (M5)
HO1	0.35	XF75	35	RING FINAL POSITION
HO2	0.35	XF75	43	RING FINAL POSITION
HO3	0.35	XF75	22	CONTROL SENSOR RETURN
HO1	0.35	XF75	24	CONTROL SENSOR RETURN
HO2	0.35	XF75	25	RING FINAL POS 1 RTN
HO1	0.35	XF69	34	RING INITIAL POSITION
HO2	0.35	XF69	26	RING INITIAL POSITION
HO1	0.35	XF69	27	RING FORWARD POSITION
HO2	0.35	XF69	28	RING FORWARD POSITION
HO1	0.35	XF69	12	CAPTURE LATCHES OPEN IND
HO2	0.35	XF69	11	CAPTURE LATCHES OPEN IND
HO1	0.35	XF69	4	CAPTURE LATCHES CLOS IND
HO2	0.35	XF69	8	CAPTURE LATCHES CLOS IND
HO2	0.35	XF72	35	PWR SUP TO CAP LAT MTR (M1) +
HO1	0.35	XF72	36	PWR SUP TO CAP LAT MTR (M1) +
HO1	0.35	XF72	2	PWR SUP TO CAP LAT MTR (M1) -
HO1	0.35	XF72	4	PWR SUP TO CAP LAT MTR (M1) -
HO2	0.35	XF72	11	CAPTURE LATCH NO. 1 CLOS
HO1	0.35	XF72	25	CAPTURE LATCH NO. 1 CLOS
HO2	0.35	XF72	32	CAPTURE LATCH NO. 1 OPEN
HO1	0.35	XF72	27	CAPTURE LATCH NO. 1 OPEN
HO2	0.35	XF72	43	PWR SUP TO CAP LAT MTR (M2) +
HO2	0.35	XF72	42	PWR SUP TO CAP LAT MTR (M2) +

Table 160-9. Electrical Interface Connections to ICM and APDA 7002 (Continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO3	0.35	XF72	5	PWR SUP TO CAP LAT MTR (M2) -
HO2	0.35	XF72	1	PWR SUP TO CAP LAT MTR (M2) -
HO3	0.35	XF72	24	CAPTURE LATCH NO. 2 CLOS
HO2	0.35	XF72	19	CAPTURE LATCH NO. 2 CLOS
HO3	0.35	XF72	26	CAPTURE LATCH NO. 2 OPEN
HO2	0.35	XF72	40	CAPTURE LATCH NO. 2 OPEN
HO3	0.35	XF72	48	PWR SUP TO CAP LAT MTR (M3) +
HO3	0.35	XF72	47	PWR SUP TO CAP LAT MTR (M3) +
HO1	0.35	XF72	9	PWR SUP TO CAP LAT MTR (M3) -
HO3	0.35	XF72	10	PWR SUP TO CAP LAT MTR (M3) -
HO1	0.35	XF72	18	CAPTURE LATCH NO. 3 CLOS
HO3	0.35	XF72	33	CAPTURE LATCH NO. 3 CLOS
HO1	0.35	XF72	39	CAPTURE LATCH NO. 3 OPEN
HO3	0.35	XF72	34	CAPTURE LATCH NO. 3 OPEN
HO1	0.35	X76	4	PWR SUP TO M6 GROUP 1 HOOKS ** (N)
HO1	0.35	X76	8	PWR SUP TO M6 GROUP 1 HOOKS ** (N)
HO1	0.35	X76	1	PWR SUP TO M6 GROUP 1 HOOKS ** (N)
HO1	0.35	X76	5	PWR SUP TO M6 GROUP 1 HOOKS ** (N)
HO2	0.35	X76	9	PWR SUP TO M7 GROUP 1 HOOKS ** (N)
HO2	0.35	X76	10	PWR SUP TO M7 GROUP 1 HOOKS ** (N)
HO2	0.35	X76	11	PWR SUP TO M7 GROUP 1 HOOKS ** (N)
HO2	0.35	X76	12	PWR SUP TO M7 GROUP 1 HOOKS ** (N)
HO1	0.35	X76	6	GROUP 1 HOOKS CLOSED **
HO2	0.35	X76	20	GROUP 1 HOOKS CLOSED **
HO1	0.35	X76	15	GROUP 1 HOOKS OPEN **
HO2	0.35	X76	22	GROUP 1 HOOKS OPEN **

Table 160-9. Electrical Interface Connections to ICM and APDA 7002 (Continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO1	0.35	XF70	4	FIXER 1 (+)
HO1	0.35	XF70	2	FIXER 1 (+)
HO1	0.35	XF70	28	FIXER 1 (-)
HO1	0.35	XF70	31	FIXER 1 (-)
HO1	0.35	XF70	46	FIXER 1 (-)
HO1	0.35	XF70	45	FIXER 1 (-)
HO2	0.35	XF70	10	FIXER 2 (+)
HO2	0.35	XF70	9	FIXER 2 (+)
HO2	0.35	XF70	27	FIXER 2 (-)
HO2	0.35	XF70	26	FIXER 2 (-)
HO2	0.35	XF70	50	FIXER 2 (-)
HO2	0.35	XF70	49	FIXER 2 (-)
HO3	0.35	XF70	8	FIXER 3 (+)
HO3	0.35	XF70	14	FIXER 3 (+)
HO3	0.35	XF70	25	FIXER 3 (-)
HO3	0.35	XF70	24	FIXER 3 (-)
HO3	0.35	XF70	44	FIXER 3 (-)
HO3	0.35	XF70	43	FIXER 3 (-)
HO	0.35	XF70	13	FIXER 4 (+)
HO	0.35	XF70	20	FIXER 4 (+)
HO	0.35	XF70	17	FIXER 4 (-)
HO	0.35	XF70	16	FIXER 4 (-)
HO	0.35	XF70	48	FIXER 4 (-)
HO	0.35	XF70	47	FIXER 4 (-)
HO	0.35	XF70	19	FIXER 5 (+)
HO	0.35	XF70	18	FIXER 5 (+)
HO	0.35	XF70	33	FIXER 5 (-)
HO	0.35	XF70	32	FIXER 5 (-)

Table 160-9. Electrical Interface Connections to ICM and APDA 7002 (Continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
HO	0.35	XF70	42	FIXER 5 (-)
HO	0.35	XF70	41	FIXER 5 (-)
HO1	0.35	XF67	4	HI-ENERGY DAMPER NO. 1 (+)
HO1	0.35	XF67	3	HI-ENERGY DAMPER NO. 1 (+)
HO1	0.35	XF67	39	HI-ENERGY DAMPER NO. 1 (-)
HO1	0.35	XF67	40	HI-ENERGY DAMPER NO. 1 (-)
HO2	0.35	XF67	17	HI-ENERGY DAMPER NO. 2 (+)
HO2	0.35	XF67	16	HI-ENERGY DAMPER NO. 2 (+)
HO2	0.35	XF67	50	HI-ENERGY DAMPER NO. 2 (-)
HO2	0.35	XF67	49	HI-ENERGY DAMPER NO. 2 (-)
HO3	0.35	XF67	6	HI-ENERGY DAMPER NO. 3 (+)
HO3	0.35	XF67	5	HI-ENERGY DAMPER NO. 3 (+)
HO3	0.35	XF67	35	HI-ENERGY DAMPER NO. 3 (-)
HO3	0.35	XF67	34	HI-ENERGY DAMPER NO. 3 (-)
HO2	0.35	X76	41	PWR SUP TO M9 GROUP 2 HOOKS ** (N)
HO2	0.35	X76	42	PWR SUP TO M9 GROUP 2 HOOKS ** (N)
HO2	0.35	X76	39	PWR SUP TO M9 GROUP 2 HOOKS ** (N)
HO2	0.35	X76	40	PWR SUP TO M9 GROUP 2 HOOKS ** (N)
HO1	0.35	X76	47	PWR SUP TO M8 GROUP 2 HOOKS ** (N)
HO1	0.35	X76	48	PWR SUP TO M8 GROUP 2 HOOKS ** (N)
HO1	0.35	X76	50	PWR SUP TO M8 GROUP 2 HOOKS ** (N)
HO1	0.35	X76	46	PWR SUP TO M8 GROUP 2 HOOKS ** (N)
HO1	0.35	X76	19	GROUP 2 HOOKS CLOSED **
HO2	0.35	X76	28	GROUP 2 HOOKS CLOSED **
HO1	0.35	X76	18	GROUP 2 HOOKS OPEN **
HO2	0.35	X76	27	GROUP 2 HOOKS OPEN **

Table 160-9. Electrical Interface Connections to ICM and APDA 7002 (Continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	DOCKING MECH. I/F PIN	FUNCTION
HO1	0.35	X77	1	GROUP 1 HOOKS IN-BETWEEN **
HO2	0.35	X77	5	GROUP 1 HOOKS IN-BETWEEN **
HO1	0.35	X77	38	GROUP 2 HOOKS IN-BETWEEN **
HO2	0.35	X77	37	GROUP 2 HOOKS IN-BETWEEN **
HO2	0.35	X76	36	CONTROL SENSOR RETURN
HO2	0.35	X76	43	CONTROL SENSOR RETURN
HO1	0.35	X77	6	CONTROL SENSOR RETURN
HO1	0.35	X77	45	READY TO HOOK
HO2	0.35	X77	48	READY TO HOOK
HO1	0.35	X77	49	UNDOCK COMPLETE
HO2	0.35	X77	50	UNDOCK COMPLETE
HO2	0.35	X77	32	INTERFACE SEALED
HO3	0.35	X77	39	INTERFACE SEALED
HO1	0.2	X77	24	INTERFACE SEALED
HO1	0.35	X77	14	CONTROL SENSOR RETURN
ML	0.35	XF71	28	BALL SCREW NO. 1 LIN ADV (COM)
ML	0.35	XF71	23	BALL SCREW NO. 1 LIN ADV (SIG)
ML	0.35	XF71	40	BALL SCREW NO. 1 LIN ADV (EXC)
ML	0.35	XF71	24	BALL SCREW NO. 2 LIN ADV (SIG)
ML	0.35	XF71	39	BALL SCREW NO. 2 LIN ADV (EXC)
ML	0.35	XF71	25	BALL SCREW NO. 3 LIN ADV (SIG)
ML	0.35	XF71	45	BALL SCREW NO. 3 LIN ADV (EXC)
ML	0.35	XF71	18	BALL SCREW NO. 1 MISALIGN (SIG)
ML	0.35	XF71	50	BALL SCREW NO. 1 MISALIGN (EXC)
ML	0.35	XF71	19	BALL SCREW NO. 2 MISALIGN (SIG)
ML	0.35	XF71	49	BALL SCREW NO. 2 MISALIGN (EXC)
ML	0.35	XF71	34	BALL SCREW NO. 3 MISALIGN (COM)

Table 160-9. Electrical Interface Connections to ICM and APDA 7002 (Continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML	0.35	XF71	20	BALL SCREW NO. 3 MISALIGN (SIG)
ML	0.35	XF71	48	BALL SCREW NO. 3 MISALIGN (EXC)
ML	0.35	XF71	13	LATCHES MANUAL REL RTN
ML	0.35	XF71	17	LATCHES MANUAL RELEASE
ML2	0.35	XF71	10	RING FINAL POSITION
ML	0.35	XF73	44	CAPTURE LATCH OPEN
ML	0.35	XF73	43	CAPTURE LATCHES CLOSED
ML	0.35	XF73	47	RING INITIAL POSITION
ML2	0.35	XF73	48	RING FORWARD POSITION
ML	0.35	XF73	21	LWR BALL SOCKET NO 1 TEMP (COM)
ML	0.35	XF73	18	LWR BALL SOCKET NO 1 TEMP (EXC)
ML	0.35	XF73	28	LWR BALL SOCKET NO 2 TEMP (COM)
ML	0.35	XF73	39	LWR BALL SOCKET NO 2 TEMP (EXC)
ML	0.35	XF73	37	LWR BALL SOCKET NO 3 TEMP (COM)
ML	0.35	XF73	34	LWR BALL SOCKET NO 3 TEMP (EXC)
ML	0.35	XF73	17	CAPTURE LATCH NO. 1 TEMP (COM)
ML	0.35	XF73	14	CAPTURE LATCH NO. 1 TEMP (EXC)
ML	0.35	XF73	25	CAPTURE LATCH NO. 2 TEMP (COM)
ML	0.35	XF73	22	CAPTURE LATCH NO. 2 TEMP (EXC)
ML	0.35	XF73	33	CAPTURE LATCH NO. 3 TEMP (COM)
ML	0.35	XF73	30	CAPTURE LATCH NO. 3 TEMP (EXC)
ML	0.35	XF73	6	SHIELD
ML	0.35	XF73	29	DOCKING RING DRIVE TEMP (COM)
ML	0.35	XF73	45	DOCKING RING DRIVE TEMP (EXC)
ML2	0.35	XF73	10	CONTROL SENSOR RETURN
ML1	0.35	X79	23	UNDOCK COMPLETE
ML1	0.35	X79	3	READY TO HOOK

