

# **Extravehicular Activity (EVA) Standard Interface Control Document**

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## **International Space Station Program**

**Revision F**

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Houston, Texas  
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## PREFACE

This Interface Control Document (ICD) defines the requirements for the interface between the Extra Vehicular Activity standard hardware and users of that hardware.

The contents of this document are intended to be consistent with the tasks and products to be prepared by Program participants. The Extra Vehicular Activity Interface Control Document may be implemented on existing contracts by an authorized contract change. This document is under the control of the ISS Interface Control Working Group (ICWG), and any changes shall be approved by the ICWG Chair.

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Program Manager (*or delegated authority*)  
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4-30-96

Date

**INTERNATIONAL SPACE STATION PROGRAM****EXTRA VEHICULAR ACTIVITY  
INTERFACE CONTROL DOCUMENT****FEBRUARY 7, 1997****TECHNICAL CONCURRENCE**

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## **1.0 INTRODUCTION**

The Space Station provides Extravehicular Activity (EVA) Aids to assist EVA crewmembers in the assembly and external maintenance of the Space Station. The EVA aids are used at worksites and along translation paths to restrain the EVA crewmembers, to provide stable work platforms, to perform assembly and maintenance tasks, and to translate both crew and equipment.

### **1.1 PURPOSE AND SCOPE**

This document defines and controls the interfaces between EVA standard hardware and users of that hardware, and is limited to those interfaces only. For the purposes of this ICD, the term “user” is defined as any element or ORU that interfaces with any EVA standard equipment item.

### **1.2 PRECEDENCE**

In the event of conflict between SSP 41162, United States On–Orbit Segment (USOS) Specification, and the contents of this Interface Control Document (ICD), the requirements of SSP 41162 shall take precedence.

### **1.3 RESPONSIBILITY AND CHANGE AUTHORITY**

This document is prepared and maintained in accordance with D684–10018–1, International Space Station Program United States On–Orbit Segment Prime Contractor Interface Control Plan. The Prime Contractor shall delegate the responsibility for preparation and maintenance of this ICD.

## 2.0 APPLICABLE DOCUMENTS

The following documents of the exact date or revision shown form a part of this document to the extent specified herein.

### 2.1 GOVERNMENT DOCUMENTS

| Document Number          | Title   |
|--------------------------|---|
| MIL-C-5541<br>Reference  | Chemical Conversion Coatings on Class 3 Aluminum and Class 3 Aluminum Alloys<br>3.6.1.4.2, 3.6.3.4.2, 3.6.4.4.2, 3.6.5.4.2  |
| NSTS 07700<br>Reference  | Space Shuttle System Payload Accommodations, Volume 14, Appendix 7, Rev.J, 29 March 1988<br>3.0   |
| SSP 30219<br>Reference   | Space Station Reference Coordinate Systems<br>3.1.1   |
| SSP 30233E<br>Reference  | Space Station Requirements for Materials and Processes<br>3.2.5.4.2, 3.2.5.4.5, 3.4.1.4.1, 3.4.1.4.2, 3.4.2.4.2, 3.6.1.4.2, 3.6.3.4.2, 3.6.4.4.2, 3.6.5.4.2, 3.7.3.4, 3.8.3.4 |
| SSP 30245A<br>Reference  | Space Station Electrical Bonding Requirements<br>3.6.3.6, 3.6.1.6, 3.6.5.6, 3.2.5.5, 3.3.1.6, 3.4.1.4.2, 3.4.2.4.1, 3.4.2.4.2, 3.6.4.6, 3.7.5, 3.8.5                          |
| SSP 30420B<br>Reference  | Space Station Electromagnetic, Ionizing Radiation and Plasma Environment Definition and Design Requirements June 18, 1993<br>3.1.5.2  |
| SSP 30425B<br>Reference  | Space Station Program Natural Environment Definition for Design<br>3.1.5.1  |
| SSP 30550<br>Reference   | Robotics Systems Integration Standards<br>3.2.6   |
| SSP 41162<br>Reference   | Segment Specification for the U.S. On-Orbit Segment<br>1.2, 3.0   |
| ICD-2-19001<br>Reference | Shuttle Orbiter/Cargo Standard Interfaces<br>3.1.5.2  |

**2.2 NON-GOVERNMENT DOCUMENTS**

| <b>Document Number</b>        | <b>Title</b>   |
|-------------------------------|--|
| ANSI Y14.5M-1982<br>Reference | Geometric Dimensioning and Tolerancing<br>3.1.2  |
| D684-10018-1<br>Reference     | International Space Station Program United States On-Orbit<br>Segment Prime Contractor Interface Control Plan<br>1.3 |

### **3.0 INTERFACES**

The following paragraphs describe the interface characteristics of the standard EVA hardware including the generic tools and crew aids, portable work platform, Crew and Equipment Translation Aid (CETA) cart and tether shuttle, Orbit–Replaceable Unit (ORU) transfer device, generic tool stowage, and the translation aids and attachments, made up of handrails / handholds, passive worksite interfaces and slidewires. The EVA generic tools and crew aids are defined in Paragraph 3.2. The portable work platform, CETA cart and tether shuttle, ORU transfer device, generic tool stowage, and the translation aids and attachments are listed in Table 3.0–1. Any hardware that must be assembled, inspected, serviced, maintained, restrained, or handled by a suited EVA crewmember using standard EVA tools and aids will meet the requirements of SSP 41162, Segment Specification for the U.S. On–Orbit Segment, and NSTS 07700, Space Shuttle System Payload Accommodations. To facilitate this activity, translation aids and support equipment will be provided.

### **3.1 GENERAL**

#### **3.1.1 COORDINATE SYSTEMS**

The Space Station coordinate system is defined in SSP 30219, Space Station Reference Coordinate Systems.

#### **3.1.2 DIMENSIONS AND TOLERANCES**

In order to ensure interchangeability, reduce manufacturing costs and allow pre–drilling of all components, all hole diameter and positional tolerances associated with this interface have been defined using ANSI Y14.5M–1982 and should be interpreted accordingly. Unless otherwise noted herein, all dimensions are in the English system of inch, pound (IP) units.

#### **3.1.3 EVA INDUCED LOADS**

All loads induced by EVA and reacted through EVA Aids hardware interfaces are shown in Table 3.1.3–1, EVA Induced Loads.

#### **3.1.4 EVA STANDARD BOLTHEADS**

All EVA actuated bolts shall conform to one of the following five configurations in order to interface with the standard EVA hand and power tools:

- ISS 7/16 in. hexagonal EVA and robotics compatible bolt
- ISS 7/16 in. 12–point EVA compatible bolt
- ISS 7/16 in. hexagonal robot and EVA compatible bolt; robotic bare bolt applications

**TABLE 3.0-1 EVA CREW AND EQUIPMENT TRANSLATION AIDS AND ATTACHMENTS**

| DESCRIPTION                                     | DRAWING/PART NUMBER |
|---|---------------------|
| Crew And Equipment Translation Aid (CETA) Cart  | SEG33106253-301     |
| Passive Coupler                                 | SEG33106353         |
| Active Coupler – Mobile Transporter             | SEG33106352         |
| Tether Shuttle                                  | SEG33106198-301     |
| APFR Flight Support Equipment                   | SEG33107124         |
| ETSD Flight Support Equipment                   | SEG33107126         |
| PFRWS Flight Support Equipment                  | SEG33107125         |
| Probe, Launch – TERA                            | SDG33107230-301     |
| EVA Tool Stowage Device Assy, A/L (1)           | SEG33106288-301     |
| o Panel Assy, Bolt Puller                       | SEG33106823         |
| o Board Assy, Adjustable Wrench                 | SEG33106318         |
| o Board Assy, Pliers                            | SEG33106314         |
| o Board Assy, Hammer                            | SEG33106320         |
| o Panel Assy, Tool Caddy                        | SEG33106324         |
| o Carrier Assy, PRD (1 of 2)                    | SEG33106316         |
| o Board Assy, Hydrazine Brush                   | SEG33106310         |
| EVA Tool Stowage Device Assy, A/L (2)           | SEG33106288-302     |
| o Panel Assy, Insert Replacement Tool           | SEG33106326         |
| o Board Assy, 1/4" x 1/2" Allen Driver          | SEG33106312         |
| o Board Assy, Small Cutter                      | SEG33106308         |
| o Panel Assy, Large Cutter                      | SEG33106825         |
| o Carrier Assy, PRD (2 of 2)                    | SEG33106316         |
| EVA Tool Stowage Device Assy, CETA              | SEG33106287         |
| o Panel Assy, 18" Socket                        | SEG33106306         |
| o Board Assy, Round TM                          | SEG33106294         |
| o Board Assy, Square TM                         | SEG33106296         |
| o Board Assy, Ratchet                           | SEG33106300         |
| o Panel Assy, Cheater Bar                       | SEG33106304         |
| o Board Assy, Socket                            | SEG33106302         |
| o Board Assy, Trash Bag                         | SEG33106292         |
| Soft Dock – CETA (1 Set = 2 Mechanisms)         | SEG33106354         |
| Handrail Assembly, Top Mounted – ISS (25.53 ")  | SEG33106347-801     |
| Handrail Assembly, Top Mounted – ISS (25.606 ") | SEG33106347-843     |
| Handrail Assembly, Top Mounted – ISS (22.625 ") | SEG33106347-805     |
| Handrail Assembly, Top Mounted – ISS (21.941 ") | SEG33106347-803     |
| Handrail Assembly, Top Mounted – ISS (15.441 ") | SEG33106347-811     |

**TABLE 3.0-1 EVA CREW AND EQUIPMENT TRANSLATION AIDS AND ATTACHMENTS  
(CONT'D)**

| DESCRIPTION  | DRAWING/<br>PART NUMBER |
|--|-------------------------|
| Handrail Assembly, Top Mounted, Custom (47.635")                                   | SEG33106466-301         |
| Handrail Assembly, Top Mounted, Custom (15.441 +6")                                | SEG33106466-313         |
| Handrail Assy, Side Mounted, Tall – ISS (25.53 ")                                  | SEG33106348-301         |
| Handrail Assy, Side Mounted, Short – ISS (25.53 ")                                 | SEG33106348-303         |
| Handrail Assembly, Top Mounted – ISS (8.53 ")                                      | SEG33106347-807         |
| Handrail Assembly, Top Mounted – ISS (8.626 ")                                     | SEG33106347-809         |
| Handhold Assy, Side Mounted, Tall – ISS (8.53 ")                                   | SEG33106350-301         |
| Handhold Assy, Side Mounted, Short – ISS (8.53 ")                                  | SEG33106350-303         |
| Handrail Assembly – OIH (24.00 ")  | SEG33106351-301         |
| Handrail Assembly – OIH (12.00 ")  | SEG33106351-305         |
| Carrier, Orbit Installed Handrail – OSE  | SEG33107831             |
| Microconical Fitting (Flanged)   | 0006056-002             |
| Microconical Fitting (3/4 Inch Hole)   | 0006055-002             |
| Microconical Fitting (Stepped Hole)  | 0006057-002             |
| Top Mounted Passive WIF Assy   | SEG33106859-301         |
| Side Mounted Passive WIF Assy  | SEG33106860-301         |
| OIWIF Socket Assy  | SEG33106861-301         |
| On-Orbit Installed WIF Adapter Plate Assy<br>(1 Set = 1 Adapter Plate + 4 Spacers) | SEG33106862-701         |
| Adjustable Fuse Tether   | SED39127200             |
| Passive WIF Adapter Assy (with Locking Pin)  | SEG33106863-301         |
| Passive WIF Adapter Assy (w/o Locking Pin)   | SEG33106863-303         |
| Slidewire Assembly – On Orbit Installed (156 ")                                    | SEG33106344-301         |
| Slidewire Assembly – On Orbit Installed (290 ")                                    | SEG33106344-303         |
| Plate, Structural Adapter – Slidewire (2 Adapters per Slidewire<br>Assembly)       | SDG33106257-001         |
| Carrier, Slidewire – OSE   | SEG33107213             |

**TABLE 3.1.3-1 EVA INDUCED LOADS**

NOTE: EVA On-Orbit Induced Loads for Inadvertent kick and kick-off, push-off loads do not apply to hardware or worksites which are assembled or maintained using robotic systems (crewmember restrained on SRMS or SSRMS).

| DESIGN LIMIT LOAD TYPE  | LIMIT LOAD                           | TYPE OF LOADING  | DIRECTION   | CATEGORY OF STRUCTURE  | APPLICATION COMMENTS   |
|---|--------------------------------------|--|---|--|--|
| EVA Handrail/<br>Handhold-<br>Primary Translation<br>Path     | 220 lb <sub>f</sub>                  | Quasi-static load applied over 3.0 inch length of handrail or handhold at worst location | Any direction   | Handrails, handholds and supporting structure  | This load applied to the primary translation path used by the crewmember to return to the airlock. This path is identified in Section 3.9.                           |
| Handrail/<br>Handhold Moment-<br>Primary Translation<br>Path  | F=100 lb <sub>f</sub><br>M=600 in-lb | Quasi-static concentrated load at worst location   | Apply 100 lb resultant force in any direction simultaneously with the bending moment. Bending moment applied as a couple of two opposing handhold forces separated by six inches. | Handrails, handholds and supporting structure  | This load applied to the primary translation path which is the primary path used by the crewmember to return to the airlock. This path is identified in Section 3.9. |
| Handrail/<br>Handhold-<br>Secondary Translation<br>Path       | 187 lb <sub>f</sub>                  | Quasi-static load applied over 3.0 inch length of handrail or handhold at worst location | Any direction   | Handrails, handholds and supporting structure  | This load applied to the secondary translation path.   |
| Crew Tether Attach  | 200 lb <sub>f</sub>                  | Quasi-static load applied to crew Tether Loop Attachment                                 | Any direction   | Crew tether loops/handrail tether point, attach hardware and support structure                 |  |
| EVA Kick-Off,<br>Push-Off Force of<br>Tethered Crew<br>Member | 200 lb <sub>f</sub>                  | Quasi-static concentrated load over a 3.0 inch diameter circular area at worst location  | Perpendicular to and directed toward surface  | All primary and secondary structure inside or near (within 24") a translation path or worksite | This maximum kick-off or push-off load applies where the crewmember is using the hardware to provide a reaction point during translation.                            |

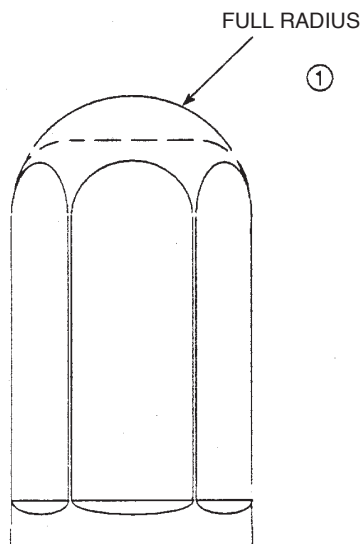
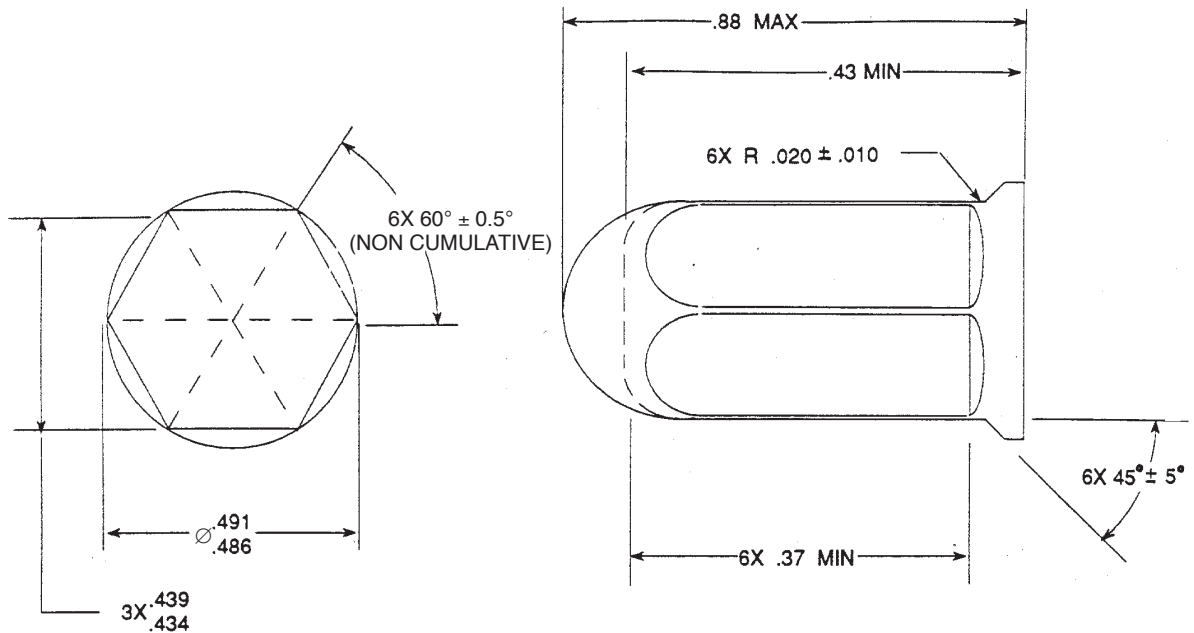


TABLE 3.1.3-1 EVA INDUCED LOADS (CONT'D)

| DESIGN LIMIT LOAD TYPE                          | LIMIT LOAD  | TYPE OF LOADING   | DIRECTION                                     | CATEGORY OF STRUCTURE   | APPLICATION COMMENTS  |
|---|---|---|---|---|---|
| Inadvertent kick, bump                          | 125 lb <sub>f</sub>   | Quasi-static, concentrated load over a 0.5 inch diameter circular area                  | Any direction                                 | Secondary structure near (within 24") a translation path or worksite  | This is an accidental impact. It should be applied to hardware near (within 24") translation paths and/or worksites.  |
| Force Application (EVA Handling Load)           | 45 lb <sub>f</sub><br>(35 in-lb <sub>f</sub> for connector panels for mate/demate of connector) | Quasi-static concentrated load over a 1.25 inch radius circular area                    | Any direction                                 | ORUs and non-structural closures and covers (including shields, cables, cable connector brackets, cable connector panels, cable clamps) | This load can be applied anytime to any hardware by the EVA crew member when in a foot restraint. All hardware must be designed to this load as a minimum. This force would be applied by the palm of the glove, tip of a boot or knee. |
| EVA load for design of PFR supporting structure | 274 lb <sub>f</sub> force;<br>4200 in-lb moment   | Quasi-static loads applied at PFR socket to structure interface                         | Force in any direction; moment about any axis | All structure on which a foot restraint is attached   | Force and moment applied simultaneously.  |
| EVA tool tether attach point                    | 75 lb <sub>f</sub>  | Concentrated load-pull (tension)  | Any direction                                 | Any structures supporting tool tether attach points   |   |
| Hatches   | 187 lb <sub>f</sub>   | Quasi-static concentrated load over a 3.0 inch diameter circular area at worst location | Any direction                                 | Hatches   |   |
| Tool Impact                                     | 125 lb <sub>f</sub>   | Concentrated load on a 0.06 inch radius circular area                                   | Any direction                                 | Windows and exposed glass surfaces  |   |

- ISS 5/16 in. hexagonal EVA compatible bolt
- ISS 5/8 in. hexagonal EVA compatible bolt

See Figures 3.1.4-1 through 3.1.4-5 for bolt head dimensions. Tolerances are user defined except where shown.



## NOTES:

ALL DIMENSIONS IN INCHES

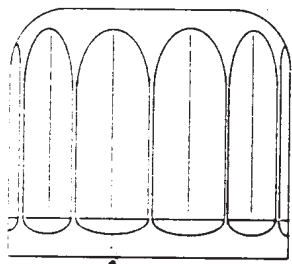
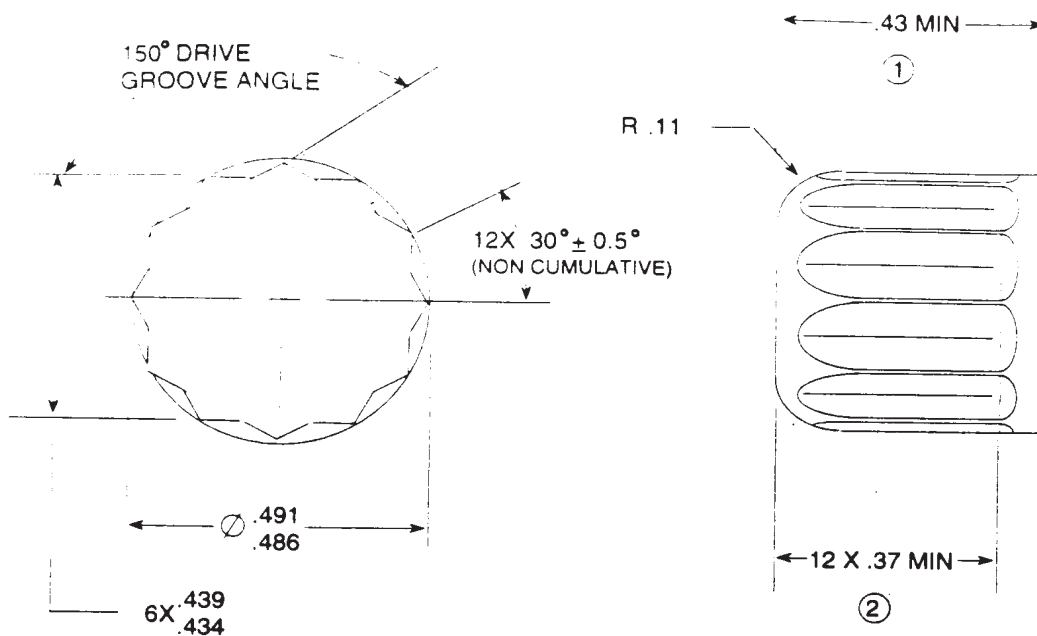
① .11 EDGE RADIUS MAY BE SUBSTITUTED FOR .25 SPHERICAL RADIUS WHEN CO-LOCATED WITH MICRO CONICAL FITTINGS

HEX BOLT SHOULDER MAY BE REMOVED TO ACCOMMODATE MECHANISM ACTIVATION AT BASE OF THE BOLT HEAD

BOLT MUST BE CO-LOCATED WITH A MICRO CONICAL FITTING, MICRO, OR H-HANDLE TO BE ROBOT COMPATIBLE

TOLERANCES ARE USER DEFINED EXCEPT WHERE SHOWN

**FIGURE 3.1.4-1 ISS 7/16 IN. HEXAGONAL EXTRAVEHICULAR (EVA) AND ROBOTIC COMPATIBLE BOLT**

**NOTES:****ALL DIMENSIONS IN INCHES**

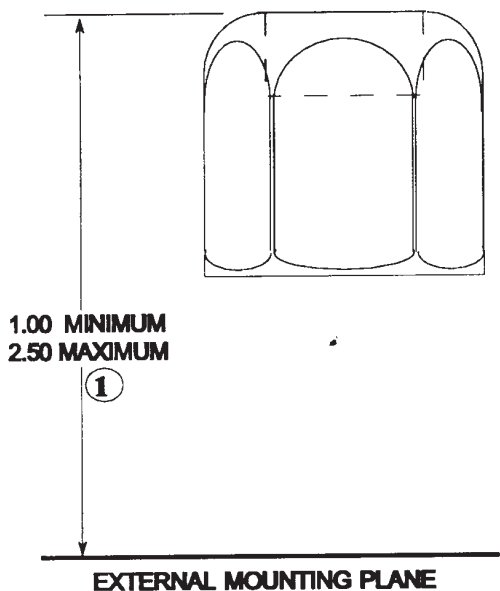
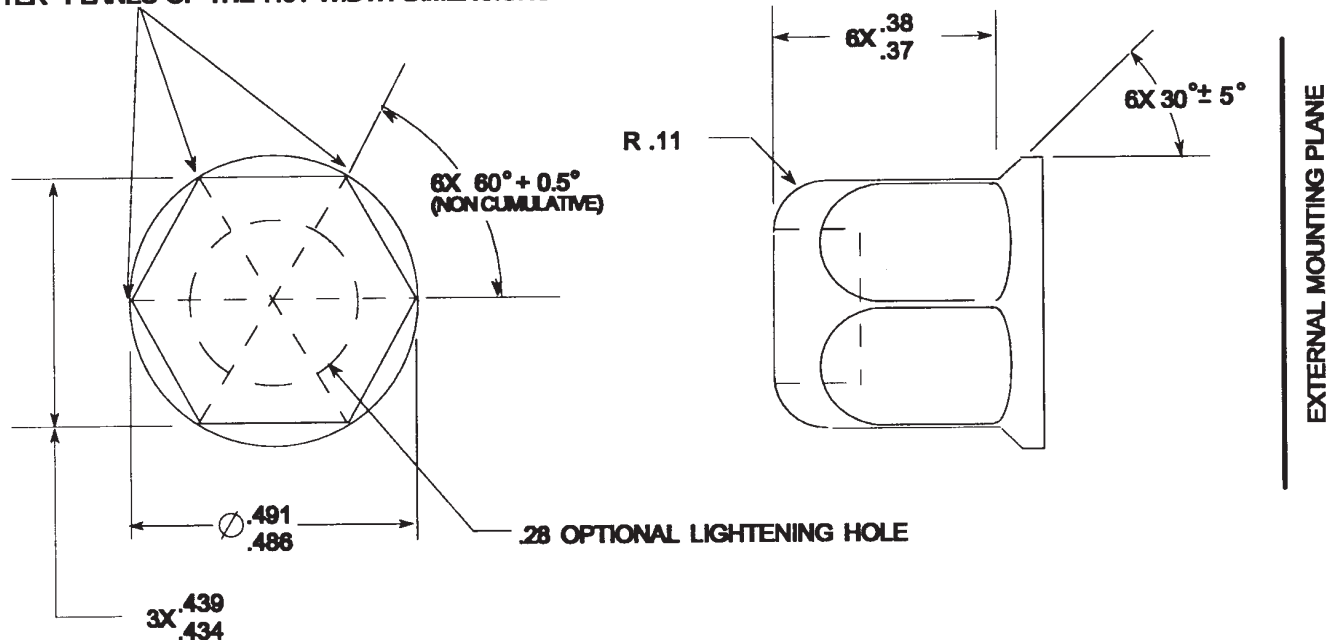
① RECOMMENDED DIMENSIONS .43 TO .45

② RECOMMENDED DIMENSIONS .37 TO .38

TOLERANCES ARE USER DEFINED EXCEPT WHERE SHOWN

**FIGURE 3.1.4-2 ISS 7/16 IN. 12 POINT EXTRAVEHICULAR (EVA) COMPATIBLE BOLT**

CENTER PLANES OF THE .491 WIDTH DIMENSIONS



NOTES:

LINEAR DIMENSIONS

|      |        |
|------|--------|
| .X   | ± .02  |
| .XX  | ± .01  |
| .XXX | ± .005 |

ANGLES ± 1/2 °

RUNOUT .010 TIR

HOLES IN ACCORDANCE WITH 10387

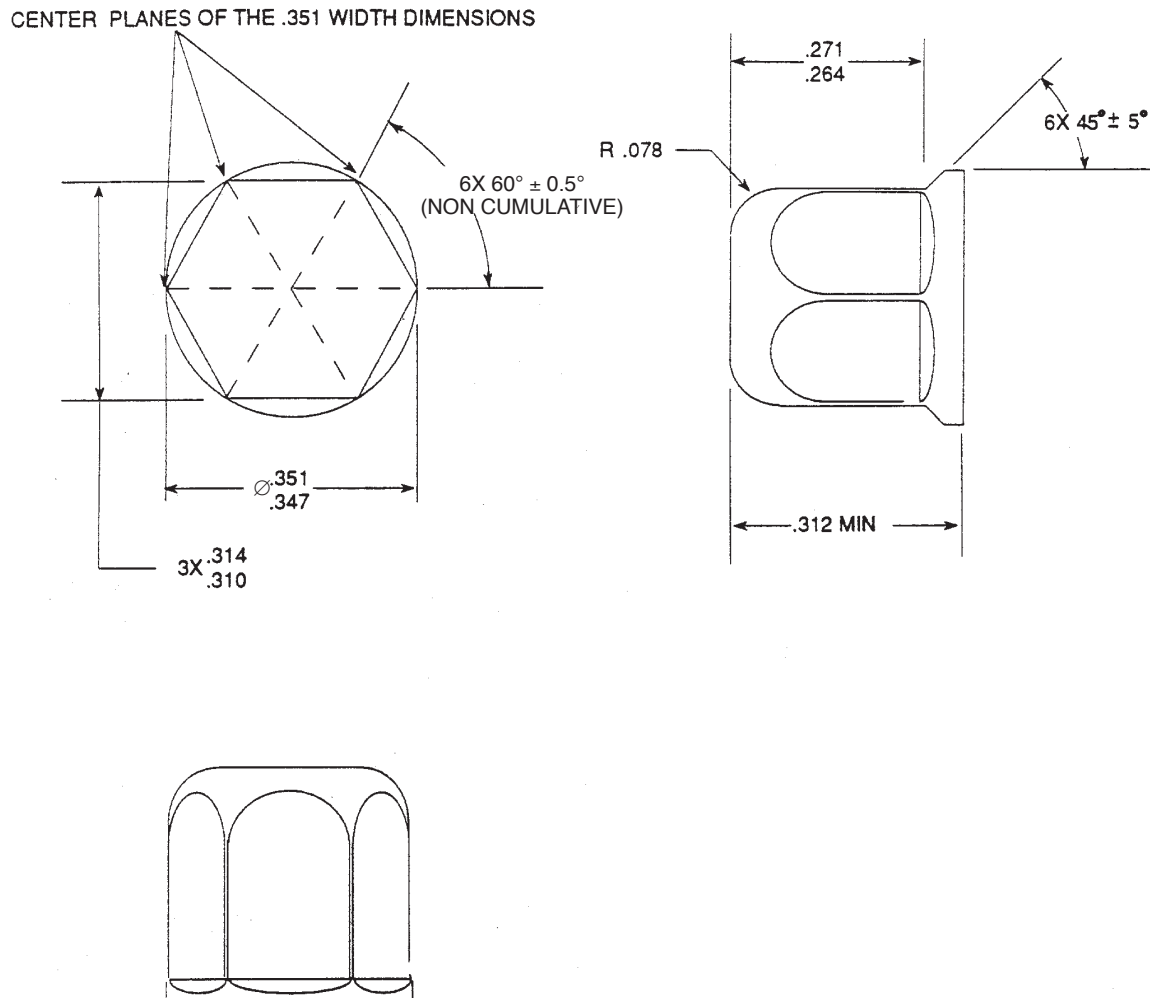
ALL DIMENSIONS IN INCHES

INTERNAL RADII .015

BREAK SHARP CORNERS .005 TO .015

① INCLUDES LIMITS ON BOLTHEAD TRAVEL

FIGURE 3.1.4-3 ISS 7/16 IN. HEXAGONAL ROBOTIC AND EXTRAVEHICULAR (EVA) COMPATIBLE BOLT; ROBOTIC BARE BOLT APPLICATIONS



## NOTES:

ALL DIMENSIONS IN INCHES

TOLERANCES ARE USER DEFINED EXCEPT WHERE SHOWN

FIGURE 3.1.4-4 ISS 5/16 IN. HEXAGONAL EXTRAVEHICULAR (EVA) COMPATIBLE BOLT

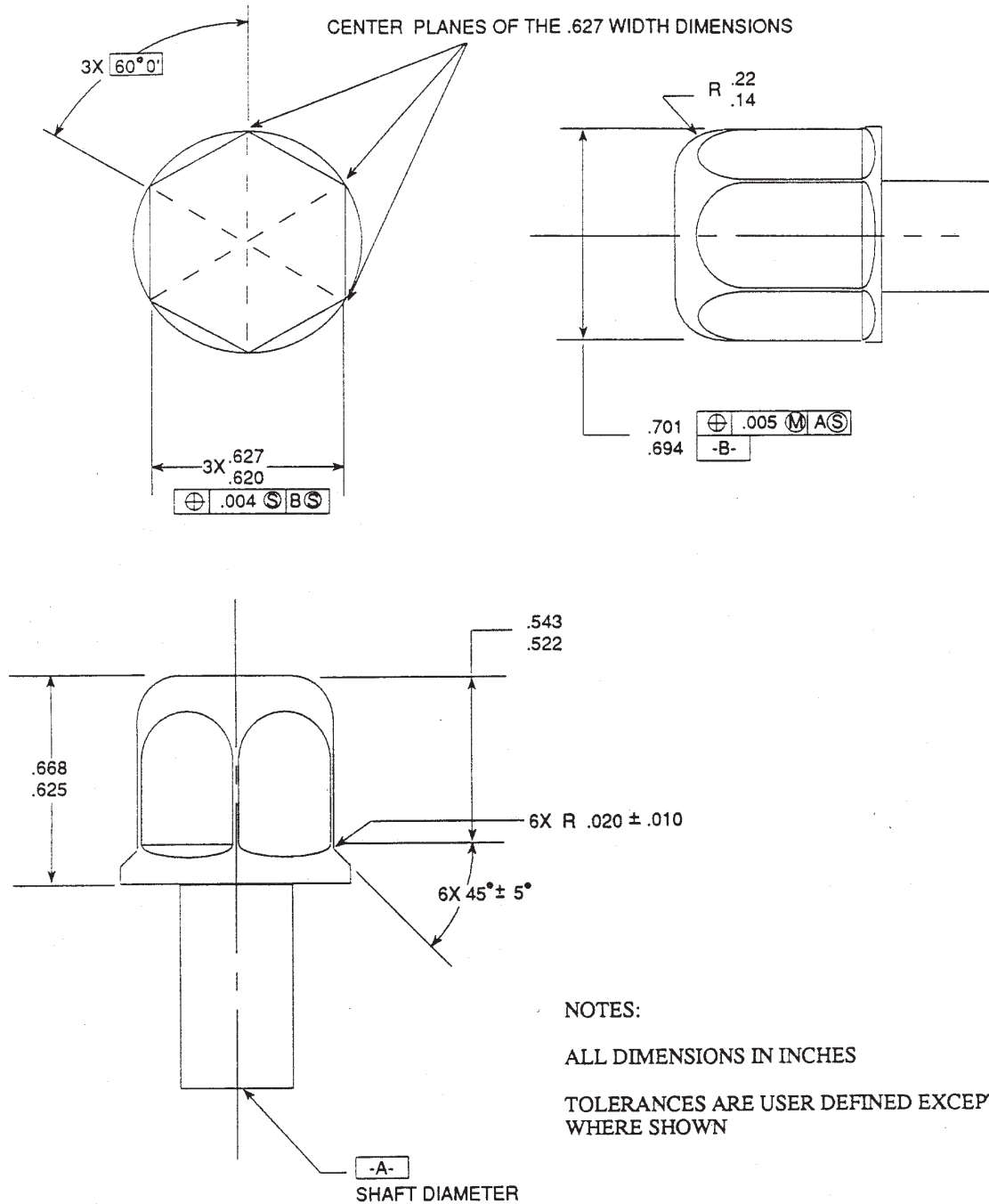


FIGURE 3.1.4-5 ISS 5/8 IN. HEXAGONAL EVA COMPATIBLE BOLT

### **3.1.5 ENVIRONMENTAL**

#### **3.1.5.1 NATURAL ENVIRONMENTS**

The EVA hardware covered in this ICD is in compliance with the requirements described in SSP 30425 for the natural environment (orbital density, composition, plasma, charged particles and electromagnetic radiation, meteoroids and space debris, magnetic and gravitational fields, thermal, pressure, and physical constants).

#### **3.1.5.2 INDUCED ENVIRONMENTS**

The induced environments are electromagnetic, electrostatic, vibration, acoustic, shock, linear and angular acceleration, pressure, low velocity impact, temperature, contamination, plasma, radiation, glow, plume impingement, forces and moments, and humidity. The EVA hardware covered in this ICD is in compliance with the requirements described in ICD-2-19001 for the NSTS environment. Design in the areas of plasma, charged particles, and electromagnetic radiation is consistent with SSP 30420, Space Station Electromagnetic, Ionizing Radiation, and Plasma Environment Definition and Requirements.

### **3.2 EVA GENERIC TOOLS AND CREW AIDS**

The EVA Generic Tools and Crew Aids to Space Station interfaces consists of envelope and mechanical interfaces. The tools and crew aids are stowed externally for use at both prepared and unprepared EVA worksites, and provide support for EVA crew tasks such as assembly, maintenance, servicing, and repair of the Space Station external elements and ORUs. The nominal tools and crew aids are listed in Table 3.2-1 and the contingency tools and crew aids are listed in Table 3.2-2. Descriptive, identification, and dimensional information on these tool and crew aids are included in Appendix B.

#### **3.2.1 PISTOL GRIP TOOL**

The Pistol Grip Tool provides controlled torque, in both forward and reverse directions, over a range from 0.5 to 25.5 ft-lbs (6 to 306 in-lbs). The Pistol Grip Tool has fourteen settings which can be programmed prior to an EVA sortie in increments of 0.1 ft-lbs (minimum).

##### **3.2.1.1 INTERFACE DESCRIPTION**

The Pistol Grip Tool interfaces mechanically with standard EVA bolt heads via standard EVA socket extensions (listed in Table 3.2-1) as shown in Figure 3.2.1.1-1.

**TABLE 3.2-1 EVA GENERIC TOOLS AND CREW AIDS – NOMINAL**

| DESCRIPTION  | DRAWING/<br>PART NUMBER |
|--|-------------------------|
| APFR Assy  | SEG33106857-301         |
| Battery Transfer Unit (BTU)                                | SEG33106329             |
| Large Trash Bag Assy                                       | SEG33106937             |
| Small Trash Bag Assy                                       | SEG33106678             |
| Battery, PGT   | GE1557025               |
| Right Angle Drive Assy – Bilateral Tools                   | SEG33106925             |
| Electronic Cuff Check List                                 | TBD                     |
| Battery, Elec Cuff Check List                              | TBD                     |
| Data Interface Box for ECC                                 | TBD                     |
| Light, Helmet Flood  | TBD                     |
| Battery, Helmet Lights                                     | TBD                     |
| Mini- Workstation – Bilateral Tool                         | TBD                     |
| Common D-Handle, OHTS                                      | SEG33107678             |
| MCF Scoop, OHTS  | SEG33107677             |
| Micro Scoop, OHTS  | SEG33106330             |
| Multi Use Tether Base Assy                                 | SEG33106869             |
| Handrail End Effector Assy – Multi Use Tether              | SEG33106890             |
| ORU Tether Assy  | SEG33108800             |
| Ball Stack Assy – Ball Stack                               | SEG33106870             |
| Orbital Replaceable Unit Transfer Device (OTD)             | SEG33106254-301         |
| Portable Foot Restraint Workstation Stanchion (PFRWS)      | SEG33106256-301         |
| Tool, Pistol Grip (PGT)                                    | GE1557000               |
| 3/8 in. Drive Ratchet Assy – Bilateral Tools               | SEG33106927             |
| Socket Extension Assy, Rigid, 5/16 X 7 – Bilateral Tools   | SEG33106928             |
| Socket Extension Assy, Rigid, 7/16 X 2 – Bilateral Tools   | SEG33106930             |
| Socket Extension Assy, Wobble, 7/16 X 6 – Bilateral Tools  | SEG33106931             |
| Socket Extension Assy, Wobble, 7/16 X 12 Bilateral Tools   | SEG33106932             |
| Socket Extension Assy, Wobble, 7/16 X 18 – Bilateral Tools | SEG33106933             |
| Socket Extension Assy, Rigid, 5/8 X 7.8 – Bilateral Tools  | SEG33106934             |
| Temporary Equipment Restraint Aid (TERA)                   | SEG33106255-301         |
| Adjustable Fuse Tether                                     | SED39127200             |



**TABLE 3.2-1 EVA GENERIC TOOLS AND CREW AIDS – NOMINAL (CONT'D)**

| DESCRIPTION  | DRAWING/PART NUMBER |
|--|---------------------|
| Adjustable Equipment Tether Assy – Bilateral Tools (Small/Small) | SEG33106945-301     |
| Adjustable Equipment Tether Assy – Bilateral Tools (Small/Large) | SEG33106945-303     |
| Adjustable Equipment Tether Assy – Bilateral Tools (Large/Large) | SEG33106945-305     |
| Safety Tether  | SEG33106674         |
| Retractable Equipment Tether 75                                  | SEG33106164         |
| Waist Tether Assy – Bilateral Tools (Small/Large)                | SEG33106943-301     |
| Drop Proof Tether IFM 3 Inch Adapter Assy – Bilateral Tools      | SEG33106947         |
| Torque Multiplier, Round (Micro Conical Fitting) – ISS           | SEG33106260         |
| Socket, 7/16, Flush – Round (MCF) Torque Multiplier              | SDG33107087-003     |
| Socket, 7/16, Proud – Round (MCF) Torque Multiplier              | SDG33107087-001     |
| Socket, 5/8, Proud – Round (MCF) Torque Multiplier               | SDG33107088-001     |
| Torque Multiplier, Square (Micro) – ISS                          | SEG33106261         |
| Socket, 7/16, Recessed – Square (Micro) Torque Multiplier        | SDG33107087-009     |
| Socket, 7/16, Flush – Square (Micro) Torque Multiplier           | SDG33107087-007     |
| Socket, 7/16, Proud – Square (Micro) Torque Multiplier           | SDG33107087-005     |
| 1/4 " X 1/2 " Allen Driver                                       | SED39120791         |
| 5/32 " Ball-end Driver Assy                                      | SEG33108851         |
| Heat Exchanger Nitrogen Vent Tool                                | 1F98590             |
| Heat Exchanger Vent Tool   | 1F98589             |
| Coldplate Vent Tool  | 1F98592             |
| Heat Exchanger Umbilical Vent Tool                               | 1F98596             |
| Radiator Beam Valve Module Vent Tool                             | 1F98597             |
| Pump Module Vent Tool  | 1F98593             |
| Flex Hose Rotary Coupler Vent Tool                               | 1F98591             |

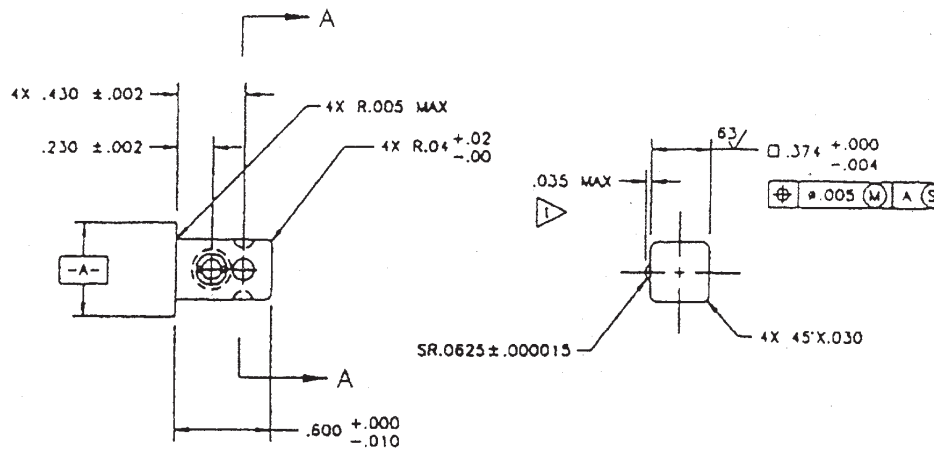
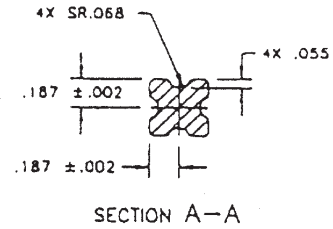
**TABLE 3.2-2 EVA GENERIC TOOLS AND CREW AIDS – CONTINGENCY**

| DESCRIPTION   | DRAWING/<br>PART NUMBER |
|---|-------------------------|
| Bolt Puller Assy – Bilateral Tools                  | SEG33106912             |
| Pin Straightner Assy – Bilateral Tools              | SEG33106913             |
| Compound Cutter                                     | SED33104404             |
| General Purpose Cutter                              | SEG33106915             |
| Forceps Assy – Bilateral Tools                      | SEG33106916             |
| Hammer Assy – Bilateral Tools                       | SEG33106917             |
| Hydrazine Brush Assy – Bilateral Tools              | SEG33106935             |
| Hydrazine Draeger Tube                              | TBD                     |
| Mechanical Finger Assy – Bilateral Tools            | SEG33106918             |
| Payload Retention Device                            | SEG33109242             |
| Needle Nose Pliers – Bilateral Tools                | SEG33106921             |
| Vise Grips Assy – Bilateral Tools                   | SEG33106922             |
| Probe Assy – Bilateral Tools                        | SEG33106923             |
| Pry Bar Assy – Bilateral Tools                      | SEG33106924             |
| Cheater Bar Assy – Bilateral Tools                  | SEG33106926             |
| EVA Scissors Assy – EVA Support Equipment           | SED33105525             |
| Socket Extension, Wobble, 1/2 X 8 – Bilateral Tools | SEG33108423             |
| Adjustable Wrench Assy – Bilateral Tools            | SEG33106911             |
| Torque Wrench Assy – Bilateral Tools                | SEG33106948             |
| Socket Caddy Assy – Bilateral Tools                 | SEG33106938             |
| Tool Caddy Assy – Bilateral Tools                   | SEG33106936             |
| Velcro/Tape Caddy                                   | SEG33106941             |
| Rigid Repair Patch Clamp Set                        | 683-33583               |
| 1/4" Fluid Line Anchor Patch                        | 1F98521                 |
| 3/8" Fluid Line Anchor Patch                        | 1F98568                 |
| 1/2" Fluid Line Anchor Patch                        | 1F98569                 |
| 3/4" Fluid Line Anchor Patch                        | 1F98528                 |
| 1" Fluid Line Anchor Patch                          | 1F98570                 |
| 1 1/2" Fluid Line Anchor Patch                      | 1F98533                 |
| Anchor Patch Torque Tool                            | 1F98537                 |
| Fluid Line Snare                                    | 1F98454                 |
| Snare Support Wedge                                 | 1F98553                 |

TOLERANCES, UNLESS OTHERWISE NOTED:

.X ±.1  
 .XX ±.02  
 .XXX ±.005

ANGLES ±1°



3/8" MALE DRIVE

FLAG NOTE:


 ADJUST BALL DETENT AS REQUIRED TO MEET SOFT DOCK FORCE OF .5 TO 2.5 LBS.