Table 160-9. Electrical Interface Connections to ICM and APDA 7002 (Continued)

EMC	RUSS WIRE SIZE (mm²)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML1	0.35	X79	9	CONTROL SENSOR RETURN
ML1	0.35	X79	26	GROUP 1 HOOKS CLOSED POS **
ML2	0.35	X79	25	GROUP 2 HOOKS OPEN POSITION **
ML1	0.35	X79	24	GROUP 1 HOOKS OPEN POSITION **
ML2	0.35	X79	17	GROUP 2 HOOKS CLOSED POS **
ML	0.35	X79	31	GROUP 1 HOOKS LINEAR ADV (EXC) **
ML	0.35	X79	40	GROUP 1 HOOKS LINEAR ADV (SIG) **
ML	0.35	X79	50	GROUP 1 HOOKS LINEAR ADV (COM) **
ML	0.35	X79	30	GROUP 2 HOOKS LINEAR ADV (EXC) **
ML	0.35	X79	46	GROUP 2 HOOKS LINEAR ADV (SIG) **
ML	0.35	X79	39	GROUP 2 HOOKS LINEAR ADV (COM) **
ML	0.35	X78	1	DOCKING I/F TEMP NO. 1 (COM)
ML	0.35	X78	4	DOCKING I/F TEMP NO. 1 (EXC)
ML	0.35	X78	5	DOCKING I/F TEMP NO. 2 (COM)
ML	0.35	X78	8	DOCKING I/F TEMP NO. 2 (EXC)
ML	0.35	X78	9	DOCKING I/F TEMP NO. 3 (COM)
ML	0.35	X78	12	DOCKING I/F TEMP NO. 3 (EXC)
ML	0.35	X78	30	HOOKS DRIVE TEMP NO. 1 (COM)
ML	0.35	X78	33	HOOKS DRIVE TEMP NO. 1 (EXC)
ML	0.35	X78	37	HOOKS DRIVE TEMP NO. 2 (COM)
ML	0.35	X78	40	HOOKS DRIVE TEMP NO. 2 (EXC)
ML	0.35	X78	34	SHD (ALL APDS TEMP MEAS)
ML1	0.35	X79	2	ICM HOOKS 1 CLOSED IND
ML1	0.35	X79	5	ICM HOOKS 3 CLOSED IND
ML1	0.35	X79	6	ICM HOOKS 5 CLOSED IND
ML1	0.35	X79	7	ICM HOOKS 9 CLOSED IND
ML1	0.35	X79	12	ICM HOOKS 11 CLOSED IND

Table 160-9. Electrical Interface Connections to ICM and APDA 7002 (Continued)

EMC	RUSS WIRE SIZE (mm^2)	DOCKING MECH. I/F CONN	PIN	FUNCTION
ML1	0.35	X79	1	ICM HOOKS 1,3,5,9,11 CLOS IND SOURCE (1)
ML1	0.35	X79	11	ICM HOOKS 1,3,5,9,11 CLOS IND SOURCE (2)
ML2	0.35	X79	19	ICM HOOKS 2 CLOSED IND
ML2	0.35	X79	20	ICM HOOKS 4 CLOSED IND
ML2	0.35	X79	47	ICM HOOKS 8 CLOSED IND
ML2	0.35	X79	48	ICM HOOKS 10 CLOSED IND
ML2	0.35	X79	49	ICM HOOKS 12 CLOSED IND
ML2	0.35	X79	18	ICM HOOKS 2,4,8,10,12 CLOS IND SOURCE (1)
ML2	0.35	X79	45	ICM HOOKS 2,4,8,10,12 CLOS IND SOURCE (2)
HO	0.35	X79	13	ICM HOOKS 7 CLOS IND SOURCE
HO	0.35	X79	21	ICM HOOKS 7 CLOS IND
HO	0.35	X79	38	ICM HOOKS 6 CLOS IND SOURCE
HO	0.35	X79	44	ICM HOOKS 6 CLOS IND

** NOTE: GROUP 1 HOOKS CONSIST OF HOOKS 1, 3, 5, 7, 9, & 11.
GROUP 2 HOOKS CONSIST OF HOOKS 2, 4, 6, 8, 10, & 12.

GROUP 1 & 2 HOOKS ACTUATOR ASSEMBLIES ATTACHED WITH HOOKS 7 & 6, RESPECTIVELY.

(N): CONTROL CAPABILITY FROM SHUTTLE AND ICM.

Table 160-10. Electrical Interface Connections to APDA 7002 Pressure Dome

EMC	AMER WIRE SIZE	PRESSURE DOME I/F CONN	PRESSURE DOME I/F PIN	FUNCTION
HO	22	XF61	C	C/L TV CAM #1 PWR +
HO	22	XF61	D	C/L TV CAM #1 PWR +
HO	22	XF61	A	C/L TV CAM #1 PWR -
HO	22	XF61	B	C/L TV CAM #1 PWR -
HO	22	XF61	g	C/L TV CAM #1 CHAS GND
HO	22	XF61	j	C/L TV CAM #1 CHAS GND
RF2	22	XF61	H	C/L TV CAM #1 SYNC OUT +
RF2	22	XF61	J	C/L TV CAM #1 SYNC OUT -
RF2	22	XF61	***	C/L TV CAM #1 SYNC OUT SHD
RF2	22	XF61	K	C/L TV CAM #1 VIDEO OUT +
RF2	22	XF61	L	C/L TV CAM #1 VIDEO OUT -
RF2	22	XF61	***	C/L TV CAM #1 VIDEO OUT SHD
RF	22	XF61	V	C/L TV CAM #1 HTR PWR +
RF	22	XF61	W	C/L TV CAM #1 HTR PWR +
RF	22	XF61	T	C/L TV CAM #1 HTR PWR -
RF	22	XF61	U	C/L TV CAM #1 HTR PWR -
HO	20	XF61	d	C/L TV CAM #1 LIGHT +
HO	20	XF61	e	C/L TV CAM #1 LIGHT +
HO	20	XF61	f	C/L TV CAM #1 LIGHT +
HO	20	XF61	P	C/L TV CAM #1 LIGHT -
HO	20	XF61	R	C/L TV CAM #1 LIGHT -
HO	20	XF61	S	C/L TV CAM #1 LIGHT -
HO	22	XF62	C	C/L TV CAM #2 PWR +
HO	22	XF62	D	C/L TV CAM #2 PWR +
HO	22	XF62	A	C/L TV CAM #2 PWR -

Table 160-10. Electrical Interface Connections to APDA 7002 Pressure Dome (continued)

EMC	AMER WIRE SIZE	PRESSURE DOME I/F		FUNCTION
		CONN	PIN	
HO	22	XF62	B	C/L TV CAM #2 PWR -
HO	22	XF62	g	C/L TV CAM #2 CHAS GND
HO	22	XF62	j	C/L TV CAM #2 CHAS GND
RF1	22	XF62	H	C/L TV CAM #2 SYNC OUT +
RF1	22	XF62	J	C/L TV CAM #2 SYNC OUT -
RF1	22	XF62	***	C/L TV CAM #2 SYNC OUT SHD
RF1	22	XF62	K	C/L TV CAM #2 VIDEO OUT +
RF1	22	XF62	L	C/L TV CAM #2 VIDEO OUT -
RF1	22	XF62	***	C/L TV CAM #2 VIDEO OUT SHD
HO	22	XF62	V	C/L TV CAM #2 HTR PWR +
HO	22	XF62	W	C/L TV CAM #2 HTR PWR +
HO	22	XF62	T	C/L TV CAM #2 HTR PWR -
HO	22	XF62	U	C/L TV CAM #2 HTR PWR -
HO	20	XF62	d	C/L TV CAM #2 LIGHT +
HO	20	XF62	e	C/L TV CAM #2 LIGHT +
HO	20	XF62	f	C/L TV CAM #2 LIGHT +
HO	20	XF62	P	C/L TV CAM #2 LIGHT -
HO	20	XF62	R	C/L TV CAM #2 LIGHT -
HO	20	XF62	S	C/L TV CAM #2 LIGHT -

*** RF shield tied to backshell

Table 160-11. Orbiter-to-ICM Interfaces, X1 and X2

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA-2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL					
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN				
X88	4	X1	93	X2	93	X103-2	4	E01	8 GA*	8	TRANSFER POWER HI (140V)
		X1	94	X2	94						
		X1	95	X2	95						
		X1	104	X2	104						
		X1	105	X2	105						
		X1	106	X2	106						
		X1	107	X2	107						
		X1	116	X2	116						
		X1	117	X2	117						
		X1	118	X2	118						
X88	7	X1	119	X2	119	X103-2	7	E01	8 GA*	8	TRANSFER POWER HI (140V)
		X1	126	X2	126						
		X1	127	X2	127						
		X1	128	X2	128						
		X1	129	X2	129						
		X1	135	X2	135						
		X1	136	X2	136						
		X1	137	X2	137						
		X1	142	X2	142						
		X1	143	X2	143						
X103	4	X2	93	X1	93	X88-2	4	E02	8 GA*	8	TRANSFER POWER HI (140V)
		X2	94	X1	94						
		X2	95	X1	95						
		X2	104	X1	104						
		X2	105	X1	105						
		X2	106	X1	106						
		X2	107	X1	107						
		X2	116	X1	116						
		X2	117	X1	117						
		X2	118	X1	118						

Table 160-11. Orbiter-to-ICM Interfaces, X1 and X2 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA-2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL					
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN				
		X2	119	X1	119						
		X2	126	X1	126						
		X2	127	X1	127						
		X2	128	X1	128						
X103	7	X2	129	X1	129	X88-2	7	E02	8 GA*	8	TRANSFER POWER HI (140V)
		X2	135	X1	135						
		X2	136	X1	136						
		X2	137	X1	137						
		X2	142	X1	142						
		X2	143	X1	143						
		X1	88	X2	88						
		X1	89	X2	89						
		X1	90	X2	90						
		X1	98	X2	98						
X85	5	X1	99	X2	99	X100-2	5	E01	8 GA*	8	TRANSFER POWER LO
		X1	100	X2	100						
		X1	101	X2	101						
		X1	110	X2	110						
		X1	111	X2	111						
		X1	112	X2	112						
		X1	113	X2	113						
		X1	122	X2	122						
		X1	123	X2	123						
		X1	124	X2	124						
X85	7	X1	125	X2	125	X100-2	7	E01	8 GA*	8	TRANSFER POWER LO
		X1	132	X2	132						
		X1	133	X2	133						
		X1	134	X2	134						
		X1	140	X2	140						
		X1	141	X2	141						

Table 160-11. Orbiter-to-ICM Interfaces, X1 and X2 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA-2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL					
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN				
X100	5	X2	88	X1	88	X85-2	5	EO2	8 GA*	8	TRANSFER POWER LO
		X2	89	X1	89						
		X2	90	X1	90						
		X2	98	X1	98						
		X2	99	X1	99						
		X2	100	X1	100						
		X2	101	X1	101						
		X2	110	X1	110						
		X2	111	X1	111						
		X2	112	X1	112						
X100	7	X2	113	X1	113	X85-2	7	EO2	8 GA*	8	TRANSFER POWER LO
		X2	122	X1	122						
		X2	123	X1	123						
		X2	124	X1	124						
		X2	125	X1	125						
		X2	132	X1	132						
		X2	133	X1	133						
		X2	134	X1	134						
		X2	140	X1	140						
		X2	141	X1	141						
X85	1	X1	33	X2	33	X100-2	1	EO1	8 GA*	8	TRANSFER POWER FAULT BOND
		X1	34	X2	34						
		X1	35	X2	35						
		X1	45	X2	45						
		X1	46	X2	46						
		X1	47	X2	47						
		X1	48	X2	48						
		X1	49	X2	49						
		X1	50	X2	50						
		X1	57	X2	57						

Table 160-11. Orbiter-to-ICM Interfaces, X1 and X2 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA-2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL					
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN				
X85	3	X1	58	X2	58	X100-2	3	EO1	8 GA*	8	TRANSFER POWER FAULT BOND
		X1	59	X2	59						
		X1	60	X2	60						
		X1	61	X2	61						
		X1	62	X2	62						
		X1	69	X2	69						
		X1	70	X2	70						
		X1	71	X2	71						
		X1	72	X2	72						
		X1	73	X2	73						
X100	1	X2	33	X1	33	X85-2	1	EO2	8 GA*	8	TRANSFER POWER FAULT BOND
		X2	34	X1	34						
		X2	35	X1	35						
		X2	45	X1	45						
		X2	46	X1	46						
		X2	47	X1	47						
		X2	48	X1	48						
		X2	49	X1	49						
		X2	50	X1	50						
		X2	57	X1	57						
X100	3	X2	58	X1	58	X85-2	3	EO2	8 GA*	8	TRANSFER POWER FAULT BOND
		X2	59	X1	59						
		X2	60	X1	60						
		X2	61	X1	61						
		X2	62	X1	62						
		X2	69	X1	69						
		X2	70	X1	70						
		X2	71	X1	71						
		X2	72	X1	72						
		X2	73	X1	73						

Table 160-11. Orbiter-to-ICM Interfaces, X1 and X2 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA-2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL					
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN				
X106	4	X1	26	X2	26	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TM/SIG)
X106	5	X1	27	X2	27	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TM/PWR)
X106	6	X1	28	X2	28	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TM/SIG)
X106	7	X1	29	X2	29	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TM/PWR)
X106	17	X1	4	X2	4	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TEST)
X106	19	X1	149	X2	149	n/a	n/a	HO1	0.35	22	ORB X1 CONN MATE (TEST)
X107	4	X2	26	X1	26	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TM/SIG)
X107	5	X2	27	X1	27	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TM/PWR)
X107	6	X2	28	X1	28	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TM/SIG)
X107	7	X2	29	X1	29	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TM/PWR)
X107	17	X2	4	X1	4	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TEST)
X107	19	X2	149	X1	149	n/a	n/a	HO2	0.35	22	ORB X2 CONN MATE (TEST)

NOTES:

8 GA* = RUSSIAN SIDE TO USE AMERICAN 8 GA WIRE FOR POWER TRANSFER; (8 GA WIRE TO BE PROVIDED TO RUSSIA BY U.S.)

A = NO RUSSIAN PIGTAILS REQUIRED FOR ORB X1/X2 CONNECTOR MATES ON ICM SIDE OF INTERFACE (LOOP BACK WITHIN RUSSIAN CONNECTOR)

B = NO RUSSIAN PIGTAILS REQUIRED FOR ORB X1/X2 CONNECTOR MATES ON EITHER SIDE OF INTERFACE

n/a = NOT APPLICABLE; NO PINS AT I/F PANEL; CONNECTOR MATE FUNCTIONS JUMPERED AT UMBILICAL INTERFACE

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X92	20	X4	112	X3	112	X92-2	20	HO1	0.35	20	DOCK MECH HEATER (H1-1 +)	
X92	21	X4	104	X3	104	X92-2	21	HO1	0.35	20	DOCK MECH HEATER (H1-1 -)	
X96	20	X3	89	X4	89	X96-2	20	HO2	0.35	20	DOCK MECH HEATER (H1-2 +)	
X96	21	X3	85	X4	85	X96-2	21	HO2	0.35	20	DOCK MECH HEATER (H1-2 -)	
X92	22	X4	116	X3	116	X92-2	22	HO3	0.35	20	DOCK MECH HEATER (H1-3 +)	
X92	23	X4	110	X3	110	X92-2	23	HO3	0.35	20	DOCK MECH HEATER (H1-3 -)	
X96	22	X3	92	X4	92	X96-2	22	HO3	0.35	20	DOCK MECH HEATER (H2-1 +)	
X96	23	X3	88	X4	88	X96-2	23	HO3	0.35	20	DOCK MECH HEATER (H2-1 -)	
X92	26	X4	113	X3	113	X92-2	26	HO1	0.35	20	DOCK MECH HEATER (H2-2 +)	
X92	27	X4	105	X3	105	X92-2	27	HO1	0.35	20	DOCK MECH HEATER (H2-2 -)	
X92	28	X4	114	X3	114	X92-2	28	HO2	0.35	20	DOCK MECH HEATER (H2-3 +)	
X92	29	X4	106	X3	106	X92-2	29	HO2	0.35	20	DOCK MECH HEATER (H2-3 -)	
X92	30	X4	117	X3	117	X92-2	30	HO3	0.35	20	DOCK MECH HEATER (H3-1 +)	
X92	31	X4	111	X3	111	X92-2	31	HO3	0.35	20	DOCK MECH HEATER (H3-1 -)	
X96	26	X3	91	X4	91	X96-2	26	HO2	0.35	20	DOCK MECH HEATER (H3-2 +)	
X96	27	X3	87	X4	87	X96-2	27	HO2	0.35	20	DOCK MECH HEATER (H3-2 -)	
X96	28	X3	90	X4	90	X96-2	28	HO1	0.35	20	DOCK MECH HEATER (H3-3 +)	
X96	29	X3	86	X4	86	X96-2	29	HO1	0.35	20	DOCK MECH HEATER (H3-3 -)	
X92	13	X4	57	X3	57	X92-2	13	HO1	0.35	22	RING ALIGNED	
X96	13	X3	40	X4	40	X96-2	13	HO2	0.35	22	RING ALIGNED	
X92	14	X4	58	X3	58	X92-2	14	HO1	0.35	22	INITIAL CONTACT	
X96	14	X3	41	X4	41	X96-2	14	HO2	0.35	22	INITIAL CONTACT	
X92	18	X4	56	X3	56	X92-2	18	HO1	0.35	22	CAPTURE (SHORT)	
X96	18	X3	39	X4	39	X96-2	18	HO2	0.35	22	CAPTURE (SHORT)	

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X92	19	X4	55	X3	55	X92-2	19	HO1	0.35	22	CAPTURE (LONG)	
X96	19	X3	38	X4	38	X96-2	19	HO2	0.35	22	CAPTURE (LONG)	
X92	1	X4	23	X3	23	X92-2	1	HO1	0.35	20	PWR SUP TO RING MTR (M4)	
X92	2	X4	24	X3	24	X92-2	2	HO1	0.35	20	PWR SUP TO RING MTR (M4)	
X92	47	X4	5	X3	5	X92-2	47	HO1	0.35	20	PWR SUP TO RING MTR (M4)	
X92	48	X4	11	X3	11	X92-2	48	HO1	0.35	20	PWR SUP TO RING MTR (M4)	
X96	2	X3	24	X4	24	X96-2	2	HO2	0.35	20	PWR SUP TO RING MTR (M5)	
X96	1	X3	23	X4	23	X96-2	1	HO2	0.35	20	PWR SUP TO RING MTR (M5)	
X96	48	X3	7	X4	7	X96-2	48	HO2	0.35	20	PWR SUP TO RING MTR (M5)	
X96	47	X3	6	X4	6	X96-2	47	HO2	0.35	20	PWR SUP TO RING MTR (M5)	
X92	24	X4	61	X3	61	X92-2	24	HO1	0.35	22	RING FINAL POSITION	
X96	24	X3	44	X4	44	X96-2	24	HO2	0.35	22	RING FINAL POSITION	
X96	46	X3	61	X4	61	X96-2	46	HO3	0.35	22	CONTROL SENSOR RETURN	
X92	45	X4	77	X3	77	X92-2	45	HO1	0.35	22	CONTROL SENSOR RETURN	
X92	46	X4	78	X3	78	X92-2	46	HO2	0.35	22	CONTROL SENSOR RETURN	
X92	3	X4	59	X3	59	X92-2	3	HO1	0.35	22	RING INITIAL POSITION	
X96	3	X3	42	X4	42	X96-2	3	HO2	0.35	22	RING INITIAL POSITION	
X92	4	X4	60	X3	60	X92-2	4	HO1	0.35	22	RING FORWARD POSITION	
X96	4	X3	43	X4	43	X96-2	4	HO2	0.35	22	RING FORWARD POSITION	
X92	11	X4	53	X3	53	X92-2	11	HO1	0.35	22	CAPTURE LATCHES OPEN IND	
X96	11	X3	36	X4	36	X96-2	11	HO2	0.35	22	CAPTURE LATCHES OPEN IND	
X92	12	X4	54	X3	54	X92-2	12	HO1	0.35	22	CAPTURE LATCHES CLOS IND	

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X96	12	X3	37	X4	37	X96-2	12	HO2	0.35	22	CAPTURE LATCHES CLOS IND	
X96	5	X3	2	X4	2	X96-2	5	HO2	0.35	20	PWR SUP TO CAP LAT MTR (M1) +	
X92	5	X4	1	X3	1	X92-2	5	HO1	0.35	20	PWR SUP TO CAP LAT MTR (M1) +	
X96	41	X3	20	X4	20	X96-2	41	HO1	0.35	20	PWR SUP TO CAP LAT MTR (M1) -	
X92	41	X4	17	X3	17	X92-2	41	HO1	0.35	20	PWR SUP TO CAP LAT MTR (M1) -	
X92	8	X4	48	X3	48	X92-2	8	HO2	0.35	20	CAPTURE LATCH NO. 1 CLOS	
X96	8	X3	31	X4	31	X96-2	8	HO1	0.35	20	CAPTURE LATCH NO. 1 CLOS	
X92	15	X4	47	X3	47	X92-2	15	HO2	0.35	20	CAPTURE LATCH NO. 1 OPEN	
X96	15	X3	30	X4	30	X96-2	15	HO1	0.35	20	CAPTURE LATCH NO. 1 OPEN	
X92	6	X4	2	X3	2	X92-2	6	HO2	0.35	20	PWR SUP TO CAP LAT MTR (M2) +	
X96	6	X3	3	X4	3	X96-2	6	HO3	0.35	20	PWR SUP TO CAP LAT MTR (M2) +	
X96	42	X3	21	X4	21	X96-2	42	HO2	0.35	20	PWR SUP TO CAP LAT MTR (M2) -	
X92	42	X4	20	X3	20	X92-2	42	HO2	0.35	20	PWR SUP TO CAP LAT MTR (M2) -	
X92	9	X4	50	X3	50	X92-2	9	HO3	0.35	20	CAPTURE LATCH NO. 2 CLOS	
X96	9	X3	33	X4	33	X96-2	9	HO2	0.35	20	CAPTURE LATCH NO. 2 CLOS	
X92	16	X4	49	X3	49	X92-2	16	HO3	0.35	20	CAPTURE LATCH NO. 2 OPEN	
X96	16	X3	32	X4	32	X96-2	16	HO2	0.35	20	CAPTURE LATCH NO. 2 OPEN	
X92	7	X4	3	X3	3	X92-2	7	HO3	0.35	20	PWR SUP TO CAP LAT MTR (M3) +	
X96	7	X3	4	X4	4	X96-2	7	HO1	0.35	20	PWR SUP TO CAP LAT MTR (M3) +	
X96	43	X3	22	X4	22	X96-2	43	HO3	0.35	20	PWR SUP TO CAP LAT MTR (M3) -	
X92	43	X4	21	X3	21	X92-2	43	HO3	0.35	20	PWR SUP TO CAP LAT MTR (M3) -	
X92	10	X4	52	X3	52	X92-2	10	HO1	0.35	20	CAPTURE LATCH NO. 3 CLOS	

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X96	10	X3	35	X4	35	X96-2	10	HO3	0.35	20	CAPTURE LATCH NO. 3 CLOS	
X92	17	X4	51	X3	51	X92-2	17	HO1	0.35	20	CAPTURE LATCH NO. 3 OPEN	
X96	17	X3	34	X4	34	X96-2	17	HO3	0.35	20	CAPTURE LATCH NO. 3 OPEN	
X93	1	X4	25	X3	25	X93-2	1	HO1	0.35	20	PWR SUP TO M6 GROUP 1 HOOKS	N
X93	5	X4	67	X3	67	X93-2	5	HO1	0.35	20	PWR SUP TO M6 GROUP 1 HOOKS	N
X93	47	X4	12	X3	12	X93-2	47	HO1	0.35	20	PWR SUP TO M6 GROUP 1 HOOKS	N
X93	48	X4	66	X3	66	X93-2	48	HO1	0.35	20	PWR SUP TO M6 GROUP 1 HOOKS	N
X97	5	X3	50	X4	50	X97-2	5	HO2	0.35	20	PWR SUP TO M7 GROUP 1 HOOKS	N
X97	1	X3	25	X4	25	X97-2	1	HO2	0.35	20	PWR SUP TO M7 GROUP 1 HOOKS	N
X97	47	X3	8	X4	8	X97-2	47	HO2	0.35	20	PWR SUP TO M7 GROUP 1 HOOKS	N
X97	48	X3	49	X4	49	X97-2	48	HO2	0.35	20	PWR SUP TO M7 GROUP 1 HOOKS	N
X93	7	X4	63	X3	63	X93-2	7	HO1	0.35	22	GROUP 1 HOOKS CLOSED	N
X97	7	X3	46	X4	46	X97-2	7	HO2	0.35	22	GROUP 1 HOOKS CLOSED	N
X93	6	X4	62	X3	62	X93-2	6	HO1	0.35	22	GROUP 1 HOOKS OPEN	N
X97	6	X3	45	X4	45	X97-2	6	HO2	0.35	22	GROUP 1 HOOKS OPEN	N
X93	18	X4	81	X3	81	X93-2	18	HO1	0.35	20	FIXER 1 (+)	
X97	18	X3	64	X4	64	X97-2	18	HO1	0.35	20	FIXER 1 (+)	
X93	19	X4	82	X3	82	X93-2	19	HO1	0.35	20	FIXER 1 (-)	
X97	19	X3	65	X4	65	X97-2	19	HO1	0.35	20	FIXER 1 (-)	
X93	20	X4	83	X3	83	X93-2	20	HO1	0.35	20	FIXER 1 (-)	
X97	20	X3	66	X4	66	X97-2	20	HO1	0.35	20	FIXER 1 (-)	
X93	21	X4	84	X3	84	X93-2	21	HO2	0.35	20	FIXER 2 (+)	
X97	21	X3	67	X4	67	X97-2	21	HO2	0.35	20	FIXER 2 (+)	