FIGURE 3.2.1.1-1 PISTOL GRIP TOOL TO EVA SOCKET EXTENSION INTERFACE

### 3.2.1.2 ENVELOPE

The maximum envelope of the Pistol Grip Tool, including battery, is 14.05 in. x 15.18 in. x 4.03 in. Figure 3.2.1.2-1 depicts the Pistol Grip Tool envelope.

### 3.2.1.3 MASS PROPERTIES

The maximum weight of the Pistol Grip Tool is 10.0 lbs. Maximum operating weight with battery is 13.5 lbs.

### 3.2.1.4 TORQUE TOLERANCE

The maximum Pistol Grip Tool torque tolerance will be  $\pm 15\%$  for torque settings up to and including 90 in-lbs and  $\pm 10\%$  for torque settings greater than 90 in-lbs.

## 3.2.2 RESERVED

### 3.2.3 TORQUE MULTIPLIER

The Torque Multiplier (TM) provides for higher torques than can be produced by the EVA power tool or the EVA ratchet wrench. There are two types of TMs. One interfaces and transfers reaction torque to an ORU or the Space Station structure through a reaction feature compatible with cylindrical Microconical fittings (MCF) and the other interfaces with the square Micro fitting (Micro). Each TM has a set of changeable 12 point sockets to accommodate the various height and size EVA compatible fasteners. The changeable sockets are stowed on an EVA tool board and use a drop proof replacement scheme requiring no additional tethering steps. The TMs are designed to provide a positive capture to the reaction fitting and then interface with the power tool or ratchet wrench for the input torque. The right angle drive may also be used between the EVA power tool and the TM.

#### 3.2.3.1 INTERFACE DESCRIPTION

The TMs interface and transfer reaction torque to an ORU or to the Space Station structure through a reaction feature compatible with the MCF and Micro robotic interfaces. The TMs provide a torque ratio of 5:1 (output to input) with a tolerance of plus or minus 10%. The TMs interface with the standard EVA 3/8 in. drive ratchet wrench or the EVA power tool. They transmit torque equally in forward and reverse directions.

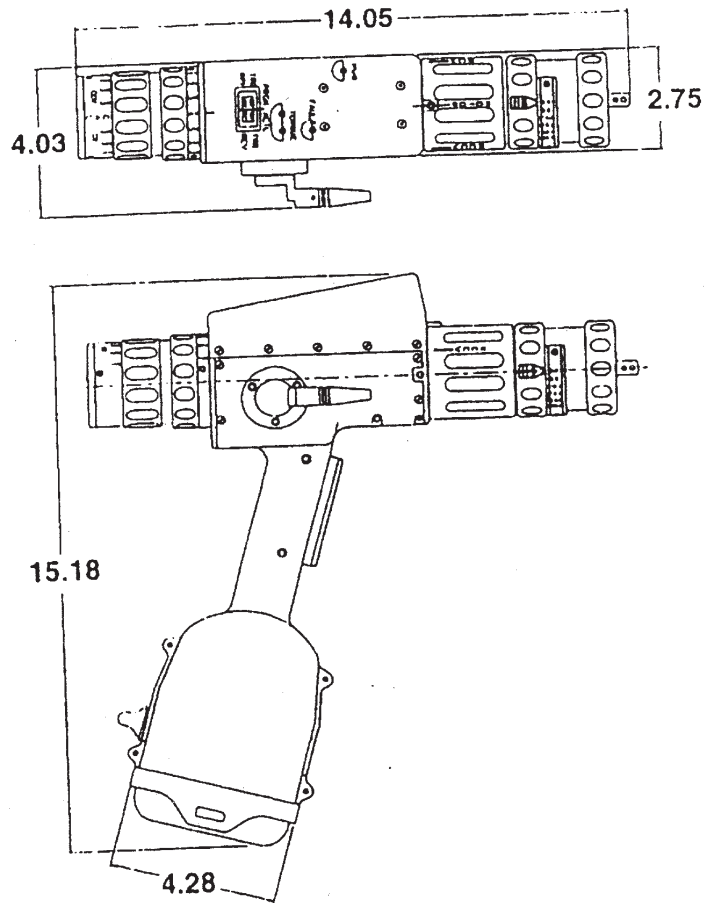


FIGURE 3.2.1.2-1 PISTOL GRIP TOOL ENVELOPE

Figures 3.2.3.1–1 through 3.2.3.1–3 show the Micro TM to bolt and torque reaction point interfaces. The Micro TM can accommodate 7/16 in. boltheads which are recessed below the top surface of the Micro interface under the specific conditions identified in Figure 3.2.3.1–1. Figure 3.2.3.1–2 defines the conditions for interfacing a Micro with a flush mounted EVA compatible bolt and Figure 3.2.3.1–3 the conditions for interfacing a Micro with a protruding EVA compatible bolt.

The MCF TM accommodates both flush and protruding 7/16 in. and protruding 5/8 in. boltheads with the MCF reaction interface as shown in Figures 3.2.3.1–4 through 3.2.3.1–6. The MCF TM cannot accommodate bolts which are recessed below the top surface of the MCF. Figures 3.2.3.1–4 and 3.2.3.1–5 show MCF TM to 7/16 in. bolthead and torque reaction point interfaces. Figure 3.2.3.1–6 shows the MCF TM to 5/8 in. bolthead and torque reaction point interfaces.

### 3.2.3.2 ENVELOPE

The envelope of the Micro TM is defined in Figure 3.2.3.2–1. The envelope can be oriented in four possible angular positions on the Micro fitting (aligned with the flats). The Micro TM has an overall length of 10.60 in. when fully extended (or bolt full out), and 9.06 in. when the torque reaction jaws are fully retracted.

The envelope of the MCF TM is defined in Figure 3.2.3.2–2. The envelope can be oriented in six possible angular positions on the MCF. The MCF TM has an overall length of 10.12 in. when fully extended (or bolt full out), and 8.84 in. when the torque reaction jaws are fully retracted.

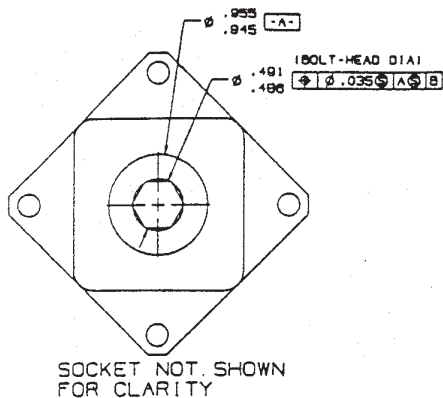
### 3.2.3.3 MASS PROPERTIES

The maximum weight of the MCF TM assembly, including three replaceable sockets and socket stowage receptacles, is 20 lbs. The maximum weight of the Micro TM assembly, including three replaceable sockets and socket stowage receptacles, is 20 lbs.

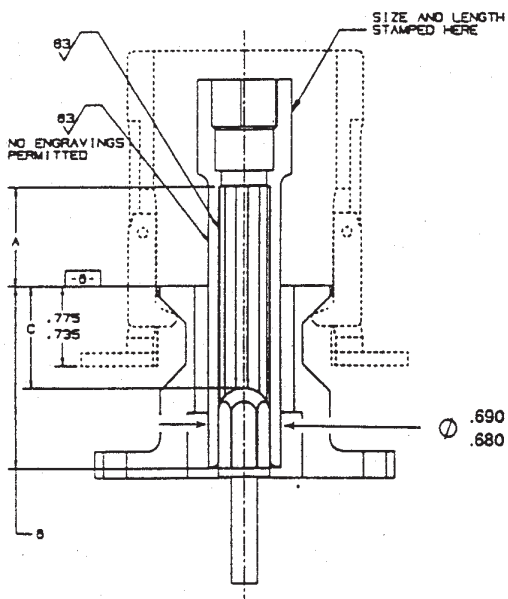
## 3.2.4 ORBITAL REPLACEABLE UNIT (ORU) HANDLING TOOL SYSTEM

### 3.2.4.1 INTERFACE DESCRIPTION

The ORU Handling Tool System is comprised of four tool configurations. The Microconical Scoop and Micro Scoop configurations have a single handle attached to the tool head. A D-handle can be attached to either Scoop configuration to permit handling of larger ORUs. The Scoop with attached D-handle is referred to as the combined Microconical or combined Micro tool. The tools will allow access for 7/16 in. sockets listed in Table 3.2.1.1–1 and provide alignment and positioning for sockets onto a 7/16 in. bolt. A protruding 5/8 in. standard bolthead mounted concentrically with an MCF or SPAR fitting will not obstruct the handling tool to fitting interface.



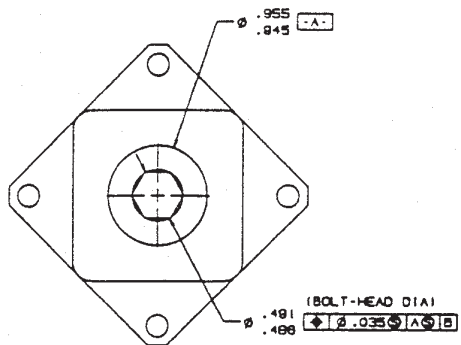
Micro installations that exceed the torque multiplier concentricity capability will require that use of an EVA socket and the torque wrench or the cheater bar to apply the required torque.



|   |                |  |
|---|----------------|--|
| A | .948           | MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)   |
| B | 1.789<br>1.689 | MAXIMUM TO ALLOW FULL .300 ENGAGEMENT OF SSP 30256 BOLT-HEAD<br>MINIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW) |
| C | 1.419          | MAXIMUM TO ALLOW FULL .300 ENGAGEMENT OF BOLT-HEAD   |

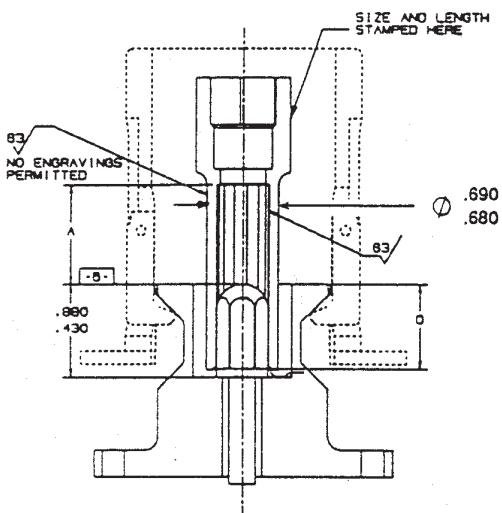
NOTE: VIOLATION OF NOTED LIMITS RESULTS IN A REDUCTION OF BOLT-TRAVEL BY AN AMOUNT EQUAL TO THE AMOUNT OF THE VIOLATION, I.E., A BOLT-HEAD .500 OUT OF THE LIMIT CAN ONLY BE DRIVEN .375 BY THE TM; A BOLT-HEAD .875 OUT OF THE LIMIT MUST NOT TRAVEL.

FIGURE 3.2.3.1-1 MICRO TORQUE MULTIPLIER TO MICRO INTERFACE – RECESSED BOLT HEADS



|   |              |  |
|---|--------------|--|
| A | .948         | MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)   |
| D | .900<br>.800 | MAXIMUM TO ALLOW FULL .300 ENGAGEMENT OF SSP 30256 BOLT-HEAD<br>MINIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW) |

NOTE: VIOLATION OF NOTED LIMITS RESULTS IN A REDUCTION OF BOLT-TRAVEL BY AN AMOUNT EQUAL TO THE AMOUNT OF THE VIOLATION, I.E., A BOLT-HEAD .500 OUT OF THE LIMIT CAN ONLY BE DRIVEN .375 BY THE TM; A BOLT-HEAD .875 OUT OF THE LIMIT MUST NOT TRAVEL.

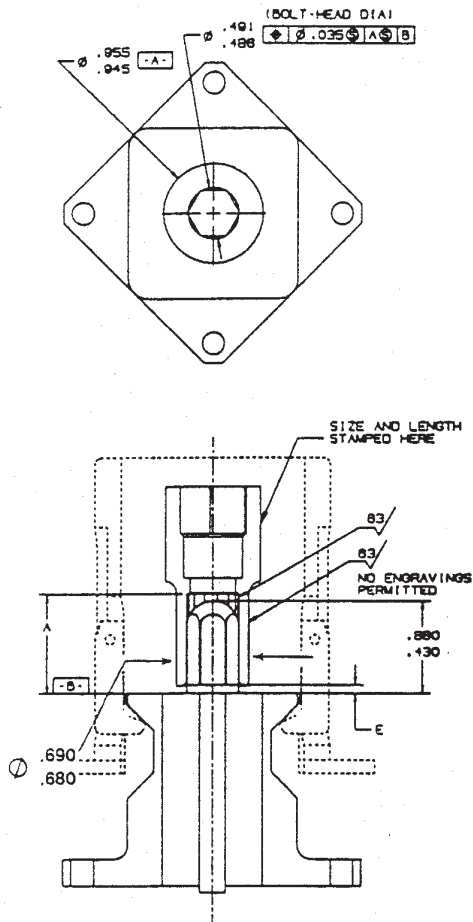


Micro installations that exceed the torque multiplier concentricity capability will require that use of an EVA socket and the torque wrench or the cheater bar to apply the required torque.

**FIGURE 3.2.3.1-2 MICRO TORQUE MULTIPLIER TO MICRO INTERFACE – FLUSH BOLT HEADS**



Micro installations that exceed the torque multiplier concentricity capability will require that use of an EVA socket and the torque wrench or the cheater bar to apply the required torque.

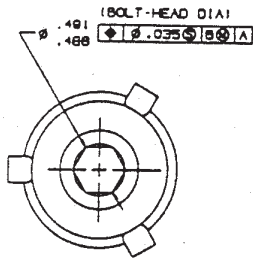


|   |              |  |
|---|--------------|--|
| A | .948         | MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)   |
| E | .080<br>.010 | MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)<br>MINIMUM TO ALLOW FULL .300 ENGAGEMENT OF SSP 30256 BOLT-HEAD |

NOTE: VIOLATION OF NOTED LIMITS RESULTS IN A REDUCTION OF BOLT-TRAVEL BY AN AMOUNT EQUAL TO THE AMOUNT OF THE VIOLATION, I.E., A BOLT-HEAD .500 OUT OF THE LIMIT CAN ONLY BE DRIVEN .375 BY THE TM; A BOLT-HEAD .875 OUT OF THE LIMIT MUST NOT TRAVEL.

**When bolt-head remains above the top surface of the micro fixture, the .950 diameter thru hole may be reduced.**

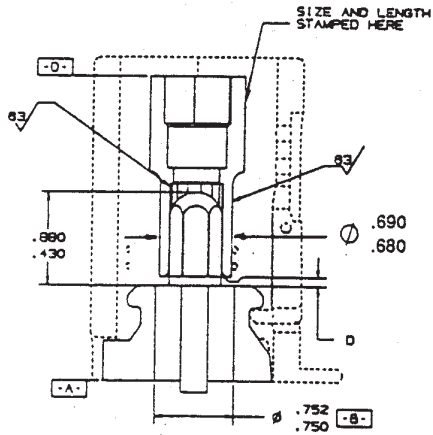
**FIGURE 3.2.3.1-3 MICRO TORQUE MULTIPLIER TO MICRO INTERFACE PROTRUDING BOLT HEADS**



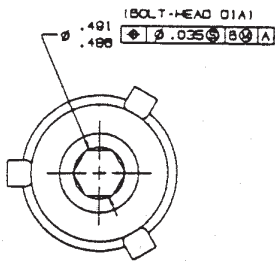
|   |      |  |
|---|------|--|
| D | .080 | MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)   |
|   | .000 | MINIMUM TO ALLOW FULL .300 ENGAGEMENT OF SSP 30256 BOLT-HEAD |

SOCKETS NOT SHOWN FOR CLARITY

NOTE: VIOLATION OF NOTED LIMITS RESULTS IN A REDUCTION OF BOLT-TRAVEL BY AN AMOUNT EQUAL TO THE AMOUNT OF THE VIOLATION, I.E., A BOLT-HEAD .500 OUT OF THE LIMIT CAN ONLY BE DRIVEN .375 BY THE TM; A BOLT-HEAD .875 OUT OF THE LIMIT MUST NOT TRAVEL.

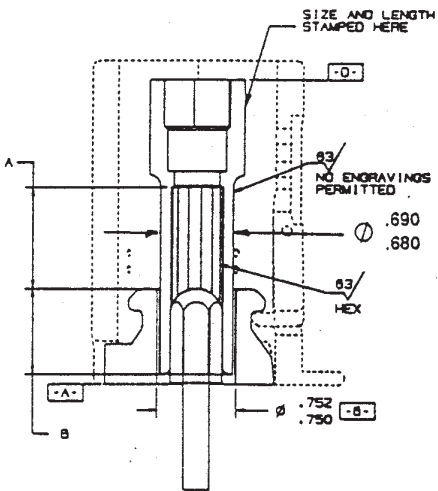


**FIGURE 3.2.3.1-4 MICROCONICAL TORQUE MULTIPLIER TO MICROCONICAL INTERFACE – PROTRUDING 7/16 BOLT HEADS**



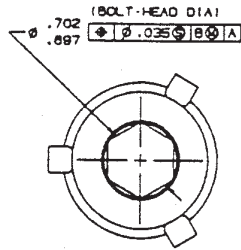
|   |              |  |
|---|--------------|--|
| A | .960         | MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)   |
| B | .830<br>.800 | MAXIMUM TO ALLOW FULL .300 ENGAGEMENT OF SSP 30256 BOLT-HEAD<br>MINIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW) |

NOTE: VIOLATION OF NOTED LIMITS RESULTS IN A REDUCTION OF BOLT-TRAVEL BY AN AMOUNT EQUAL TO THE AMOUNT OF THE VIOLATION, I.E., A BOLT-HEAD .500 OUT OF THE LIMIT CAN ONLY BE DRIVEN .375 BY THE TM; A BOLT-HEAD .875 OUT OF THE LIMIT MUST NOT TRAVEL.



FLUSH BOLT-HEAD  
 IN MICRO-CONICAL  
 INTERFACE

FIGURE 3.2.3.1-5 MICROCONICAL TORQUE MULTIPLIER TO MICROCONICAL INTERFACE – FLUSH 7/16 BOLT HEADS



|   |      |  |
|---|------|--|
| E | .125 | MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)   |
|   | .000 | MINIMUM TO ALLOW FULL .300 ENGAGEMENT OF SSP 30256 BOLT-HEAD |

NOTE: VIOLATION OF NOTED LIMITS RESULTS IN A REDUCTION OF BOLT-TRAVEL BY AN AMOUNT EQUAL TO THE AMOUNT OF THE VIOLATION, I.E., A BOLT-HEAD .500 OUT OF THE LIMIT CAN ONLY BE DRIVEN .375 BY THE TM; A BOLT-HEAD .875 OUT OF THE LIMIT MUST NOT TRAVEL.

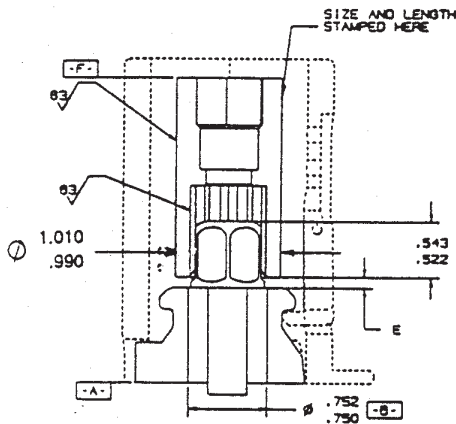


FIGURE 3.2.3.1-6 MICROCONICAL TORQUE MULTIPLIER TO MICRO INTERFACE – PROTRUDING 5/8 BOLT HEADS

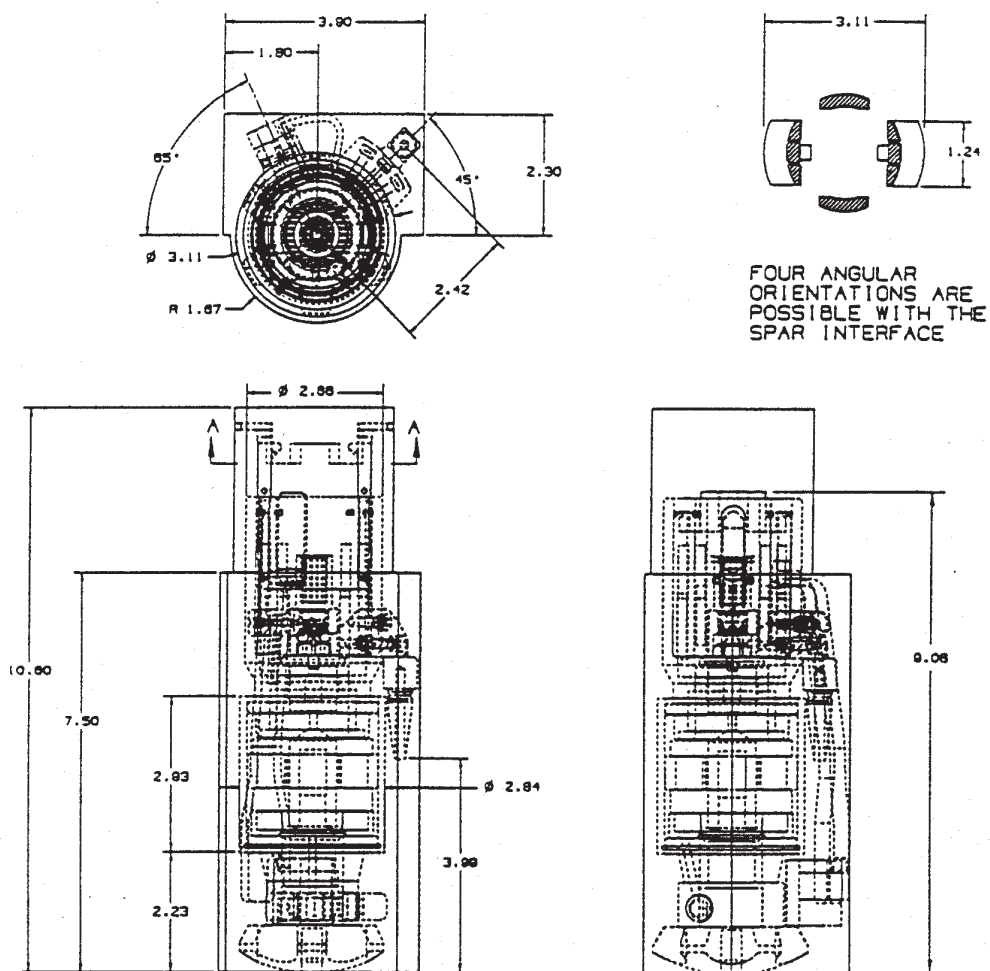


FIGURE 3.2.3.2-1 MICRO TORQUE MULTIPLIER ENVELOPE

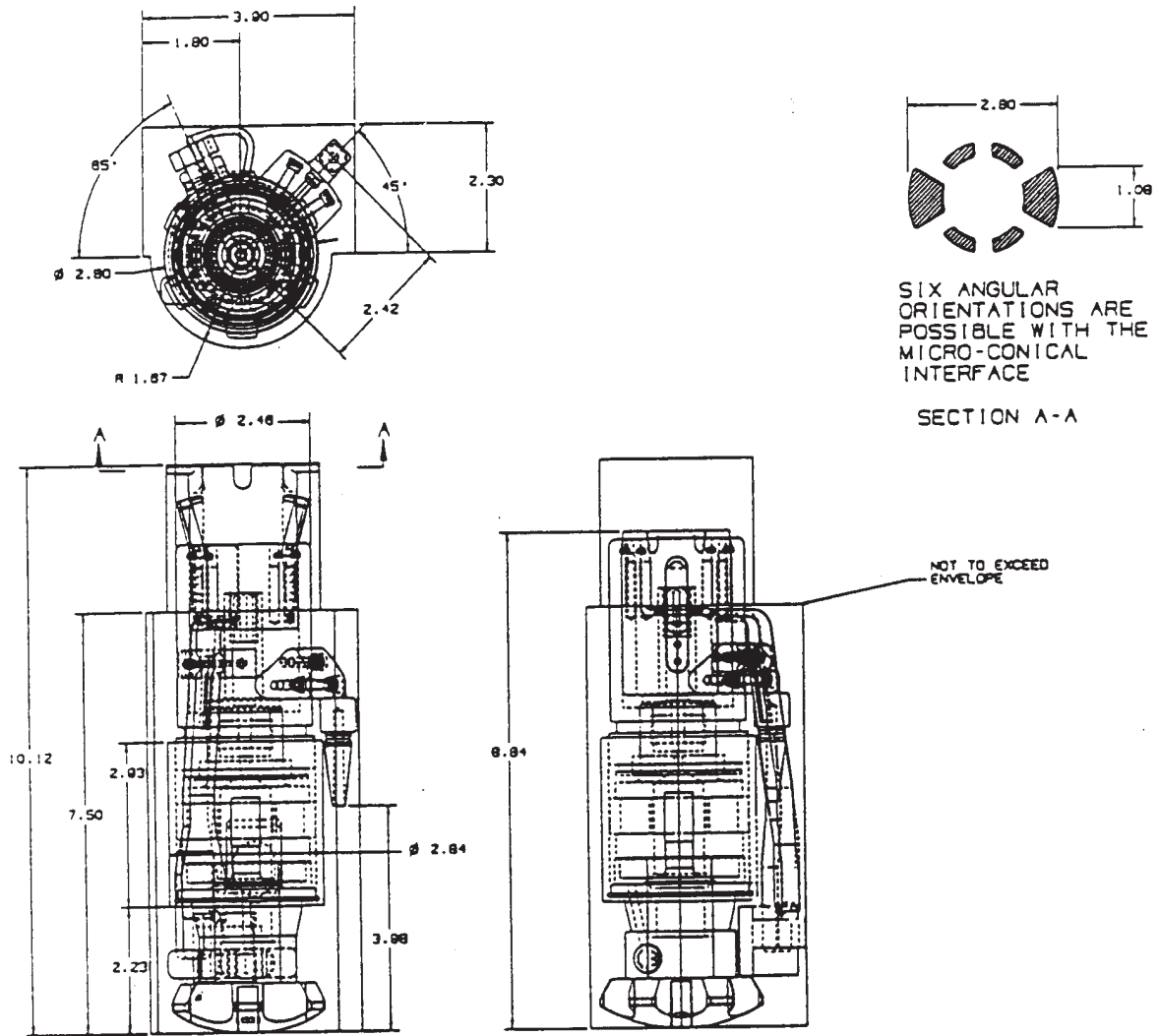


FIGURE 3.2.3.2-2 MICROCONICAL TORQUE MULTIPLIER ENVELOPE

### 3.2.4.2 ENVELOPE

Figures 3.2.4.2–1 and 3.2.4.2–2 show the tool and access envelope for the Microconical Scoop and Combined Microconical tool configurations. Figures 3.2.4.2–3 and 3.2.4.2–4 show the tool and access envelope for the Micro Scoop and Combined Micro tool configurations. Interface orientations for each envelope are included on the figures. Also shown on each figure are the criteria for tool envelope use for ORU masses and volumes as well as ORU moments of inertia about the interface.

### 3.2.4.3 MASS PROPERTIES

The maximum specification weight of the ORU Handling Tool System is 60 lbs.

### 3.2.4.4 LOADS

All ORU handling tool configurations with the Microconical and Micro fittings comply with the secondary translation path loads of 187 lbf.

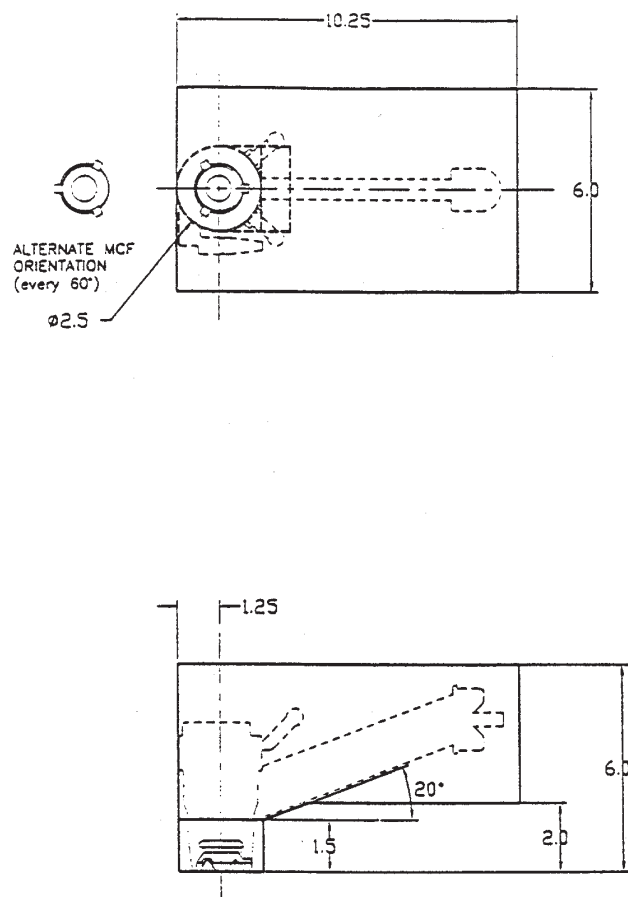
## 3.2.5 MICROCONICAL FITTINGS (MCF)

### 3.2.5.1 INTERFACE DESCRIPTION

External ISS ORUs that require a robotic interface will have MCFs (or SPAR fittings) mounted to them so that they can be handled by the Special Purpose Dexterous Manipulator using a tool. These same ORU mounted MCFs will be used by EVA crewmembers to grasp the ORUs with the MCT. This section describes the interface information for the MCFs, all of which are ground installed.

### 3.2.5.2 ENVELOPE

There are three MCF configurations. One unit has a 0.75 in. center hole and a flange base with four counterbored holes for cap screws for mounting. A second unit also has a 0.75 in. center hole, but no flange, and mounts to the ORU via six bolts screwed into the bottom of the fitting with the boltheads inside the ORU housing. The third unit is like the second except that the center hole is counterbored (stepped). The upper portion of the hole is 0.675 in. in diameter to a depth of 0.355 in. and the lower portion is 0.406 in. in diameter. Hardware envelope dimensions and footprints for the three configurations are shown in Figures 3.2.5.2–1 and 3.2.5.2–2. The MCF profile interface details are shown in Figure 3.2.5.2–3. Note that the 0006057 stepped hole unit is not depicted since the hole configuration does not affect the mounting interface. Figure 3.2.4.2–3 shows the clearance envelope around the MCFs necessary for an EVA crewmember to grasp the MCF with the MCT.



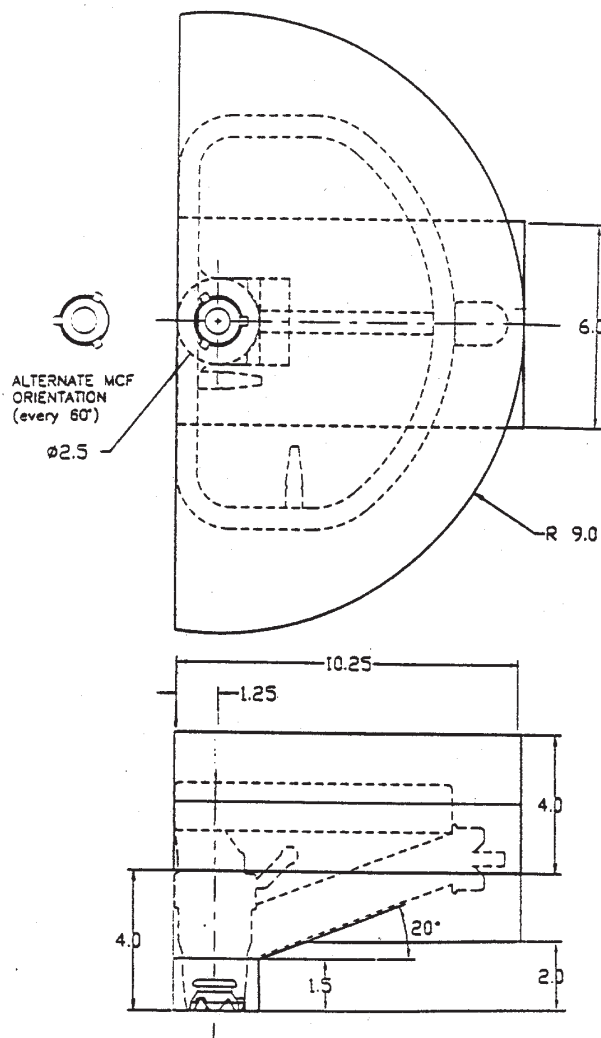
Use for CRUs :  
 < 150 lbs and 6 cu ft  
 and max. mass moment of inertia  
 about the primary handling interface  
 < 8.0 Slug ft<sup>2</sup>

**FIGURE 3.2.4.2-1 MICROCONICAL SCOOP ENVELOPE**



## TOLERANCES, UNLESS OTHERWISE NOTED

|             |      |        |
|-------------|------|--------|
| DIMENSIONAL | ..X  | ± .1   |
|             | .XX  | ± .02  |
|             | .XXX | ± .005 |
| ANGULAR:    | X°   | ± 3°   |
|             | X.X° | ± .5°  |



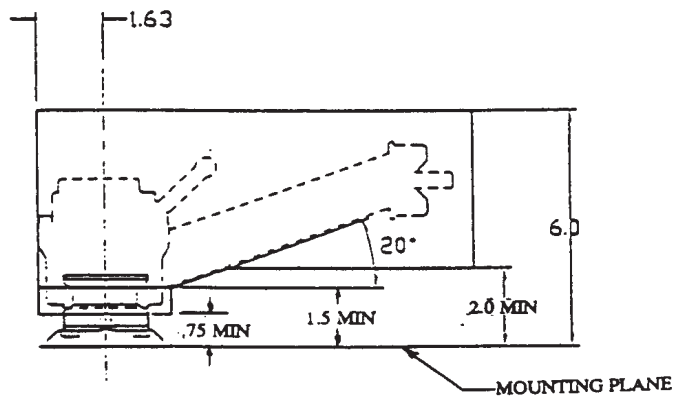
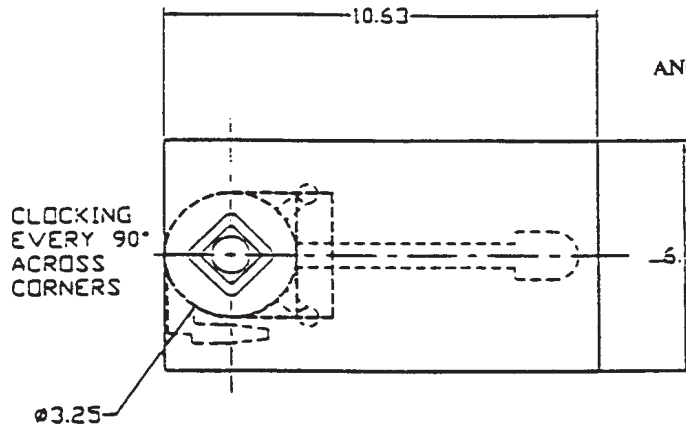
Use for □RU Volumes  
 > 150 lbs or 6 cu ft  
 or max. mass moment of inertia  
 about the primary handling interface  
 > 8.0 Slug ft<sup>2</sup>

**FIGURE 3.2.4.2-2 MICROCONICAL COMBINED TOOL ENVELOPE**

TOLERANCES, UNLESS OTHERWISE NOTED

|              |      |        |
|--------------|------|--------|
| DIMENSIONAL: | X    | ± .1   |
|              | .XX  | ± .02  |
|              | .XXX | ± .005 |

|          |      |       |
|----------|------|-------|
| ANGULAR: | X°   | ± 3°  |
|          | X.X° | ± .5° |

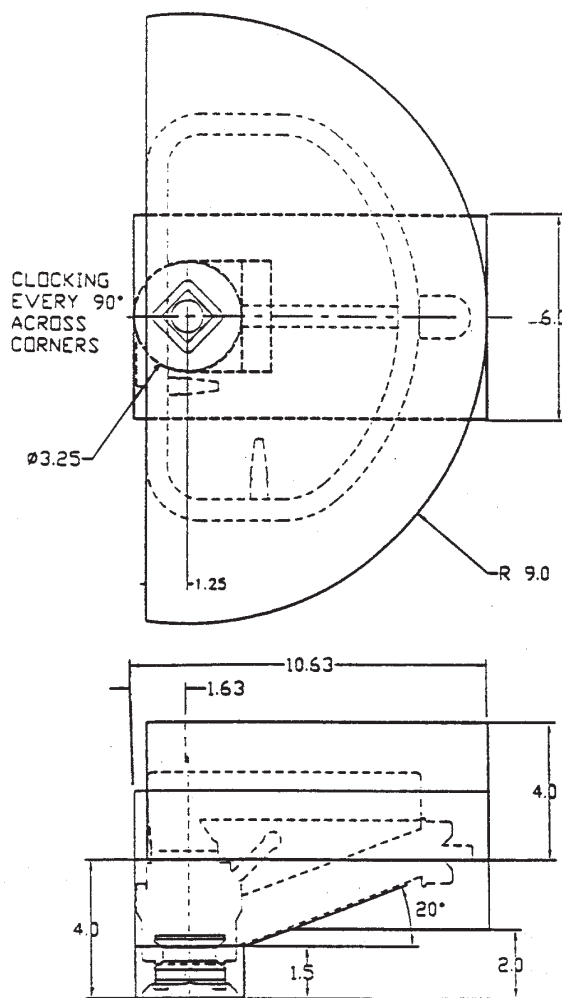


Use for CRUs :  
 < 150 lbs and 6 cu ft  
 and max. mass moment of inertia  
 about the primary handling interface  
 < 8.0 Slug ft<sup>2</sup>

**FIGURE 3.2.4.2-3 MICRO SCOOP ENVELOPE**

TOLERANCES, UNLESS OTHERWISE NOTED

|             |      |        |
|-------------|------|--------|
| DIMENSIONAL | ..X  | ± .1   |
|             | .XX  | ± .02  |
|             | .XXX | ± .005 |
| ANGULAR:    | X°   | ± 3°   |
|             | X.X° | ± .5°  |



Use for ORU Volumes  
 > 150 lbs or 6 cu ft  
 or max. mass moment of inertia  
 about the primary handling interface  
 > 8.0 Slug ft<sup>2</sup>

**FIGURE 3.2.4.2-4 MICRO COMBINED TOOL ENVELOPE**

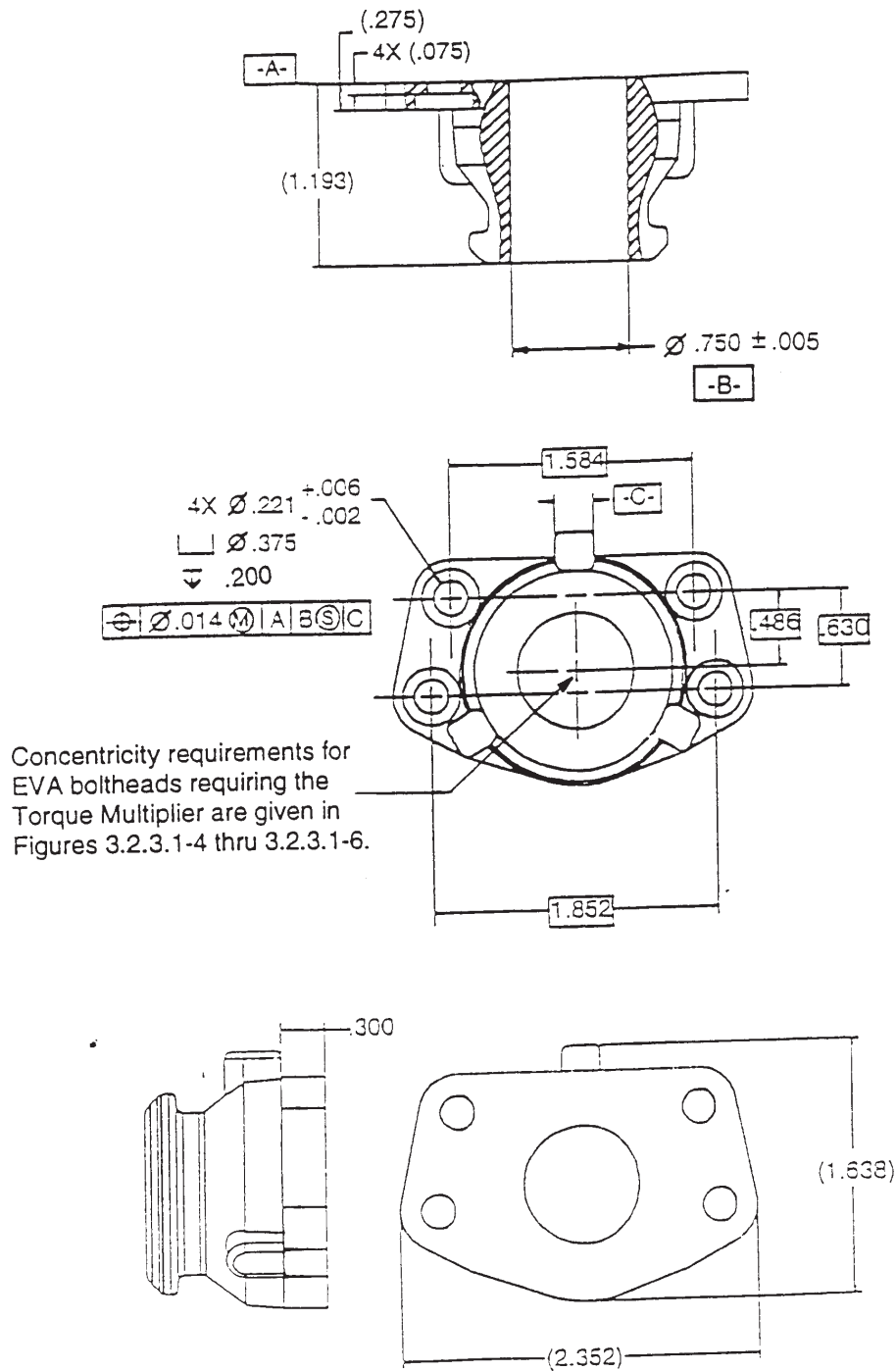


FIGURE 3.2.5.2-1 0006056 MICROCONICAL FITTING BOLTHOLE PATTERN AND FOOTPRINT

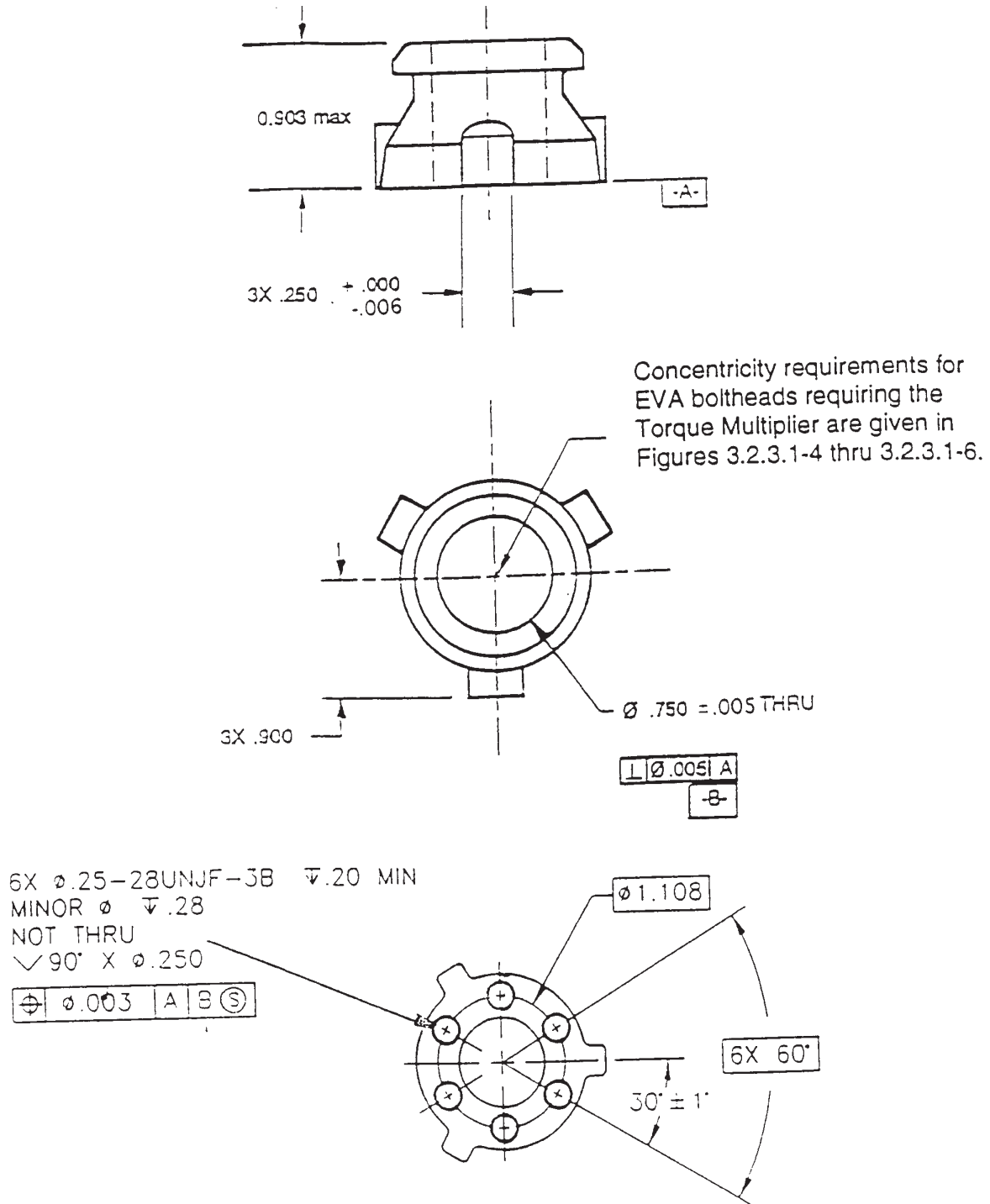


FIGURE 3.2.5.2-2 0006055 AND 0006057 MICROCONICAL FITTING BOLTHOLE PATTERN AND FOOTPRINT

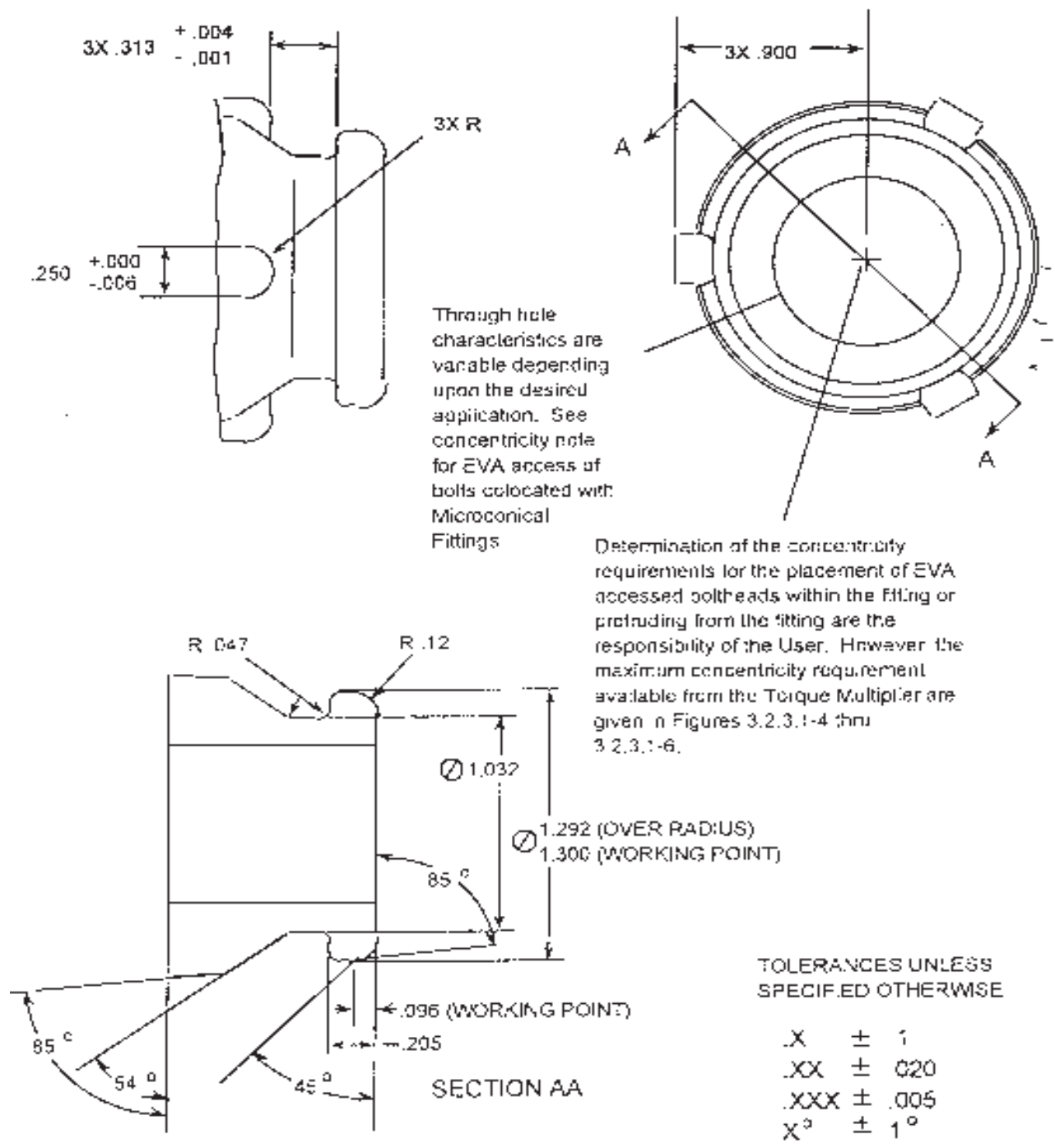


FIGURE 3.2.5.2-3 MICROCONICAL FITTING PROFILE INTERFACE

### **3.2.5.3 STRUCTURAL**

#### **3.2.5.3.1 LOADING**

The loading criteria for the 0006056 (flanged) MCF is that it must support a concentrated load of 50 lbs in any direction and a moment of 125 ft–lbs in any direction. The corresponding load and moment for the 0006055 and 0006057 MCFs are 500 lbs and 250 ft–lbs, respectively.