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X93	22	X4	85	X3	85	X93-2	22	HO2	0.35	20	FIXER 2 (-)	
X97	22	X3	68	X4	68	X97-2	22	HO2	0.35	20	FIXER 2 (-)	
X93	23	X4	86	X3	86	X93-2	23	HO2	0.35	20	FIXER 2 (-)	
X97	23	X3	69	X4	69	X97-2	23	HO2	0.35	20	FIXER 2 (-)	
X93	24	X4	87	X3	87	X93-2	24	HO3	0.35	20	FIXER 3 (+)	
X97	24	X3	70	X4	70	X97-2	24	HO3	0.35	20	FIXER 3 (+)	
X93	30	X4	88	X3	88	X93-2	30	HO3	0.35	20	FIXER 3 (-)	
X97	30	X3	71	X4	71	X97-2	30	HO3	0.35	20	FIXER 3 (-)	
X93	31	X4	89	X3	89	X93-2	31	HO3	0.35	20	FIXER 3 (-)	
X97	31	X3	72	X4	72	X97-2	31	HO3	0.35	20	FIXER 3 (-)	
X93	16	X4	90	X3	90	X93-2	16	HO	0.35	20	FIXER 4 (+)	
X97	16	X3	73	X4	73	X97-2	16	HO	0.35	20	FIXER 4 (+)	
X93	17	X4	91	X3	91	X93-2	17	HO	0.35	20	FIXER 4 (-)	
X97	17	X3	74	X4	74	X97-2	17	HO	0.35	20	FIXER 4 (-)	
X93	25	X4	92	X3	92	X93-2	25	HO	0.35	20	FIXER 4 (-)	
X97	25	X3	75	X4	75	X97-2	25	HO	0.35	20	FIXER 4 (-)	
X93	27	X4	93	X3	93	X93-2	27	HO	0.35	20	FIXER 5 (+)	
X97	27	X3	76	X4	76	X97-2	27	HO	0.35	20	FIXER 5 (+)	
X93	28	X4	94	X3	94	X93-2	28	HO	0.35	20	FIXER 5 (-)	
X97	28	X3	77	X4	77	X97-2	28	HO	0.35	20	FIXER 5 (-)	
X93	29	X4	95	X3	95	X93-2	29	HO	0.35	20	FIXER 5 (-)	
X97	29	X3	78	X4	78	X97-2	29	HO	0.35	20	FIXER 5 (-)	
X93	26	X4	96	X3	96	X93-2	26	HO1	0.35	20	HI-ENERGY DAMPER NO. 1 (+)	

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X97	26	X3	79	X4	79	X97-2	26	HO1	0.35	20	HI-ENERGY DAMPER NO. 1 (+)	
X93	34	X4	97	X3	97	X93-2	34	HO1	0.35	20	HI-ENERGY DAMPER NO. 1 (-)	
X97	34	X3	80	X4	80	X97-2	34	HO1	0.35	20	HI-ENERGY DAMPER NO. 1 (-)	
X93	35	X4	98	X3	98	X93-2	35	HO2	0.35	20	HI-ENERGY DAMPER NO. 2 (+)	
X97	35	X3	81	X4	81	X97-2	35	HO2	0.35	20	HI-ENERGY DAMPER NO. 2 (+)	
X93	36	X4	99	X3	99	X93-2	36	HO2	0.35	20	HI-ENERGY DAMPER NO. 2 (-)	
X97	36	X3	82	X4	82	X97-2	36	HO2	0.35	20	HI-ENERGY DAMPER NO. 2 (-)	
X93	32	X4	100	X3	100	X93-2	32	HO3	0.35	20	HI-ENERGY DAMPER NO. 3 (+)	
X97	32	X3	83	X4	83	X97-2	32	HO3	0.35	20	HI-ENERGY DAMPER NO. 3 (+)	
X93	33	X4	103	X3	103	X93-2	33	HO3	0.35	20	HI-ENERGY DAMPER NO. 3 (-)	
X97	33	X3	84	X4	84	X97-2	33	HO3	0.35	20	HI-ENERGY DAMPER NO. 3 (-)	
X97	2	X3	9	X4	9	X97-2	2	HO2	0.35	20	PWR SUP TO M9 GROUP 2 HOOKS	N
X97	3	X3	51	X4	51	X97-2	3	HO2	0.35	20	PWR SUP TO M9 GROUP 2 HOOKS	N
X97	49	X3	26	X4	26	X97-2	49	HO2	0.35	20	PWR SUP TO M9 GROUP 2 HOOKS	N
X97	50	X3	52	X4	52	X97-2	50	HO2	0.35	20	PWR SUP TO M9 GROUP 2 HOOKS	N
X93	2	X4	14	X3	14	X93-2	2	HO1	0.35	20	PWR SUP TO M8 GROUP 2 HOOKS	N
X93	3	X4	68	X3	68	X93-2	3	HO1	0.35	20	PWR SUP TO M8 GROUP 2 HOOKS	N
X93	49	X4	29	X3	29	X93-2	49	HO1	0.35	20	PWR SUP TO M8 GROUP 2 HOOKS	N
X93	50	X4	69	X3	69	X93-2	50	HO1	0.35	20	PWR SUP TO M8 GROUP 2 HOOKS	N
X93	9	X4	65	X3	65	X93-2	9	HO1	0.35	22	GROUP 2 HOOKS CLOSED	N
X97	9	X3	48	X4	48	X97-2	9	HO2	0.35	22	GROUP 2 HOOKS CLOSED	N
X93	8	X4	64	X3	64	X93-2	8	HO1	0.35	22	GROUP 2 HOOKS OPEN	N
X97	8	X3	47	X4	47	X97-2	8	HO2	0.35	22	GROUP 2 HOOKS OPEN	N

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X93	4	X4	73	X3	73	X93-2	4	HO1	0.35	22	GROUP 1 HOOKS IN-BETWEEN	
X97	4	X3	56	X4	56	X97-2	4	HO2	0.35	22	GROUP 1 HOOKS IN-BETWEEN	
X97	10	X3	57	X4	57	X97-2	10	HO1	0.35	22	GROUP 2 HOOKS IN-BETWEEN	
X93	10	X4	74	X3	74	X93-2	10	HO2	0.35	22	GROUP 2 HOOKS IN-BETWEEN	
X93	46	X4	79	X3	79	X93-2	46	HO2	0.35	22	CONTROL SENSOR RETURN	N
X97	46	X3	62	X4	62	X97-2	46	HO2	0.35	22	CONTROL SENSOR RETURN	N
X93	40	X4	80	X3	80	X93-2	40	HO1	0.35	22	CONTROL SENSOR RETURN	
X93	11	X4	75	X3	75	X93-2	11	HO1	0.35	22	READY TO HOOK	
X97	11	X3	58	X4	58	X97-2	11	HO2	0.35	22	READY TO HOOK	
X93	12	X4	76	X3	76	X93-2	12	HO1	0.35	22	UNDOCK COMPLETE	
X97	12	X3	59	X4	59	X97-2	12	HO2	0.35	22	UNDOCK COMPLETE	
X93	14	X4	71	X3	71	X93-2	14	HO2	0.35	22	INTERFACE SEALED	
X97	15	X3	55	X4	55	X97-2	15	HO3	0.35	22	INTERFACE SEALED	
X97	13	X3	53	X4	53	X97-2	13	HO1	0.35	22	INTERFACE SEALED	
X93	13	X4	70	X3	70	X93-2	13	HO3	0.35	22	INTERFACE SEALED	
X97	40	X3	63	X4	63	X97-2	40	HO1	0.35	22	CONTROL SENSOR RETURN	
X109	1	X3	10	X4	10	X109-2	1	ML	0.35	22	BALL SCREW NO. 1 LIN ADV (COM)	
X109	2	X3	11	X4	11	X109-2	2	ML	0.35	22	BALL SCREW NO. 1 LIN ADV (SIG)	
X109	3	X3	12	X4	12	X109-2	3	ML	0.35	22	BALL SCREW NO. 1 LIN ADV (EXC)	
X109	4	X3	13	X4	13	X109-2	4	ML	0.35	22	BALL SCREW NO. 2 LIN ADV (SIG)	
X109	19	X3	128	X4	128	X109-2	19	ML	0.35	22	BALL SCREW NO. 2 LIN ADV (EXC)	
X109	5	X3	14	X4	14	X109-2	5	ML	0.35	22	BALL SCREW NO. 3 LIN ADV (SIG)	
X109	21	X3	135	X4	135	X109-2	21	ML	0.35	22	BALL SCREW NO. 3 LIN ADV (EXC)	
X109	6	X3	15	X4	15	X109-2	6	ML	0.35	22	BALL SCREW NO. 1 MISALIGN (SIG)	

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X109	22	X3	136	X4	136	X109-2	22	ML	0.35	22	BALL SCREW NO. 1 MISALIGN (EXC)	
X109	7	X3	16	X4	16	X109-2	7	ML	0.35	22	BALL SCREW NO. 2 MISALIGN (SIG)	
X109	23	X3	137	X4	137	X109-2	23	ML	0.35	22	BALL SCREW NO. 2 MISALIGN (EXC)	
X109	8	X3	17	X4	17	X109-2	8	ML	0.35	22	BALL SCREW NO. 3 MISALIGN (COM)	
X109	9	X3	18	X4	18	X109-2	9	ML	0.35	22	BALL SCREW NO. 3 MISALIGN (SIG)	
X109	10	X3	19	X4	19	X109-2	10	ML	0.35	22	BALL SCREW NO. 3 MISALIGN (EXC)	
X109	12	X3	28	X4	28	X109-2	12	ML	0.35	22	LATCHES MANUAL REL RTN	
X109	11	X3	27	X4	27	X109-2	11	ML	0.35	22	LATCHES MANUAL RELEASE	
X109	13	X3	29	X4	29	X109-2	13	ML2	0.35	22	RING FINAL POSITION	
X109	14	X3	93	X4	93	X109-2	14	ML	0.35	22	CAPTURE LATCH OPEN	
X109	15	X3	94	X4	94	X109-2	15	ML	0.35	22	CAPTURE LATCHES CLOSED	
X109	16	X3	124	X4	124	X109-2	16	ML	0.35	22	RING INITIAL POSITION	
X109	17	X3	125	X4	125	X109-2	17	ML2	0.35	22	RING FORWARD POSITION	
X108	1	X4	122	X3	122	X108-2	1	ML	0.35	22	LWR BALL SOCKET NO 1 TEMP (COM)	2S-22
X108	2	X4	123	X3	123	X108-2	2	ML	0.35	22	LWR BALL SOCKET NO 1 TEMP (EXC)	2S-22
X108	3	X4	124	X3	124	X108-2	3	ML	0.35	22	LWR BALL SOCKET NO 2 TEMP (COM)	2S-23
X108	4	X4	125	X3	125	X108-2	4	ML	0.35	22	LWR BALL SOCKET NO 2 TEMP (EXC)	2S-23
X108	5	X4	126	X3	126	X108-2	5	ML	0.35	22	LWR BALL SOCKET NO 3 TEMP (COM)	2S-24
X108	6	X4	128	X3	128	X108-2	6	ML	0.35	22	LWR BALL SOCKET NO 3 TEMP (EXC)	2S-24
X108	7	X4	129	X3	129	X108-2	7	ML	0.35	22	CAPTURE LATCH NO. 1 TEMP (COM)	2S-25
X108	8	X4	130	X3	130	X108-2	8	ML	0.35	22	CAPTURE LATCH NO. 1 TEMP (EXC)	2S-25
X108	9	X4	131	X3	131	X108-2	9	ML	0.35	22	CAPTURE LATCH NO. 2 TEMP (COM)	2S-26
X108	10	X4	132	X3	132	X108-2	10	ML	0.35	22	CAPTURE LATCH NO. 2 TEMP (EXC)	2S-26
X108	11	X4	133	X3	133	X108-2	11	ML	0.35	22	CAPTURE LATCH NO. 3 TEMP (COM)	2S-27

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X108	12	X4	134	X3	134	X108-2	12	ML	0.35	22	CAPTURE LATCH NO. 3 TEMP (EXC)	2S-27
X108	13	X4	135	X3	135	X108-2	13	ML	0.35	22	DOCKING RING DRIVE TEMP (COM)	2S-28
X108	14	X4	136	X3	136	X108-2	14	ML	0.35	22	DOCKING RING DRIVE TEMP (EXC)	2S-28
X109	25	X3	143	X4	143	X109-2	25	ML1	0.35	22	UNDOCK COMPLETE	
X109	24	X3	138	X4	138	X109-2	24	ML1	0.35	22	READY TO HOOK	
X109	20	X3	132	X4	132	X109-2	20	ML1	0.35	22	READY TO HOOK RTN	
X109	28	X3	147	X4	147	X109-2	28	ML1	0.35	22	GROUP 1 HOOKS CLOSED POS	
X109	27	X3	145	X4	145	X109-2	27	ML2	0.35	22	GROUP 2 HOOKS OPEN POSITION	
X109	26	X3	144	X4	144	X109-2	26	ML1	0.35	22	GROUP 1 HOOKS OPEN POSITION	
X109	29	X3	182	X4	182	X109-2	29	ML2	0.35	22	GROUP 2 HOOKS CLOSED POS	
X109	18	X3	126	X4	126	X109-2	18	ML2	0.35	22	GROUP 2 HOOKS CLOSE POS RTN	
X108	25	X4	148	X3	148	X108-2	25	ML	0.35	22	GRP 1 HKS LINEAR ADV (EXC)	
X108	26	X4	149	X3	149	X108-2	26	ML	0.35	22	GRP 1 HKS LINEAR ADV (SIG)	
X108	27	X4	150	X3	150	X108-2	27	ML	0.35	22	GRP 1 HKS LINEAR ADV (COM)	
X108	28	X4	182	X3	182	X108-2	28	ML	0.35	22	GRP 2 HKS LINEAR ADV (EXC)	
X108	29	X4	183	X3	183	X108-2	29	ML	0.35	22	GRP 2 HKS LINEAR ADV (SIG)	
X108	30	X4	184	X3	184	X108-2	30	ML	0.35	22	GRP 2 HKS LINEAR ADV (COM)	
X108	15	X4	137	X3	137	X108-2	15	ML	0.35	22	DOCKING I/F TEMP NO. 1 (COM)	2S-29
X108	16	X4	138	X3	138	X108-2	16	ML	0.35	22	DOCKING I/F TEMP NO. 1 (EXC)	2S-29
X108	17	X4	139	X3	139	X108-2	17	ML	0.35	22	DOCKING I/F TEMP NO. 2 (COM)	2S-30
X108	18	X4	140	X3	140	X108-2	18	ML	0.35	22	DOCKING I/F TEMP NO. 2 (EXC)	2S-30
X108	19	X4	141	X3	141	X108-2	19	ML	0.35	22	DOCKING I/F TEMP NO. 3 (COM)	2S-31
X108	20	X4	142	X3	142	X108-2	20	ML	0.35	22	DOCKING I/F TEMP NO. 3 (EXC)	2S-31
X108	21	X4	144	X3	144	X108-2	21	ML	0.35	22	HOOKS DRIVE TEMP NO. 1 (COM)	2S-32

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X108	22	X4	145	X3	145	X108-2	22	ML	0.35	22	HOOKS DRIVE TEMP NO. 1 (EXC)	2S-32
X108	23	X4	146	X3	146	X108-2	23	ML	0.35	22	HOOKS DRIVE TEMP NO. 2 (COM)	2S-33
X108	24	X4	147	X3	147	X108-2	24	ML	0.35	22	HOOKS DRIVE TEMP NO. 2 (EXC)	2S-33
X108	50	X4	143	X3	143	X108-2	50	ML	0.35	22	SHD (ALL APDS TEMP MEAS)	
X92	32	X4	160	X3	160	X92-2	32	ML1	0.35	22	ICM APDA1 HOOKS 1 CLOSED IND	
X92	33	X4	159	X3	159	X92-2	33	ML1	0.35	22	ICM APDA1 HOOKS 3 CLOSED IND	
X92	34	X4	158	X3	158	X92-2	34	ML1	0.35	22	ICM APDA1 HOOKS 5 CLOSED IND	
X92	35	X4	157	X3	157	X92-2	35	ML1	0.35	22	ICM APDA1 HOOKS 9 CLOSED IND	
X92	36	X4	156	X3	156	X92-2	36	ML1	0.35	22	ICM APDA1 HOOKS 11 CLOSED IND	
X92	37	X4	153	X3	153	X92-2	37	ML1	0.35	22	ICM APDA1 HOOKS 1,3,5,9,11 CLOS IND SOURCE (1)	
X92	38	X4	152	X3	152	X92-2	38	ML1	0.35	22	ICM APDA1 HOOKS 1,3,5,9,11 CLOS IND SOURCE (2)	
X96	32	X3	103	X4	103	X96-2	32	ML2	0.35	22	ICM APDA1 HOOKS 2 CLOSED IND	
X96	33	X3	104	X4	104	X96-2	33	ML2	0.35	22	ICM APDA1 HOOKS 4 CLOSED IND	
X96	34	X3	105	X4	105	X96-2	34	ML2	0.35	22	ICM APDA1 HOOKS 8 CLOSED IND	
X96	35	X3	106	X4	106	X96-2	35	ML2	0.35	22	ICM APDA1 HOOKS 10 CLOSED IND	
X96	36	X3	107	X4	107	X96-2	36	ML2	0.35	22	ICM APDA1 HOOKS 12 CLOSED IND	
X96	37	X3	114	X4	114	X96-2	37	ML2	0.35	22	ICM APDA1 HOOKS 2,4,8,10,12 CLOS IND SOURCE (1)	
X96	38	X3	121	X4	121	X96-2	38	ML2	0.35	22	ICM APDA1 HOOKS 2,4,8,10,12 CLOS IND SOURCE (2)	
X96	40	X3	122	X4	122	X96-2	40	ML2	0.35	22	ICM-1 X3 CONN MATE (TM/SIG) (To Orb)	
X96	39	X3	123	X4	123	X96-2	39	ML2	0.35	22	ICM-1 X3 CONN MATE (TM/PWR) (To Orb)	
X92	40	X4	154	X3	154	X92-2	40	ML1	0.35	22	ICM-1 X4 CONN MATE (TM/SIG) (To Orb)	
X92	39	X4	155	X3	155	X92-2	39	ML1	0.35	22	ICM-1 X4 CONN MATE (TM/PWR) (To Orb)	
X111	31	X3	176	X4	176	X97-2	44	ML2	0.35	22	ORB X3 CONN MATE (TM/SIG)	

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X111	32	X3	177	X4	177	X97-2	45	ML2	0.35	22	ORB X3 CONN MATE (TM/PWR)	
X110	31	X4	176	X3	176	X93-2	44	ML1	0.35	22	ORB X4 CONN MATE (TM/SIG)	
X110	32	X4	177	X3	177	X93-2	45	ML1	0.35	22	ORB X4 CONN MATE (TM/PWR)	
X94	36	X4	179	X3	179	X94-2	36	HO1	0.35	20	PRI INH 1 CONTROL (Z)	
X94	37	X4	180	X3	180	X94-2	37	HO1	0.35	20	PRI INH 2 CONTROL (K)	
X94	29	X4	173	X3	173	X94-2	29	HO1	0.35	20	PRI INH 2 CONTROL (H)	
X94	28	X4	174	X3	174	X94-2	28	HO1	0.35	20	PRI INH 1 CONTROL (J)	
X94	39	X4	181	X3	181	X94-2	31	HO1	0.35	20	(Reserved for NRL - from Pass Hks Mtr Controls)	
X94	30	X4	175	X3	175	X94-2	30	HO1	0.35	20	(Reserved for NRL - from Pass Hks Mtr Controls)	
X94	31	X4	178	X3	178	X94-2	39	HO1	0.35	20	(Reserved for NRL - from Pass Hks Mtr Controls)	
X94	38	X4	151	X3	151	X94-2	38	HO1	0.35	20	(Reserved for NRL - from Pass Hks Mtr Controls)	
X99	36	X3	173	X4	173	X99-2	36	HO2	0.35	20	(Reserved for NRL - from Pass Hks Mtr Controls)	
X99	37	X3	174	X4	174	X99-2	37	HO2	0.35	20	(Reserved for NRL - from Pass Hks Mtr Controls)	
X99	29	X3	179	X4	179	X99-2	29	HO2	0.35	20	(Reserved for NRL - from Pass Hks Mtr Controls)	
X99	28	X3	180	X4	180	X99-2	28	HO2	0.35	20	(Reserved for NRL - from Pass Hks Mtr Controls)	
X99	39	X3	178	X4	178	X99-2	31	HO2	0.35	20	BU INH 2 CONTROL (E)	
X99	30	X3	184	X4	184	X99-2	30	HO2	0.35	20	BU INH 1 CONTROL (F)	
X99	31	X3	175	X4	175	X99-2	39	HO2	0.35	20	BU INH 1 CONTROL (Q)	
X99	38	X3	156	X4	156	X99-2	38	HO2	0.35	20	BU INH 2 CONTROL (C)	
X94	32	X4	44	X3	44	X94-2	32	HO1	0.35	22	DSPP DS8 OPEN (SAFE)	
X94	33	X4	43	X3	43	X94-2	33	HO1	0.35	22	DSPP DS8 OPEN (PWR)	
X94	24	X4	38	X3	38	X94-2	24	HO1	0.35	22	DSPP DS8 CLOSED (ARM)	

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X94	25	X4	37	X3	37	X94-2	25	HO1	0.35	22	DSPP DS8 CLOSED (PWR)	
X94	43	X4	31	X3	31	X94-2	43	HO1	0.35	22	(Reserved for NRL - from Pass Hks Mtr Status Ind)	
X94	44	X4	39	X3	39	X94-2	44	HO1	0.35	22	(Reserved for NRL - from Pass Hks Mtr Status Ind)	
X94	48	X4	35	X3	35	X94-2	48	HO1	0.35	22	(Reserved for NRL - from Pass Hks Mtr Status Ind)	
X94	49	X4	34	X3	34	X94-2	49	HO1	0.35	22	(Reserved for NRL - from Pass Hks Mtr Status Ind)	
X99	32	X3	1	X4	1	X99-2	32	HO2	0.35	22	(Reserved for NRL - from Pass Hks Mtr Status Ind)	
X99	33	X3	5	X4	5	X99-2	33	HO2	0.35	22	(Reserved for NRL - from Pass Hks Mtr Status Ind)	
X99	24	X3	95	X4	95	X99-2	24	HO2	0.35	22	(Reserved for NRL - from Pass Hks Mtr Status Ind)	
X99	25	X3	96	X4	96	X99-2	25	HO2	0.35	22	(Reserved for NRL - from Pass Hks Mtr Status Ind)	
X99	43	X3	54	X4	54	X99-2	43	HO2	0.35	22	DSPP DS9 OPEN (SAFE)	
X99	44	X3	60	X4	60	X99-2	44	HO2	0.35	22	DSPP DS9 OPEN (PWR)	
X99	48	X3	97	X4	97	X99-2	48	HO2	0.35	22	DSPP DS9 CLOSED (ARM)	
X99	49	X3	98	X4	98	X99-2	49	HO2	0.35	22	DSPP DS9 CLOSED (PWR)	
X94	40	X4	72	X3	72	X94-2	40	ML1	0.35	22	(Reserved for NRL - from Pass Hks Position Ind)	
X94	45	X4	109	X3	109	X94-2	45	ML1	0.35	22	(Reserved for NRL - from Pass Hks Position Ind)	
X94	46	X4	101	X3	101	X94-2	46	ML1	0.35	22	(Reserved for NRL - from Pass Hks Position Ind)	
X94	50	X4	102	X3	102	X94-2	50	ML1	0.35	22	(Reserved for NRL - from Pass Hks Position Ind)	
X99	40	X3	99	X4	99	X99-2	40	ML2	0.35	22	(Reserved for NRL - from Pass Hks Position Ind)	
X99	45	X3	100	X4	100	X99-2	45	ML2	0.35	22	(Reserved for NRL - from Pass Hks Position Ind)	
X99	46	X3	101	X4	101	X99-2	46	ML2	0.35	22	(Reserved for NRL - from Pass Hks Position Ind)	