#### **3.2.5.3.2 MASS PROPERTIES**

The maximum weight of the 0006056 MCF is 0.45 lbs, the 0006055 MCF is 0.25 lbs, and the 0006057 MCF is 0.31 lbs. The center of mass of all three configurations is at the centroid.

### **3.2.5.4 MECHANICAL**

#### **3.2.5.4.1 MOUNTING AND INSTALLATIONS**

The MCF mounting bolthole pattern dimensions are shown in Figure 3.2.5.2–1 for the 0006056 configuration and in Figure 3.2.5.2–2 for the 0006055 and 0006057 configurations. Users of these MCFs should apply these patterns to their ORUs for the purpose of pre–drilling holes to install the MCFs.

The concentricity tolerance (the maximum allowable offset) for a 7/16 in. flush or protruding bolthead mounted through the MCF and applied over the bolt travel distance of 0.875 in. is defined in Figures 3.2.3.1–4 and 3.2.3.1–5. The tolerance for a 5/8 in. protruding bolthead applied over a travel distance of 0.875 in. is defined in Figure 3.2.3.1–6.

#### **3.2.5.4.2 SURFACE FINISH**

The MCFs meet the finish requirements found in SSP 30233, Space Station Requirements for Materials and Processes.

#### **3.2.5.4.3 LOCATION AND ORIENTATION**

The location of the MCFs on the ISS hardware is determined by the MCF user and is included on the assembly drawings for various user hardware items.

#### **3.2.5.4.4 FASTENERS**

The user will provide fasteners that are compatible with the material and finish for the MCFs, and will specify fastener engagement depth on the installation drawing for the 0006056

configuration. Bolt specifications for the 0006055 and 0006057 configurations are included on Figure 3.2.5.2–2.

#### **3.2.5.4.5 MATERIALS**

The MCF material is stainless steel and meets the requirements of SSP 30233, Space Station Requirements for Materials and Processes.

#### **3.2.5.5 THERMAL**

The MCF is designated an incidental contact EVA crew interface. Thermal control of this component is achieved by passive techniques.

#### **3.2.5.6 ELECTRICAL BONDING**

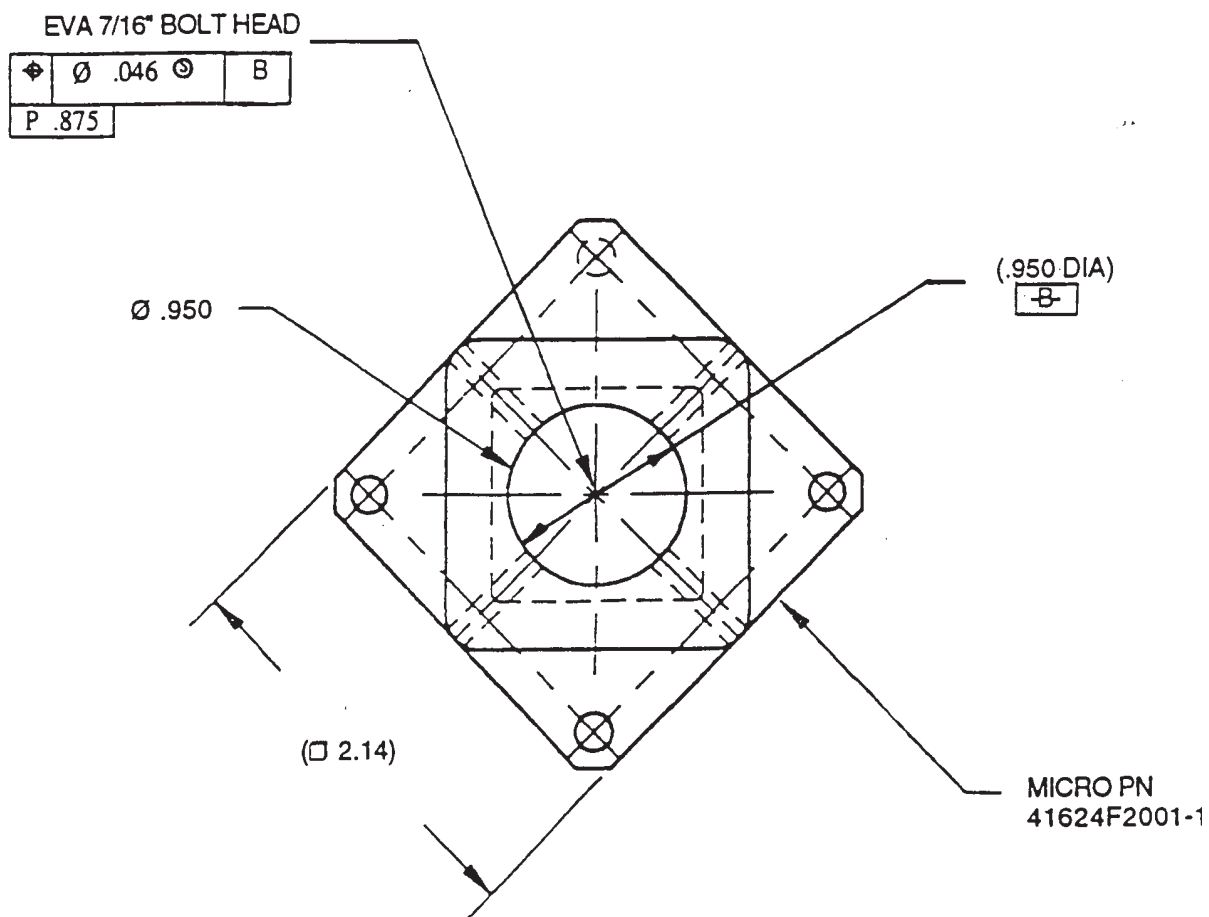
The MCF to user interface will satisfy a class S bond per SSP 30245, Space Station Electrical Bonding Specification, in its entirety.

### **3.2.6 SPAR MICRO FITTING**

Many external ISSA ORUs use the SPAR Micro fitting as the robotic interface instead of the MCF. The SPAR Micro EVA ORU Handling Tool and the Special Purpose Dexterous Manipulator tool will interface with the SPAR Micro for ORU handling. Design details of the SPAR Micro are contained in SSP 30550, Robotics Systems Integration Standards.

Figure 3.2.6–1 shows the SPAR Micro footprint, as well as the tolerance for EVA bolt concentricity within the 0.950 in. diameter center hole of the fitting.





NOTE: Refer to SSP 30550, Robotics Systems Integration Standards for design information.

FIGURE 3.2.6-1 MICRO FOOTPRINT AND EVA BOLT CONCENTRICITY TOLERANCE

### 3.3 PORTABLE WORK PLATFORM

The PWP is designed to attach to the SRMS or the SSRMS for use by an EVA crewmember to provide support for EVA crew tasks such as assembly, maintenance, servicing, and repair of Space Station external elements and ORUs at both prepared and unprepared EVA worksites. Figure 3.3–1 shows the PWP assembly.

The Portable Work Platform (PWP) to Space Station interfaces consist of envelope, structural, and mechanical interfaces. The PWP consists of three EVA equipment items, the Articulating Portable Foot Restraint (APFR), the Temporary Equipment Restraint Aid (TERA), and the Portable Foot Restraint Workstation Stanchion (PFRWS). The APFR and the TERA have functional or stowage interfaces to ISS elements. In addition, the PWP is restrained for launch by external interfaces with the TERA, APFR, and PFRWS. Launch interfaces are through launch restraints to Truss segment S0. On-orbit functional and stowage interfaces are via passive WIFs on the ISS elements. Individual sections are included in this ICD for each PWP EVA equipment item. The following paragraphs dictate the ICD requirements for a PWP only.

The PWP functionally interfaces with only one ISS element once on-orbit, the Mobile Remote Servicer Base System (MBS). This functional interface is required in that the MBS must provide an attachment interface and room for stowage of the PWP. The PWP attaches to the MBS by attaching the TERA to the passive WIF denoted as “P9” on the MBS as shown in Figure 3.3–2.

Figure 3.3–2 also shows the passive WIF mounting location, denoted as “P10”, required for stowing the PWP onto the MBS and onto the SSRMS. The passive WIF “P10” shall have a dedicated APFR stowed on it to facilitate the EVA removal and installation of the PWP into its stowage location.

Figure 3.3–3 shows the installation and removal envelope necessary to install the PWP onto a passive WIF “P9” via the TERA.

#### 3.3.1 ARTICULATING PORTABLE FOOT RESTRAINT

The APFR provides an EVA crewmember with a stable work platform to facilitate assembly, maintenance, servicing and repair tasks of Space Station external elements and ORUs at planned worksites, and at unplanned worksites when attached to the SRMS or the SSRMS via the Temporary Equipment Restraint Aid (TERA). The APFR can be adjusted from  $-90^\circ$  (foot platform toward the worksite interface) to  $+90^\circ$  prior to ingress. The APFR can be operated in settings from  $-72^\circ$  to  $+90^\circ$  with the  $-90^\circ$  setting for storage and translation only. In addition, the EVA crewmember can articulate the foot platform  $\pm 90^\circ$  in roll and  $360^\circ$  in yaw without egressing the APFR. The APFR also has a load limiter to limit maximum crew induced forces and bending moments at the GFE worksite interface to structure attachment interface. The Figure 3.3.1–1 shows the APFR.

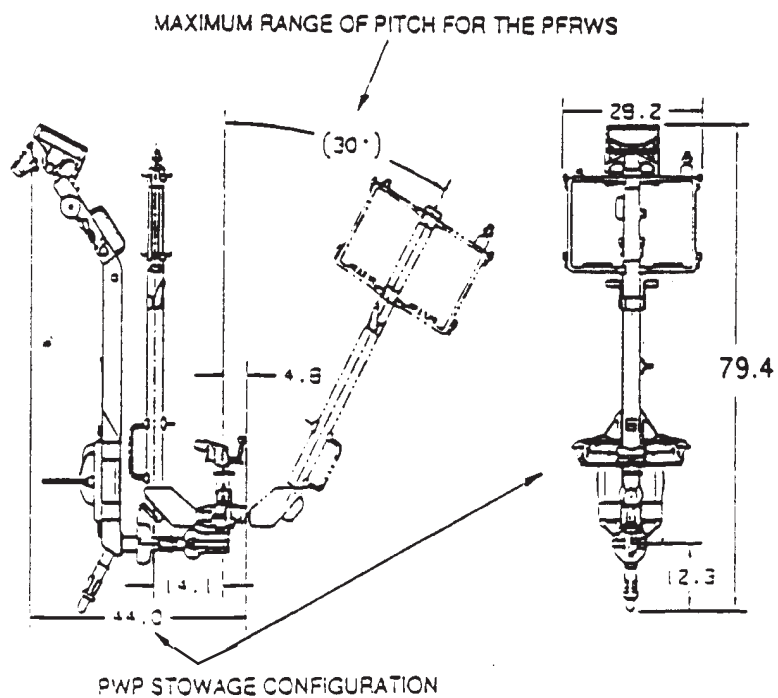
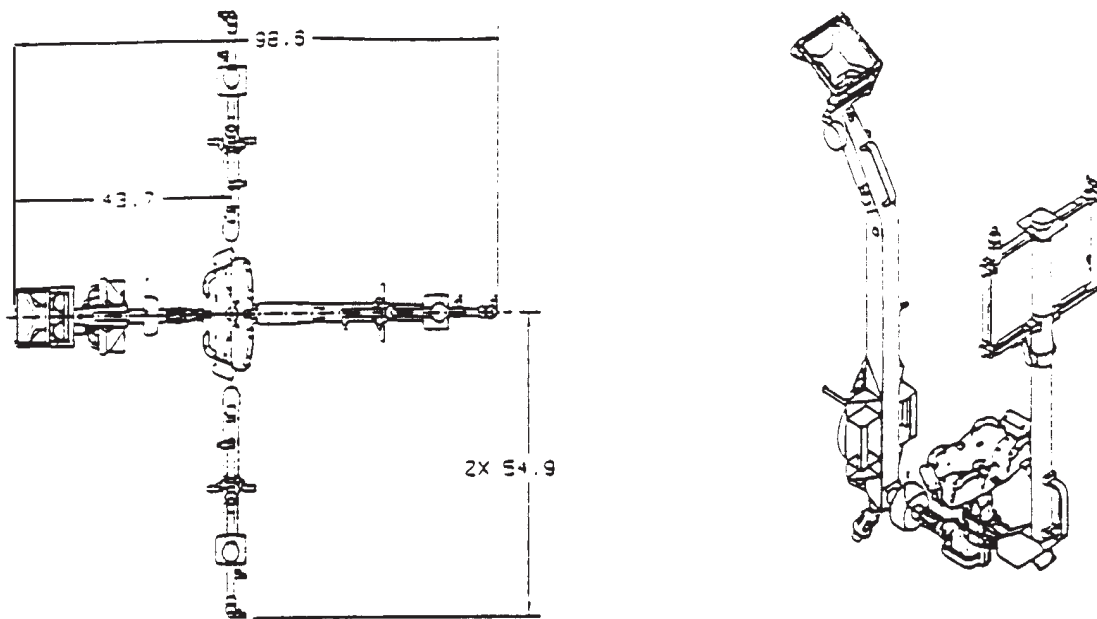


FIGURE 3.3-1 PORTABLE WORK PLATFORM (PWP) ASSEMBLY

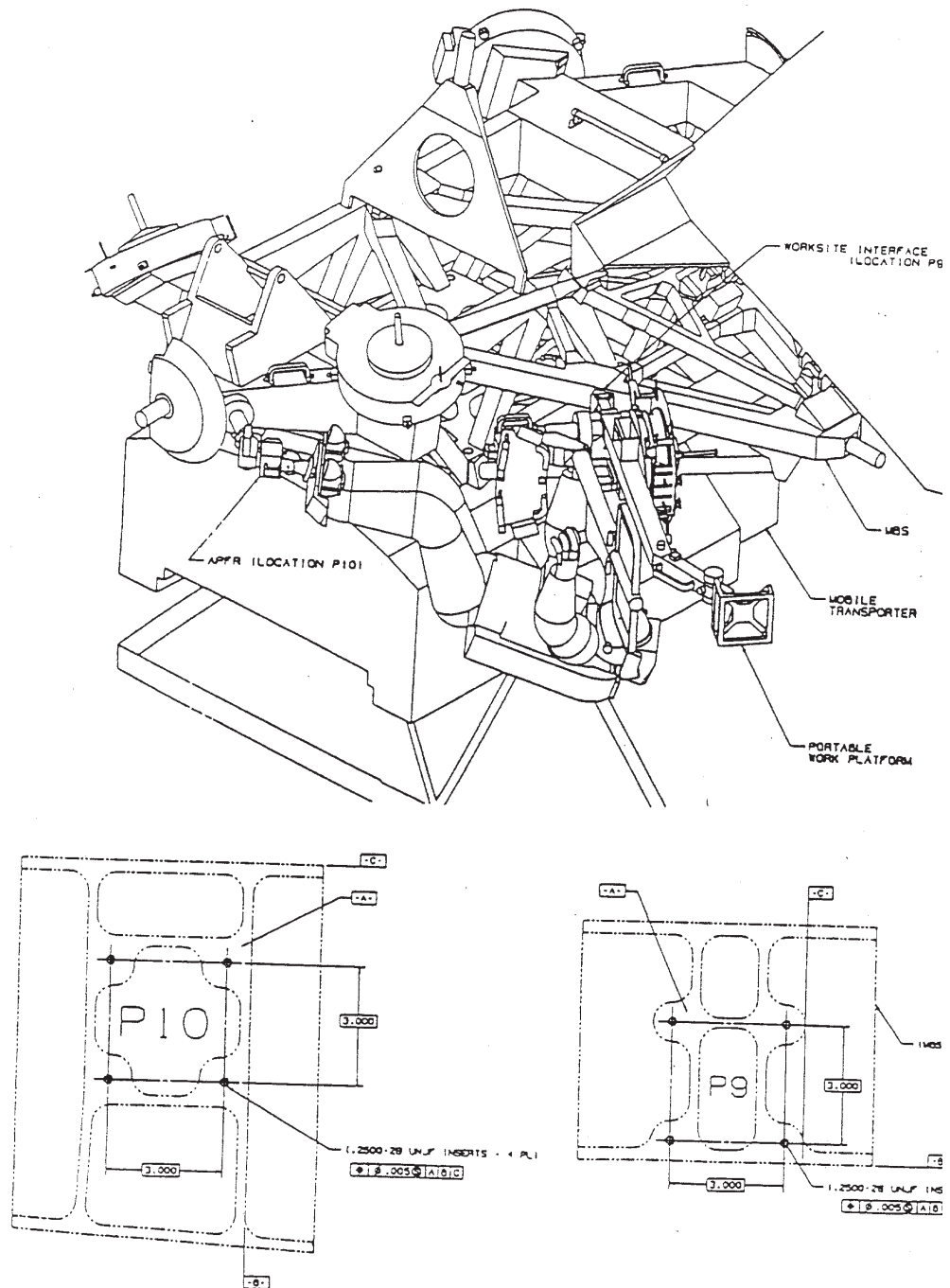
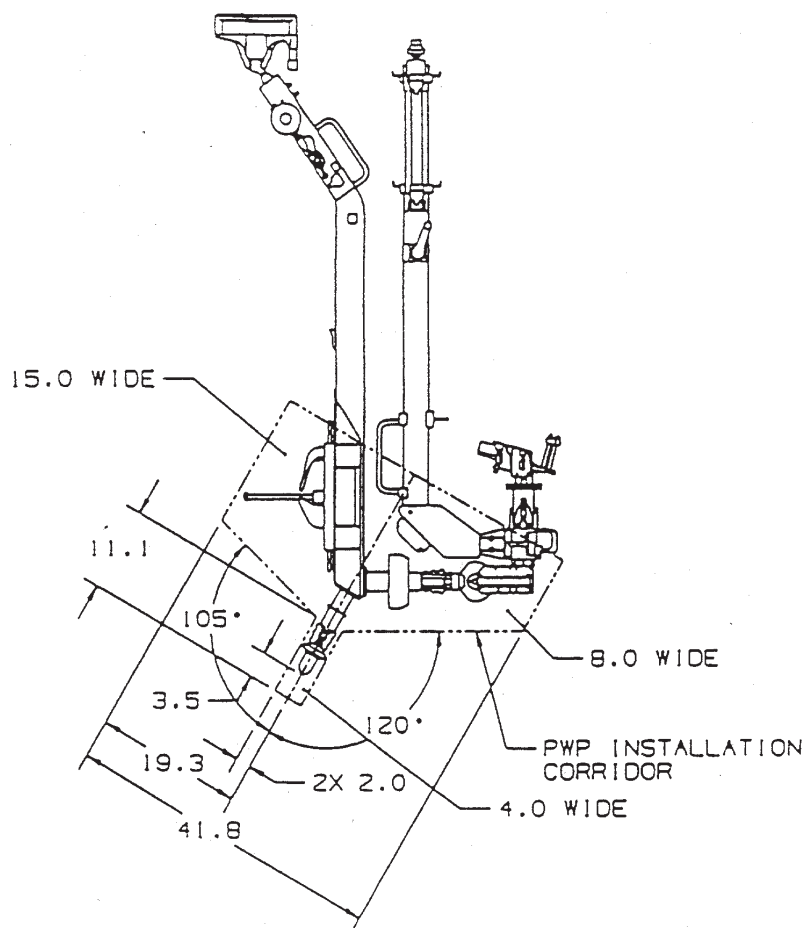


FIGURE 3.3-2 PORTABLE WORK PLATFORM (PWP) STOWED ON MBS



**FIGURE 3.3-3 INSTALLATION AND REMOVAL ENVELOPE FOR THE PORTABLE WORK PLATFORM (PWP) ON THE MBS**

### **3.3.1.1 INTERFACE DESCRIPTION**

The APFR physically interfaces with the Space Station external elements at various planned worksites to provide EVA crewmembers with positive, stable restraint for EVA tasks and on-orbit stowage and with the Spacelab Pallet and Z1 Truss Segment flight support equipment for launch. The APFR interface to prepared worksites is via GFE WIFs. The WIF is comprised of an active probe on the APFR and a passive socket (see section 3.6.4) installed at the various worksites. The APFR launch attachment points and center of gravity (CG) are shown in Figure 3.3.1.1-1 through Figure 3.3.1.1-3.

### **3.3.1.2 ENVELOPE**

The maximum stowage dimensions for the APFR are 25 in. x 25 in. x 30 in. Figure 3.3.1.2-1 shows the APFR configured into its minimum stowage volume. Figures 3.6.4.2.2-1 through 3.6.4.2.2-3 define the EVA clearance envelope around the WIF necessary for a crewmember to install and remove the APFR.

### **3.3.1.3 STRUCTURAL**

#### **3.3.1.3.1 LOADING**

See Table 3.1.3-1 for crew induced loads on the APFR.

#### **3.3.1.3.2 MASS PROPERTIES**

The maximum weight of the APFR with active worksite interface is 50 lbs.

#### **3.3.1.4 OPERATIONAL**

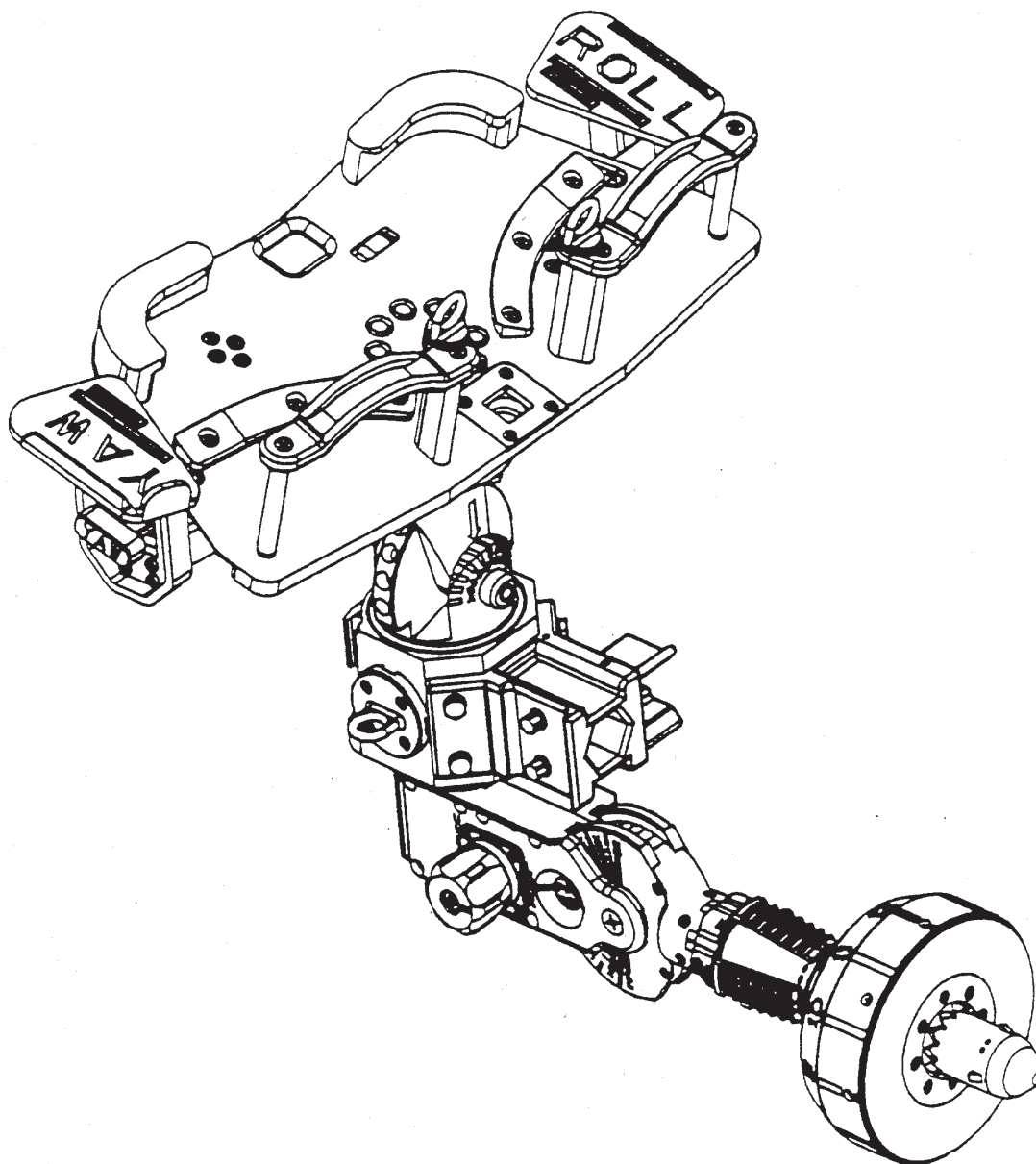
The APFR critical dimensions and yaw, pitch and roll positioning adjustments, for use in the placement of passive worksite interfaces, are shown in figures 3.3.1.4-1 through 3.3.1.4-5.

#### **3.3.1.5 THERMAL**

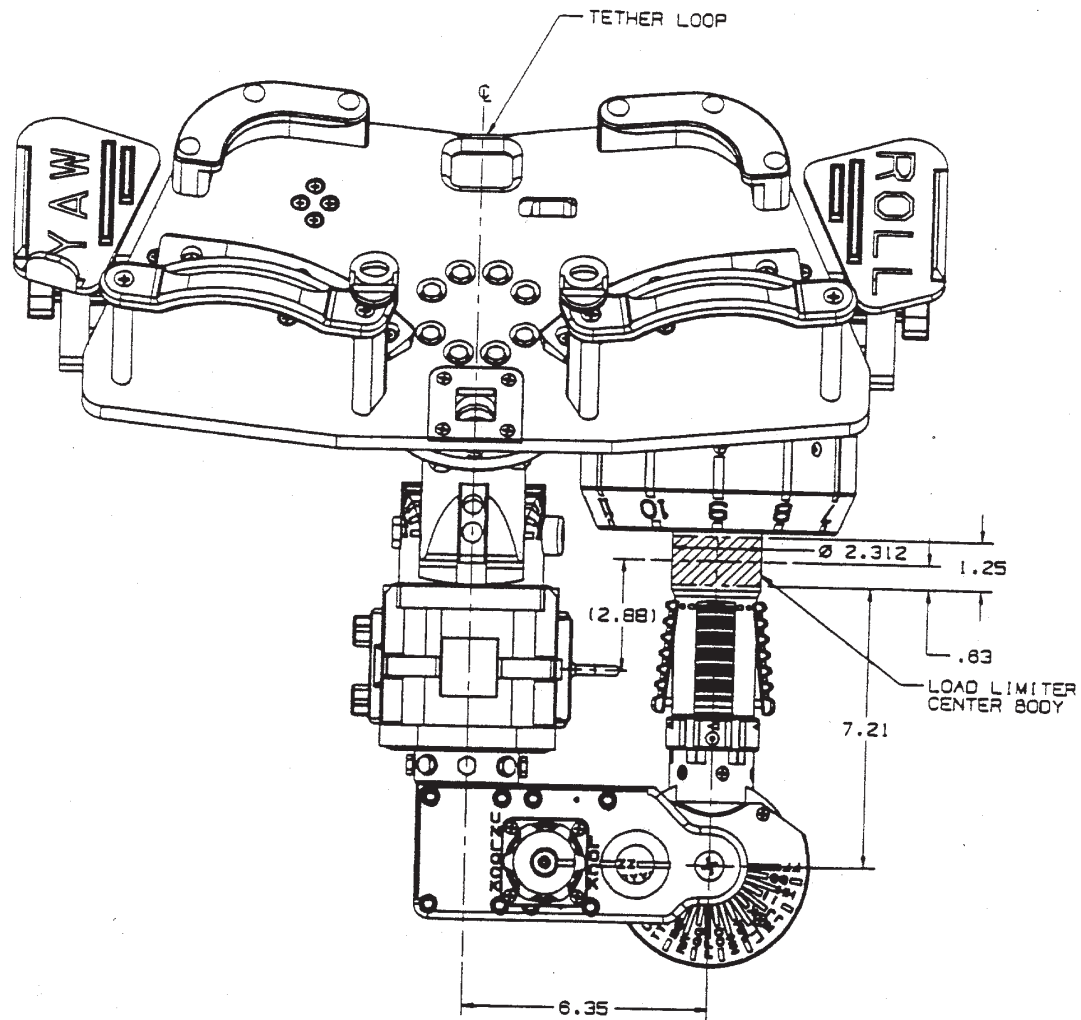
The APFR is designated as an “unlimited contact” EVA interface. Thermal control of this hardware is achieved by passive techniques.

#### **3.3.1.6 ELECTRICAL BONDING**

The APFR launch restraint contact surfaces, shown in Figure 3.3.1.1-1, will satisfy a Class S bond per SSP 30245, Space Station Electrical Bonding Specification, in its entirety.



**FIGURE 3.3.1-1 ARTICULATING PORTABLE FOOT RESTRAINT (APFR)**



All dimensions are  
toleranced as follows  
unless stated otherwise:  
.00 +/- .01  
.000 +/- .005  
angular +/- 1 degree

**FIGURE 3.3.1.1-1 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) LAUNCH RESTRAINT ATTACHMENT LOCATION - LOAD LIMITER CENTER BODY**



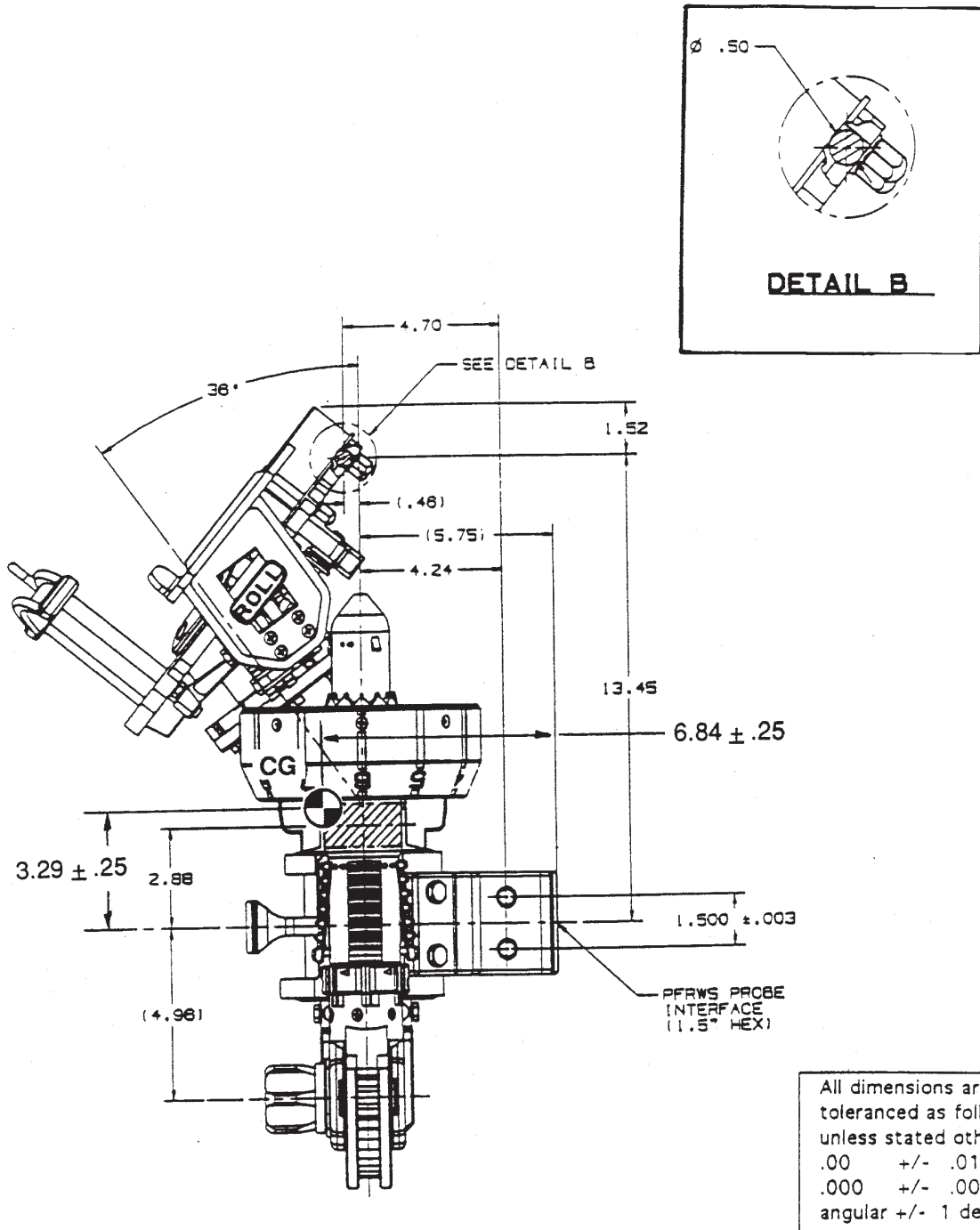


FIGURE 3.3.1.1-2 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) LAUNCH RESTRAINT LOCATION - TETHER LOOP

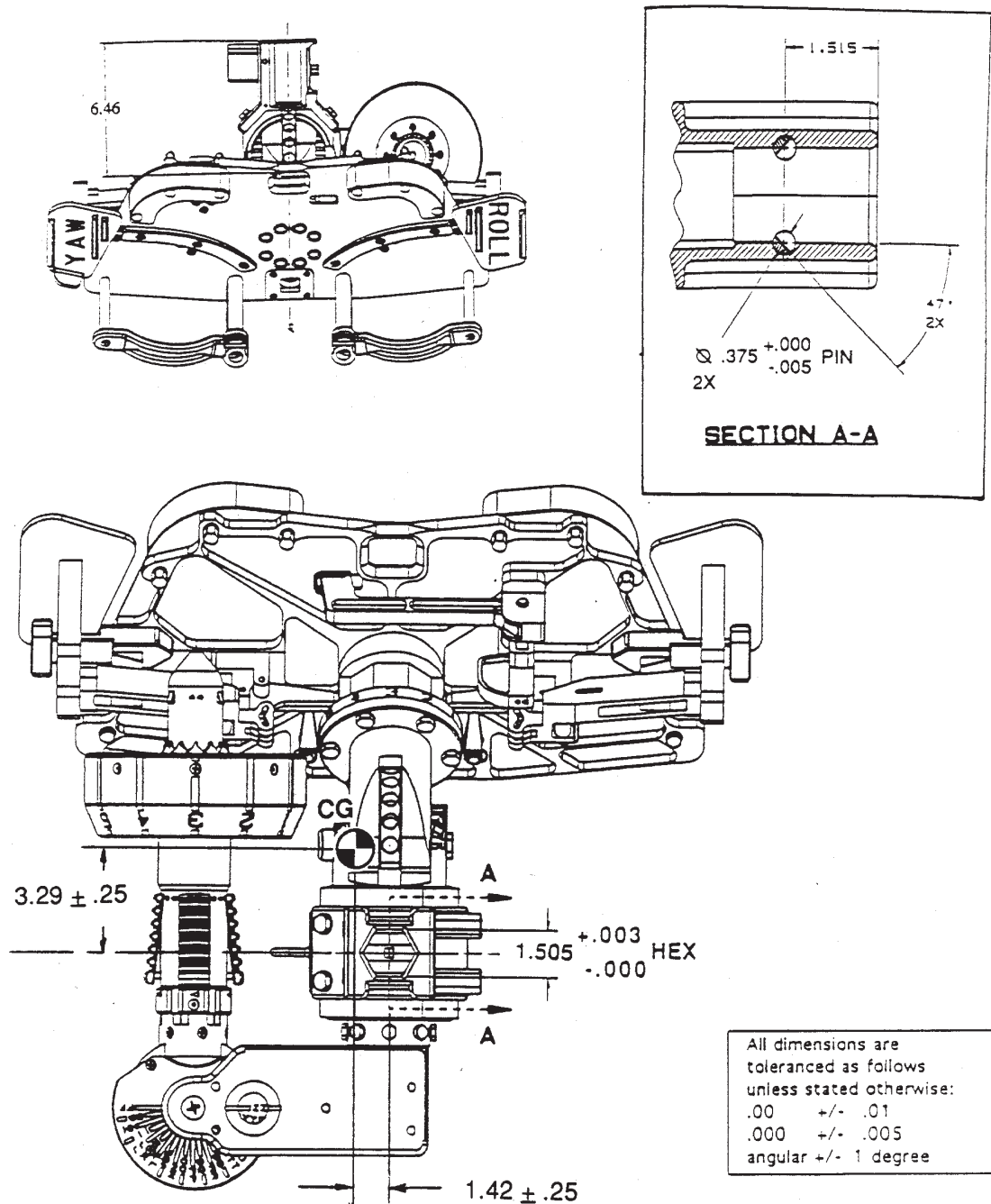
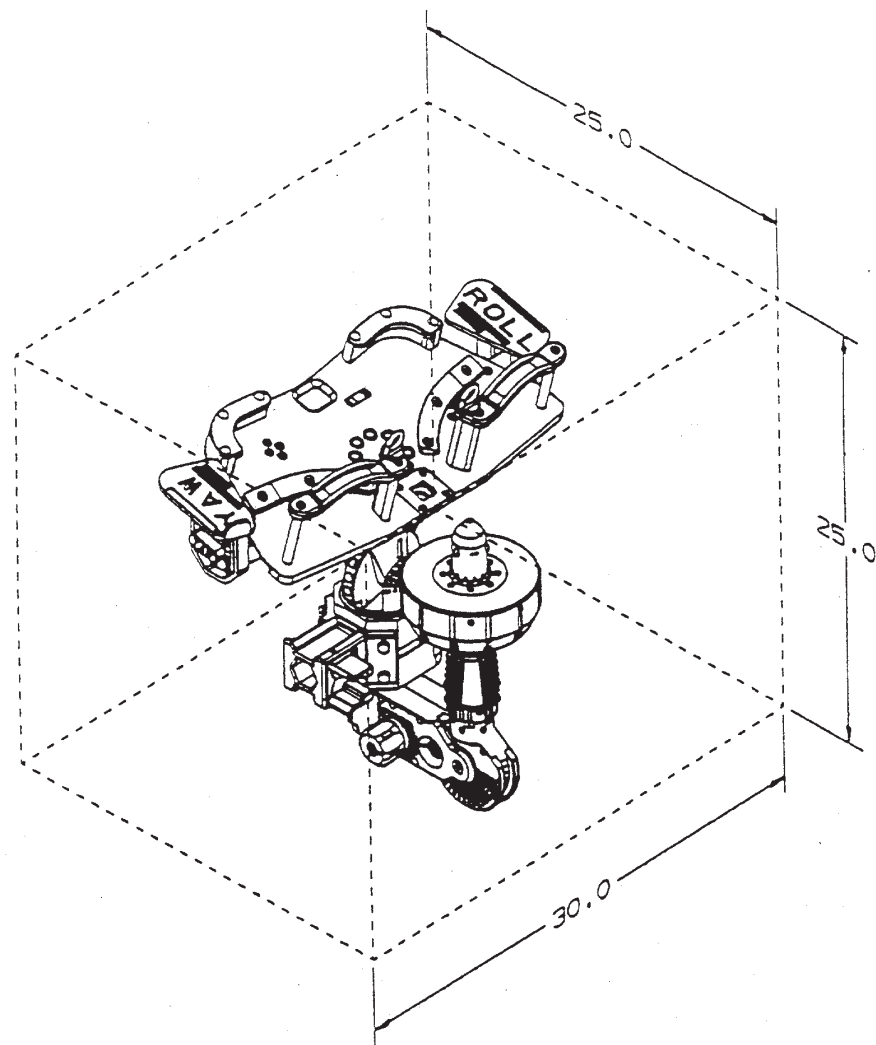