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X99	50	X3	102	X4	102	X99-2	50	ML2	0.35	22	(Reserved for NRL - from Pass Hks Position Ind)	
X94	1	X4	4	X3	4	X94-2	1	HO	0.35	22	C/L TV CAM #2 LIGHT +	2S-1
X94	5	X4	10	X3	10	X94-2	5	HO	0.35	22	C/L TV CAM #2 LIGHT +	2S-1
X94	6	X4	9	X3	9	X94-2	6		0.35		SPARE***	2S-1*
X94	2	X4	28	X3	28	X94-2	2	HO	0.35	22	C/L TV CAM #2 LIGHT -	2S-2
X94	3	X4	19	X3	19	X94-2	3	HO	0.35	22	C/L TV CAM #2 LIGHT -	2S-2
X94	7	X4	18	X3	18	X94-2	7		0.35		SPARE***	2S-2*
X94	4	X4	22	X3	22	X94-2	4	HO	0.35	22	C/L TV CAM #2 PWR +	2S-3
X94	8	X4	32	X3	32	X94-2	8	HO	0.35	22	C/L TV CAM #2 PWR +	2S-3
X94	9	X4	30	X3	30	X94-2	9		0.35		SPARE***	2S-3*
X94	10	X4	41	X3	41	X94-2	10	HO	0.35	22	C/L TV CAM #2 PWR -	2S-4
X94	16	X4	42	X3	42	X94-2	16	HO	0.35	22	C/L TV CAM #2 PWR -	2S-4
X94	17	X4	40	X3	40	X94-2	17		0.35		SPARE***	2S-4*
X94	15	X4	108	X3	108	X94-2	15	HO	0.35	22	C/L TV CAM #2 HTR PWR + **	2S-5
X94	22	X4	107	X3	107	X94-2	22	HO	0.35	22	C/L TV CAM #2 HTR PWR + **	2S-5
X94	23	X4	120	X3	120	X94-2	23		0.35		SPARE***	2S-5*
X94	13	X4	118	X3	118	X94-2	13	HO	0.35	22	C/L TV CAM #2 HTR PWR - **	2S-6
X94	14	X4	119	X3	119	X94-2	14	HO	0.35	22	C/L TV CAM #2 HTR PWR - **	2S-6
X94	21	X4	115	X3	115	X94-2	21		0.35		SPARE***	2S-6*
X94	12	X4	8	X3	8	X94-2	12	HO	0.35	22	C/L TV CAM #2 LIGHT +	2S-7
X94	19	X4	7	X3	7	X94-2	19		0.35		SPARE***	2S-7
X94	20	X4	6	X3	6	X94-2	20		0.35		SPARE***	2S-7*
X94	11	X4	13	X3	13	X94-2	11	HO	0.35	22	C/L TV CAM #2 LIGHT -	2S-8
X94	18	X4	16	X3	16	X94-2	18		0.35		SPARE***	2S 8
X94	26	X4	15	X3	15	X94-2	26		0.35		SPARE***	2S-8*

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X94	27	X4	36	X3	36	X94-2	27	HO	0.35	22	C/L TV CAM #2 CHAS GND	2S-9
X94	34	X4	27	X3	27	X94-2	34	HO	0.35	22	C/L TV CAM #2 CHAS GND	2S-9
X94	35	X4	26	X3	26	X94-2	35		0.35		SPARE***	2S-9*
X94	41	X4	45	X3	45	X94-2	41		0.35		SPARE***	2S-10
X94	42	X4	33	X3	33	X94-2	42		0.35		SPARE***	2S-10
X94	47	X4	46	X3	46	X94-2	47		0.35		SPARE***	2S-10*
X111	1	X3	161	X4	161	X111-2	1	RF2	0.2*	22	SPARE***	2S-11
X111	2	X3	162	X4	162	X111-2	2	RF2	0.2*	22	SPARE***	2S-11
X111	3	X3	163	X4	163	X111-2	3	RF2	0.35	22	SPARE***	2S-11*
X111	11	X3	164	X4	164	X111-2	11	RF2	0.2*	22	C/L TV CAM #1 VIDEO OUT +	2S-12
X111	12	X3	165	X4	165	X111-2	12	RF2	0.2*	22	C/L TV CAM #1 VIDEO OUT -	2S-12
X111	13	X3	166	X4	166	X111-2	13	RF2	0.35	22	C/L TV CAM #1 VIDEO OUT SHD	2S-12*
X111	15	X3	167	X4	167	X111-2	15	RF2	0.2*	22	SPARE***	2S-13
X111	16	X3	168	X4	168	X111-2	16	RF2	0.2*	22	SPARE***	2S-13
X111	17	X3	169	X4	169	X111-2	17	RF2	0.35	22	SPARE***	2S-13*
X111	20	X3	170	X4	170	X111-2	20	RF2	0.2*	22	C/L TV CAM #1 SYNC OUT +	2S-14
X111	21	X3	171	X4	171	X111-2	21	RF2	0.2*	22	C/L TV CAM #1 SYNC OUT -	2S-14
X111	22	X3	172	X4	172	X111-2	22	RF2	0.35	22	C/L TV CAM #1 SYNC OUT SHD	2S-14*
X110	1	X4	161	X3	161	X110-2	1	RF1	0.2*	22	SPARE***	2S-15
X110	2	X4	162	X3	162	X110-2	2	RF1	0.2*	22	SPARE***	2S-15
X110	3	X4	163	X3	163	X110-2	3	RF1	0.35	22	SPARE***	2S-15*
X110	11	X4	164	X3	164	X110-2	11	RF1	0.2*	22	C/L TV CAM #2 VIDEO OUT +	2S-16
X110	12	X4	165	X3	165	X110-2	12	RF1	0.2*	22	C/L TV CAM #2 VIDEO OUT -	2S-16
X110	13	X4	166	X3	166	X110-2	13	RF1	0.35	22	C/L TV CAM #2 VIDEO OUT SHD	2S-16*

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X110	15	X4	167	X3	167	X110-2	15	RF1	0.2*	22	SPARE***	2S-17
X110	16	X4	168	X3	168	X110-2	16	RF1	0.2*	22	SPARE***	2S-17
X110	17	X4	169	X3	169	X110-2	17	RF1	0.35	22	SPARE***	2S-17*
X110	20	X4	170	X3	170	X110-2	20	RF1	0.2*	22	C/L TV CAM #2 SYNC OUT +	2S-18
X110	21	X4	171	X3	171	X110-2	21	RF1	0.2*	22	C/L TV CAM #2 SYNC OUT -	2S-18
X110	22	X4	172	X3	172	X110-2	22	RF1	0.35	22	C/L TV CAM #2 SYNC OUT SHD	2S-18*
X111	34	X3	109	X4	109	X99-2	26	RF/HO	0.2*(b)	22	C/L TV CAM #1 HTR PWR + **	2S-19
X111	35	X3	110	X4	110	X99-2	27	RF/HO	0.2*(b)	22	C/L TV CAM #1 HTR PWR + **	2S-19
X111	36	X3	111	X4	111	X111-2	36	RF	0.35		SPARE*** (SHIELD WIRE NOT REQUIRED)	2S-19*
X111	38	X3	118	X4	118	X99-2	34	RF/HO	0.2*(b)	22	C/L TV CAM #1 HTR PWR - **	2S-20
X111	39	X3	119	X4	119	X99-2	35	RF/HO	0.2*(b)	22	C/L TV CAM #1 HTR PWR - **	2S-20
X111	40	X3	120	X4	120	X111-2	40	RF	0.35		SPARE*** (SHIELD WIRE NOT REQUIRED)	2S-20*
X111	48	X3	115	X4	115	X111-2	48	RF	0.2*	22	SPARE***	2S-21
X111	49	X3	116	X4	116	X111-2	49	RF	0.2*	22	SPARE***	2S-21
X111	50	X3	117	X4	117	X111-2	50	RF	0.35		SPARE***	2S-21*
X99	1	X3	129	X4	129	X99-2	1	HO	0.35	22	C/L TV CAM #1 LIGHT +	
X99	2	X3	130	X4	130	X99-2	2	HO	0.35	22	C/L TV CAM #1 LIGHT +	
X99	3	X3	148	X4	148	X99-2	3	HO	0.35	22	C/L TV CAM #1 LIGHT +	
X99	4	X3	149	X4	149	X99-2	4	HO	0.35	22	C/L TV CAM #1 LIGHT -	
X99	5	X3	150	X4	150	X99-2	5	HO	0.35	22	C/L TV CAM #1 LIGHT -	
X99	6	X3	151	X4	151	X99-2	6	HO	0.35	22	C/L TV CAM #1 LIGHT -	
X99	7	X3	153	X4	153	X99-2	7	HO	0.35	22	C/L TV CAM #1 PWR +	
X99	8	X3	154	X4	154	X99-2	8	HO	0.35	22	C/L TV CAM #1 PWR +	
X99	9	X3	155	X4	155	X99-2	9	HO	0.35	22	C/L TV CAM #1 PWR -	

Table 160-12. Orbiter-to-ICM Interfaces, X3 and X4 (continued)

ORBITER DOCKING MECHANISM (-3002)				ICM / PMA - 2 (-8002)				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
INTERFACE PANEL		UMB I/F		UMB I/F		INTERFACE PANEL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X99	41	X3	131	X4	131	X99-2	41	HO	0.35	22	C/L TV CAM #1 PWR -	
X99	42	X3	146	X4	146	X99-2	42	HO	0.35	22	C/L TV CAM #1 CHAS GND	
X99	47	X3	152	X4	152	X99-2	47	HO	0.35	22	C/L TV CAM #1 CHAS GND	

NOTES:

2S = (FOR 2S-1 THRU 2S-21) TWO CONDUCTOR TWISTED & SHIELDED THRU A SINGLE SHIELD PIN (*DENOTES SHIELD PIN)
RUSS WIRE SIZE 0.2* = 75-OHM, 0.2MM² WIRE
RUSS WIRE SIZE 0.2*(b) = 75-OHM, 0.2MM² WIRE ON 3002 MECHANISM ONLY; 0.35MM² WIRE ON 8002 MECHANISM
0.35MM² PIGTAILS ON ICM SIDE, TO BE SINGLE CONDUCTORS (NO T/S).
0.35MM² WIRE TO BE SPLICED INTO PIGTAIL ON ORBITER SIDE.
N = NAVAL RESEARCH LAB WILL HAVE CAPABILITY TO CONTROL THESE FUNCTIONS DURING THE ICM/FGB UNDOCKING STAGE.
SPARE*** = NO RUSSIAN PIGTAILS REQUIRED ON PMA-2 (-8002) SIDE.
** Additional power source for Camera Heaters supplied by PPSU via ICM Canister

Table 160-13. ICM-to-FGB Interfaces, X3 and X4

ICM / PMA - 1 (-7002)				FGB				EMC	RUSS WIRE SIZE (mm^2)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X114	1	X4	116	X3	116	X113	1	RF1	0.2*	22	DATA BUS (A) #1 HI	2S-1
X114	2	X4	117	X3	117	X113	2	RF1	0.2*	22	DATA BUS (A) #1 LO	2S-1
X114	3	X4	118	X3	118	X113	3	RF1	0.35	22	DATA BUS (A) #1 SHD	2S-1*
X114	4	X4	115	X3	115	X113	4	RF1	0.2*	22	DATA BUS (A) #2 HI	2S-2
X114	9	X4	128	X3	128	X113	9	RF1	0.2*	22	DATA BUS (A) #2 LO	2S-2
X114	10	X4	129	X3	129	X113	10	RF1	0.35	22	DATA BUS (A) #2 SHD	2S-2*
X114	18	X4	159	X3	159	X113	18	RF1	0.2*	22	DATA BUS (A) #7 HI	2S-3
X114	19	X4	160	X3	160	X113	19	RF1	0.2*	22	DATA BUS (A) #7 LO	2S-3
X114	20	X4	172	X3	172	X113	20	RF1	0.35	22	DATA BUS (A) #7 SHD	2S-3*
X114	21	X4	169	X3	169	X113	21	RF1	0.2*	24	DATA BUS (A) #8 HI	2S-4
X114	22	X4	170	X3	170	X113	22	RF1	0.2*	24	DATA BUS (A) #8 LO	2S-4
X114	23	X4	171	X3	171	X113	23	RF1	0.35	22	DATA BUS (A) #8 SHD	2S-4*
X114	45	X4	141	X3	141	X113	45	RF1	0.2*	22	DATA BUS (A) #12 HI	2S-5
X114	46	X4	155	X3	155	X113	46	RF1	0.2*	22	DATA BUS (A) #12 LO	2S-5
X114	50	X4	167	X3	167	X113	50	RF1	0.35	22	DATA BUS (A) #12 SHD	2S-5*
X114	25	X4	1	X3	1	X113	25	ML1	0.35	22	ICM-1 X4 CONN MATE (TM/SIG) (To FGB)	2T-1
X114	33	X4	182	X3	182	X113	33	ML1	0.35	22	ICM-1 X4 CONN MATE (TM/PWR) (To FGB)	2T-1
X114	40	X4	2	X3	2	X113	40	ML1	0.35	22	ICM-1 X4 CONN MATE (TM/SIG) (To Orb)	2T-3
X114	39	X4	181	X3	181	X113	39	ML1	0.35	22	ICM-1 X4 CONN MATE (TM/PWR) (To Orb)	2T-3
X114	31	X4	4	n/a	n/a	n/a	n/a	n/a	n/a	22	For ground test only ***	2T-3
X114	32	X4	173	n/a	n/a	n/a	n/a	n/a	n/a	22	For ground test only ***	2T-3

NOTES:

**NO RUSSIAN PIGTAILS REQUIRED FOR FGB CONNECTOR-MATE FUNCTIONS

RUSSIAN WIRE SIZE 0.2* = 75-OHM, 0.2mm² WIRE

***NO RUSSIAN PIGTAILS REQUIRED

Table 160-13. ICM-to-FGB Interfaces, X3 and X4 (continued)

ICM / PMA - 1 (-7002)				FGB				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X113	1	X3	116	X4	116	X114	1	RF2	0.2*	22	DATA BUS (B) #1 HI	2S-6
X113	2	X3	117	X4	117	X114	2	RF2	0.2*	22	DATA BUS (B) #1 LO	2S-6
X113	3	X3	118	X4	118	X114	3	RF2	0.35	22	DATA BUS (B) #1 SHD	2S-6*
X113	4	X3	115	X4	115	X114	4	RF2	0.2*	22	DATA BUS (B) #2 HI	2S-7
X113	9	X3	128	X4	128	X114	9	RF2	0.2*	22	DATA BUS (B) #2 LO	2S-7
X113	10	X3	129	X4	129	X114	10	RF2	0.35	22	DATA BUS (B) #2 SHD	2S-7*
X113	18	X3	159	X4	159	X114	18	RF2	0.2*	22	DATA BUS (B) #7 HI	2S-8
X113	19	X3	160	X4	160	X114	19	RF2	0.2*	22	DATA BUS (B) #7 LO	2S-8
X113	20	X3	172	X4	172	X114	20	RF2	0.35	22	DATA BUS (B) #7 SHD	2S-8*
X113	21	X3	169	X4	169	X114	21	RF2	0.2*	24	DATA BUS (B) #8 HI	2S-9
X113	22	X3	170	X4	170	X114	22	RF2	0.2*	24	DATA BUS (B) #8 LO	2S-9
X113	23	X3	171	X4	171	X114	23	RF2	0.35	22	DATA BUS (B) #8 SHD	2S-9*
X113	45	X3	141	X4	141	X114	45	RF2	0.2*	22	DATA BUS (B) #12 HI	2S-10
X113	46	X3	155	X4	155	X114	46	RF2	0.2*	22	DATA BUS (B) #12 LO	2S-10
X113	50	X3	167	X4	167	X114	50	RF2	0.35	22	DATA BUS (B) #12 SHD	2S-10*
X113	25	X3	1	X4	1	X114	25	ML2	0.35	22	ICM-1 X3 CONN MATE (TM/SIG) (To FGB)	2T-2
X113	33	X3	182	X4	182	X114	33	ML2	0.35	22	ICM-1 X3 CONN MATE (TM/PWR) (To FGB)	2T-2
X113	40	X3	2	X4	2	X114	40	ML2	0.35	22	ICM-1 X3 CONN MATE (TM/SIG) (To Orb)	2T-4
X113	39	X3	181	X4	181	X114	39	ML2	0.35	22	ICM-1 X3 CONN MATE (TM/PWR) (To Orb)	2T-4
X113	31	X3	4	n/a	n/a	n/a	n/a	n/a	n/a	22	For ground test only ***	2T-4
X113	32	X3	173	n/a	n/a	n/a	n/a	n/a	n/a	22	For ground test only ***	2T-4

NOTES:

2S = TWO CONDUCTORS TWISTED & SHIELDED THRU A SINGLE SHIELD PIN (* DENOTES SHIELD PIN)

2T = TWO CONDUCTORS TWISTED BUT NOT SHIELDED

***NO RUSSIAN PIGTAILS REQUIRED

Table 160-13a. ICM-to-FGB Interfaces, X1 and X2

ICM / PMA – 1 (-7002)				FGB				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X106	29	X1	61						0.35	22	SPARE *	
X106	30	X1	62						0.35	22	SPARE *	
X106	31	X1	63						0.35	22	SPARE *	
X106	34	X1	64						0.35	22	SPARE *	
X106	35	X1	72						0.35	22	SPARE *	
X106	36	X1	73						0.35	22	SPARE *	
X106	37	X1	74						0.35	22	SPARE *	
X106	38	X1	75						0.35	22	SPARE *	
X106	39	X1	81						0.35	22	SPARE *	
X106	40	X1	82						0.35	22	SPARE *	
X106	41	X1	83						0.35	22	SPARE *	
X106	42	X1	84						0.35	22	SPARE *	
X106	43	X1	90						0.35	22	SPARE *	
X106	44	X1	91						0.35	22	SPARE *	
X106	45	X1	92						0.35	22	SPARE *	
X106	46	X1	93						0.35	22	SPARE *	
X106	47	X1	101						0.35	22	SPARE *	
X106	48	X1	102						0.35	22	SPARE *	
X106	49	X1	103						0.35	22	SPARE *	
X106	50	X1	104						0.35	22	SPARE *	
X106	1	X1	1						0.35	22	SPARE *	2T
X106	4	X1	4						0.35	22	SPARE *	2T
X106	11	X1	79						0.35	22	SPARE *	2T
X106	17	X1	86						0.35	22	SPARE *	2T
X106	26	X1	149						0.35	22	SPARE *	2T

Table 160-13a. ICM-to-FGB Interfaces, X1 and X2 (continued)

ICM / PMA – 1 (-7002)				FGB				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X106	33	X1	150						0.35	22	SPARE *	2T
X106	15	X1	145						0.35	22	SPARE *	
X107	29	X2	61						0.35	22	SPARE *	
X107	30	X2	62						0.35	22	SPARE *	
X107	31	X2	63						0.35	22	SPARE *	
X107	34	X2	64						0.35	22	SPARE *	
X107	35	X2	72						0.35	22	SPARE *	
X107	36	X2	73						0.35	22	SPARE *	
X107	37	X2	74						0.35	22	SPARE *	
X107	38	X2	75						0.35	22	SPARE *	
X107	39	X2	81						0.35	22	SPARE *	
X107	40	X2	82						0.35	22	SPARE *	
X107	41	X2	83						0.35	22	SPARE *	
X107	42	X2	84						0.35	22	SPARE *	
X107	43	X2	90						0.35	22	SPARE *	
X107	44	X2	91						0.35	22	SPARE *	
X107	45	X2	92						0.35	22	SPARE *	
X107	46	X2	93						0.35	22	SPARE *	
X107	47	X2	101						0.35	22	SPARE *	
X107	48	X2	102						0.35	22	SPARE *	
X107	49	X2	103						0.35	22	SPARE *	
X107	50	X2	104						0.35	22	SPARE *	
X107	1	X2	1						0.35	22	SPARE *	2T
X107	4	X2	4						0.35	22	SPARE *	2T
X107	11	X2	79						0.35	22	SPARE *	2T

Table 160-13a. ICM-to-FGB Interfaces, X1 and X2 (continued)

ICM / PMA - 1 (-7002)				FGB				EMC	RUSS WIRE SIZE (mm²)	AMER WIRE SIZE (GA)	FUNCTIONS	NOTE
DISCONN. PNL		I/F		I/F		DISCONN. PNL						
CONN	PIN	CONN	PIN	CONN	PIN	CONN	PIN					
X107	17	X2	86						0.35	22	SPARE *	2T
X107	26	X2	149						0.35	22	SPARE *	2T
X107	33	X2	150						0.35	22	SPARE *	2T
X107	15	X2	145						0.35	22	SPARE *	

* NO RUSSIAN PIGTAILS

2T = TWO CONDUCTORS TWISTED BUT NOT SHIELDED

· 1._Who must follow part 3?

Chapter 404

Biosafety and bloodborne pathogens

This could be you . . .

A janitor was stuck by a hypodermic needle left in a trash can.

An employee found blood drops around his work area.

1. Who must follow this chapter?

You must follow this chapter if you work with or may be exposed to biohazards including blood, and "other potentially infectious materials" as a part of your job. JSC has adopted the recommendations found in the Center for Disease Control and Prevention and National Institute of Health "Universal Precautions" and "Biosafety in Microbiological and Biomedical Laboratories" for controlling biohazards in the workplace.

If you don't work with blood or body fluids, but find them in your work area, follow Paragraph 2 below. If you are a supervisor, Paragraph 20 lists your responsibilities for biohazards.

2. What if I discover blood or other potentially infectious body fluids?

If you find blood or other potentially infectious body fluids around your work area:

a. Leave it alone. Without the proper training and equipment, you risk getting a bloodborne disease.
b. Block off the area to prevent others from contacting it.
c. Report it to Emergency Operations Center at 483-4658 and to your facility manager. They will send janitorial personnel trained in bloodborne pathogens to clean it up.

3. What are Biohazards and Bloodborne Pathogens?

The following definitions apply to this chapter:

a. **Biological Hazards or Biohazards** are those infectious agents that present a risk of death, injury or illness to employees. Bloodborne pathogens and other potentially infectious materials (Subparagraphs b and c below) are considered biohazards.
b. **Bloodborne Pathogens**— pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).
c. **Other Potentially Infectious Materials** is an Occupational Safety and Health Administration (OSHA) definition which includes:

- The following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids
- Any unfixed tissue or organ (other than intact skin) from a human (living or dead)
- HIV-containing cell or tissue cultures, organ cultures

- HIV- or HBV-containing culture medium or other solutions
- Blood, organs, or other tissues from experimental animals infected with HIV or HBV.

4. What OSHA requirements apply to bloodborne pathogens?

If your job description includes possible exposure to blood or "other potentially infectious materials," you must follow the OSHA 29 CFR 1910.1030, "Bloodborne Pathogens."

5. Who determines if I work in a job that exposes me to biohazards or bloodborne pathogens?

JSC Medical Sciences has a Biosafety Control Board that evaluates the use of any new potential biohazardous or pathogenic materials.

The Occupational Health Office evaluates all areas where civil service or contract workers could be exposed to bloodborne pathogens. Your management must help in evaluating these areas.

6. What are the biosafety levels and what precautions must I take for each?

You must classify all biohazards or biological materials as Biohazard 1,2 3, or 4. You must also follow the requirements in the table below for the biosafety level that matches the biohazard classification when working with any biohazardous material in a laboratory or clinical setting.

Bio-safety level . . .	*Involves these agents . . .*	*Follow these practices . . .*	*Use this safety equipment (primary barriers) . . .*	*Use these facilities (secondary barriers) . . .*
1	Not known to cause disease in healthy adults	Standard micro-biological practices	None required	Open bench top sink required
2	Associated with human disease, hazard = auto-inoculation, ingestion, mucous membrane exposure	BSL-1 practice plus: Limited access; biohaz-ard warning signs; "sharps" precautions; biosafety manual defining any needed waste decon-tamination or medical surveillance policies	Class I or II BSCs or other physical containment devices used for manipulating any agents that cause splashes or aerosols of infectious materials PPE: laboratory coats; gloves; face protection as needed	BSL-1 plus: Autoclave available
3	Indigenous or exotic agents with potential for aerosol transmission; disease may have serious or lethal consequences	BSL-2 practice plus: Controlled access; decontaminate all waste; decontaminate lab clothing before laundering; baseline serum	Class I or II BSCs or other physical contain-ment devices used for manipulating any agents PPE: protective lab clothing; gloves; respira-tory protection as needed	BSL-2 plus: Physical separation from access corridors; self-closing, double-door access; exhausted air not recirculated; negative airflow into lab
4	Dangerous or exotic agents which pose high risk of life-threatening disease, aerosol-trans-mitted lab infections; or related agents with unknown risk of transmission	BSL-3 practice plus: Change clothing before entering; shower on exit; decontaminate all material when exiting facility	Conduct all procedures in Class III BSCs or Class I or II BSCs with full-body, air-supplied, positive-pressure personnel suit	BSL-3 plus: Separate building or isolated zone; dedi-cated supply and exhaust, vacuum, and decon systems; other requirements outlined in the test

BSL- Biosafety Level

BSC- Biosafety Cabinet

7. When must I have a written exposure control plan?

Any organization or company whose employees may be exposed to blood and "other potentially infectious materials" must have a written exposure control plan that is tailored to the work area and designed to minimize worker exposure. The plan must contain the items listed in 29 CFR 1910.1030(c). This exposure control plan will include but is not limited to:

a. Exposure determination and hazard analysis, which describe the occupation and tasks with exposure.
b. Methods to comply with applicable requirements.
c. Communicating hazards to exposed employees.
d. Recordkeeping.
e. The procedures to follow after an exposure to blood or other infectious materials.
f. Hepatitis B vaccination option

You must update the written exposure control plan yearly.