FIGURE 3.3.1.1-3 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) LAUNCH RESTRAINT LOCATION - HEX RECEPTABLE



**FIGURE 3.3.1.2-1 MINIMUM ARTICULATING PORTABLE FOOT RESTRAINT (APFR) STORAGE VOLUME**

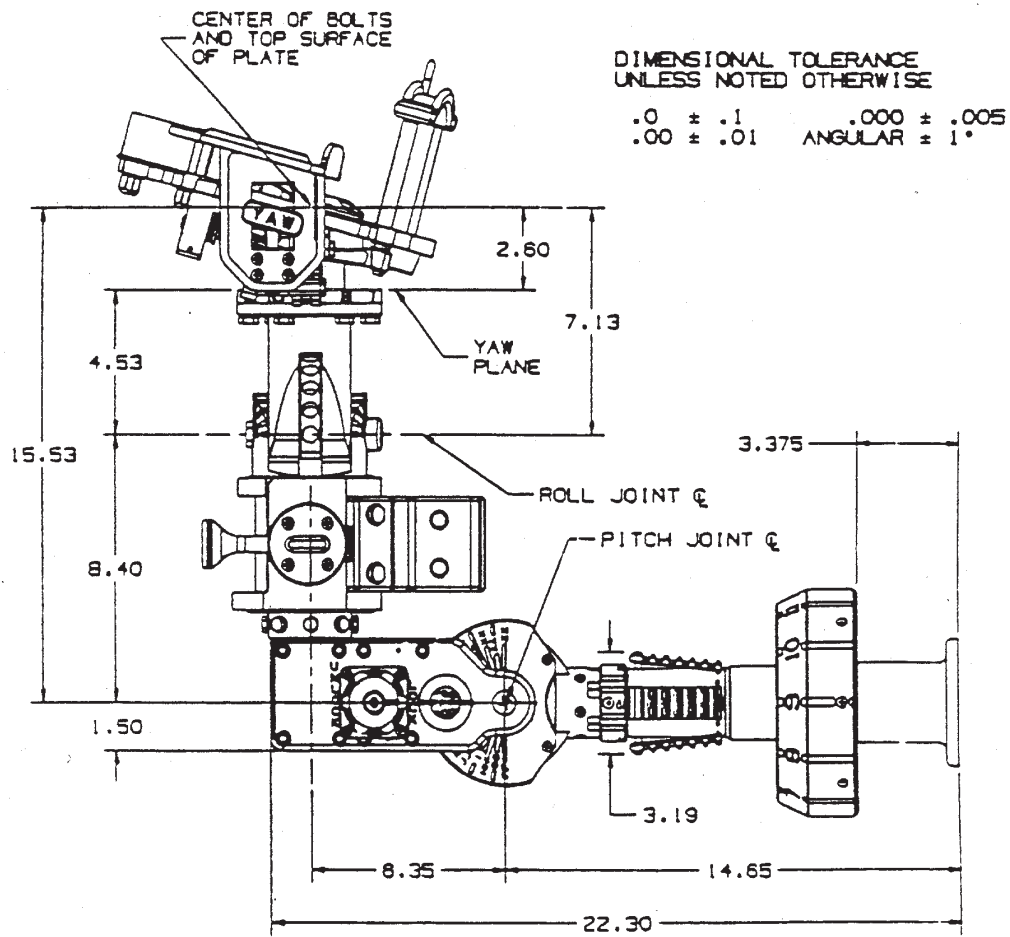


FIGURE 3.3.1.4-1 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) CRITICAL DIMENSIONS - SIDE VIEW

DIMENSIONAL TOLERANCE  
UNLESS NOTED OTHERWISE  
.0 ± .1      .000 ± .005  
.00 ± .01    ANGULAR ± 1°

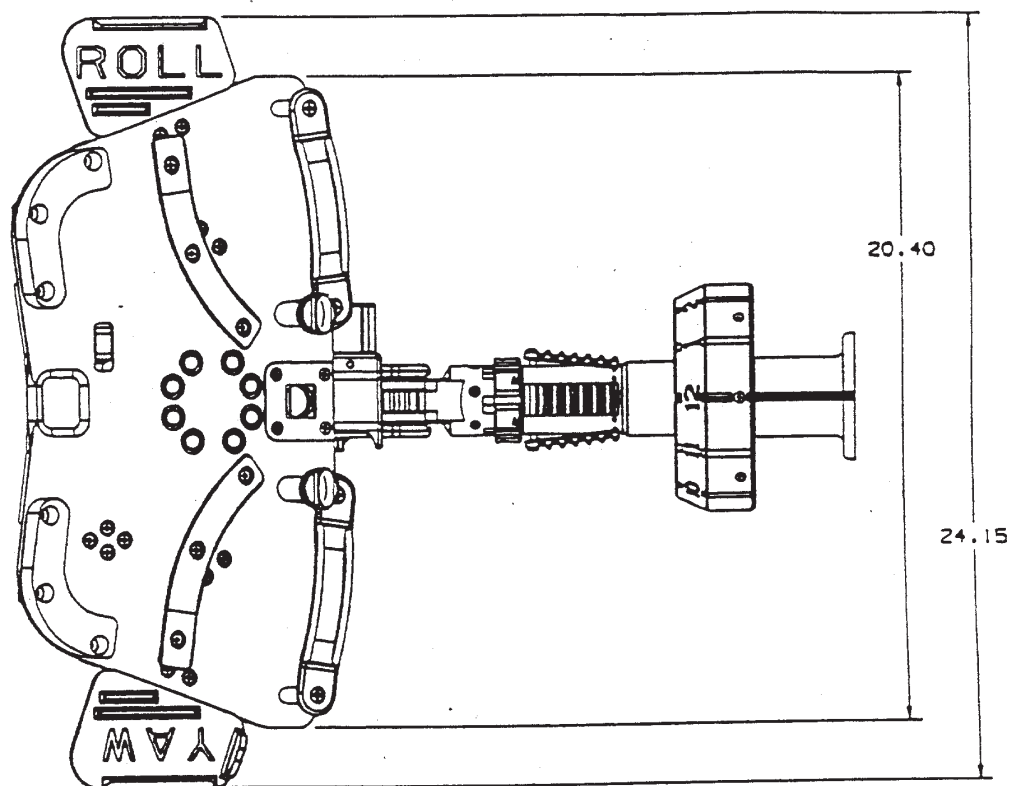


FIGURE 3.3.1.4-2 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) CRITICAL DIMENSIONS - TOP VIEW

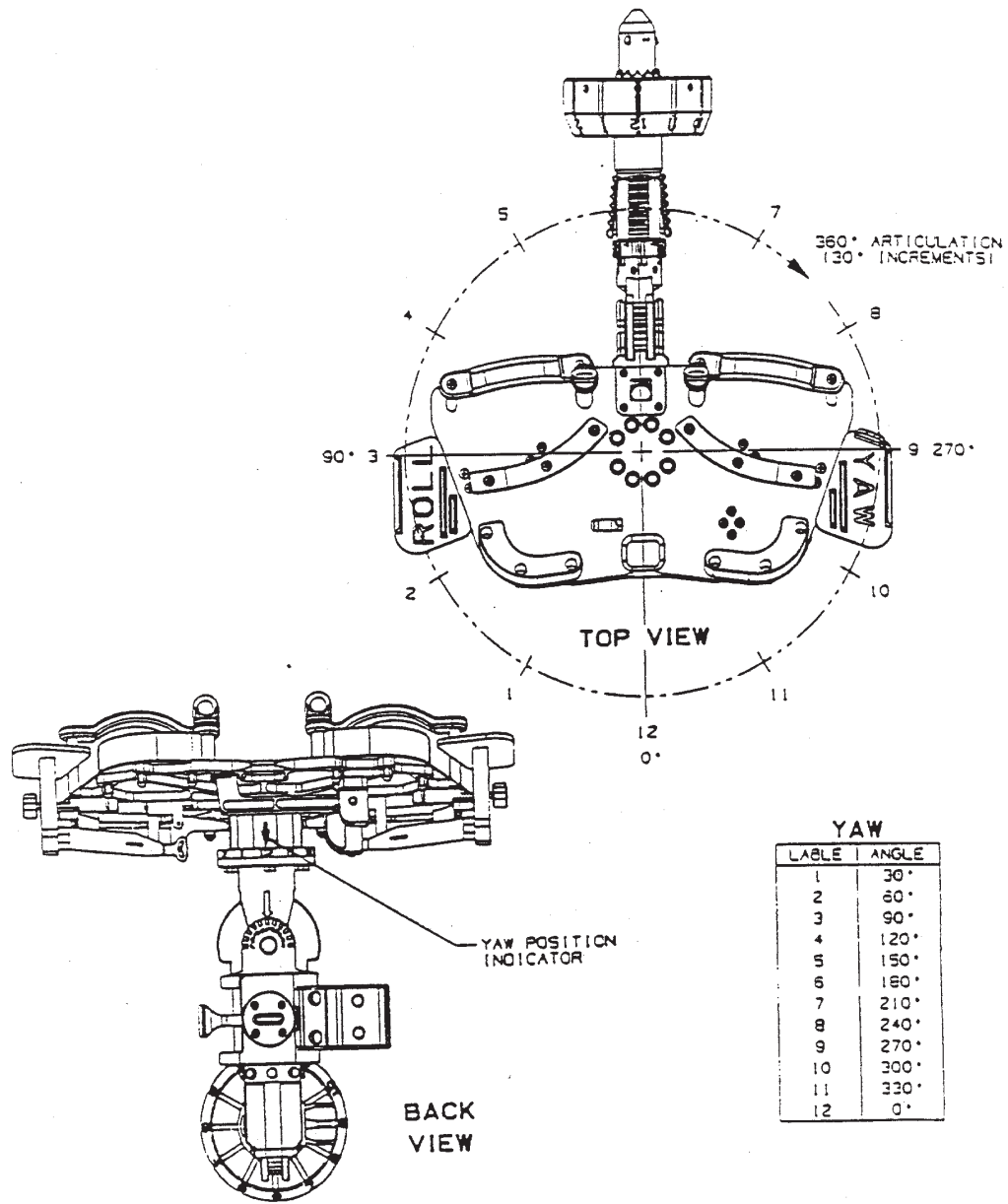


FIGURE 3.3.1.4-3 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) FUNCTIONAL POSITIONS - YAW

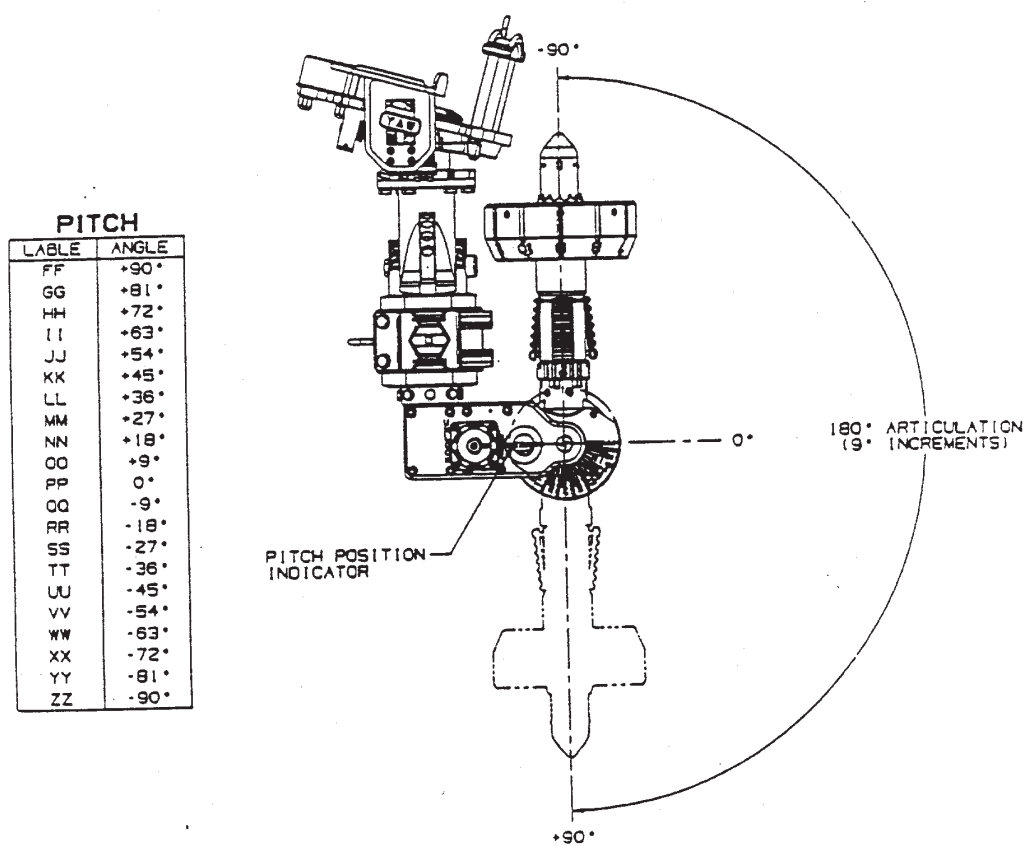
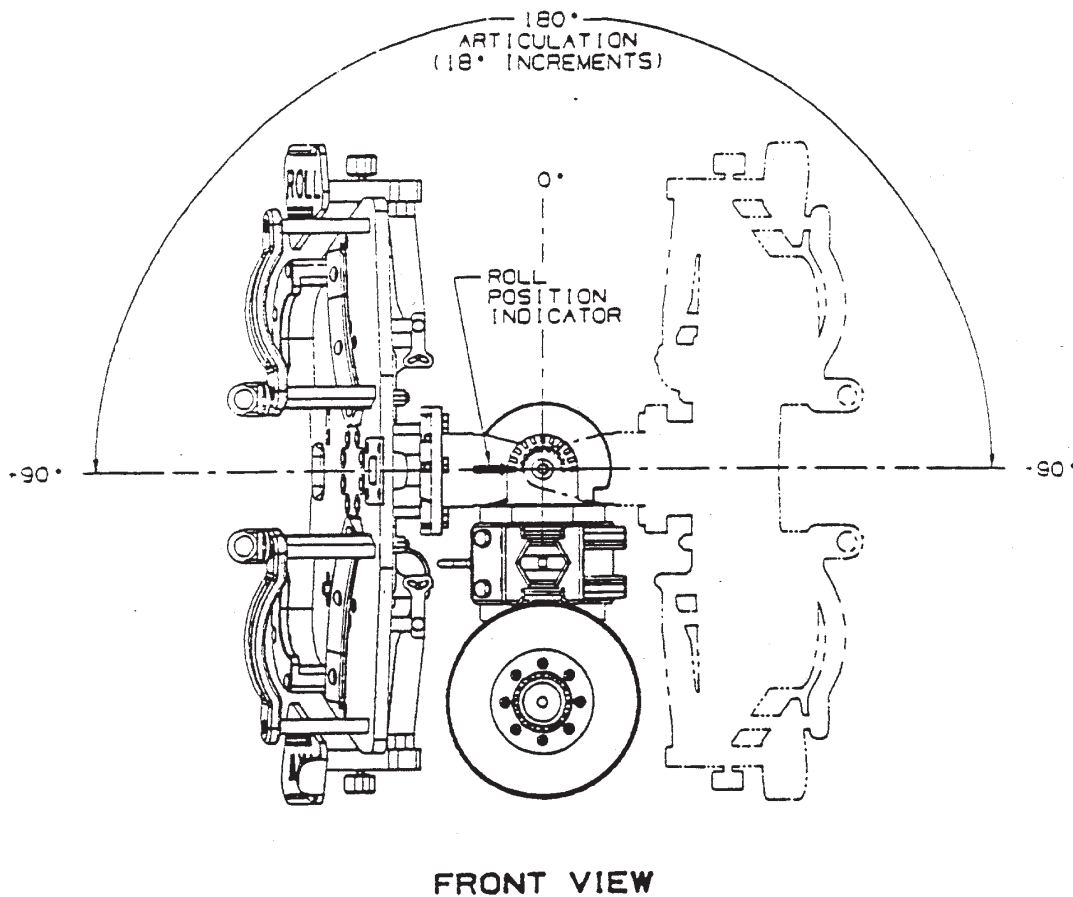


FIGURE 3.3.1.4-4 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) FUNCTIONAL POSITIONS - PITCH



## ROLL

| TABLE | ANGLE |
|-------|-------|
| A     | +90°  |
| B     | +72°  |
| C     | +54°  |
| D     | +36°  |
| E     | +18°  |
| F     | 0°    |
| G     | -18°  |
| H     | -36°  |
| J     | -54°  |
| K     | -72°  |
| L     | -90°  |

FIGURE 3.3.1.4-5 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) FUNCTIONAL POSITIONS – ROLL



### 3.3.2 TEMPORARY EQUIPMENT RESTRAINT AID (TERA)

The TERA provides restraint for ORUs and EVA equipment while being attached to either the Space Station Remote Manipulator System (SSRMS) or the SRMS. The TERA provides a passive WIF for attachment of an APFR, with or without a PFRWS, for assembly of the PWP. The TERA also provides attachments for GFE tethers for temporary restraint of ORUs at a PWP worksite. See Figure 3.3.2-1 for an isometric view of the TERA.

#### 3.3.2.1 INTERFACE DESCRIPTION

The TERA interfaces with four external ISS elements. The first interface is with ORU(s) installed on a cargo pallet (CHIA subcarrier) with an active Common Structural Interface (CSI) latching mechanism. The second interface is with the launch interfaces (flight support equipment) on Segment S0. The third interface is with the SRMS or the SSRMS. The final TERA interface is functional and is to the MBS via a GFE passive WIF for PWP stowage.

The TERA launch attachment points and center of gravity (CG) are shown in Figure 3.3.2.1-1. Specifically, one of the TERA launch restraints is via the TERA passive WIF which engages an active WIF probe on the launch structure (datum -B- in Figure 3.3.2.1-2). The active WIF probe, is supplied by the TERA provider as GFE to the TERA FSE provider. Figure 3.3.2.1-2 shows the required relationship between the TERA passive WIF and the active WIF probe. This relationship requires a maximum tolerance of  $\pm .030$  in. between the TERA and the TERA FSE latch when the TERA passive WIF is installed onto the FSE active WIF probe. The TERA provider shall assure that the combined passive WIF and active WIF probe does not exceed the  $\pm .030$  in. tolerance prior to delivery of the active WIF probe. Figure 3.3.2.1-1 also shows the lifting points provided on the TERA for ground handling.

A passive CSI grid (ORU Grid interface), see Figure 3.3.2.1-3, is provided by the TERA for rigid restraint of a cargo pallet during both PWP worksite operations and PWP translation. An active latching CSI mechanism that can attach to the ORU Grid interface shall be provided as part of the cargo pallet. The maximum cargo pallet envelope shall not exceed 62.0 in. x 42.0 in. x 3.0 in. (excluding any ORU alignment guides) per Figure 3.3.2.1-4. The maximum size ORU(s) volume (including any ORU to pallet interface hardware) that may be placed on the cargo pallet shall not exceed a volume with the dimensions of 50 in. length x 40 in. width x 45 in. height.

The TERA to SRMS or SSRMS interface is via a modified Flight Releasable Grapple Fixture (FRGF). Modifications to a standard FRGF for TERA use consist of removal of the grapple target and reduction of the abutment plate to a diameter of 14 inches.

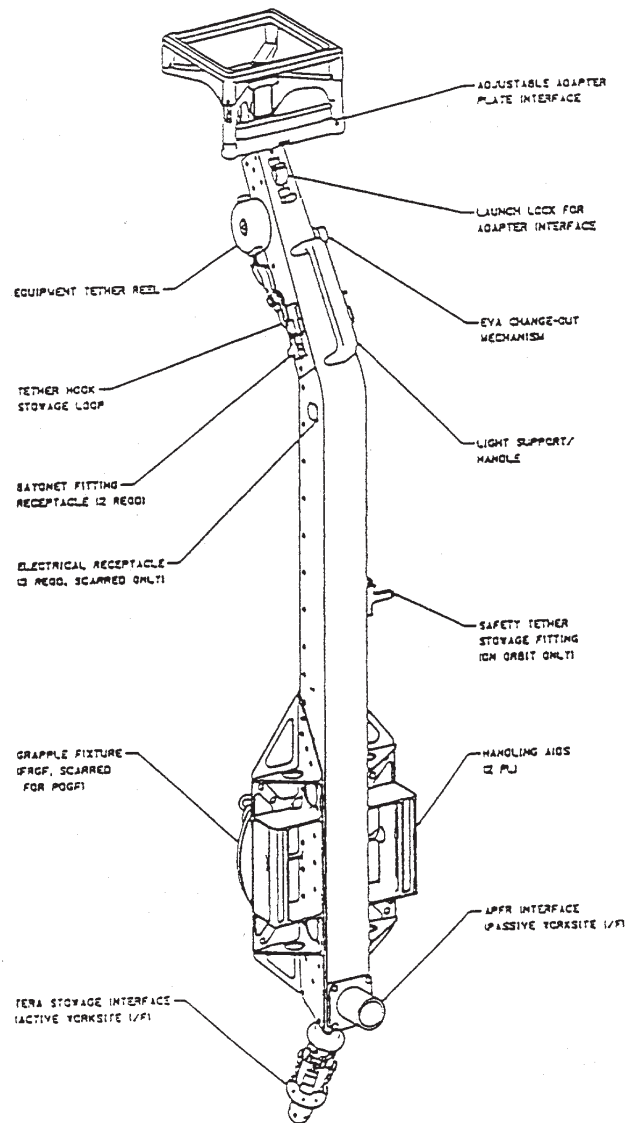


FIGURE 3.3.2-1 TEMPORARY EQUIPMENT RESTRAINT AID (TERA)

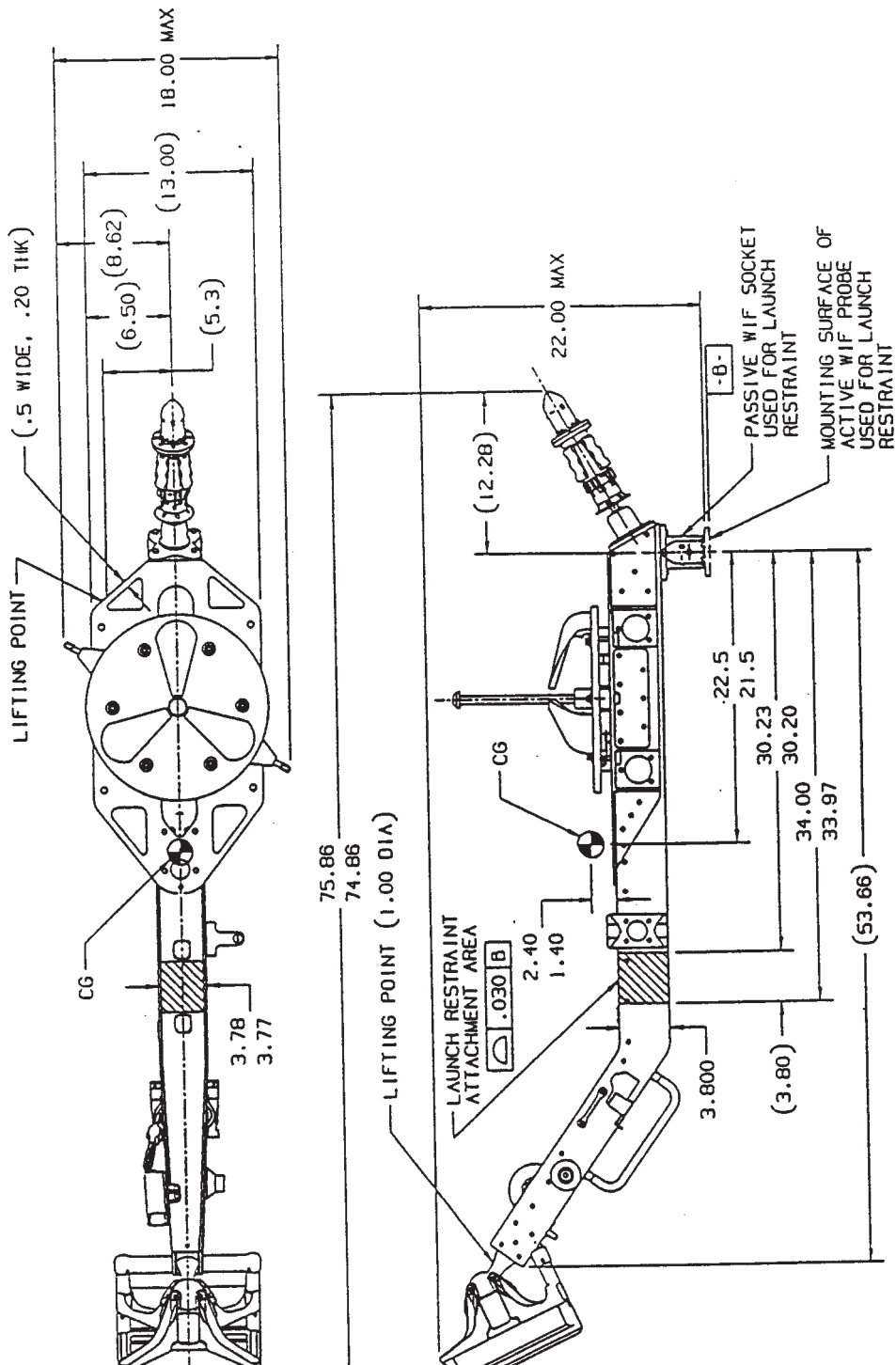


FIGURE 3.3.2.1-1 TERA LAUNCH RESTRAINT ATTACHMENT

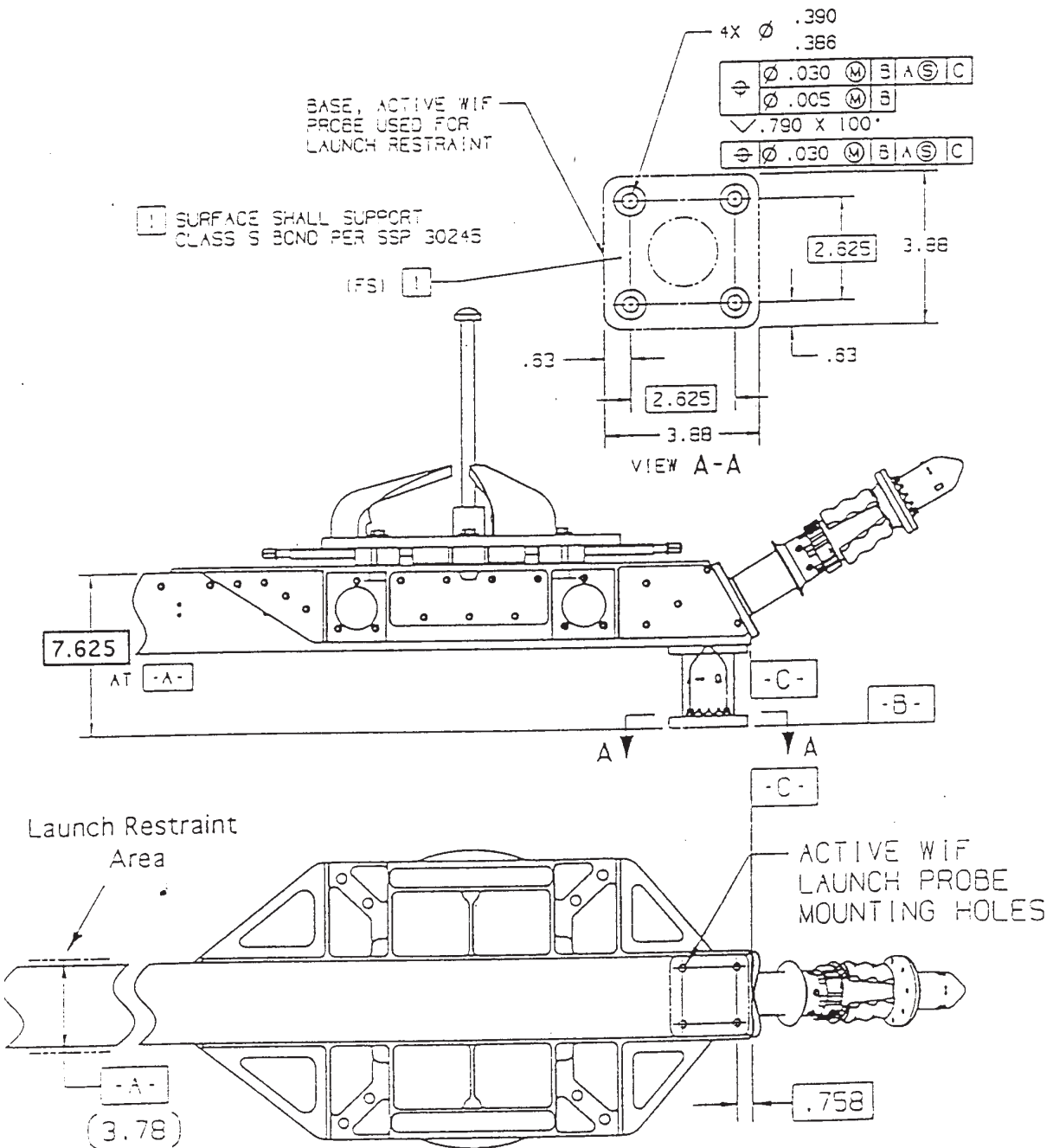


FIGURE 3.3.2.1-2 TEMPORARY EQUIPMENT RESTRAINT AID (TERA) WIF LAUNCH RESTRAINT ATTACHMENT DETAIL

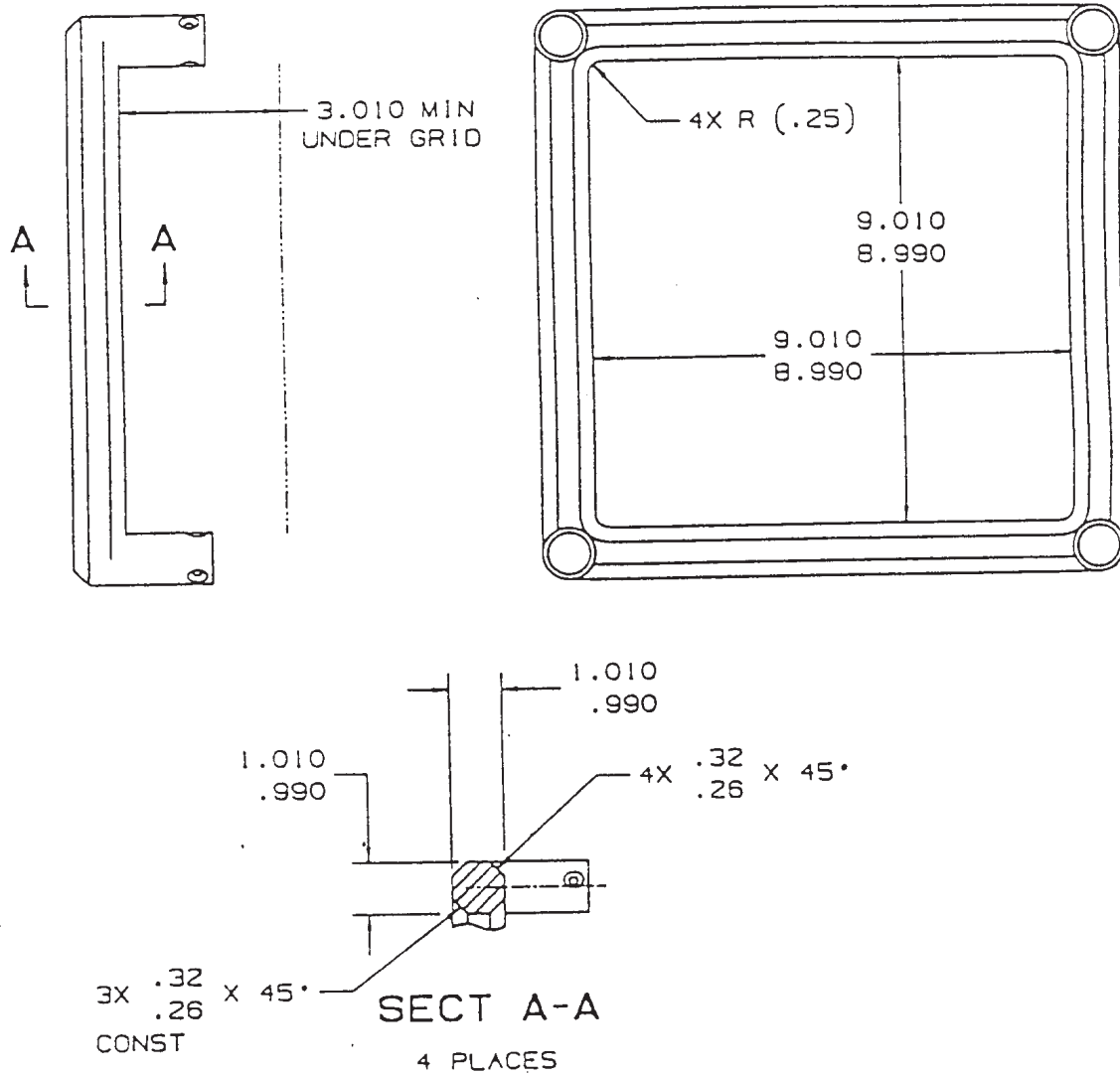


FIGURE 3.3.2.1-3 TERA ORU RESTRAINT GRID

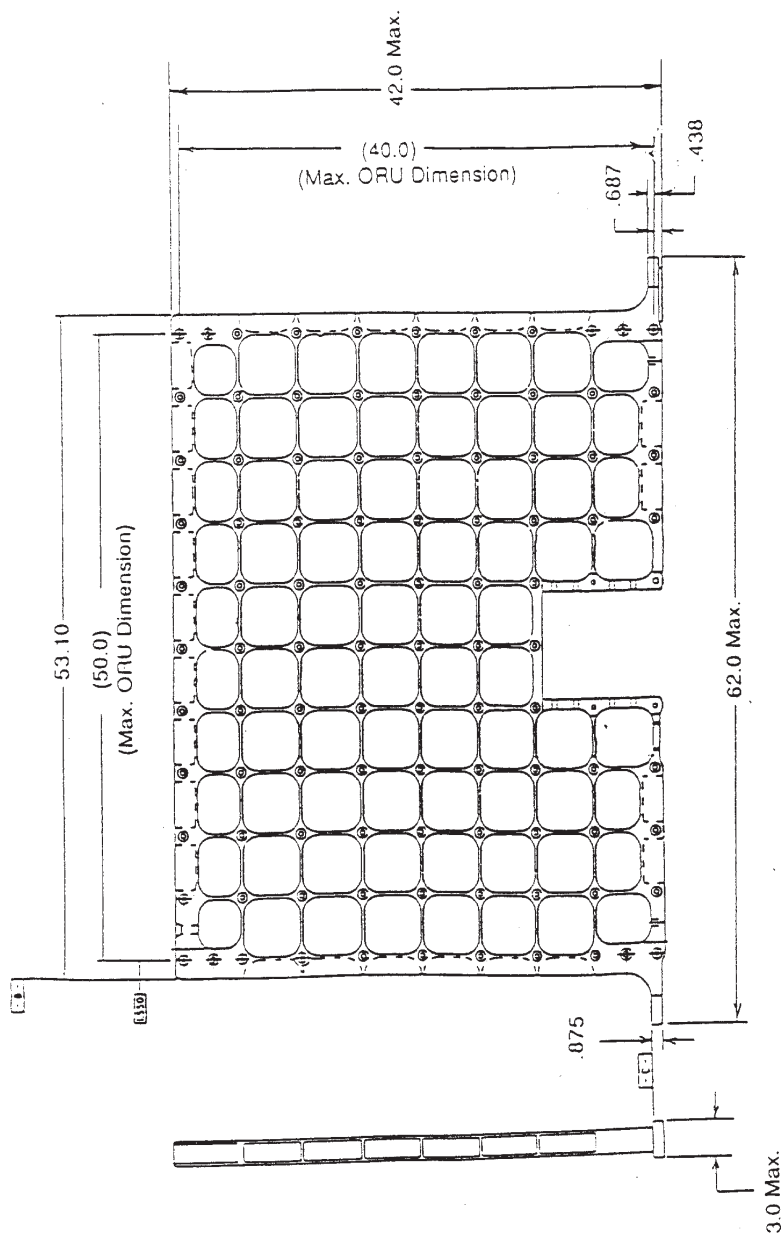


FIGURE 3.3.2.1-4 MAXIMUM CARGO PALLET ENVELOPE

### 3.3.2.2 ENVELOPE

The maximum envelope dimensions (launch and on-orbit) for the TERA are shown in Figure 3.3.2.2-1. The required removal envelope for the TERA from the launch restraint location requires an additional 4 inches to be added to the TERA volume in the direction shown in Figure 3.3.2.2-1.

### 3.3.2.3 STRUCTURAL

#### 3.3.2.3.1 LOADING

When the TERA is mated with the passive WIF "P9" on the MBS, the maximum induced loads to structure at the MBS interface are to be limited by a load limiting mechanism to a maximum of 1800 in-lbs bending and torsion moment and 125 lbf in shear.

Launch loads induced by the TERA launch support equipment shall not exceed those shown below.

**TABLE 3.3.2.3.1-1 TERA INTERFACE PEAK LAUNCH LOADS**

| X (G's) | Y (G's) | Z (G's) |
|---------|---------|---------|
| 7.10    | 3.7     | 9.6     |

Segment S0 location, NSTS Coordinates

Launch loads are from Segment S0 integrator coupled loads analysis and are based on a TERA weight of 68 lbs.

#### 3.3.2.3.2 MASS PROPERTIES

The maximum weight of the TERA with active worksite interface and FRGF is 72.0 lbs.

#### 3.3.2.4 ELECTRICAL BONDING

The TERA launch restraint contact surfaces, as indicated in Figure 3.3.2.1-2, will satisfy a class S bond per SSP 30245, Space Station Electrical Bonding Specification, in its entirety. In particular, the TERA electrical bonding path shall be completed through the TERA active WIF.

#### 3.3.2.5 THERMAL

The TERA is designated as an "unlimited contact" EVA interface. Thermal control of this hardware is achieved by passive techniques.

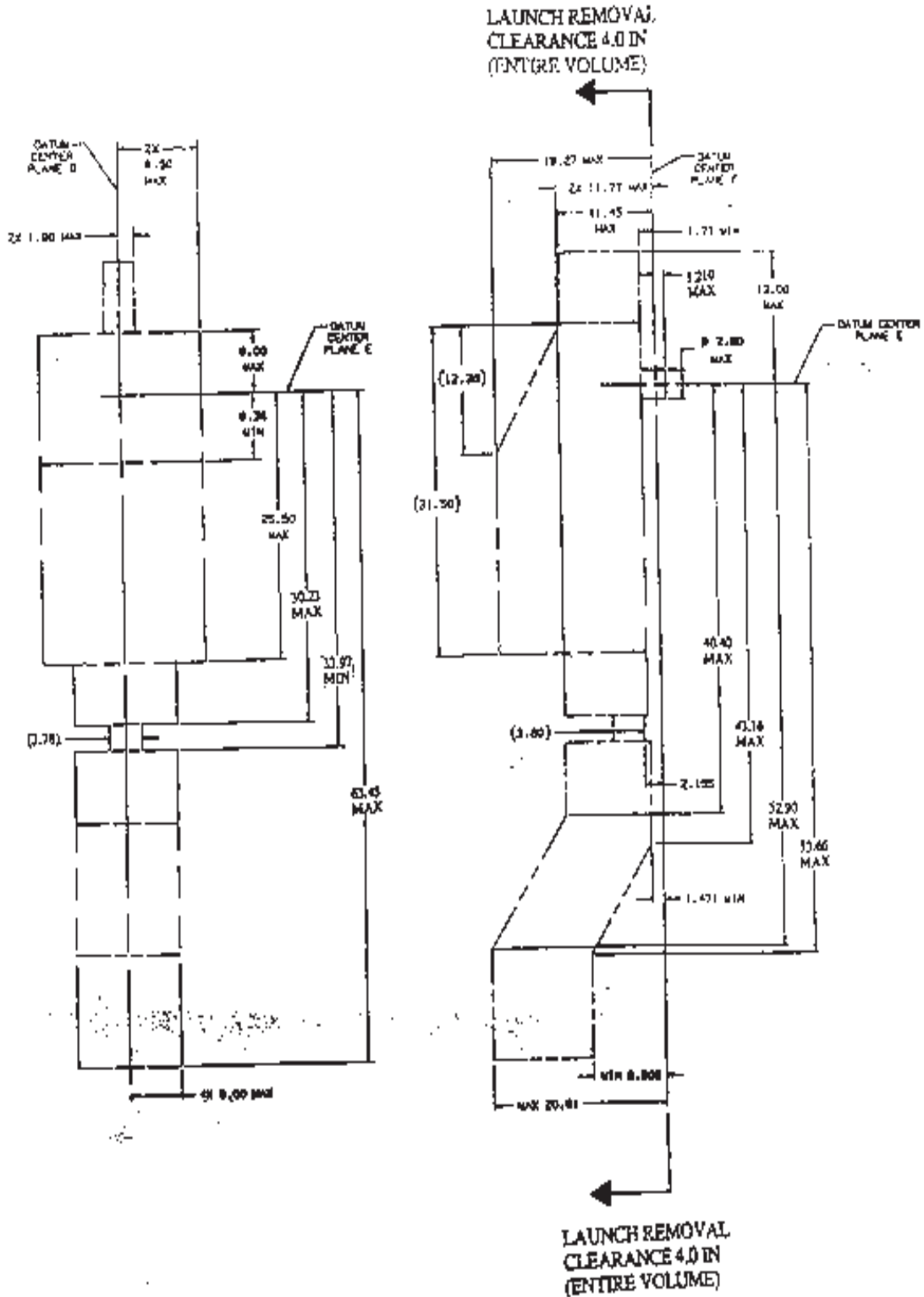


FIGURE 3.3.2.2-1 TEMPORARY EQUIPMENT RESTRAINT AID (TERA) MAXIMUM LAUNCH ENVELOPE



### 3.3.3 PORTABLE FOOT RESTRAINT WORKSTATION STANCHION

The PFRWS provides restraints for EVA equipment and tools and mounts to the APFR. Figure 3.3.3-1 shows a detailed picture of the PFRWS. Additionally, if a PFRWS is not used during an EVA, the PFRWS can be stored on the CETA Cart during the EVA, via the same interface that is used to mount the PFRWS onto the APFR (a 1.5 in. hexagonal socket).

#### 3.3.3.1 INTERFACE DESCRIPTION

The only PFRWS interface to external elements is the launch interface of the PFRWS to Segment S0. The PFRWS launch tie-down points and center of gravity (CG) are shown in Figure 3.3.3.1-1. Figure 3.3.3.1-2 provides the details of the PFRWS probe used as a launch tie-down point.

In addition, Figure 3.3.3.1-2 gives the required relationship between the PFRWS hex probe and the hex socket launch restraint. This relationship requires a maximum tolerance of  $\pm .030$ " between the PFRWS stanchion and the two PFRWS FSE latches when the PFRWS probe is installed on the hex socket launch restraint. This is controlled by the dimensions on the PFRWS hex probe in Figure 3.3.3.1-2. The dimensions show the relationship between the hex feature and the groove on the PFRWS hex probe that are related to the PFRWS stanchion launch attachment location area denoted as datums -A- and -B-.

The PFRWS FSE Integrator is intentionally setting the centerline of the two stanchion latches to a basic value of 9.845" from the centerline of the two PIP Pin holes on the hex socket. The PFRWS stanchion centerline to the centerline of the PIP pin groove on the hex probe is 9.827; "Basic". This is an intentional offset of  $\pm .018$  that can create a preload.

#### 3.3.3.2 ENVELOPE

The maximum launch envelope for the PFRWS is shown in Figure 3.3.3.2-1. The PFRWS launch removal envelope will require an additional 4 inches to the PFRWS launch envelope as indicated in Figure 3.3.3.2-1.