8. What precautions must I observe when I work with blood or other potentially infectious materials?

If you work with any blood or body fluids listed above, you must observe these "Universal Precautions":

a. Treat all blood and body fluids as infectious. Urine, feces, saliva, and vomit are not considered a potentially infectious material unless they are visibly contaminated with blood.
b. Always wear appropriate personal protective equipment (PPE) such as gloves, lab coats or aprons, and eye or face shields for the task at hand.
c. Wash your hands with biocidal soap immediately after removing your PPE or coming in contact with blood or body fluids.
d. Remove all PPE before leaving the work area and place in the appropriate container for storage, decontamination, or disposal.
e. Don't eat, drink, smoke, apply cosmetics or handle contact lenses in the work area.
f. Don't store food and drink in refrigerators or freezers where blood or other infectious materials are stored.
g. Minimize splashing and spraying blood or other infectious materials while handling them, while cleaning equipment, or during any other clean-up procedure.
h. Don't pipet or suction with your mouth.
i. Make sure all ventilation hoods and biological safety cabinets are inspected at least every year.

9. What precautions must I observe when using needles?

If you use needles with blood or other infectious materials, observe these precautions:

a. Don't shear, bend or break used needles.
b. Don't recap or resheath by hand.
c. Don't remove used needles from disposable syringes.
d. Dispose of used needles in an approved biohazard container.

10. What housekeeping precautions must I observe?

Housekeeping is an important part of your protection so observe these requirements:

a. Disinfect all work surfaces with and appropriate biocide at the end of each work shift or when they are contaminated.
b. Replace protective coverings such as foil or plastic wrap used to protect equipment at the end of the work shift or when they become contaminated.
c. Disinfect all waste containers labeled biohazard on a regular schedule and clean them when they are visibly contaminated.
d. Don't pick up broken glassware with your hands. Use tongs or a brush and dustpan. Dispose of broken glassware in a puncture-proof biohazard container so it won't injure other workers.
e. Place all specimens in a closeable, leakproof container and label the container before storing or transporting.
f. Use a secondary container if the first is likely to be damaged.

11. What disposal precautions must I observe?

Disposal is an important part of protecting others so observe these requirements:

a. Place all infectious waste in closeable, leakproof containers that are color-coded or labeled as described in Paragraph 12 below.
b. Keep infectious waste separate from other waste.
c. Wear protective gloves when handling infectious waste.
d. Make sure that infectious waste is picked up and transported by trained personnel only and that it is disposed of in a biological incinerator. In emergencies, first responders may take properly bagged waste to the JSC Clinic for disposal during working hours.
e. Minimize handling laundry that is contaminated. Bag it at the site in a properly labeled container and take it to a laundry for cleaning.

12. What labeling requirements are used for blood and body fluids?

Labels must be fluorescent orange or orange-red and include the word BIOHAZARD and the biohazard symbol in a contrasting color. Place this warning sign on all containers of infectious waste, and on refrigerators or freezers that contain infectious materials. You may use red bags or containers in place of labels for containers of infectious waste.

13. What protective clothing and equipment must I use when working with blood and potentially infectious materials?

You must wear the following protective equipment:

a. Latex gloves
b. Lab coat or apron and eye and face protection if splashing or spraying is possible

14. May I get a Hepatitis B virus vaccination?

The JSC Clinic provides HBV vaccine to all on-site contractor and civil service employees in the job classifications listed in the exposure control plan for your area. The Occupational Health Officer must concur before you get the vaccine. This vaccine must be offered to you at no cost within 10 working days of being assigned duties that could expose you to blood or other potentially infectious materials. You may decline this vaccine when it is offered by signing a declination form. (See Attachment 404A in Appendix 4A.) If you later change your mind, you can still get the vaccine from the JSC Clinic.

15. What training must I have to work safely with blood and body fluids?

You must be trained within 10 working days of being assigned duties that could expose you to blood or other potentially infectious materials and yearly thereafter to handle blood and body fluids listed in the "Universal Precautions" of the Center for Disease Control and Prevention safely. Your training must include:

a. A copy of 29 CFR 1910.1030 and an explanation of its contents.
b. A general explanation of the epidemiology, symptoms, and modes of transmission of bloodborne diseases.
c. An explanation of how to recognize activities that may involve exposure to blood and other potentially infectious material.
d. An explanation of the use and limitations of practices that will prevent or reduce exposure, including appropriate engineering controls, work practices, and PPE.
e. Information on the types, selection, proper use, location, removal, handling, decontamination or disposal of PPE.
f. Information on the HBV vaccine, including information on its effectiveness, safety, the benefits of being vaccinated, and that the vaccination will be offered to you free of charge.
g. Information on the appropriate actions to take and persons to contact if you or someone else are exposed to blood or body fluids.
h. An explanation of the procedure to follow if an exposure incident occurs, including how to report the incident and the medical follow-up that will occur.
i. Information on the post-exposure evaluation and follow-up that will be provided for you after an exposure incident.
j. An explanation of the signs, labels, and color-coding system.
k. An opportunity to ask questions of the person conducting the training session. Training is available through the Occupational Health Office.
l. Information on the Center for Disease Control Prevention's Communicable Hotline (1-800-342-2437) to receive personal, confidential, and reliable information.

See chapter 108, "Safety and health training," of this handbook for more information on training.

16. What must I do if I'm exposed to blood or other infectious materials?

If you are exposed to blood or body fluids, get medical treatment immediately. You have a two-hour window of opportunity to start treatment. If you are treated at an outside medical facility, go to your site Clinic as soon as possible for a follow-up visit. Follow the table below:

If the exposure is . . .	*Then . . .*
An emergency where you need an ambulance	• Call x33333 at JSC and the Sonny Carter Training Facility, x44444 at Ellington Field, 911 at any off-site location, or x5911 at White Sands Test Facility.
To the eye, mouth, other mucous membrane or non-intact skin	• Flood the area with water for 15-20 minutes or wash with soap. • Go to the JSC Clinic or emergency room if the Clinic is closed for post-exposure follow-up.
To intact skin	• Immediately and thoroughly wash the affected area with biocidal soap. • Go to the JSC Clinic or emergency room if the Clinic is closed for post-exposure follow-up.

17. What will the clinic do?

For JSC employees, the JSC Clinic will provide a confidential medical evaluation to you if you have been exposed and will:

a. Document the:

- Route(s) of exposure.
- HBV and HIV antibody status of the source individual, if known.
- The circumstances under which the exposure occurred.
- Any "first aid" or "prophylactic" measures that you received.

b. Collect and test the source individual's blood to determine the presence of HIV or HBV infection, if the source individual can be identified, and permission given. You will be informed of applicable laws and regulations about disclosing the identity and infectious status of the source individual.
c. Collect blood from you as soon as possible after the exposure incident to determine your HBV, Hepatitis C, and HIV antibody status.
d. Follow-up on you, including the following:

- Antibody or antigen testing
- Counseling
- Evaluation of reported illnesses
- Safe and effective post-exposure treatment under standard recommendations for medical practice

18. What medical records does JSC keep?

a. The JSC Clinic keeps all medical exposure records for the duration of your employment plus 30 years.
b. These medical records are available to you and anyone with your written consent.
c. You must file an injury report (JSC Form 340) for any exposure. The Safety Office will send a copy to your supervisor or company.

19. Where can I get more information on biohazards and bloodborne pathogens?

You can find more information on bloodborne pathogens in these documents or contact the JSC Clinic:

a. 29 CFR 1910.1030
b. "Universal Precautions" guidelines from the Center for Disease Control and Prevention
c. "Bio Safety in Microbiological and Bio medical Laboratories," published by the Center for Disease Control and Prevention and the National Institute of Health

20. Who else has responsibilities for bloodborne pathogen safety?

As a ***supervisor***, you must:

a. Control all exposures to bloodborne pathogens through a written exposure control plan designed to minimize worker exposure.
b. Make sure your employees follow the requirements of this chapter and your exposure control plan.
c. Make sure your employees are trained in protecting themselves from bloodborne pathogens.
d. Provide adequate PPE.
b. Offer to all employees the Hepatitis B vaccination and training within 10 working days of

being assigned to a job in which they could be exposed.

Chapter 404

Biosafety and bloodborne pathogens

This could be you . . .

A janitor was stuck by a hypodermic needle left in a trash can.

An employee found blood drops around his work area.

1. Who must follow this chapter?

You must follow this chapter if you work with or may be exposed to biohazards including blood, and "other potentially infectious materials" as a part of your job. JSC has adopted the recommendations found in the Center for Disease Control and Prevention and National Institute of Health "Universal Precautions" and "Biosafety in Microbiological and Biomedical Laboratories" for controlling biohazards in the workplace.

If you don't work with blood or body fluids, but find them in your work area, follow Paragraph 2 below. If you are a supervisor, Paragraph 20 lists your responsibilities for biohazards.

2. What if I discover blood or other potentially infectious body fluids?

If you find blood or other potentially infectious body fluids around your work area:

a. Leave it alone. Without the proper training and equipment, you risk getting a bloodborne disease.
b. Block off the area to prevent others from contacting it.
c. Report it to Emergency Operations Center at 483-4658 and to your facility manager. They will send janitorial personnel trained in bloodborne pathogens to clean it up.

3. What are Biohazards and Bloodborne Pathogens?

The following definitions apply to this chapter:

a. **Biological Hazards or Biohazards** are those infectious agents that present a risk of death, injury or illness to employees. Bloodborne pathogens and other potentially infectious materials (Subparagraphs b and c below) are considered biohazards.
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   - The following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids
   - Any unfixed tissue or organ (other than intact skin) from a human (living or dead)
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e. Place all specimens in a closeable, leakproof container and label the container before storing or transporting.
f. Use a secondary container if the first is likely to be damaged.

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Disposal is an important part of protecting others so observe these requirements:

a. Place all infectious waste in closeable, leakproof containers that are color-coded or labeled as described in Paragraph 12 below.
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Housekeeping is an important part of your protection so observe these requirements:

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- Blood, organs, or other tissues from experimental animals infected with HIV or HBV.

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1	Not known to cause disease in healthy adults	Standard micro-biological practices	None required	Open bench top sink required
2	Associated with human disease, hazard = auto-inoculation, ingestion, mucous membrane exposure	BSL-1 practice plus: Limited access; biohaz-ard warning signs; "sharps" precautions; biosafety manual defining any needed waste decon-tamination or medical surveillance policies	Class I or II BSCs or other physical containment devices used for manipulating any agents that cause splashes or aerosols of infectious materials PPE: laboratory coats; gloves; face protection as needed	BSL-1 plus: Autoclave available
3	Indigenous or exotic agents with potential for aerosol transmission; disease may have serious or lethal consequences	BSL-2 practice plus: Controlled access; decontaminate all waste; decontaminate lab clothing before laundering; baseline serum	Class I or II BSCs or other physical contain-ment devices used for manipulating any agents PPE: protective lab clothing; gloves; respira-tory protection as needed	BSL-2 plus: Physical separation from access corridors; self-closing, double-door access; exhausted air not recirculated; negative airflow into lab
4	Dangerous or exotic agents which pose high risk of life-threatening disease, aerosol-trans-mitted lab infections; or related agents with unknown risk of transmission	BSL-3 practice plus: Change clothing before entering; shower on exit; decontaminate all material when exiting facility	Conduct all procedures in Class III BSCs or Class I or II BSCs with full-body, air-supplied, positive-pressure personnel suit	BSL-3 plus: Separate building or isolated zone; dedi-cated supply and exhaust, vacuum, and decon systems; other requirements outlined in the test

BSL- Biosafety Level

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f. Information on the HBV vaccine, including information on its effectiveness, safety, the benefits of being vaccinated, and that the vaccination will be offered to you free of charge.
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h. An explanation of the procedure to follow if an exposure incident occurs, including how to report the incident and the medical follow-up that will occur.
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d. Provide adequate PPE.
b. Offer to all employees the Hepatitis B vaccination and training within 10 working days of

being assigned to a job in which they could be exposed.