#### 3.3.3.3 STRUCTURAL

##### 3.3.3.3.1 LOADING

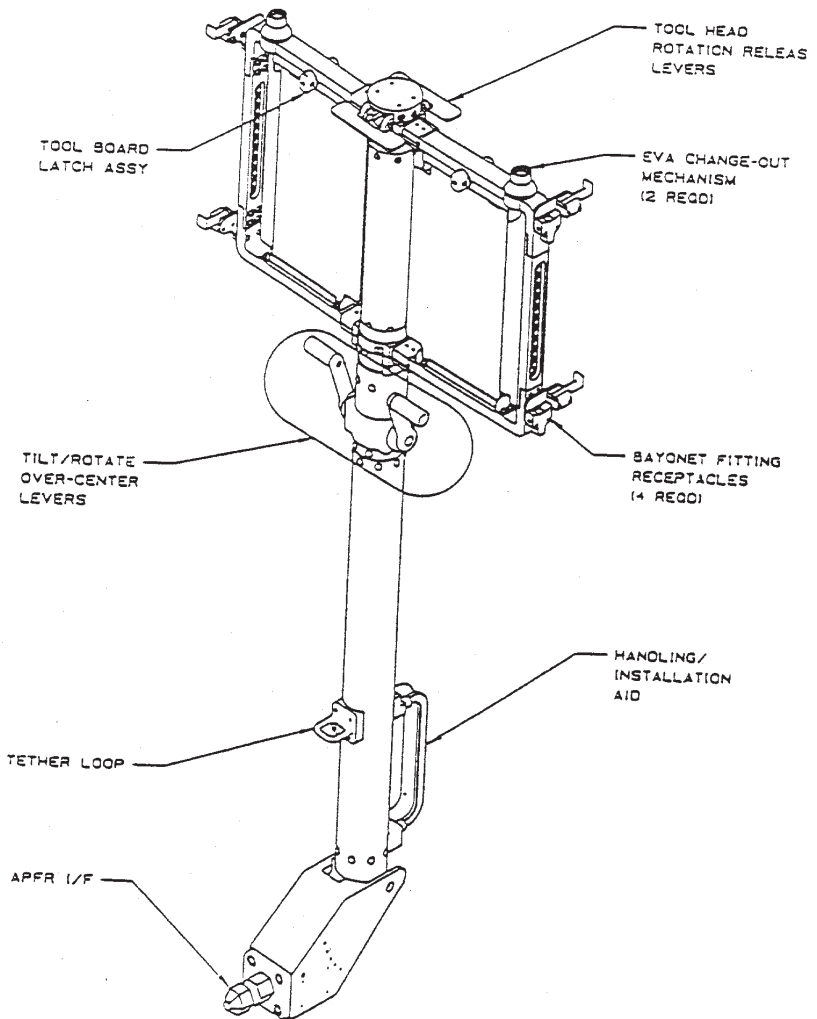
The design launch loads induced by the PFRWS launch support equipment shall not exceed those shown below.

**TABLE 3.3.3.3.1-1 PFRWS INTERFACE PEAK LAUNCH LOADS**

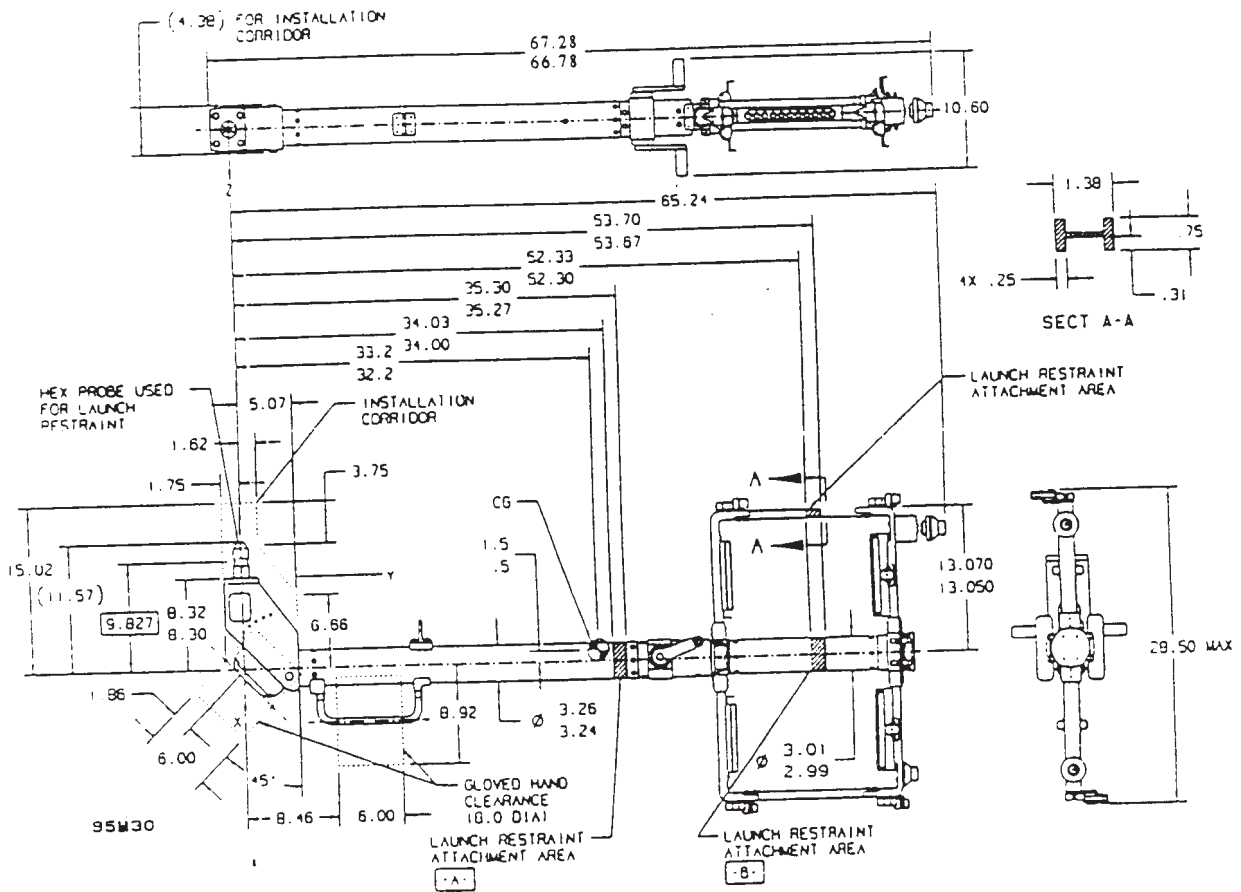
| X (G's) | Y (G's) | Z (G's) |
|---------|---------|---------|
| 7.10    | 3.7     | 9.6     |

Segment S0 location, NSTS Coordinates

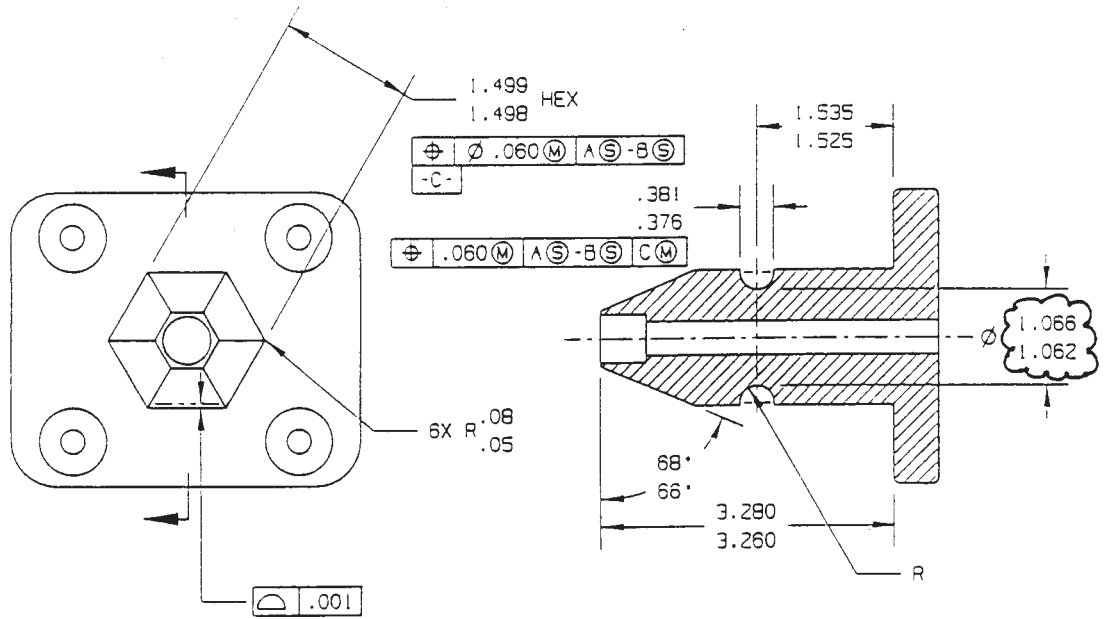
Launch loads are from Segment S0 integrator coupled loads analysis and are based on a PFRWS weight of 48 lbs.



**FIGURE 3.3.3-1 PORTABLE FOOT RESTRAINT WORKSTATION STANCHION (PFRWS)**

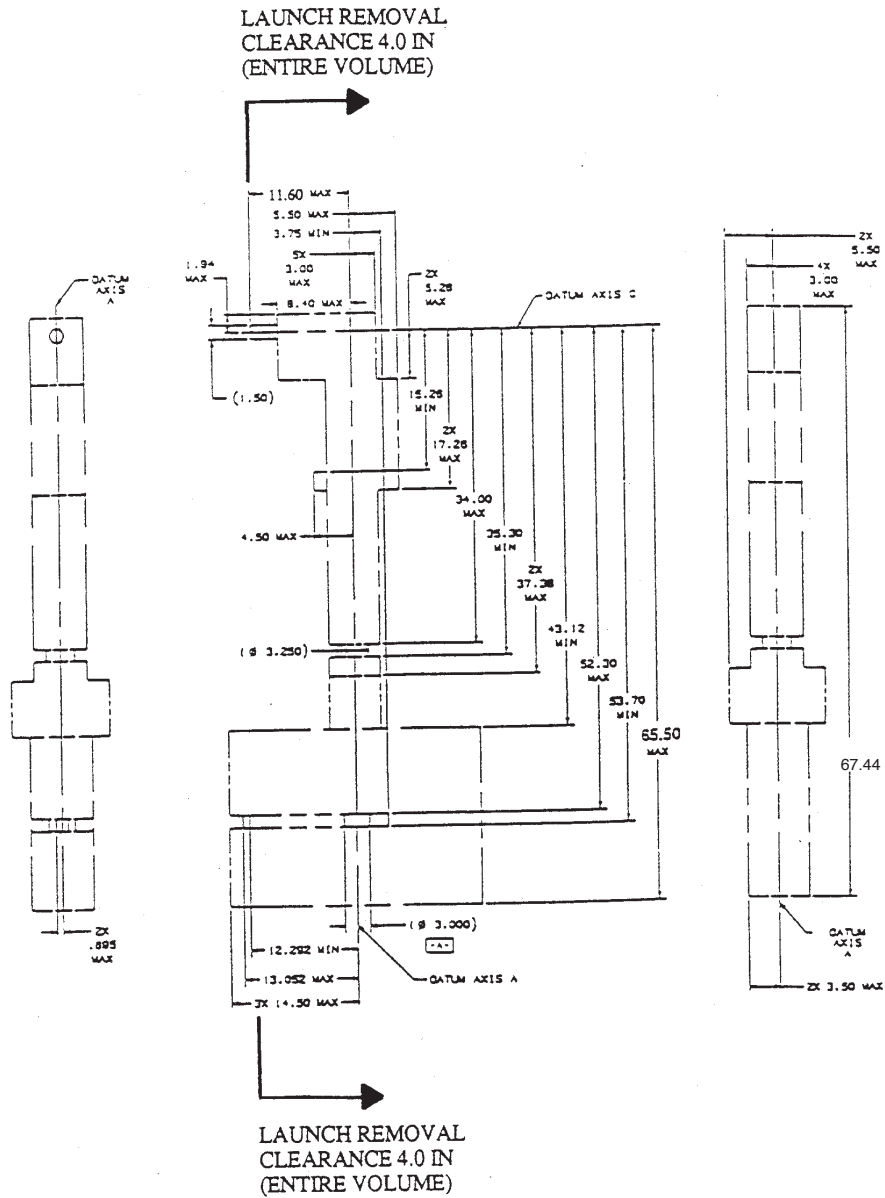


**FIGURE 3.3.3.1-1 PORTABLE FOOT RESTRAINT WORKSTATION STANCHION (PFRWS) LAUNCH RESTRAINT ATTACHMENT**



NOTE: SEE FIGURE 3.3.3.1-1 FOR DATUMS -A- AND -B-.

**FIGURE 3.3.3.1-2 PORTABLE FOOT RESTRAINT WORKSTATION STANCHION (PFRWS)  
HEX PROBE LAUNCH RESTRAINT ATTACHMENT**



**FIGURE 3.3.3.2-1 PORTABLE FOOT RESTRAINT WORKSTATION STANCHION (PFRWS)  
MAXIMUM LAUNCH ENVELOPE**

### **3.3.3.3.2 MASS PROPERTIES**

The maximum weight of the PFRWS is 47 lbs.

### **3.3.3.4 ELECTRICAL BONDING**

The PFRWS launch restraint contact surfaces, as indicated in Figure 3.3.3.1–2, will satisfy a class S bond per SSP 30245, Space Station Electrical Bonding Specification, in its entirety. In particular, the PFRWS electrical bonding path shall be completed through the PFRWS hex probe.

### **3.3.3.5 THERMAL**

The PFRWS is designated as an “unlimited contact” EVA interface. Thermal control of this hardware is achieved by passive techniques.

## **3.4 CREW AND EQUIPMENT TRANSLATION AID (CETA)**

### **3.4.1 CETA TETHER SHUTTLE**

The Tether Shuttle provides unencumbered, tethered and manual EVA translation along the nadir side of the MT–CETA rail. In order to accommodate worst case Solar Alpha Rotary Joint (SARJ) tolerances, the Tether Shuttle shall be capable of being removed from the rail on one side of the SARJ and reinstalled on the rail on the other side of the SARJ, and is not required to cross the rail gap at the SARJ. The Tether Shuttle also provides stowage for an ERCM Safety Tether Reel (ERCM STR).

#### **3.4.1.1 INTERFACE DESCRIPTION**

The Tether Shuttle is held in place on Segment S0 during launch by the launch and stowage support structure. The launch and stowage support structure control dimensions are shown by Figure 3.4.1.1–1. Tether Shuttle to launch and stowage support structure interfaces and center-of-gravity (CG) are shown in Figure 3.4.1.1–2 and Figure 3.4.1.1–3. In addition, the Tether Shuttle wheel bogie spacing is shown in Figure 3.4.1.1–3. Note that the Tether Shuttles are stowed on-orbit at the Tether Shuttle launch locations. During on-orbit usage (during translation), the Tether Shuttle may impact (interface) with the Tether Shuttle rail stops and with the Mobile Transporter (MT). The location and associated impact area on the Tether Shuttle is shown in Figure 3.4.1.1–3. The location and associated impact area on the Tether Shuttle rail

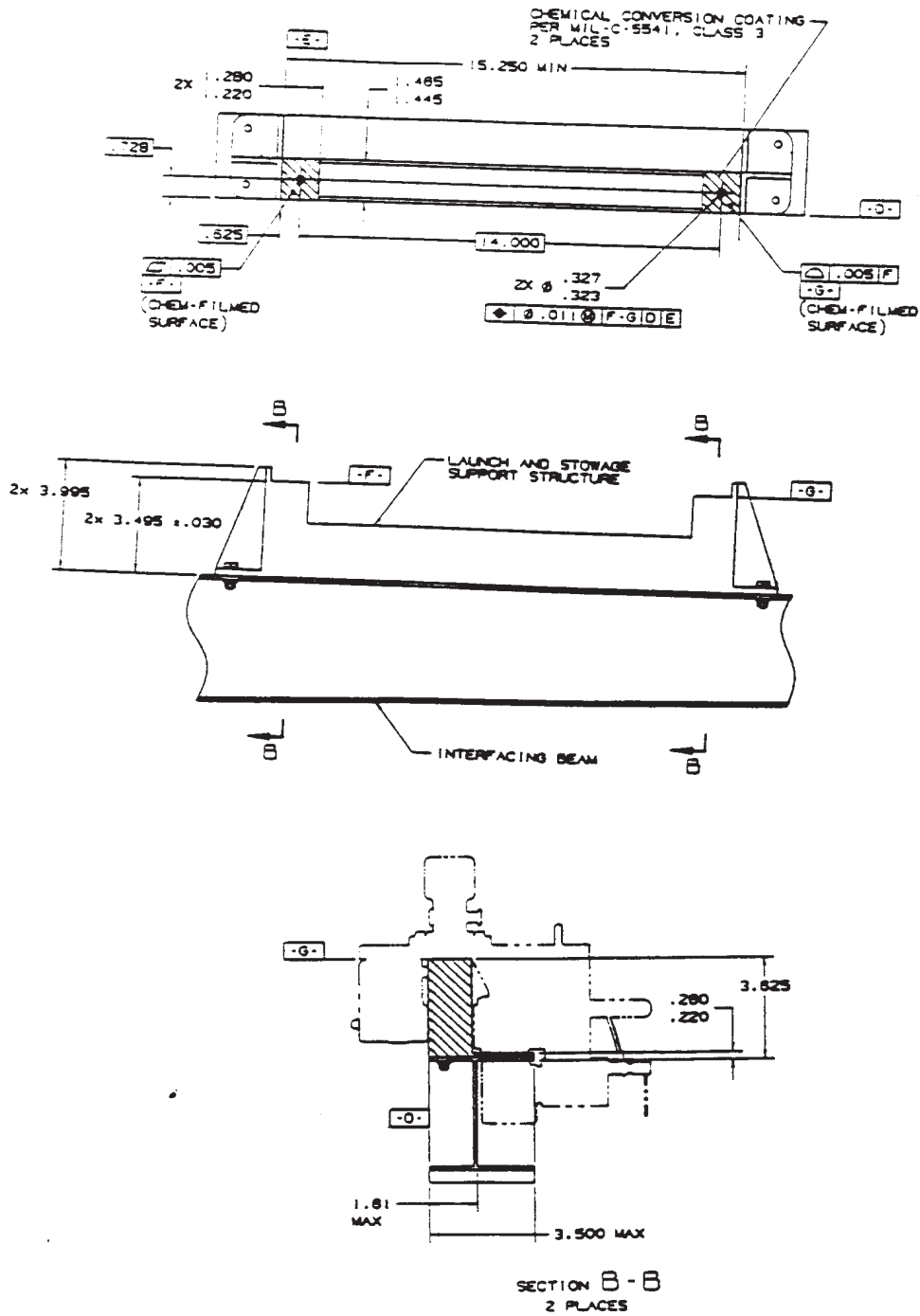
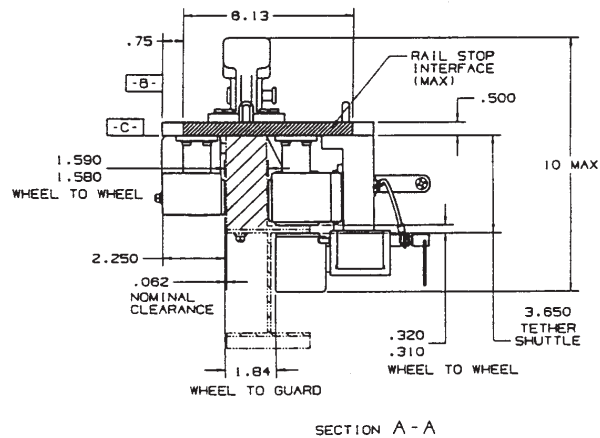
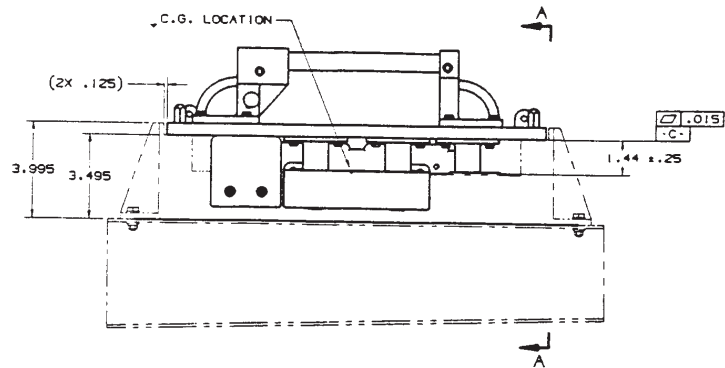


FIGURE 3.4.1.1-1 TETHER SHUTTLE TO LAUNCH AND STOWAGE INTERFACE – LAUNCH BRACKET

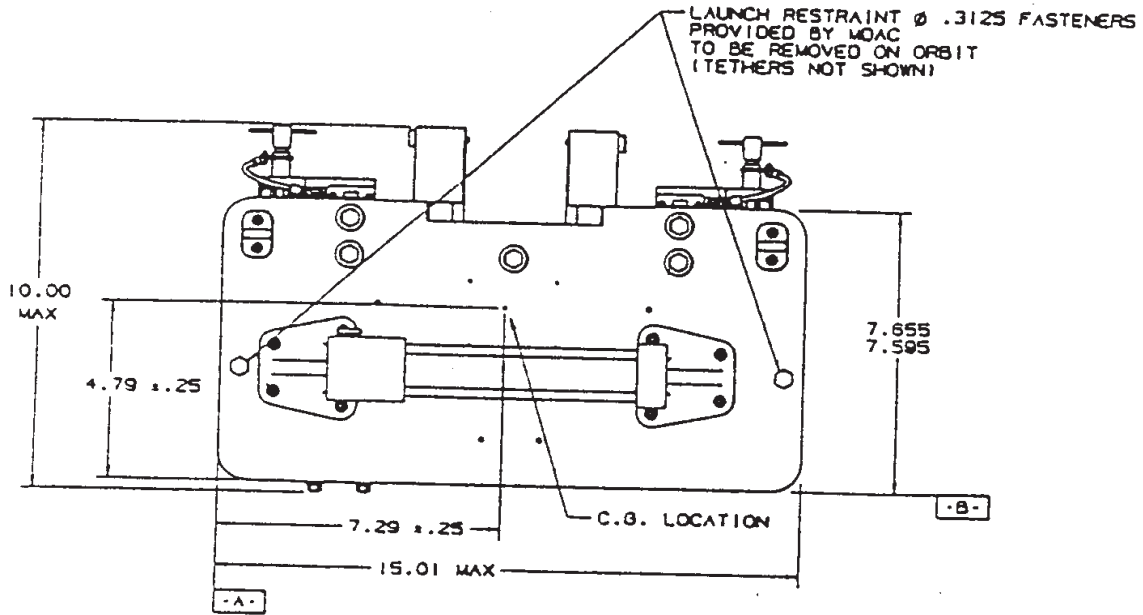


SECTION A - A

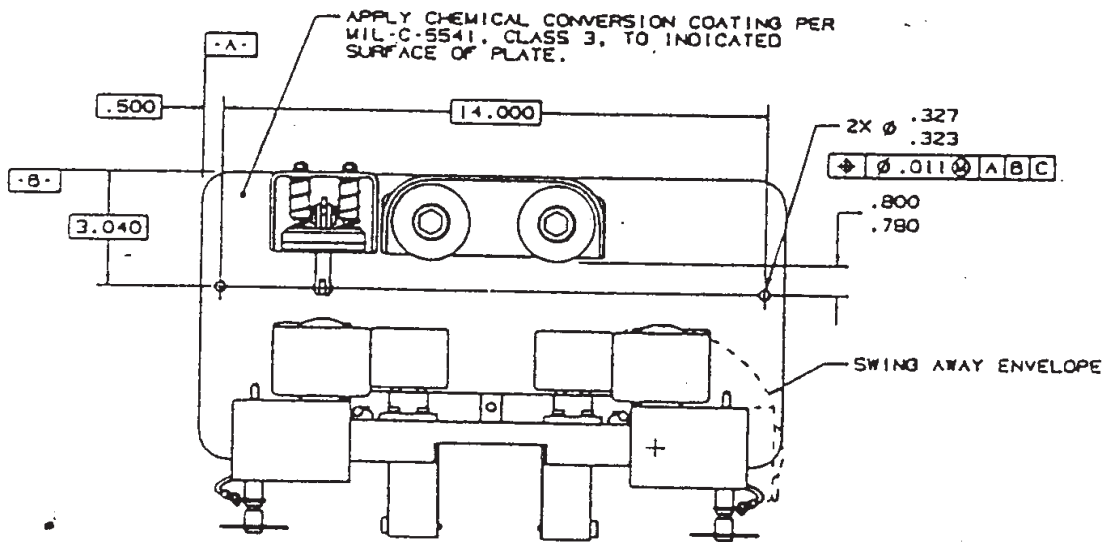
DIMENSIONAL TOLERANCES: .0 +/- .1  
 (UNLESS OTHERWISE NOTED) .00 +/- .03  
 .000 +/- .010

**FIGURE 3.4.1.1-2 TETHER SHUTTLE TO LAUNCH AND STOWAGE INTERFACE – TETHER SHUTTLE**





LAUNCH STRUCTURE OMITTED FOR CLARITY



LAUNCH STRUCTURE OMITTED FOR CLARITY

FIGURE 3.4.1.1-3 TETHER SHUTTLE TO LAUNCH AND STOWAGE INTERFACE – TETHER SHUTTLE (CONCLUDED)

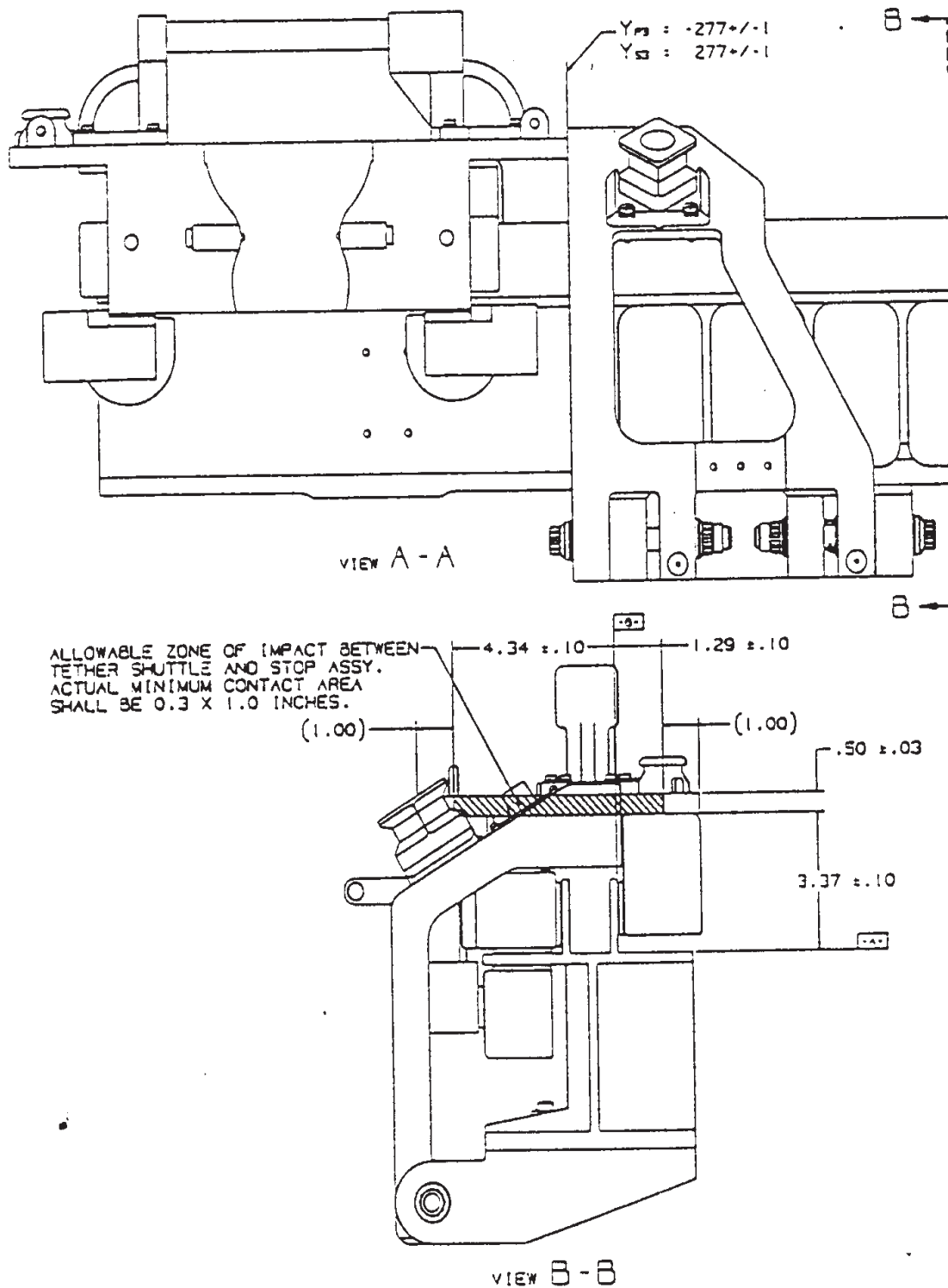


FIGURE 3.4.1.1-4 TETHER SHUTTLE STOP INTERFACE

stops is shown in Figure 3.4.1.1–4 and the location on the MT that the Tether Shuttle may impact against is shown in Figure 3.4.1.1–5.

### **3.4.1.2 ENVELOPE**

#### **3.4.1.2.1 HARDWARE**

The maximum hardware launch envelope dimensions of each Tether Shuttle is 15.1 in. x 10 in. x 10 in. See Figure 3.4.1.2.1–1 for details. The maximum on-orbit volume envelope dimensions for each Tether Shuttle, including the Extended Range Crewmember (ECRM) Safety Tether Reel, is 15.1 in. x 10 in. x 10 in.

#### **3.4.1.2.2 EVA**

The access envelope for stowage, installation and removal of the Tether Shuttle is shown in Figure 3.4.1.2.2–1. The Tether Shuttle operates within the CETA Cart translation corridor.

### **3.4.1.3 STRUCTURAL**

#### **3.4.1.3.1 STIFFNESS**

A first mode of 25 Hz is sufficient. The natural frequency of the Tether Shuttle final design will be greater than 40 Hz.

#### **3.4.1.3.2 LOADING**

There shall be no separation or gapping at the Tether Shuttle to launch restraint structure interface during launch or landing. Load factors are 13 g's in any one direction with 3.25 g's in the other two directions.

The on-orbit loads transmitted by the Tether Shuttle onto the nadir MT/CETA rail shall be governed by a 200 lb tether load and shall not exceed a line contact load of 300 lbs. between a wheel bogie roller and the MT/CETA rail.

The Tether Shuttle and the PG–1 Tether Shuttle rail stops inboard of the SARJ shall be capable of withstanding a compressive load of 1500 lbs (limit) due to impact of the Tether Shuttle onto the Tether Shuttle rail stop. The compressive load shall be applied over a minimum impact area of 0.3 inches by 1.0 inch and restricted to the impact areas specified in Figure 3.4.1.1–3 and Figure 3.4.1.1–4. Note that the compressive load of 1500 lbs is an equivalent static load that

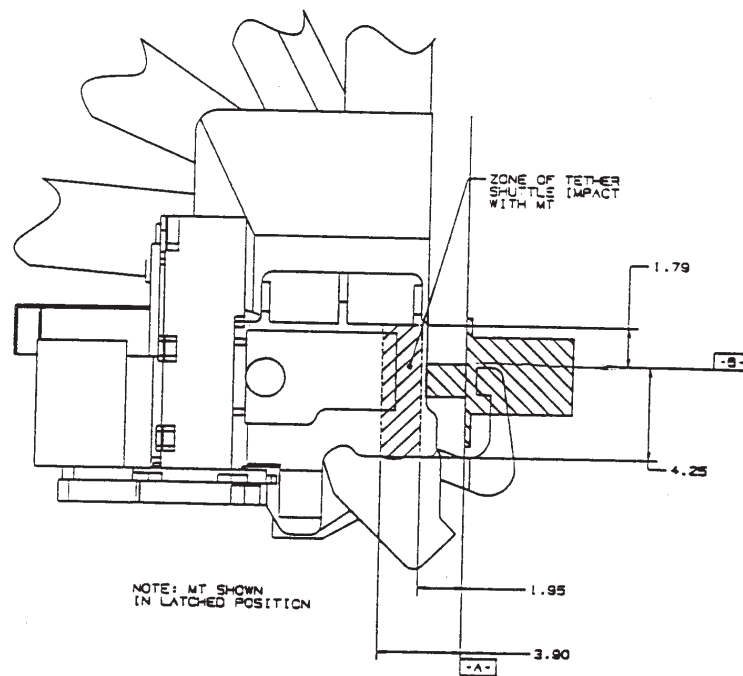


FIGURE 3.4.1.1-5 TETHER SHUTTLE TO MOBILE TRANSPORTER INTERFACE – MOBILE TRANSPORTER

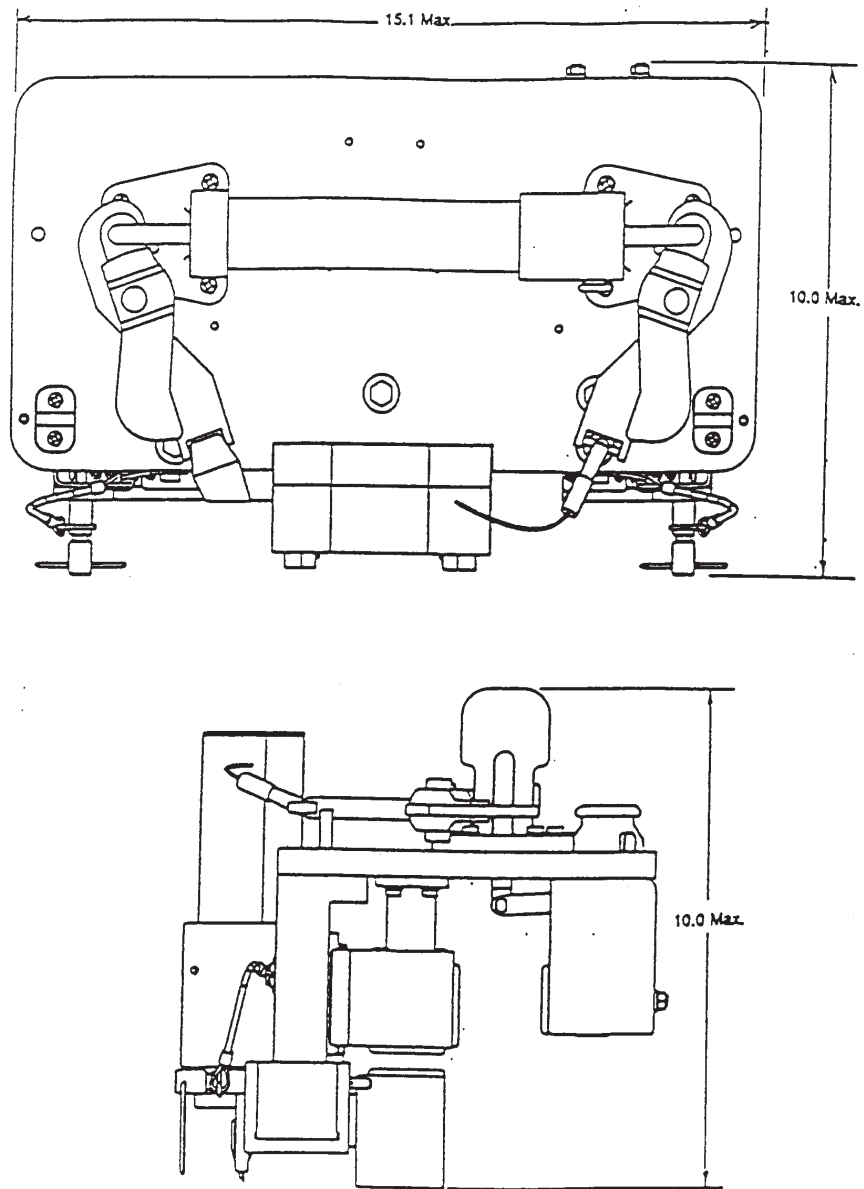


FIGURE 3.4.1.2.1-1 TETHER SHUTTLE STOWAGE ENVELOPE

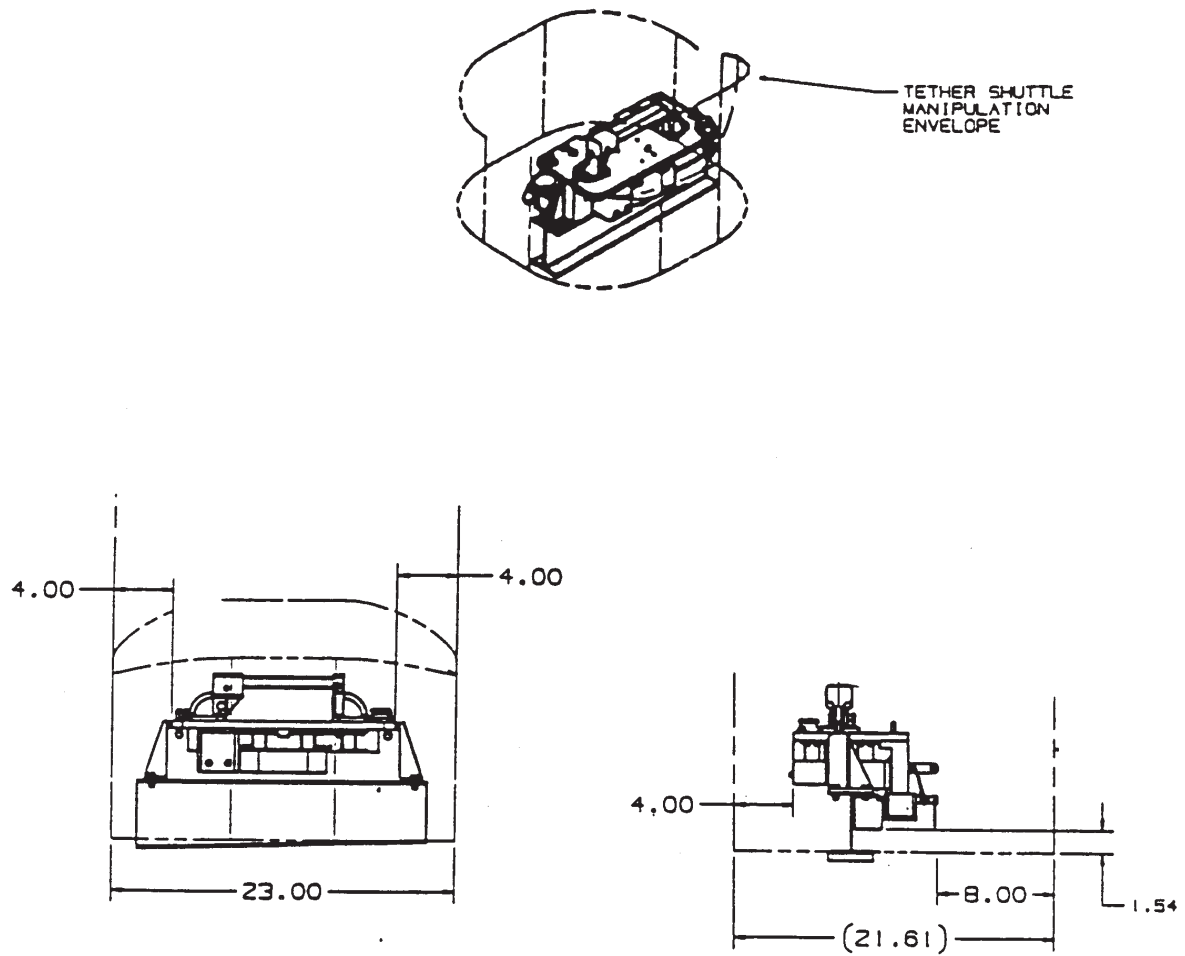


FIGURE 3.4.1.2.2-1 TETHER SHUTTLE EVA ACCESS ENVELOPE

corresponds to the Tether Shuttle moving at 3 ft/sec with a total mass of 25 lbm at impact to a Tether Shuttle rail stop.

#### **3.4.1.3.3 MASS PROPERTIES**

The maximum weight of the Tether Shuttle is 25 lbs. without the Extended Range Crewmember (ERCM) safety tether reel. The location of the Tether Shuttle center-of-gravity (CG) is shown in Figure 3.4.1.1-2 and Figure 3.4.1.1-3.

#### **3.4.1.4 MECHANICAL**

##### **3.4.1.4.1 MATERIALS**

Tether Shuttle materials meet the requirements of SSP 30233, Space Station Requirements for Materials and Processes.

##### **3.4.1.4.2 SURFACE FINISH**

Tether Shuttle surface finishes meet the requirements of SSP 30233, Space Station Requirements for Materials and Processes.

##### **3.4.1.5 THERMAL**

The Tether Shuttle is designated as "unlimited contact" EVA interface. Thermal control of this hardware is achieved by passive techniques. Contacting MT rail surfaces are calculated to be within the range between -85° F and +185° F.

##### **3.4.1.6 ELECTRICAL BONDING**

The Tether Shuttle launch restraint contact surfaces, as indicated in Figure 3.4.1.1-2 and Figure 3.4.1.1-3, will satisfy a Class S bond per SSP 30245, Space Station Electrical Bonding Specification, in its entirety.

#### **3.4.2 CETA CART**

This section defines CETA Cart to Integrated Truss Segment (ITS) interfaces inboard of the Solar Alpha Rotary Joints (SARJ).

The CETA Cart provides for restrained and controlled translation of the crew, EVA equipment, and cargo (ORUs) along the MT-CETA rails. The CETA Cart provides the capability to be used as an EVA work platform at worksites in proximity to the Integrated Truss Segment (ITS) structure. To translate the CETA Cart along the MT rail, the EVA crewmember is provided the

CETA handrails located along side the Nadir MT–CETA rail on Face 1. The CETA Handrails are the responsibility of the ITS providers. The CETA Cart launch and on–orbit configurations are shown in Figures 3.4.2–1 and 3.4.2–2, respectively.



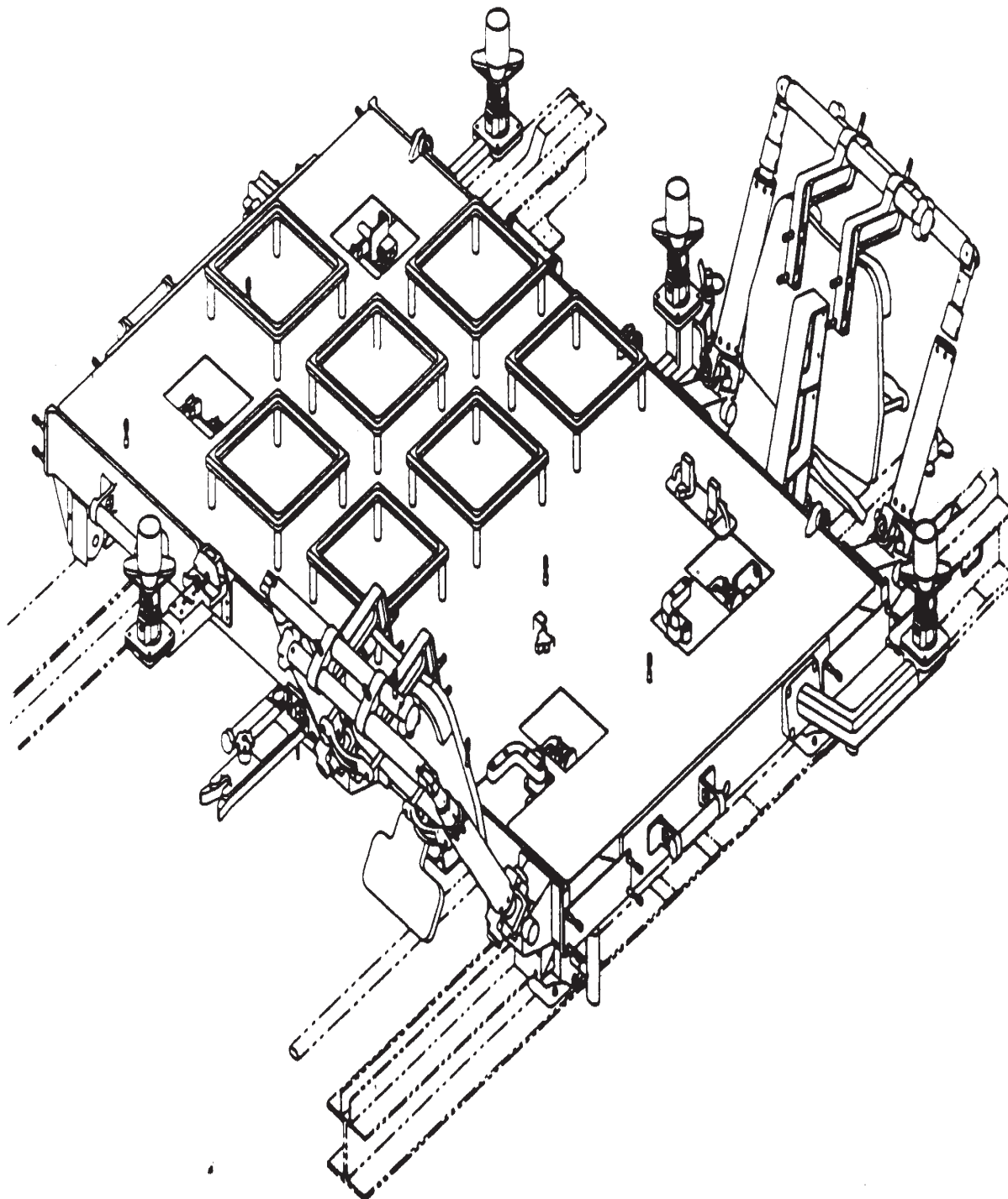


FIGURE 3.4.2-1 CETA CART LAUNCH CONFIGURATION

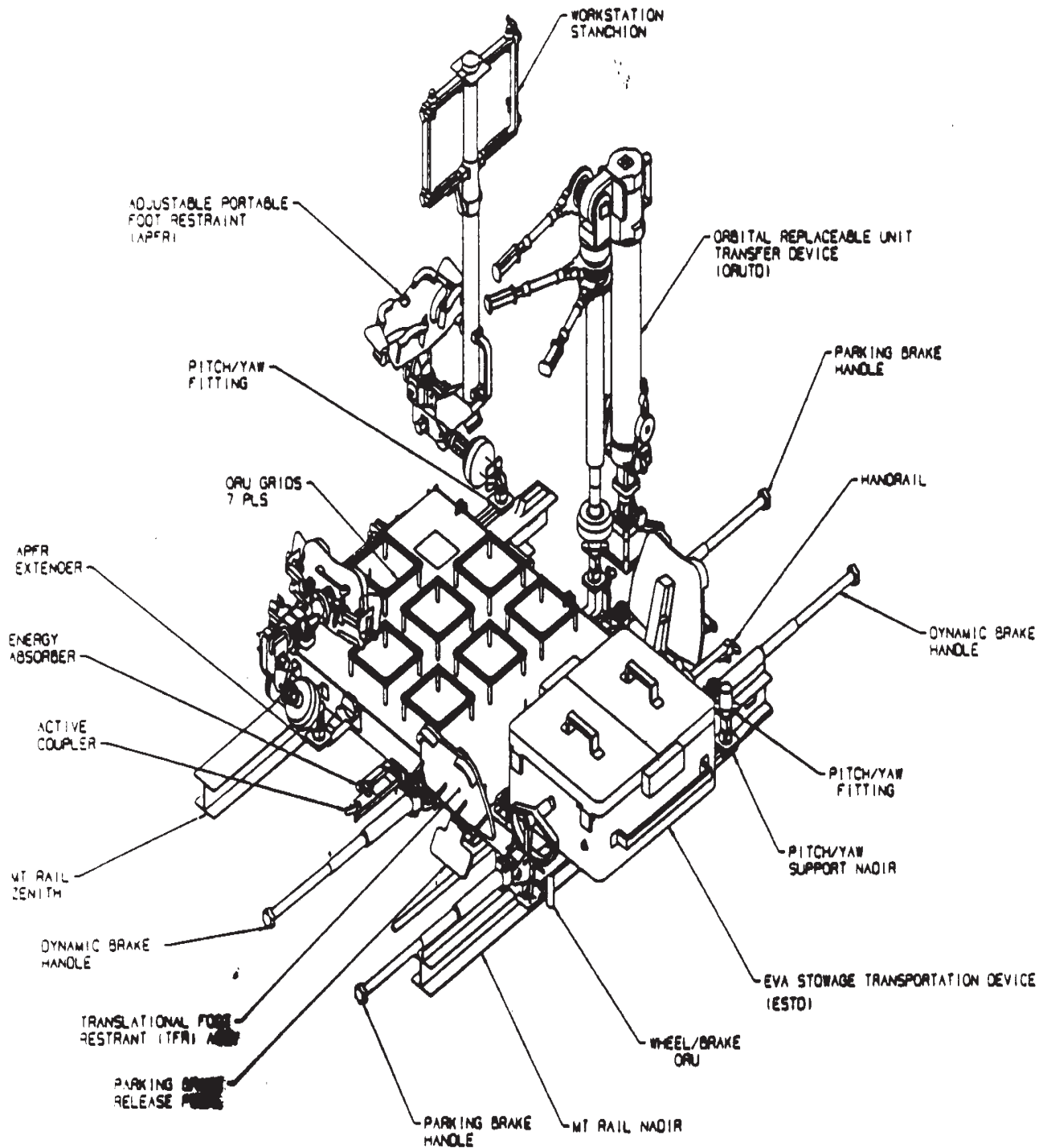


FIGURE 3.4.2-2 CETA CART ON-ORBIT TRANSLATION CONFIGURATION

### 3.4.2.1 INTERFACE DESCRIPTION

The CETA Cart interfaces with several ISS elements. The first is with ITS segments S1 and P1 for launch. The second is with the MT–CETA rails. The third is with the ITS structure. The fourth is with the Mobile Transporter (MT). And the final CETA Cart interface is with cargo (ORU or ORU(s) on CHIA subcarriers/cargo pallet). Note that any dimension that is shown as a maximum (Max) or a minimum (Min) and that is a CETA Cart controlled dimensions, area, etc. shall not be impinged upon by the opposing interfacing element.

Maximum: the highest that that value can be without affecting the CETA Cart design

Minimum: the lowest that that value can be without affecting the CETA Cart design

If a Max or Min value is an ISS element controlled value, it shall not be impinged upon by the CETA Cart.

#### 3.4.2.1.1 CETA CART LAUNCH INTERFACE

The first CETA Cart interface is with ITS S1 and P1 and is used for launching the CETA Carts to orbit. One CETA Cart is launched on ITS S1 and the other is launched on ITS P1. The CETA Cart launch configuration is shown in Figure 3.4.2–1. The launch restraint locations of the CETA Cart on S1 and P1 is defined by the integrator those Truss Segments. Those locations are specified in Figure 3.4.2.1.1–1 ( $Y = +149.750$  on Segment S1 and  $Y = -149.750$  on Segment P1). These two values are relative to the ITS S1/P1 coordinate system and defines the location of the center of the launch restraint hole pattern (in Y axis). Figure 3.4.2.1.1–1 also shows the ITS structure (S1 and P1) bolt hole pattern and hole size to be supplied by Segments S1 and P1 for the CETA Cart launch restraint system and are dimensioned relative to the MT–CETA Rail datums. Figure 3.4.2.1.1–2 shows the floating nut that is provided by the S1/P1 provider onto which the CETA Cart launch restraint bolts will attach.

The CETA Cart provider is responsible for providing the launch restraints (fasteners/bolts) that attach the CETA Carts to ITS S1 and P1. The CETA Cart bolt pattern interfaces supplied by the CETA Carts are shown in Figure 3.4.2.1.1–3 and are dimensioned relative to the CETA Cart datums. Figure 3.4.2.1.1–3 shows the CETA Cart bolt hole pattern and bolt size relative to the CETA Cart datums and also shows the flatness requirements for both the CETA Cart and the MT–CETA rail at the launch location on S1 and P1.

The launch restraint bolt pattern on the CETA Cart and the bolt hole pattern on Segments S1 and P1 shall be located by a Support Fixture (drill template) that is to be provided by the ITS S1 and P1 provider (MDA–Huntington Beach). The Support Fixture shall then be used to locate the four (4) hole pattern onto ITS S1 and P1 within the tolerance specified in Figure 3.4.2.1.1–1 and Figure 3.4.2.1.1–3. The Support Fixture shall then be used to locate the same four (4) bolt hole pattern onto the two CETA Carts. This will assure that the 4 bolt hole pattern is the same on both the CETA Carts and on the ITS launch locations.

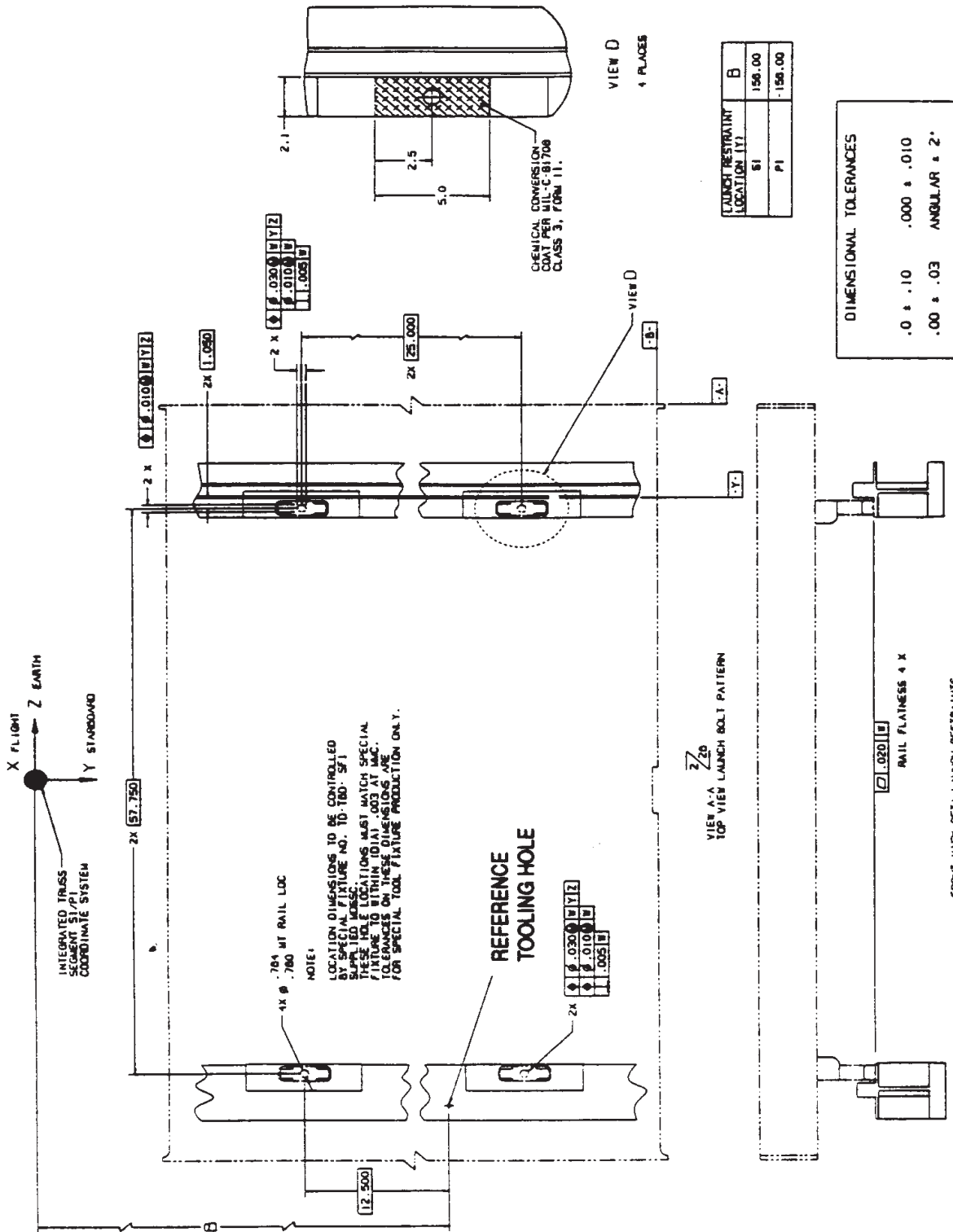


FIGURE 3.4.2.1.1-1 CETA CART LAUNCH RESTRAINT FOOT PRINT AND BOLT PATTERN

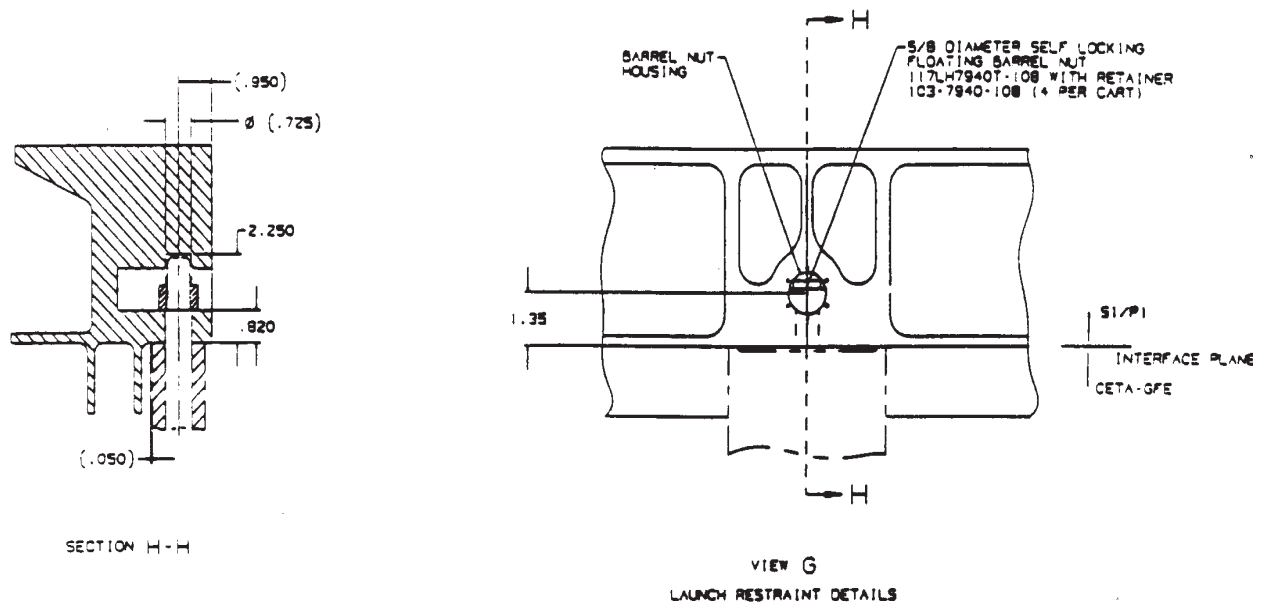


FIGURE 3.4.2.1.1-2 CETA CART LAUNCH RESTRAINT DETAILS



Figure 3.4.2.1.1–1 shows the footprint envelope that the CETA Cart launch restraint must stay within and also shows the footprint relative to the 4 bolt hole pattern set on the MT–CETA rails. Figure 3.4.2.1.1–3 (View C) shows the CETA Cart launch restraint footprint relative to the bolt centerline. Figure 3.4.2.1.1–4 (View B) shows the CETA Cart wheel bogie spacing requirements while on the MT–CETA rail at the launch location on S1 and P1.

In order to support the attachment of the CETA Cart(s) to ITS S1 and P1, the CETA Cart provides four lift points. The lift points locations and the hole diameter and thread size are defined in Figure 3.4.2.1.1–4. Note that the CETA Cart will be delivered with lifting eyelets on each of the lifting points. Two stay out zones are also defined in Figure 3.4.2.1.1–4. These stay out zones are required only during installation of the CETA Cart onto the ITS and are required for the attachment of the four CETA Cart launch restraints. The lifting point locations and the stay out zones are dimensioned relative to CETA Cart datums –A– and –B–.

Figure 3.4.2.1.1–4 also shows a top view of the CETA Cart in its Launch configuration. Figure 3.4.2.1.1–5 shows an end view of the CETA Cart (while on the MT–CETA rail launch location). This view shows the envelope dimensions in the “Z” and “X” directions (relative to the ISS coordinate system).

### 3.4.2.1.2 CETA CART TO MT–CETA RAIL INTERFACE

The second CETA Cart interface is with the MT–CETA rails (on Face 1 of the ITS from S3 to P3). The MT–CETA rails allow the CETA Carts to attach to the ISS and allow the crew to translate EVA equipment and cargo along Face 1 of the ITS. The MT–CETA rails are placed such that one is on the Nadir side of Face 1 and one on the Zenith side of Face 1. This interface consists ITS joints and profiles. Figure 3.4.2.1.2–1 (View Y and View DE) show the profile views of the Nadir and Zenith rails. Figure 3.4.2.1.2–1 also defines the relationship that must be maintained between the two rails (nadir & zenith). Even though Figure 3.4.2.1.2–1 gives a nominal nadir and zenith height for the vertical flange of  $1.80 \pm .06$ , the maximum possible vertical interference is defined by the MT worksite tie down points as  $2.475 \pm .003$  inches above Datum –W–. As stated before, the MT–CETA rails have gaps and misalignments at the various segment–to–segment connections and also at the junctions at each SARJ. Figure 3.4.2.1.2–2 shows the maximum ITS to ITS joint gaps and misalignments. Figure 3.4.2.1.2–3 shows the tapers at the end of each rail at the ITS to ITS connections.

The SARJ consists of three segments of rail that when aligned allow the MT and the CETA Carts to cross the SARJ connection. Figures 3.4.2.1.2–4, 3.4.2.1.2–5, and 3.4.2.1.2–6 show the relationship between the three segments of rail. Figures 3.4.2.1.2–7 and 3.4.2.1.2–8 show the maximum SARJ gaps and misalignments at the two joints that make up the SARJ connection. Figures 3.4.2.1.2–9 and 3.4.2.1.2–10 show the tapers at the end of each rail segment at the two SARJ gaps. Figure 3.4.2.1.2–11 shows periodic indentations created by tie down sensors for the MT that are located on the MT–CETA rails.









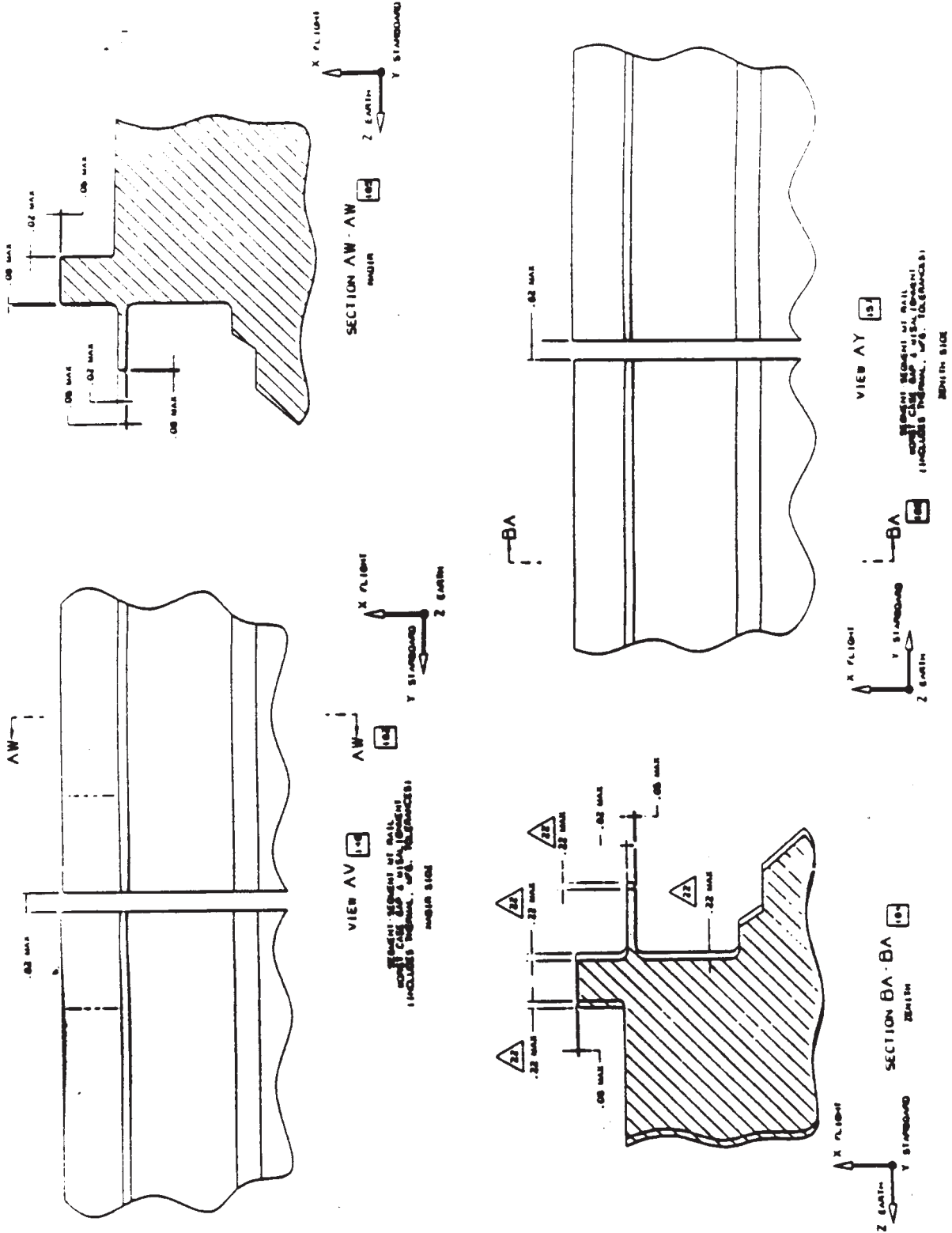


FIGURE 3.4.2.1.2-2 MT-CETA RAIL ITS SEGMENT TO ITS SEGMENT GAPS AND MISALIGNMENTS





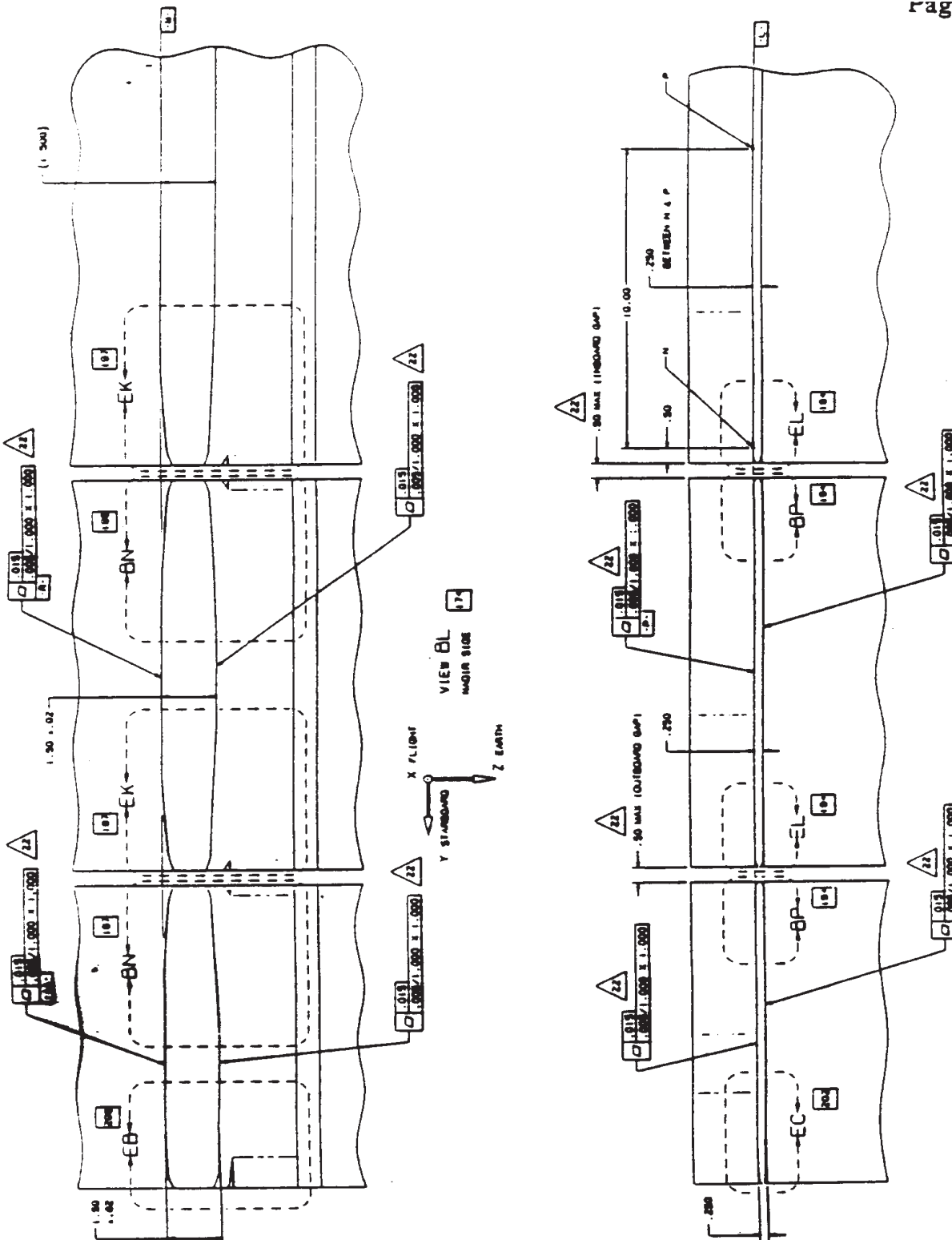


FIGURE 3.4.2.1.2-5 SOLAR ARRAY ROTARY JOINT SEGMENT RELATIONSHIPS – NADIR DETAIL

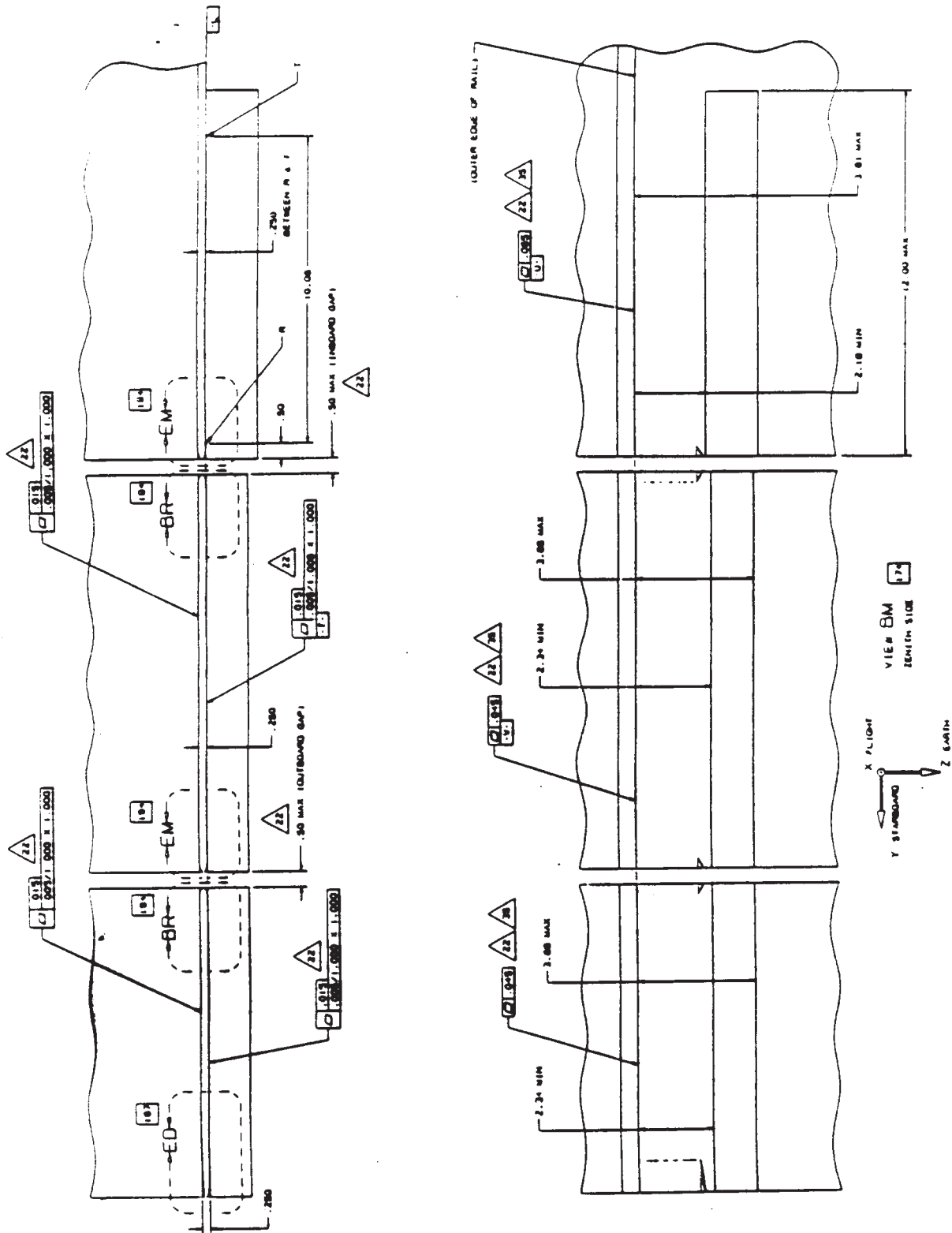


FIGURE 3.4.2.1.2-6 SOLAR ARRAY ROTARY JOINT SEGMENT RELATIONSHIPS - ZENITH DETAIL







During on-orbit usage, the CETA cart dynamic brakes, parking brakes, and the CETA cart wheel bogies will physically interface with the MT-CETA rails. The CETA Cart nominal wheel bogies spacings are shown in Figure 3.4.2.1.1-4 and the removal envelope in Figure 3.4.2.1.2-12.

### 3.4.2.1.3 CETA CART TO ITS STRUCTURE INTERFACE

The third interface, CETA Cart to ITS structure, encompasses three interfaces; worksite setup locations from the CETA cart, CETA Cart translation envelope relative to the ITS structure, and the CETA Cart energy absorbers to the MT-CETA Stops interface. A nominal on-orbit configuration of the CETA Cart is shown in Figure 3.4.2-2 which is used in determining these interfaces. Figure 3.4.2.1.3-1 defines the interface between the MT-CETA rails and the CETA.

The CETA Cart worksite locations are shown in Figure 3.4.2.1.3-2. Figure 3.4.2.1.3-2 also shows the WIF Pitch/Yaw fitting locations and the handhold locations on the CETA Cart. Note that one of the WIF Pitch/Yaw fittings is located on an extender that can be moved from 7 inches to 36 inches from the edge of the CETA Cart at 3.25 inch increments. To allow greater flexibility in setting up the APFRs to the necessary orientations, the CETA Cart provides Pitch/Yaw fittings underneath each WIF. Figure 3.4.2.1.3-3 shows pitch/yaw fitting articulation travel and the increment spacings.

The CETA Cart energy absorbers interface with the MT-CETA rail stops located on Face 1 at the ends of each ITS (located between the MT-CETA rails). Figures 3.4.2.1.3-4 and Figure 3.4.2.1.3-5 show details of the CETA Cart to MT-CETA rail stop. The CETA Energy Absorber misalignment envelope is defined by the rectangle with the dimensions .475 by .357 as shown in Figure 3.4.2.1.3-4 and is dimensioned relative to Datums -W- and -Y- (MT-CETA rail Datums).

### 3.4.2.1.4 CETA CART TO MOBILE TRANSPORTER (MT) INTERFACE

The fourth CETA Cart interface is with the Mobile Transporter (MT). This CETA Cart interface encompasses the location and the supplied elements (provided by the CETA Cart provider) of the system that couples the CETA Cart(s) to the MT. The coupling system elements is provided by the CETA Cart provider. The CETA Carts attach to the Mobile Transporter while on the MT-CETA rail or to the second CETA cart that is attached to the MT to CETA coupler engaged during on-orbit stowage. These are unique MT stowage sites. In addition, once the CETA Cart(s) are coupled to the MT, the relationship between these two elements creates a larger system that must be controlled by the Prime Integrator to other ISS elements.

The active and passive coupler as shown in Figures 3.4.2.1.4-1 and 3.4.2.1.4-2 are provided by the CETA Cart to the MT integrator/provider. Figures 3.4.2.1.4-1 and 3.4.2.1.4-2 also show the maximum allowable envelope dimensions for the active and passive couplers. The MT integrator/provider shall assure that the active and passive coupler attachment points are



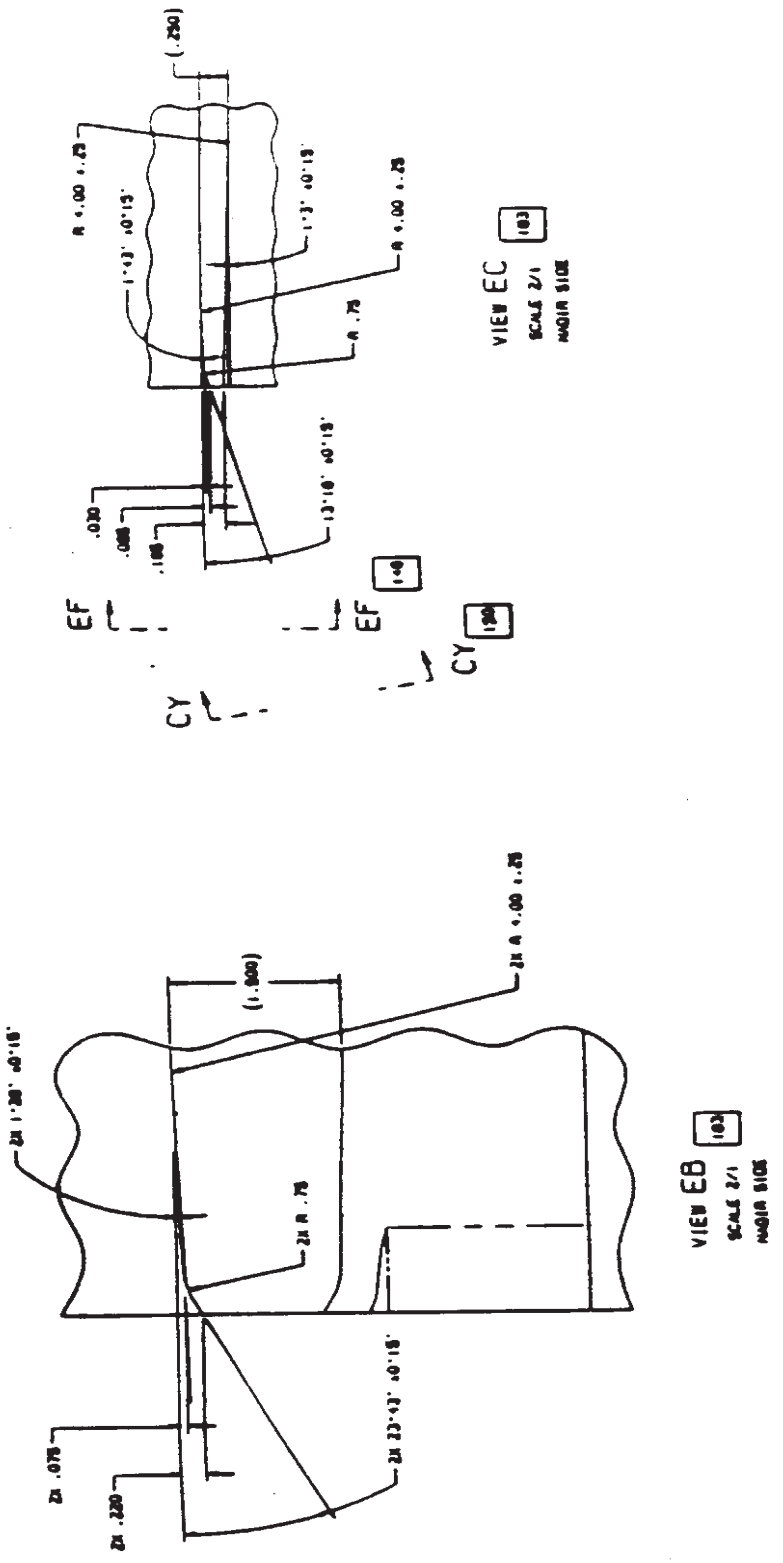


FIGURE 3.4.2.1.2-10 SOLAR ARRAY ROTARY JOINT RAIL END TAPERS (CONT'D)

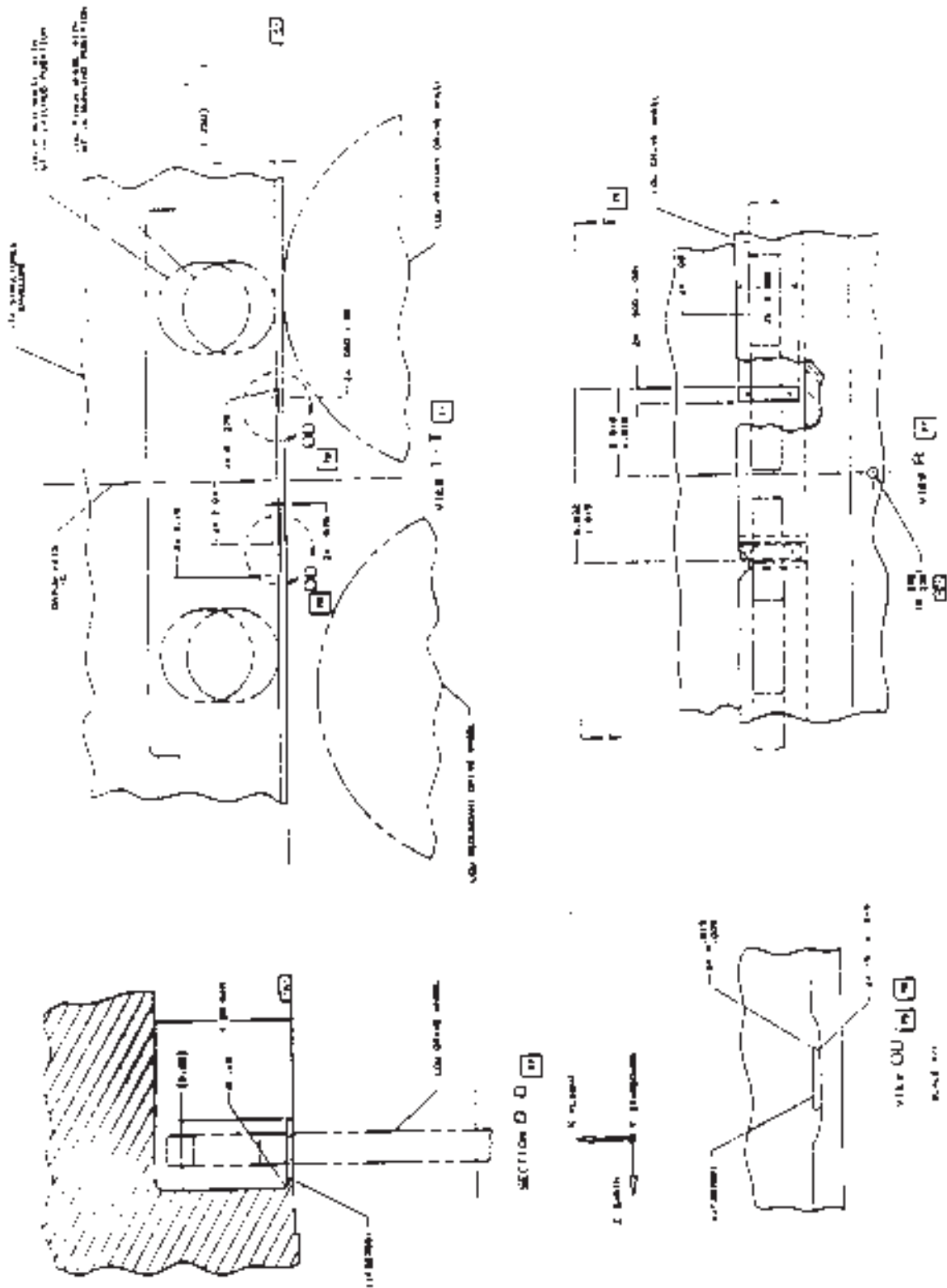


FIGURE 3.4.2.1.2-11 MT TIE DOWN SENSOR DETAILS

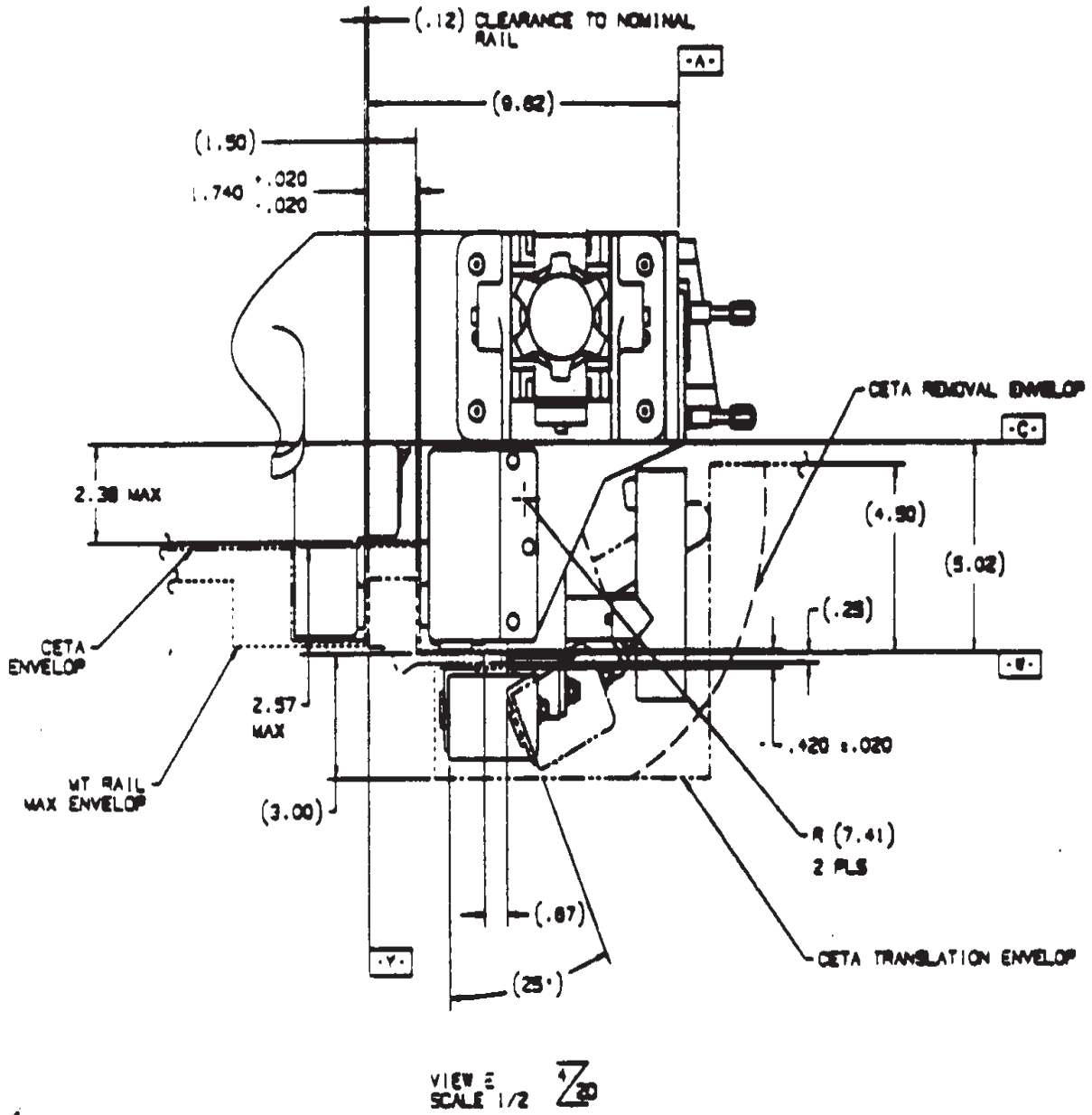
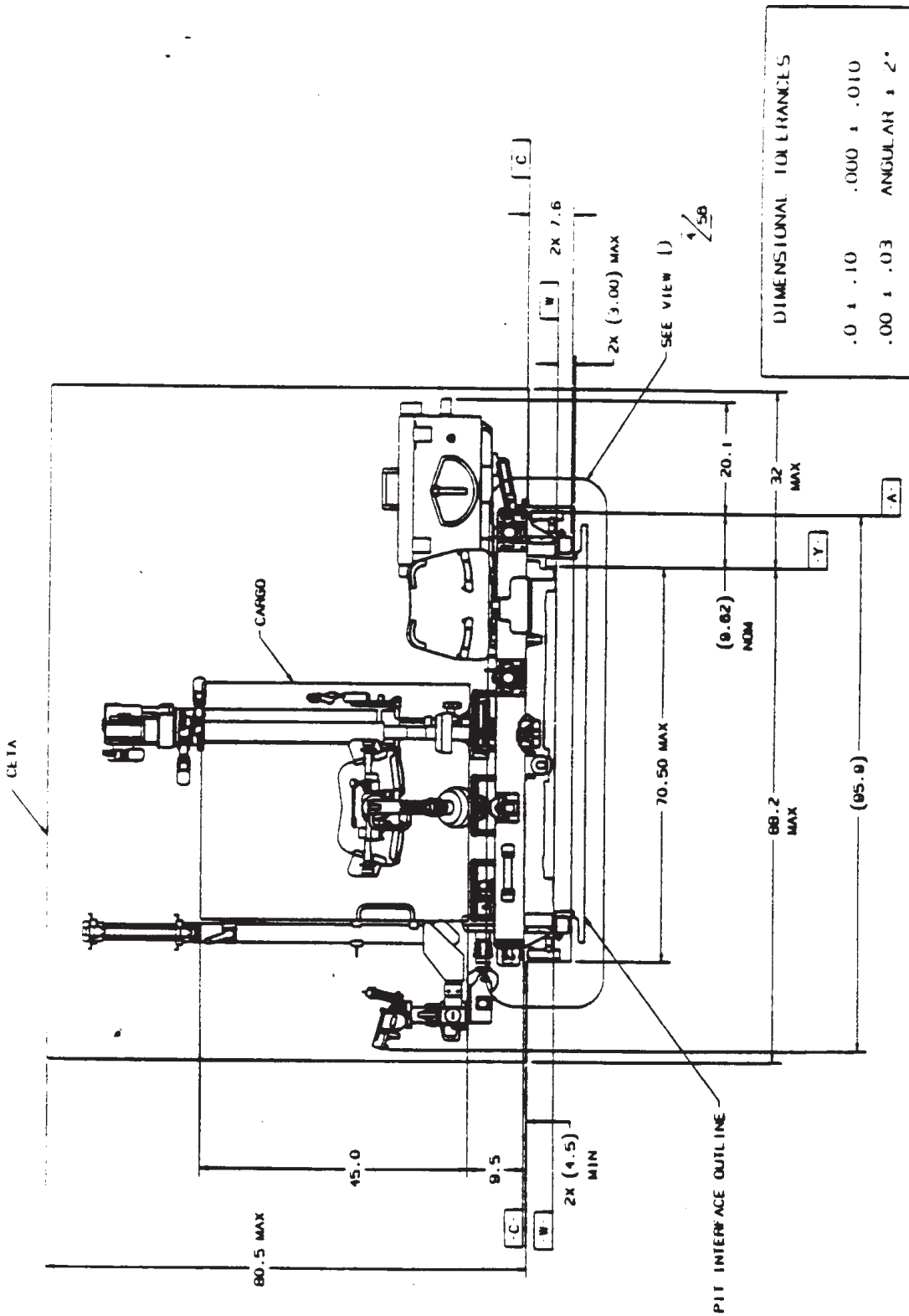
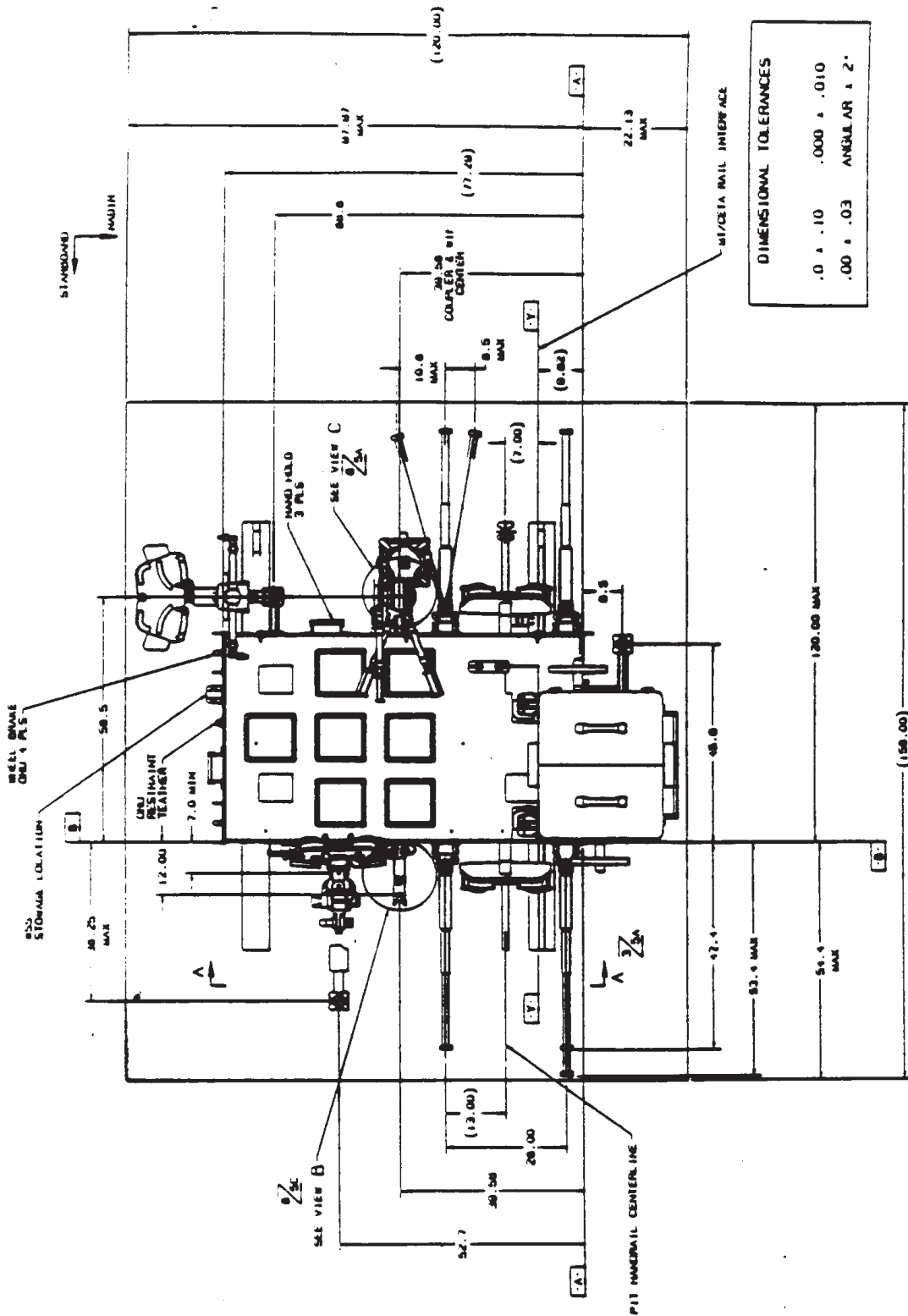


FIGURE 3.4.2.1.2-12 CETA WHEEL BOGIE REMOVAL ENVELOPE



VIEW A-A  $\frac{2}{30}$   
 CETA ON ORBIT TRANSLATION ENVELOP

FIGURE 3.4.2.1.3-1 CETA CART FRAME TO MT-CETA RAIL INTERFACE



CETA ON ORBIT TRANSLATION ENVELOPE

FIGURE 3.4.2.1.3-2 CETA CART WORKSITE LOCATIONS



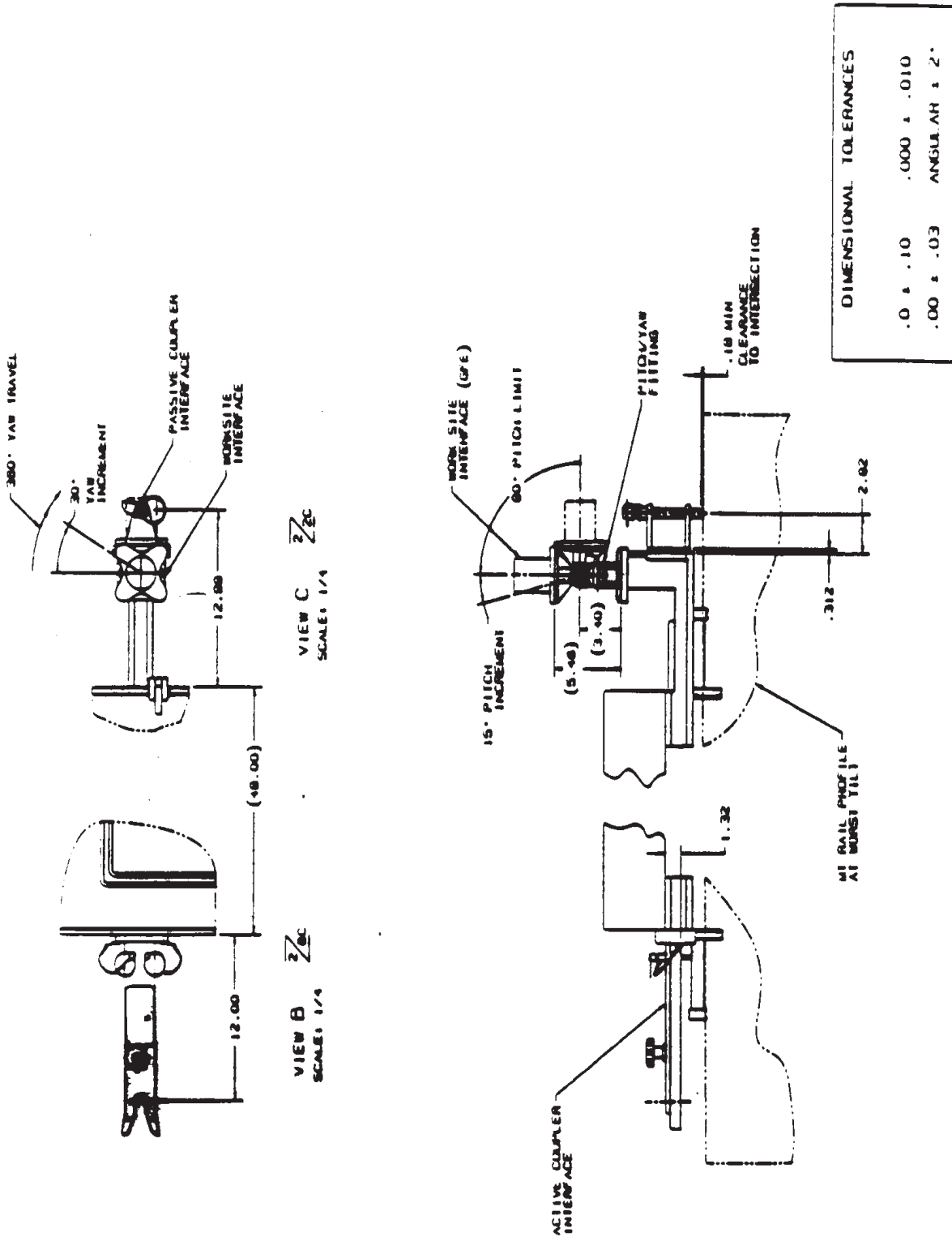


FIGURE 3.4.2.1.3-3 CETA PITCH/YAW FITTING ARTICULATION RANGE AND INCREMENTAL SETTINGS





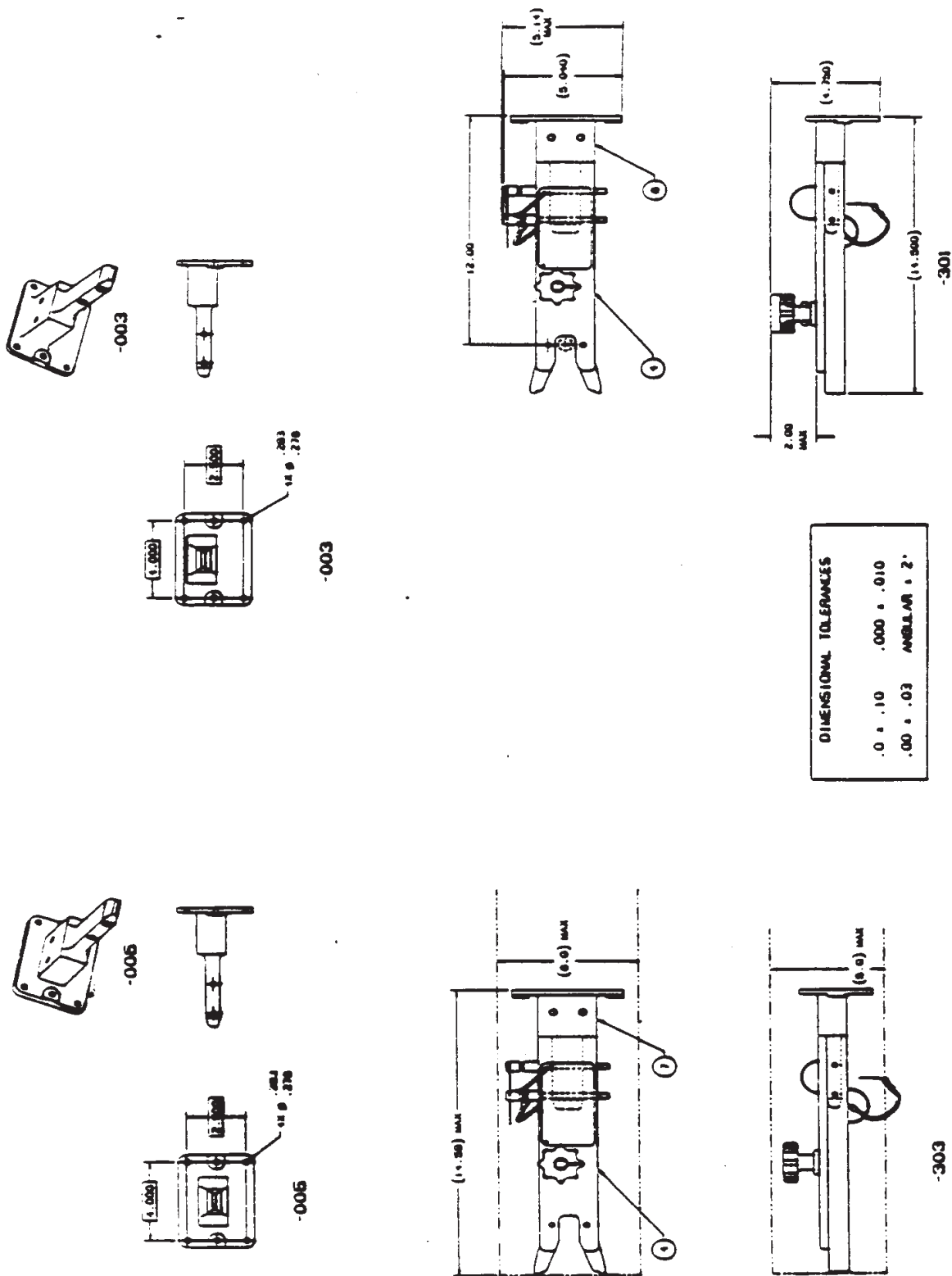


FIGURE 3.4.2.1.4-1 CETA CART ACTIVE COUPLER

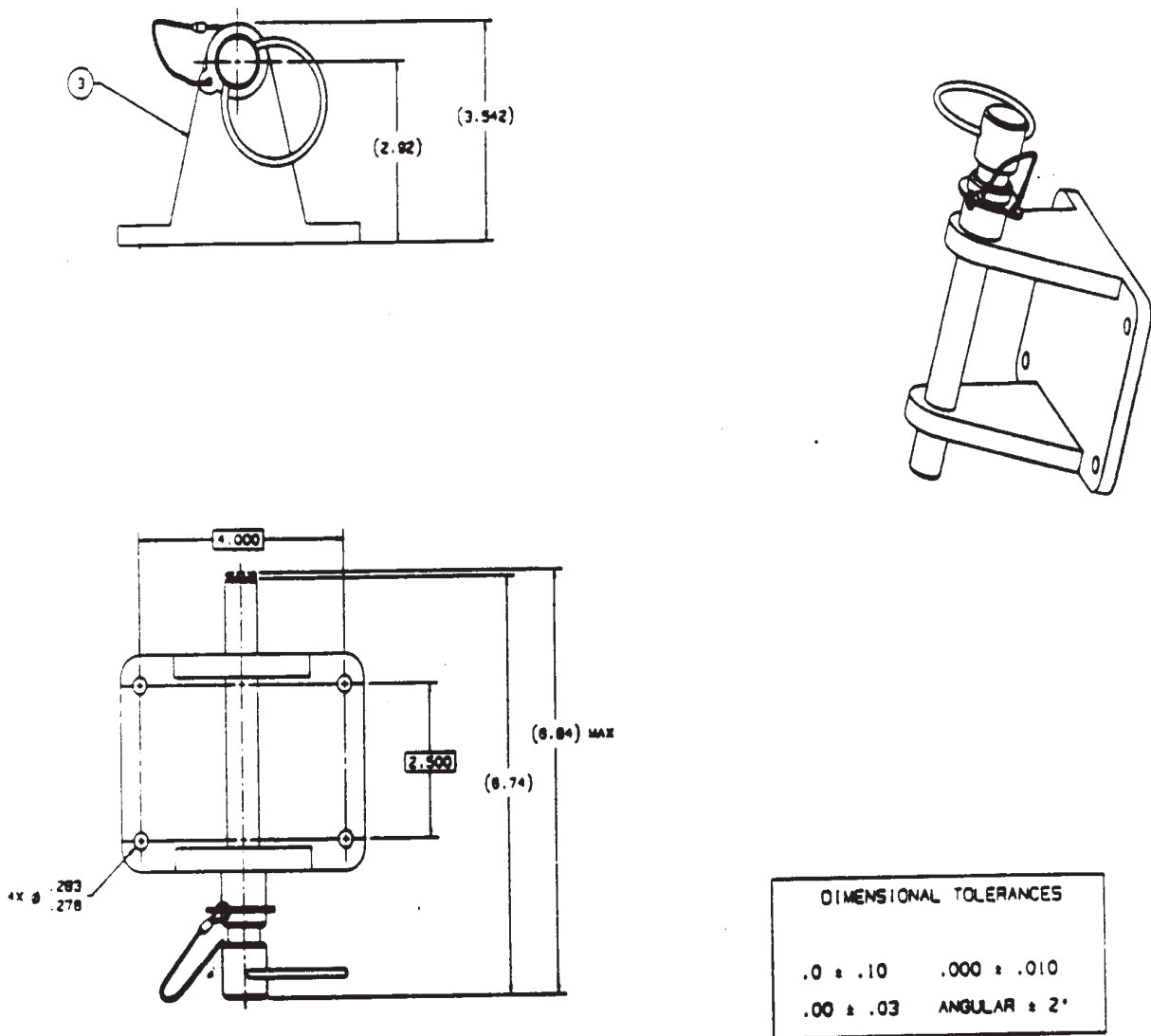


FIGURE 3.4.2.1.4-2 CETA CART PASSIVE COUPLER

located within the envelope and by the hole pattern specified in Figures 3.4.2.1.4–1, 3.4.2.1.3–2, and 3.4.2.1.3–3.

### **3.4.2.1.5 CETA CART TO CARGO INTERFACE**

The final CETA Cart interface is with cargo. Cargo is defined as a CHIA subcarrier/cargo pallet that includes an Active Common Structural Interface (CSI) latching mechanism and attached ORUs. In order to support attachment of cargo onto the CETA Cart, several Passive Common Structural Interfaces (CSIs) Grids are supplied by the CETA Cart per Figure 3.4.2.1.5–1. In addition, the CETA Cart allows a maximum footprint for cargo per Figure 3.4.2.1.5–1.

### **3.4.2.2 ENVELOPE**

#### **3.4.2.2.1 HARDWARE**

The maximum envelope of each CETA cart for launch is 89 in. (brake handles retracted and stowed for launch) longitudinally x 93.5 in. laterally x 32 in. in height above Datum W of the rail. Figures 3.4.2.1.1–4 and 3.4.2.1.1–5 reflect the CETA launch envelope.

The maximum on-orbit envelope of each CETA cart includes the EVA Tool Stowage Device, the ORU Transfer Device, and the Articulating Portable Foot Restraint with Tool Stanchion, as well as the maximum volume of cargo. Figures 3.4.2.1.3–1 and 3.4.2.1.3–2 show the CETA on-orbit envelope.

The CETA will operate within the MT/MBS translation envelope. The minimum translation envelope required for CETA along the entire rail length is described by a 136 in. lateral x 133 in. high (above the truss stay out envelope) rectangle.

#### **3.4.2.2.2 EVA**

In order to limit loads onto the MT/CETA rail, the CETA Cart shall only be utilized by a single crewmember at an EVA worksite. EVA crewmembers shall perform only translation operations from the Translation Foot Restraint (TFR).

### **3.4.2.3 STRUCTURAL**

#### **3.4.2.3.1 STIFFNESS**

The natural frequency of the CETA final design shall be greater than 35 Hz.

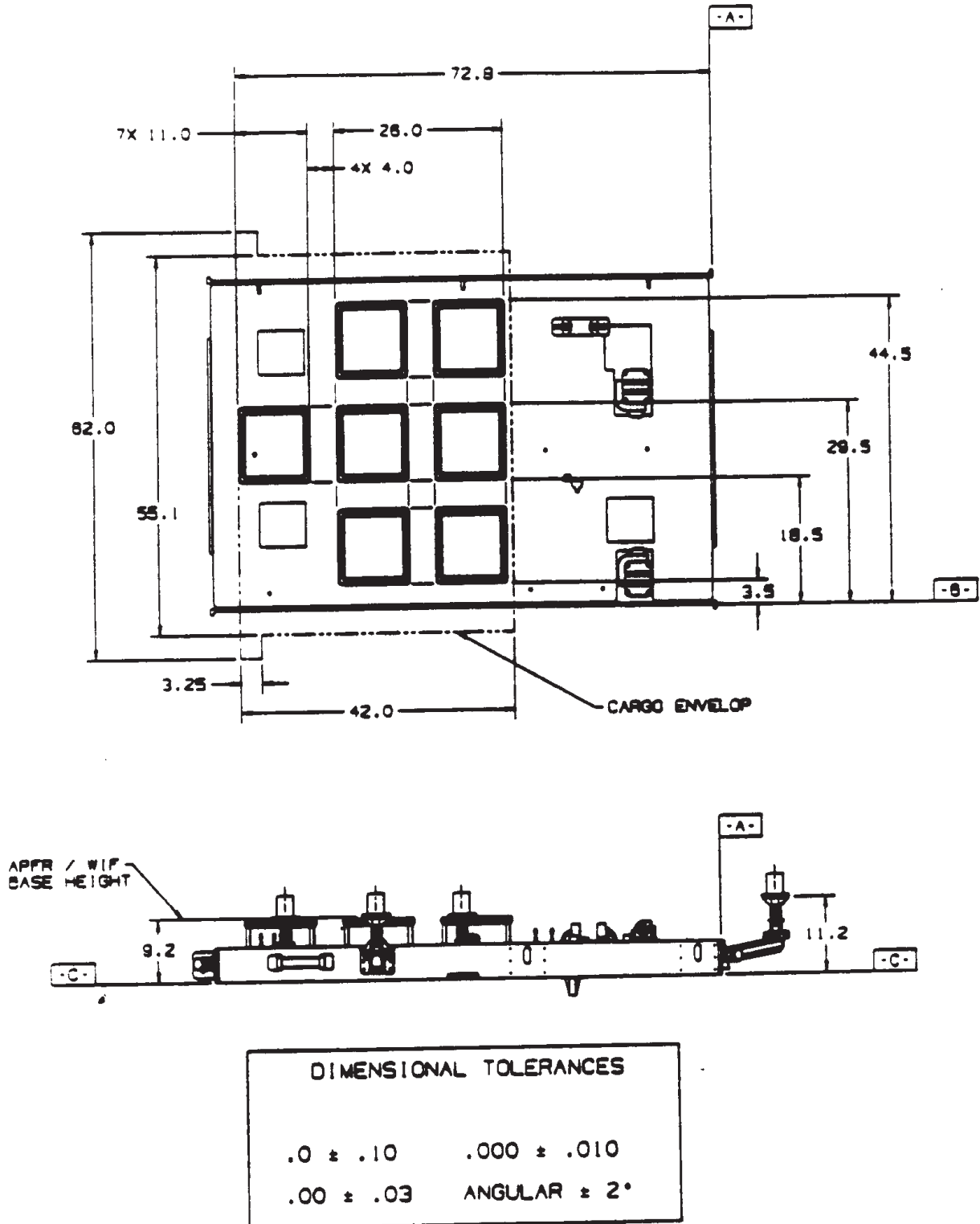


FIGURE 3.4.2.1.5-1 CETA CART CARGO INTERFACE AND MAXIMUM CARGO FOOTPRINT

### 3.4.2.3.2 LOADING

There will be no separation or gapping at the CETA Cart to ITS S1 or P1 launch interfaces. The launch loads and load factors shall not exceed those shown in Tables 3.4.2.3.2-1 and 3.4.2.3.2-2 below. The CETA Cart shall be designed to no less than these limit loads. These launch loads are derived from coupled loads analysis conducted by the ITS S1 and P1 integrators.

**TABLE 3.4.2.3.2-1 CETA CART INTERFACE PEAK LAUNCH LOADS**

| Fx (lbf) | Fy (lbf) | Fz (lbf) | Mx (lbf) | My (lbf) | Mz (lbf) |
|----------|----------|----------|----------|----------|----------|
| +/- 2312 | +/- 1178 | +/- 2262 | +/- 5154 | +/- 6708 | 0        |

**TABLE 3.4.2.3.2-2 CETA CART NSTS MAXIMUM FLIGHT LOAD FACTORS**

| Nx (G)          | Ny (G)          | Nz (G)          |
|-----------------|-----------------|-----------------|
| + 2.37 / - 5.60 | + 2.86 / - 2.93 | + 6.81 / - 5.66 |

The CETA energy absorbers shall not induce loads greater than 400 lbs onto the MT-CETA rail stops and the MT-CETA rail stops shall be capable of withstanding loads up to 400 lbs.

The interface between the CETA Carts (wheel bogies and brakes) and the MT-CETA rail shall be capable of withstanding loads up to 300 lbs. between the CETA Cart interface to MT-CETA rails. Note that the CETA Carts are to cross the SARJs at no greater than 1 ft/sec in order to avoid exceeding the 300 lb. rail impact load.

The interface between the CETA Carts couplers and the MT shall be capable of withstanding loads up to 250 lbs. between the CETA Cart coupler interface to MT/MT Energy absorbers.

The interface between the CETA Cart CSI grids and Cargo shall be capable of withstanding loads of up to 125 lbs. in shear and 5625 in-lbs (125 lb x 45 inches) in bending and torsion. These loads are at the attachment between the CETA Cart CSI grid interface(s) and the stored cargo (via an active latching mechanism on the CHIA subcarrier/cargo pallet).

### 3.4.2.3.3 MASS PROPERTIES

The launch weight of the CETA cart shall not exceed 632 lbs. The maximum mass of a loaded CETA cart, including crew and EVA removable CETA ancillary equipment, i.e., ETSD, OTD, PFRWS, and APFRs will be operationally maintained to a mass not to exceed 2200 lbm. The launch weight of the active portion of the CETA coupler, launched mounted to a Mobile Transporter energy absorber, shall not exceed 5.5 lbs. The launch weight of the passive portion of the CETA coupler, launched mounted to a Mobile Transporter energy absorber, shall not exceed 2.0 lbs.



### **3.4.2.4 MECHANICAL**

#### **3.4.2.4.1 MATERIALS**

CETA cart materials meet the requirements of SSP 30233, Space Station Requirements for Materials and Processes.

#### **3.4.2.4.2 SURFACE FINISH**

CETA cart surface finishes meet the requirements of SSP 30233, Space Station Requirements for Materials and Processes.

#### **3.4.2.5 THERMAL**

The CETA cart is designated as “unlimited contact” EVA interface. Thermal control of this hardware is achieved by passive techniques. Contacting Mobile Transporter rail surface temperatures are calculated to be within the range between  $-85^{\circ}$  and  $+185^{\circ}$ F.

#### **3.4.2.6 ELECTRICAL BONDING**

The CETA cart launch restraint contact surfaces, as indicated in Figure 3.4.2.1.1–1, will satisfy a class S bond per SSP 30245, Space Station Electrical Bonding Requirements, in its entirety.

### **3.5 ORBITAL REPLACEABLE UNIT TRANSFER DEVICE (OTD)**

The OTD is a crane–like device with an extending/retracting boom mechanism that is to be used to restrain and translate cargo and ORUs of up to 600 lb. mass, and EVA equipment. Figure 3.5–1 shows the OTD.

The OTD is primarily operated from the CETA cart (see figure 3.5–2) in support of on–orbit maintenance operations conducted by an EVA crewmember from the CETA Cart. The OTD can also be used from specific passive WIF(s) on Truss Segment P3 in order to support retrieval of cargo (ORUs and cargo pallets) from the ULCs that are attached to Truss Segment P3. This will only occur when the SSRMS, Mobile Transporter, or the SPDM are not operational.

#### **3.5.1 INTERFACE DESCRIPTION**

There are three interfaces between the OTD and ISS elements. The first is with cargo. The second is with structures from which the OTD will be operated. These structures must have passive WIFs on which to attach the OTD and the structure must be able to support the loads produced by the OTD. The third is the interfaces between the OTD and launch FSE.

The OTD interfaces with cargo via the OTD common structural interface (CSI) passive grid. The CSI passive grid design is the same as the TERA grid shown in Figure 3.3.2.1-1, TERA ORU Adapter Plate Interface.

The OTD is primarily operated from the CETA Carts. The OTD can be installed on any of the passive WIFs on the CETA Carts. Two locations on Truss Segment P3 have been identified as OTD installation locations to support transport of cargo from the ULCs on P3 to the CETA Carts. Any OTD stowage location or on-orbit operating location must meet the loads specified in paragraph 3.5.3.1. Two passive WIFs have been identified that can support the OTD loads on Truss Segment P3. Passive WIF #1 on Face 3, shown in Figure 3.5.1-1, and a corresponding Passive WIF on Face 5.

To support the launch of the OTD, OTD grasp areas, their cross sections and the directions of restraint are given in Figures 3.5.1-2 through 3.5.1-6. Figure 3.5.1-2 shows where the OTD may be grasped (grasp areas) by the launch FSE. Figures 3.5.1-3, through 3.5.1-6 show the cross sections at each of the OTD launch grasp areas.

### **3.5.2 ENVELOPE**

The maximum launch and on-orbit stowage envelope dimensions for the OTD are 72 in. x 24in. x 16 in. (see Figure 3.5.2-1). The volume required for removal of the OTD from the launch support equipment is 72 in. x 24 in. x 35 in. as shown in Figure 3.5.2-1.

### **3.5.3 STRUCTURAL**

#### **3.5.3.1 LOADING**

The OTD is capable of producing bending and torsional moments of 5780 in-lb and a shear load of 125 lbf, simultaneously, at the interfacing between the Passive WIF and support structure. Table 3.3.3.1-2, design loads for the PFRWS, TERA, and OTD, shows the OTD launch design loads.

#### **3.5.3.2 MASS PROPERTIES**

The maximum weight of the OTD is 231 lbs.

#### **3.5.4 ELECTRICAL BONDING**

The OTD will satisfy the class S bond per SSP 30245, Space Station Electrical Bonding Specification, in its entirety, when installed onto the OTD FSE and any passive WIF during on-orbit usage or stowage.

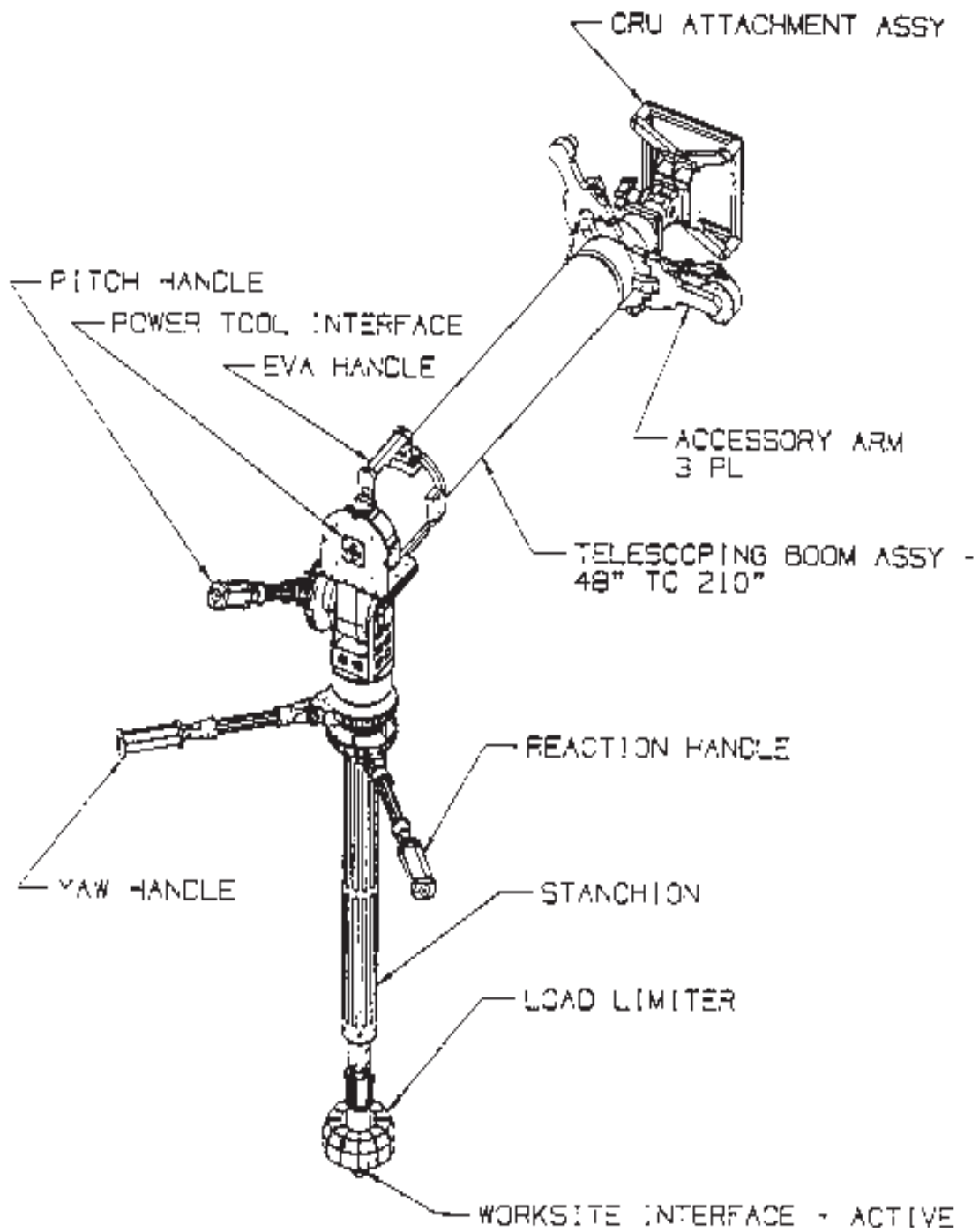


FIGURE 3.5-1 ORU TRANSFER DEVICE

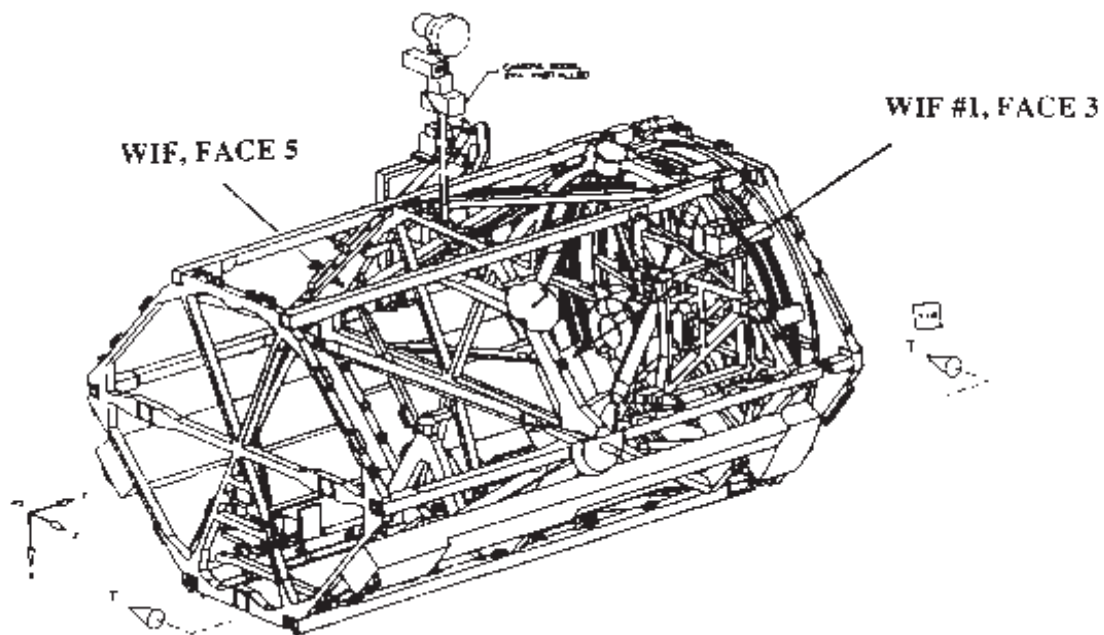
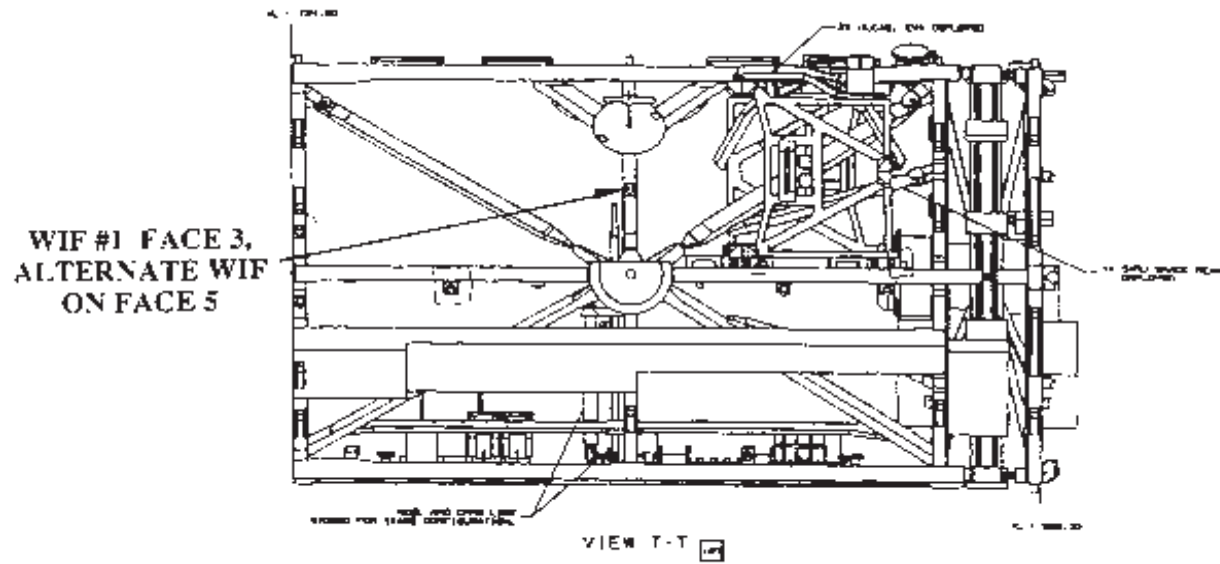


FIGURE 3.5.1-1 OTD USE LOCATIONS ON TRUSS SEGMENT P3

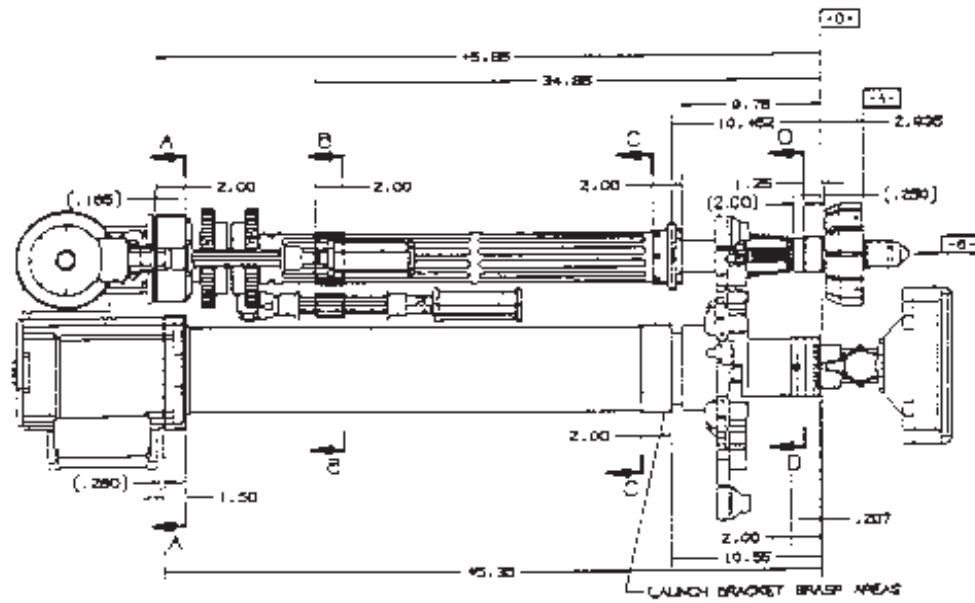


FIGURE 3.5.1-2 ORU TRANSFER DEVICE LAUNCH BRACKET RESTRAINT LOCATIONS

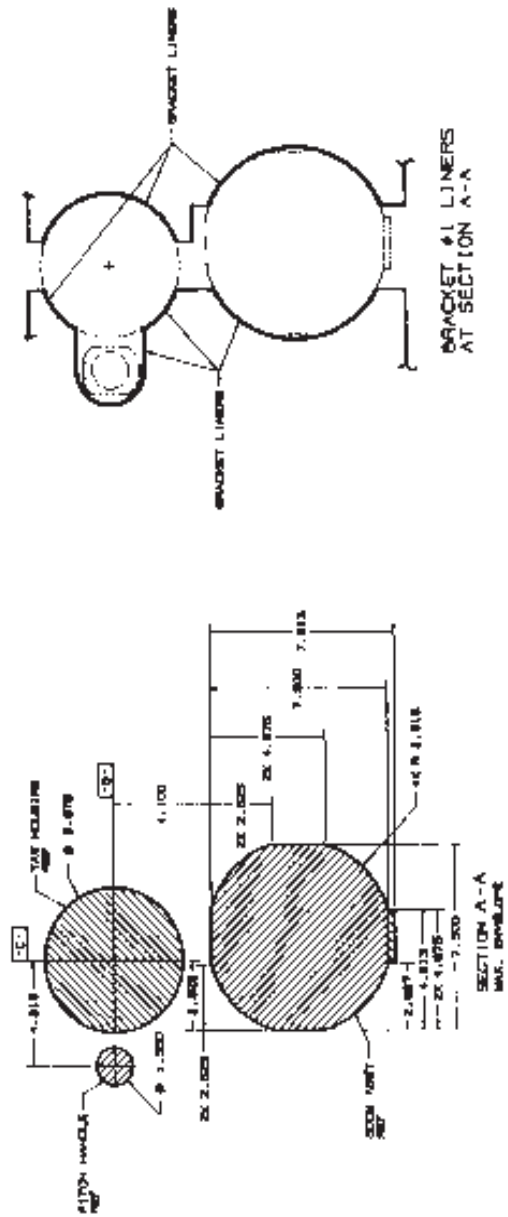


FIGURE 3.5.1-3 ORU TRANSFER DEVICE LAUNCH BRACKET 1 INTERFACE

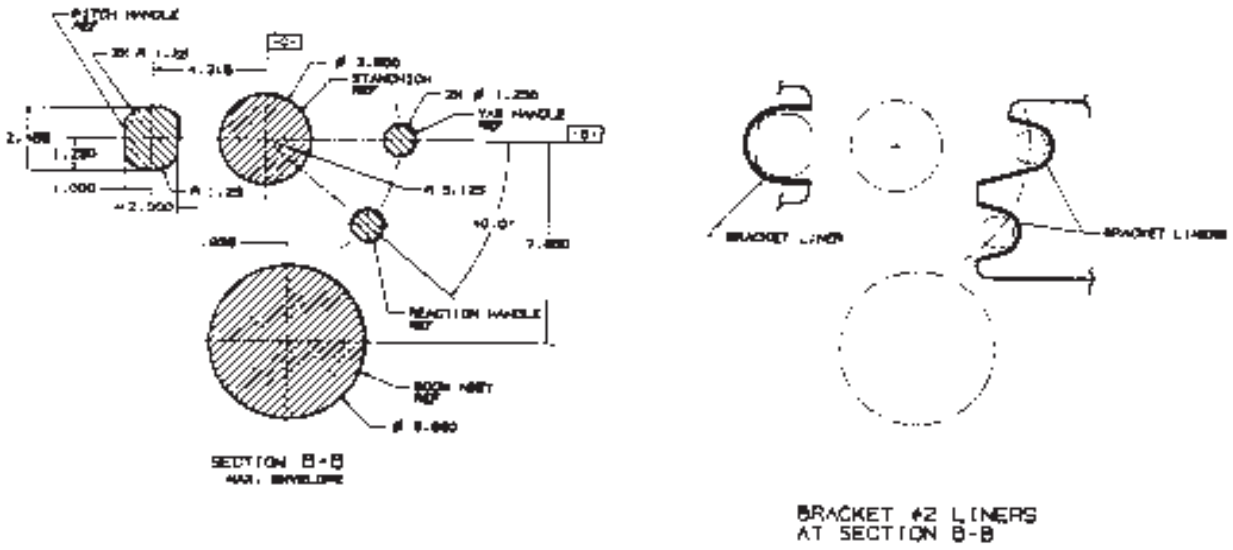


FIGURE 3.5.1-4 ORU TRANSFER DEVICE LAUNCH BRACKET 2 INTERFACE

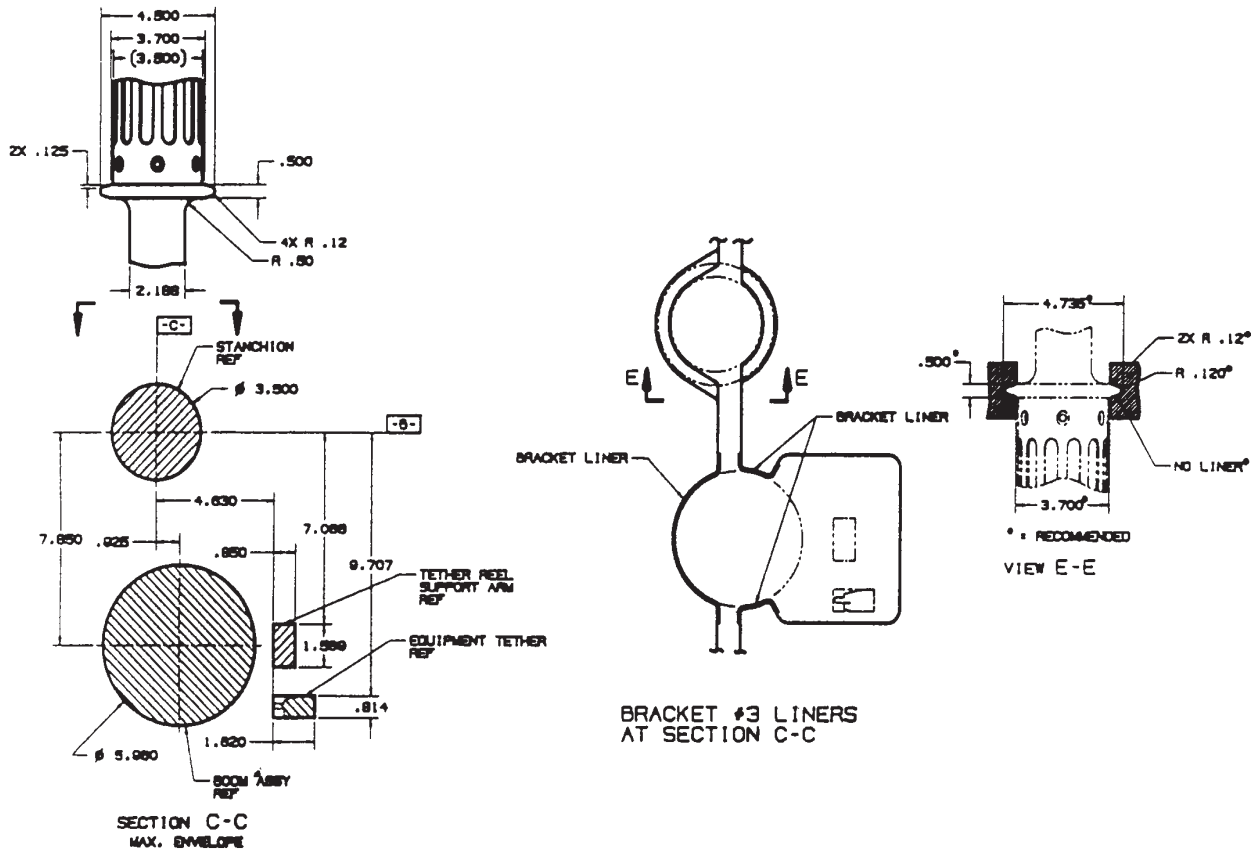


FIGURE 3.5.1-5 ORU TRANSFER DEVICE LAUNCH BRACKET 3 INTERFACE



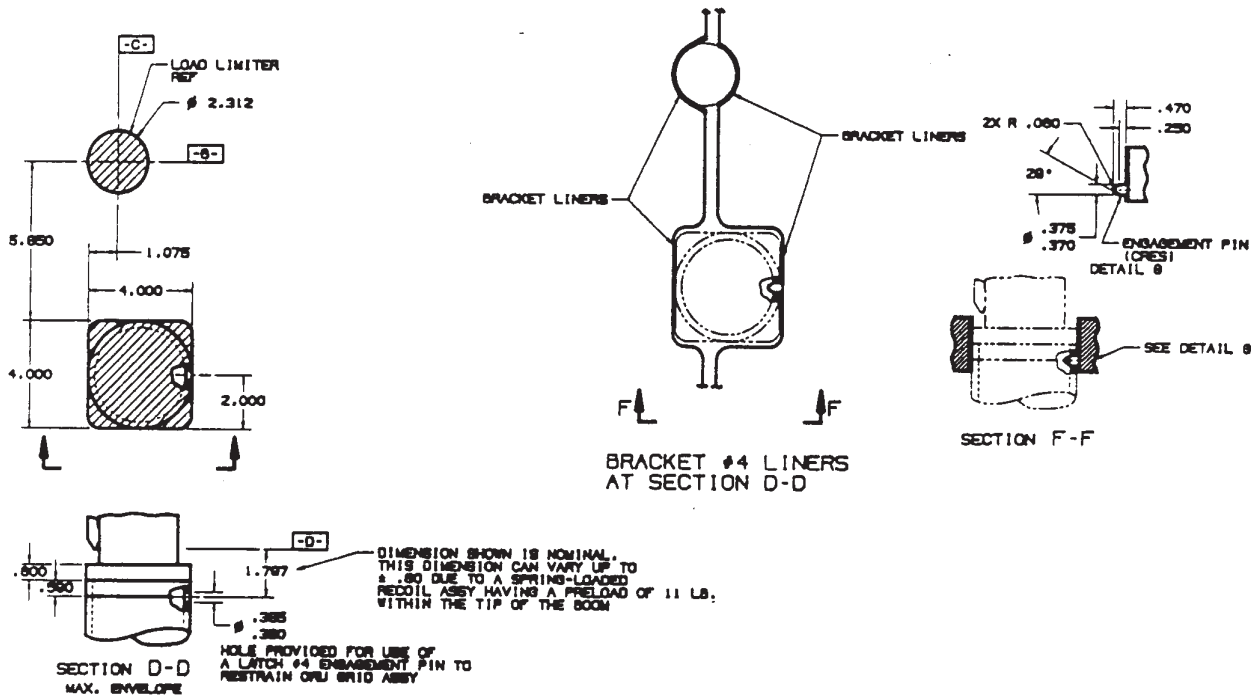


FIGURE 3.5.1-6 ORU TRANSFER DEVICE LAUNCH BRACKET 4 INTERFACE

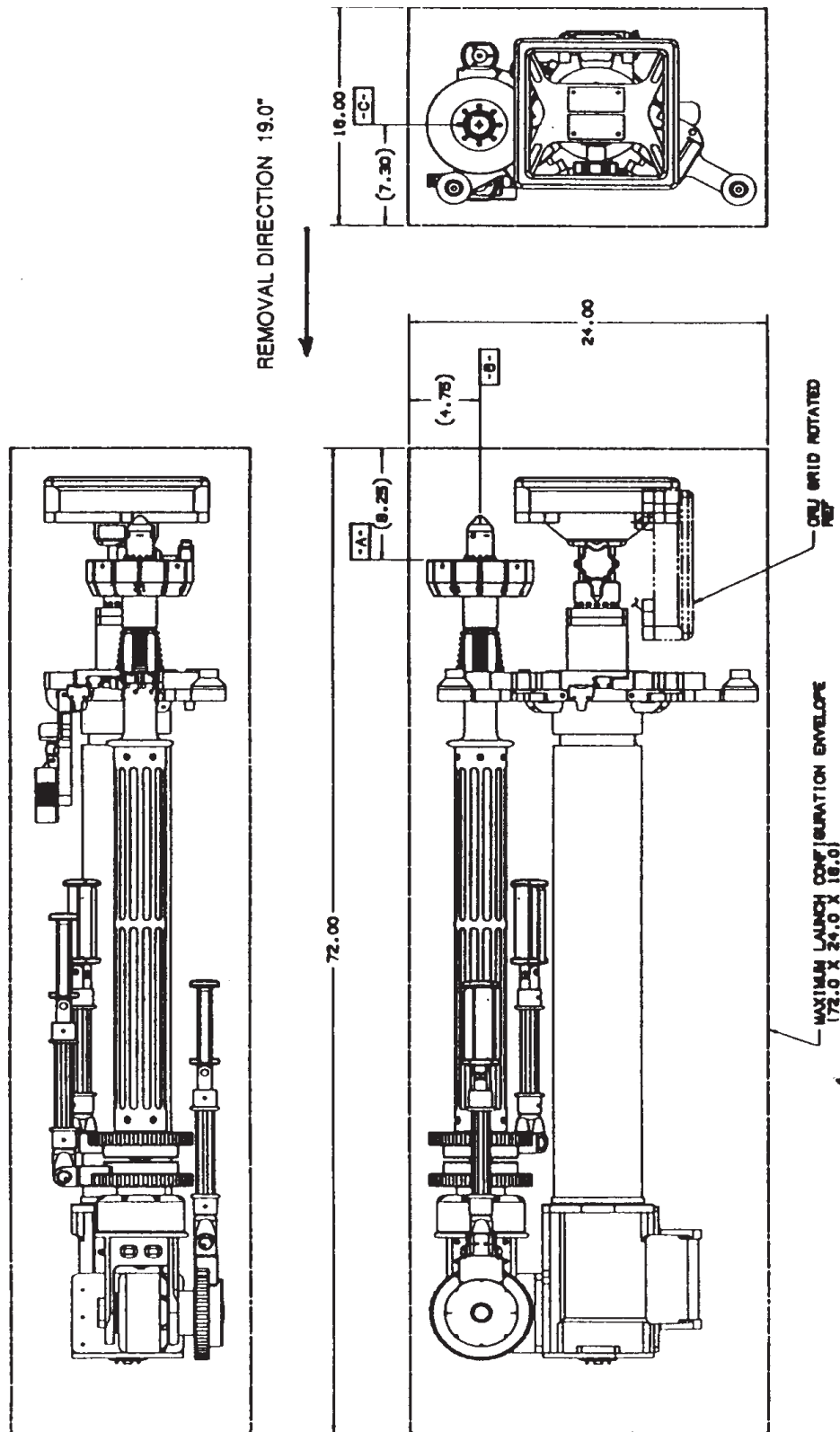


FIGURE 3.5.2-1 ORU TRANSFER DEVICE LAUNCH AND STORAGE ENVELOPE

### **3.5.5 THERMAL**

The OTD is designated as an “unlimited contact” EVA interface. Thermal control of this component is achieved by passive techniques. Responsibility for maintaining the heat transfer rates within specified limits is the responsibility of the ISS Prime.

## **3.6 TRANSLATION AIDS AND ATTACHMENTS (TA&A)**

### **3.6.1 HANDRAIL / HANDHOLD (GROUND INSTALLED)**

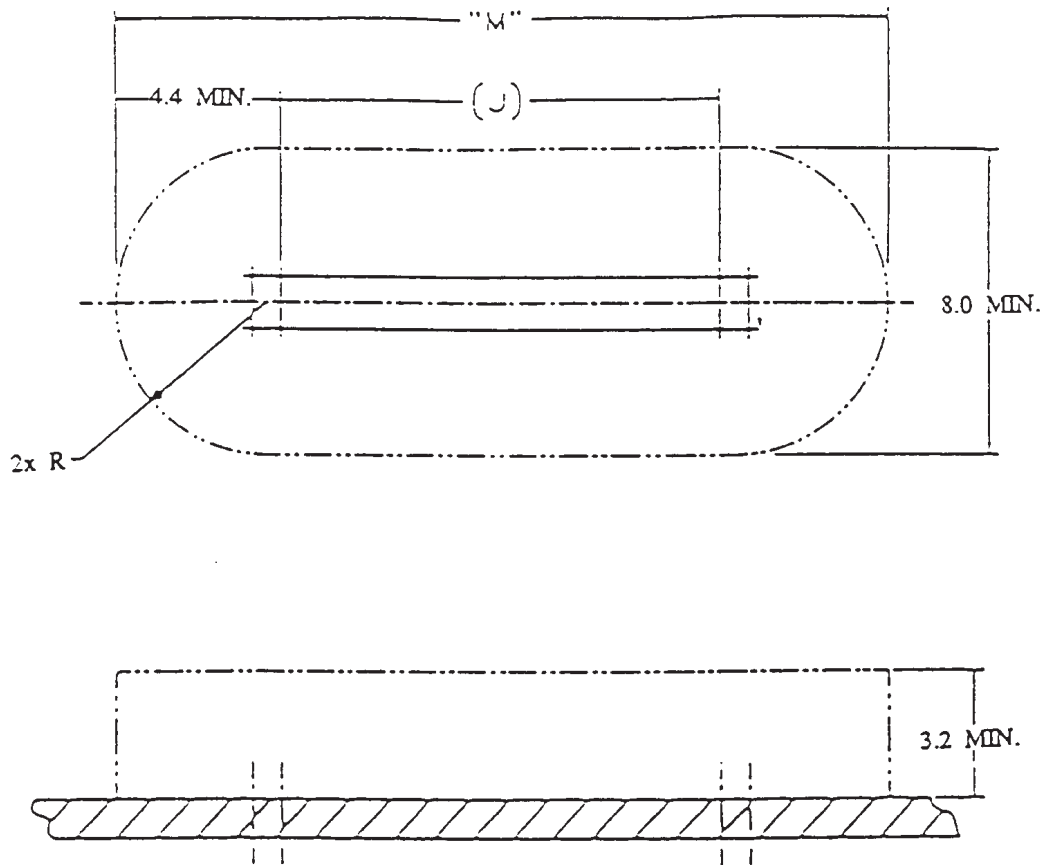
#### **3.6.1.1 INTERFACE DESCRIPTION**

EVA handrails/handholds will be supplied to facilitate translation or provide restraint for a crewmember in a space suit on the exterior surface of the Space Station elements. These handrails/handholds will accommodate EVA tether hooks by having tether points designed into the standoffs to restrain the crewmember or loose equipment. This section describes the interface information for three styles of handrails/handholds that will be installed on the ground. Interface requirements for presently defined customized lengths are included. For on-orbit installed handrails, see section 3.6.5

#### **3.6.1.2 ENVELOPE**

##### **3.6.1.2.1 HARDWARE**

The ground installed handrail/handhold has three different style stand-offs; one for top mounting and a tall and a short stand-off for side mounting. The standard length of the handrails is nominally 24 in. between the stand-offs, and handholds, 6 in. between stand-offs. Customized handrail lengths are provided where required. Hardware dimensions are shown in figures 3.6.1.2.1-1 through 3.6.1.2.1-6 and Figures 3.6.1.4.1-1 through 3.6.1.4.1-4.



| Part Number                           | Description                  | J (Ref) | M (Min) |
|---------------------------------------|------------------------------|---------|---------|
| SEG33106347-801<br>(Ref. 5835754-501) | Handrail, Top Mounted        | 25.530  | 34.3    |
| SEG33106347-811                       | Handrail, Custom, 15.441 in. | 15.441  | 24.2    |
| SEG33106347-803                       | Handrail, Custom, 21.941 in. | 21.941  | 30.7    |
| SEG33106347-805                       | Handrail, Custom, 22.625 in. | 22.625  | 31.4    |
| SEG33106347-843                       | Handrail, Custom, 25.606 in. | 25.606  | 34.4    |
| SEG33106347-807<br>(Ref. 5835755-501) | Handhold, Top Mounted        | 8.530   | 17.3    |
| SEG33106347-809                       | Handhold Custom, 8.626       | 8.626   | 17.4    |

**FIGURE 3.6.1.2.1-1 TOP MOUNTED HANDRAIL/HANDHOLD ACCESS ENVELOP  
(GROUND INSTALLED)**

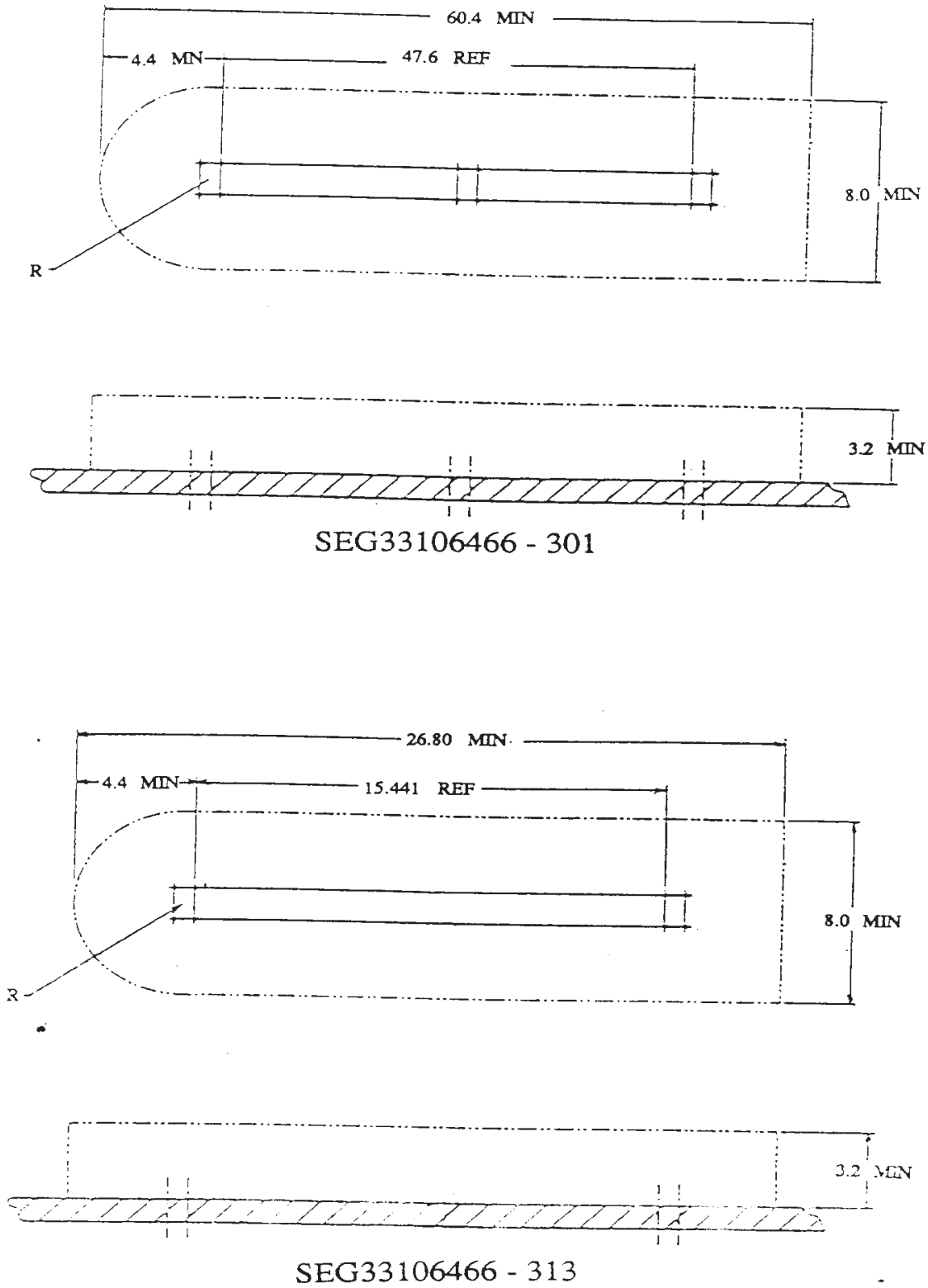


FIGURE 3.6.1.2.1-2 TOP MOUNTED CUSTOM LENGTH HANDRAIL ACCESS ENVELOPE (GROUND INSTALLED)

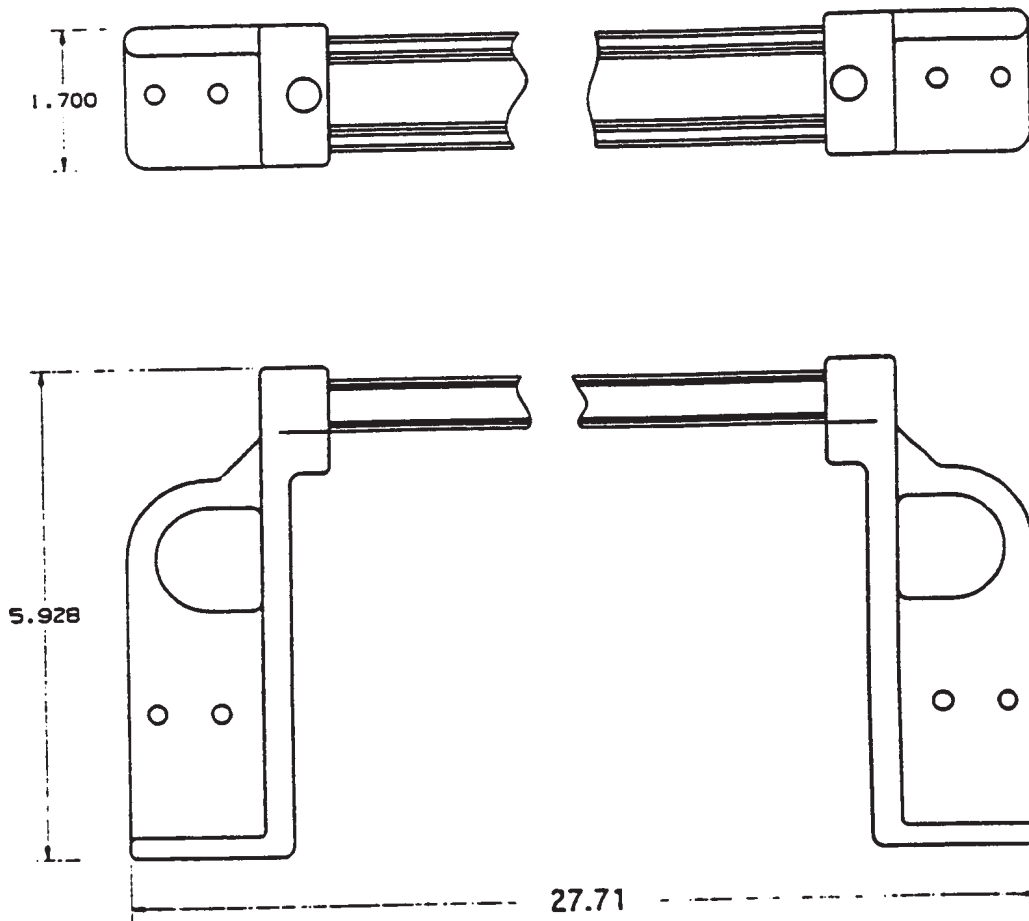


FIGURE 3.6.1.2.1-3 TALL SIDE MOUNTED HANDRAIL ENVELOPE (GROUND INSTALLED)

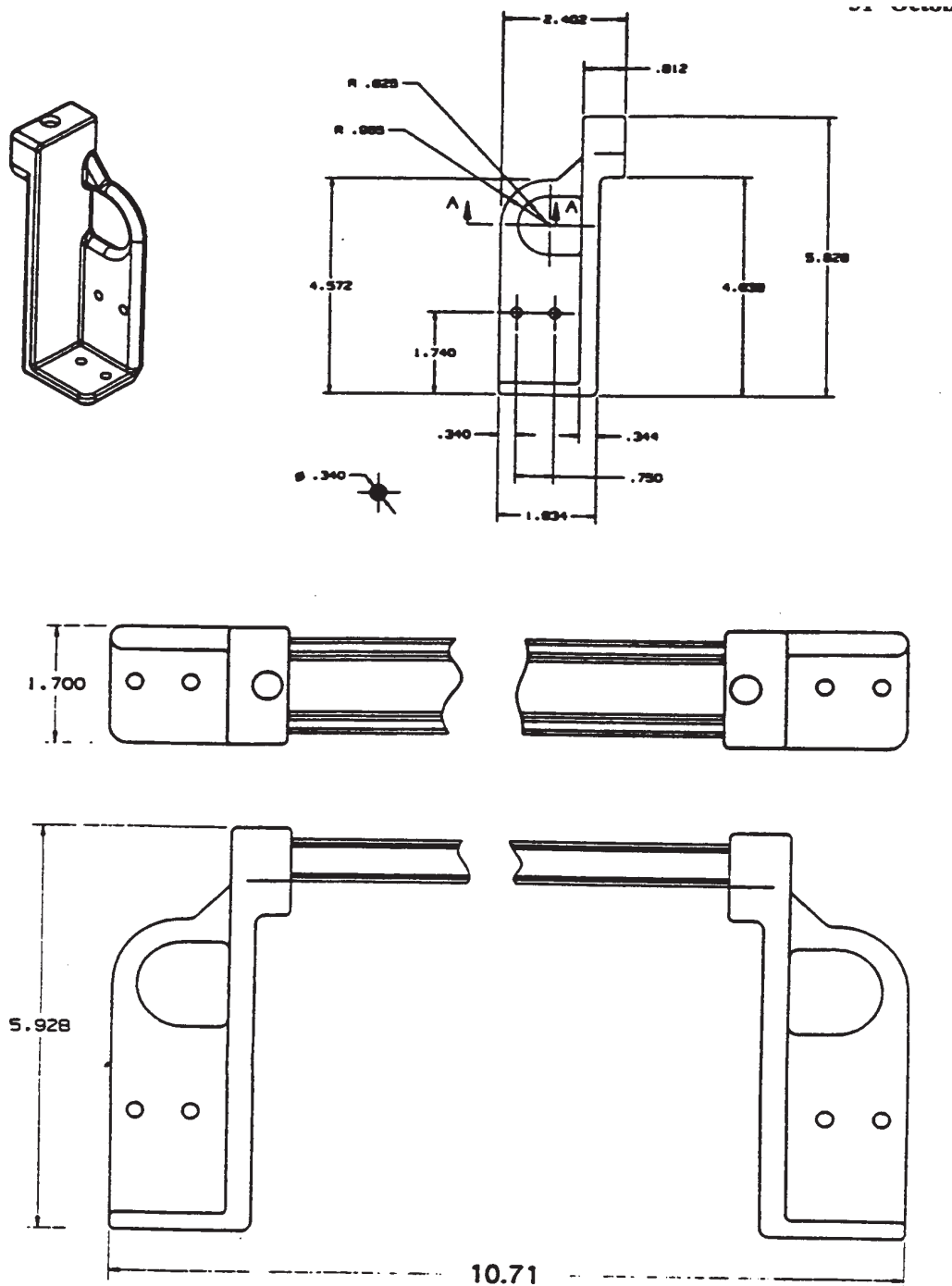
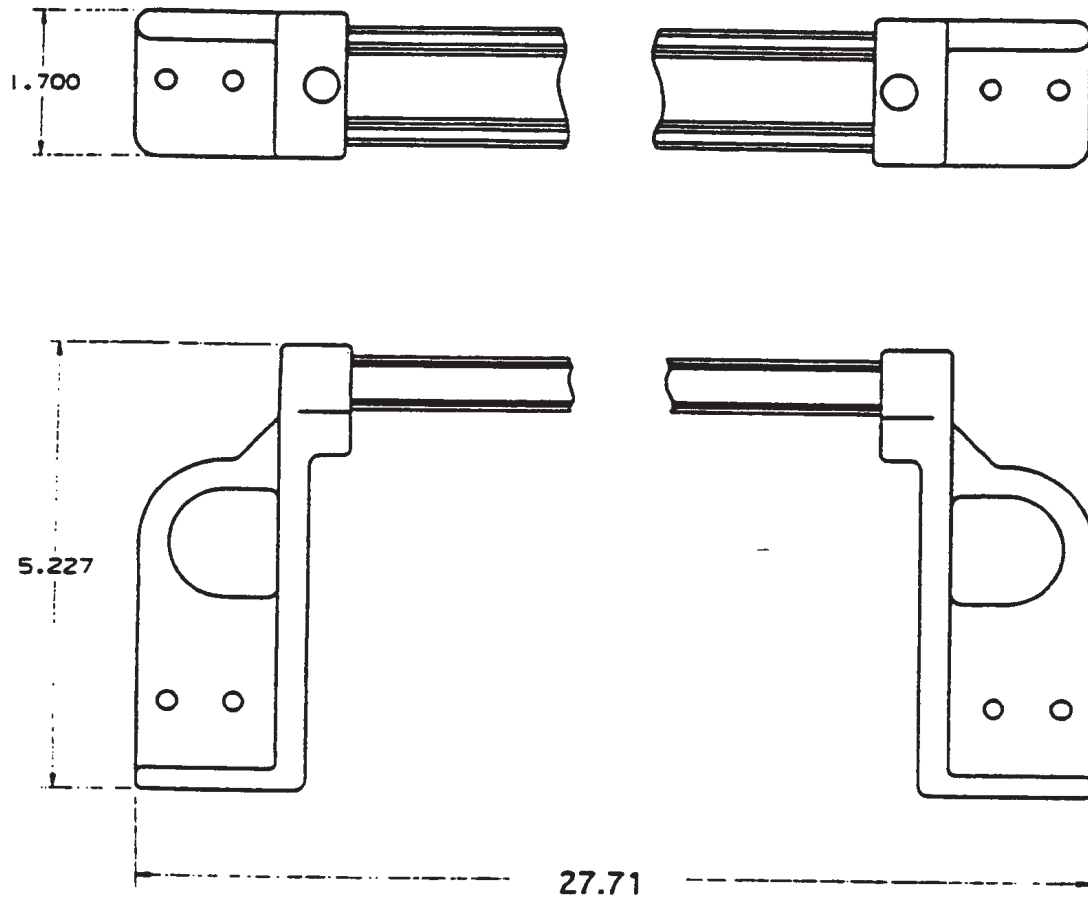
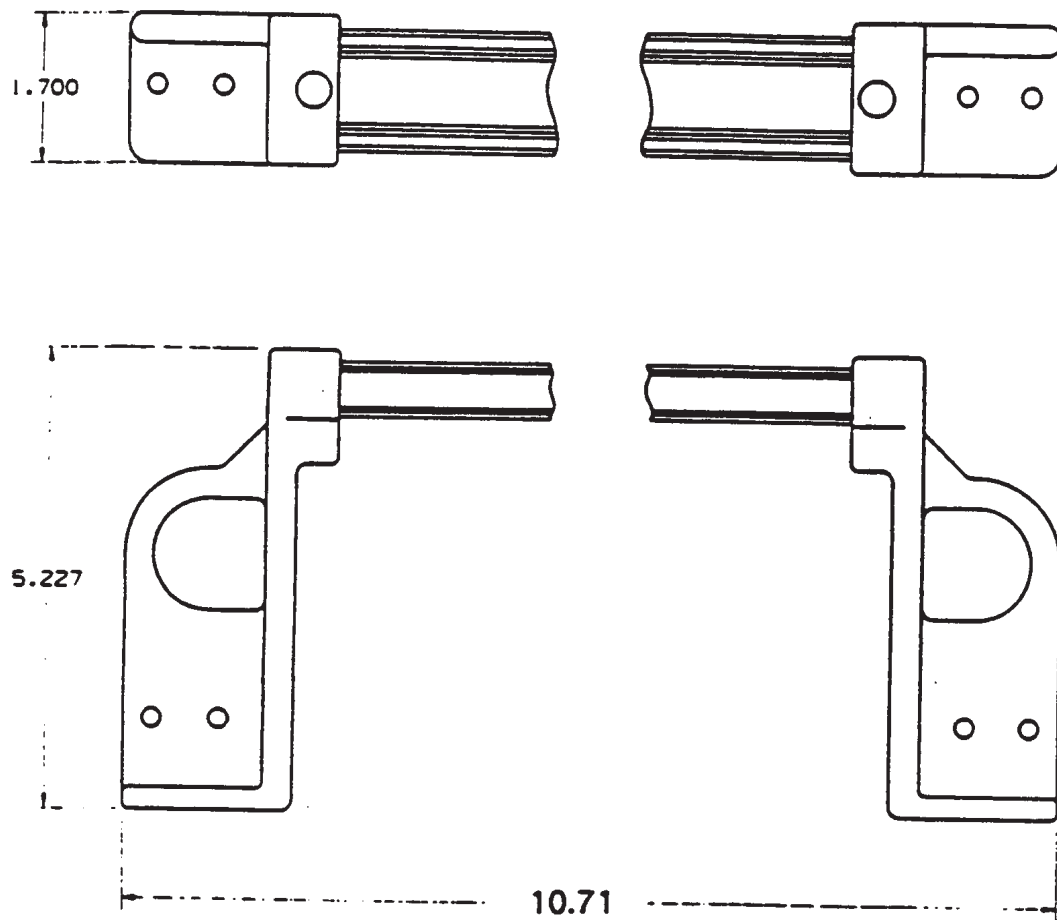


FIGURE 3.6.1.2.1-4 TALL SIDE MOUNTED HANDHOLD ENVELOPE (GROUND INSTALLED)



**FIGURE 3.6.1.2.1-5 SHORT SIDE MOUNTED HANDRAIL ENVELOPE (GROUND INSTALLED)**





**FIGURE 3.6.1.2.1-6 SHORT SIDE MOUNTED HANDHOLD ENVELOPE (GROUND INSTALLED)**

#### **3.6.1.4.2 SURFACE FINISH**

The ground installed handrails/handholds meet the finish requirements found in SSP 30233, Space Station Requirements for Materials and Processes. The surface finish color will be yellow. The faying surface is chemical conversion coated per MIL-C-5541, Class 3, for electrical bonding.

#### **3.6.1.4.3 FASTENERS**

The user will provide #10 (0.190 in. dia) bolts and associated fastener hardware that is compatible with the material and protective finish on the handrail/handhold stand-offs.

#### **3.6.1.4.4 MATERIALS**

The handrail/handhold stand-off material is 7075-T7351 aluminum alloy.

#### **3.6.1.5 THERMAL**

The handrails/handholds are designated “unlimited contact” EVA crew interfaces. Thermal control of these components is achieved by passive techniques.

#### **3.6.1.6 ELECTRICAL BONDING**

The handrail/handhold to user interface shall satisfy a Class S bond per SSP 30245, Space Station Electrical Bonding Specification, as specified in Figures 3.6.1.4.1-1 through 3.6.1.4.1-8. Note that Figure 3.6.1.4.1-2 shows an alternate bonding surface for top mounted handrails and handholds.

#### **3.6.2 RESERVED**

#### **3.6.3 SLIDEWIRE**

##### **3.6.3.1 INTERFACE DESCRIPTION**

EVA installable slidewires with sliders to facilitate translation of the two crewmembers in space suits on the exterior surface of Space Station elements and ground installed structural adapter plates will be supplied. The slidewire has standard standoffs and the cable length is sized for each specific element. This item can be installed on-orbit, is classified as an ORU and meets the requirements for EVA compatibility.

### **3.6.3.2 ENVELOPE**

#### **3.6.3.2.1 HARDWARE**

Hardware envelope dimensions are shown in Figure 3.6.3.2.1-1

#### **3.6.3.2.2 EVA**

Figures 3.6.3.2.2-1, -2, and -3 define the EVA clearance envelope around the slidewire necessary to use the slidewire as a translation aid.

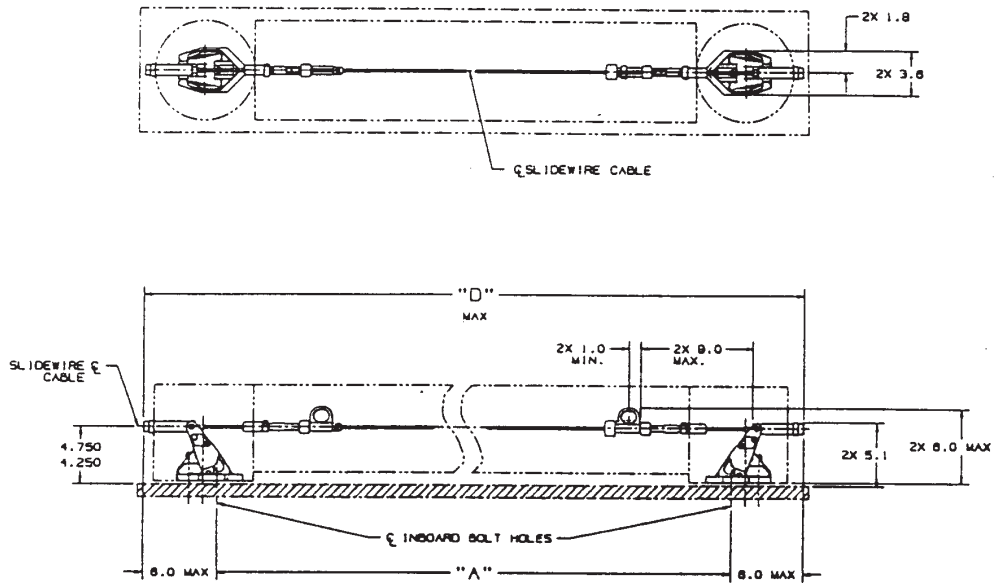
### **3.6.3.3 STRUCTURAL**

#### **3.6.3.3.1 LOADING**

The slidewire will support EVA tether tension limit loads of 200 lbs in any direction, and will always have a positive pre-load. The slidewire will exert a maximum shear load of 1150 lbs and a maximum bending moment of 5000 in-lbs at the standoff interface.

#### **3.6.3.3.2 MASS PROPERTIES**

The maximum weight of the slidewire, including the ground installed adapter plates, is 14.3 lbs. The maximum weight of the slidewire assembly, consisting of two standoffs and a cable assembly, is 13.5 lbs. The maximum weight of each of the two ground installed adapter plates is 0.8 lbs each.



| PART NUMBER     | DESCRIPTION     | USE LOCATION | A                  | D     |
|-----------------|-----------------|--------------|--------------------|-------|
| SEG33106344-301 | SLIDEWIRE -13FT | NODE         | 156.085<br>155.835 | 168.1 |
| SEG33106344-303 | SLIDEWIRE -24FT | HAB & LAB    | 289.815<br>289.565 | 301.9 |

FIGURE 3.6.3.2.1-1 SLIDEWIRE HARDWARE ENVELOPE

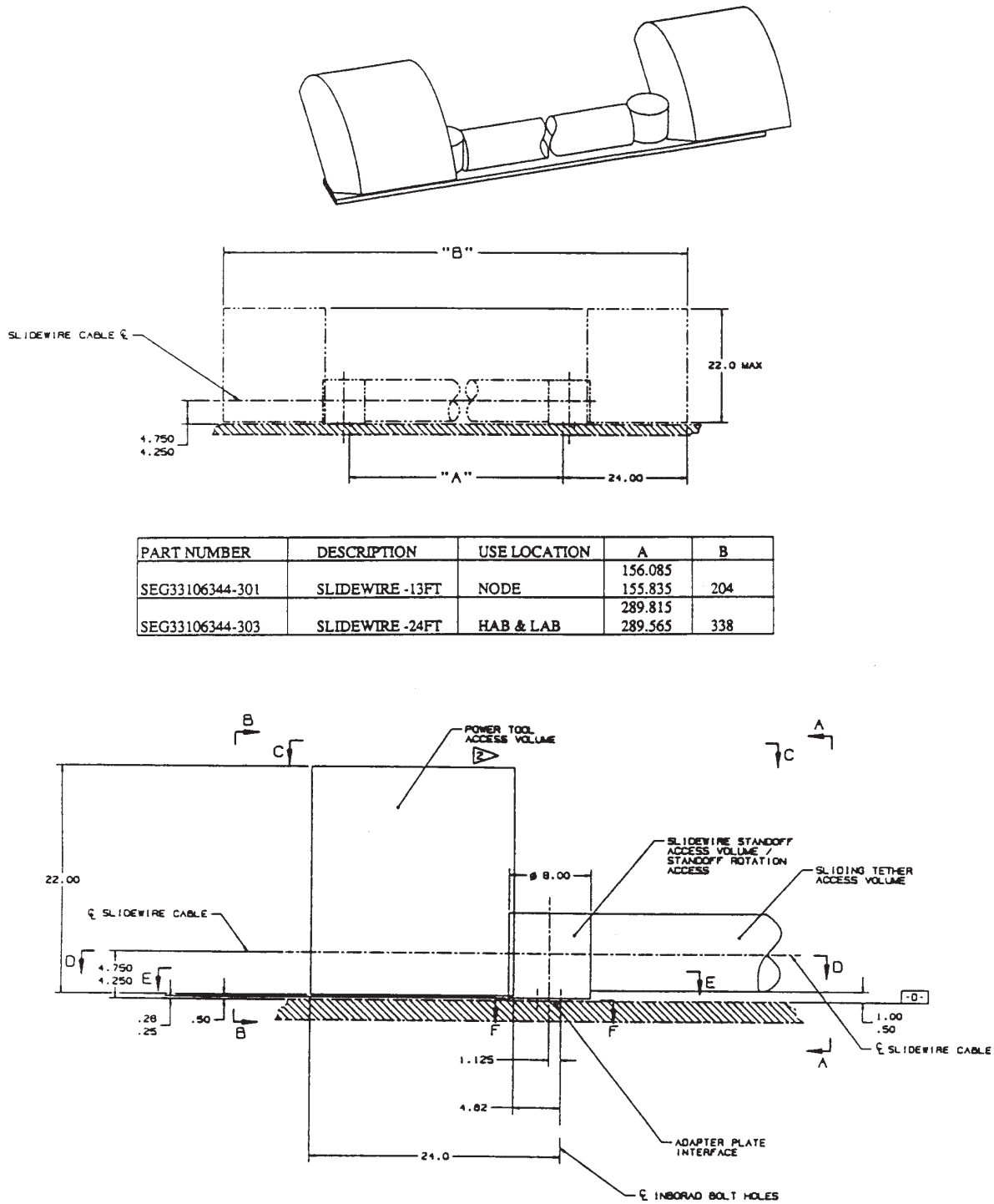


FIGURE 3.6.3.2.2-1 SLIDEWIRE EVA CLEARANCE ENVELOPE (SIDE VIEWS)

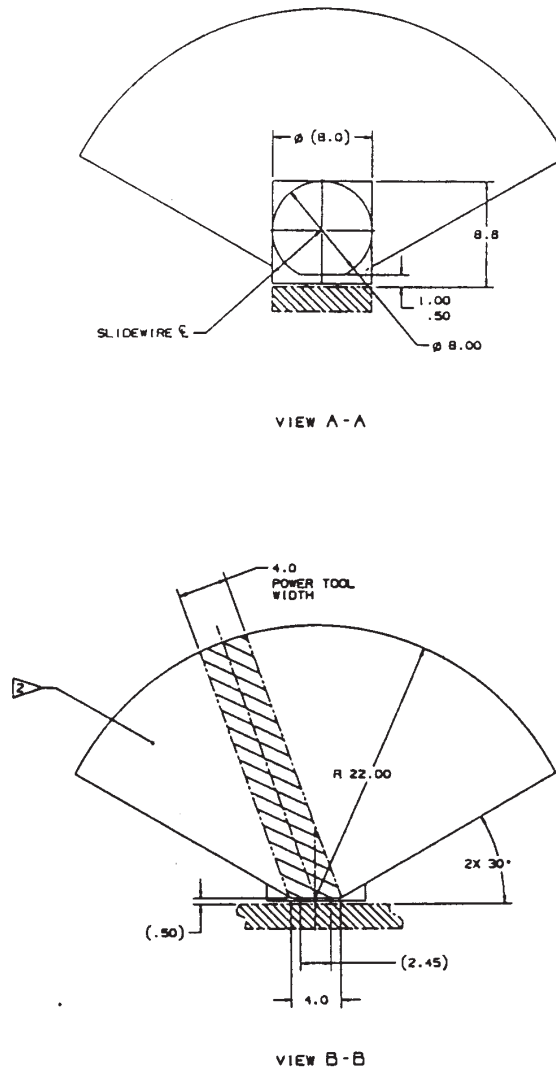


FIGURE 3.6.3.2.2-2 SLIDEWIRE EVA CLEARANCE ENVELOPE (END VIEWS)



### **3.6.3.4 MECHANICAL**

#### **3.6.3.4.1 MOUNTING AND INSTALLATIONS**

The slidewire standoffs mount to slidewire adapter plates. The adapter plates interface with the Space Station structure. Figure 3.6.3.4.1-1 shows the user side interface bolthole pattern and clearance volume required for slidewire bracket installation.

#### **3.6.3.4.2 SURFACE FINISH**

The slidewire standoffs meet the finish requirements found in SSP 30233, Space Station Requirements for Materials and Processes. The faying surface is chemical conversion coated per MIL-C-5541, Class 3, for electrical bonding.

#### **3.6.3.4.3 FASTENERS**

Captive fasteners will be provided with the slidewire stand-off. The captive bolts are .2500-28 UNJF-3A with a maximum engagement depth of 0.87 in.

#### **3.6.3.4.4 MATERIALS**

The slidewire stand-off interface material is 7075-T7351 aluminum alloy.

### **3.6.3.5 THERMAL**

The slidewire standoffs are designated “incidental contact” EVA crew interfaces. Thermal control of this hardware is achieved by passive techniques. The installation design activity is responsible for maintaining the heat transfer rates within the specified limits.

### **3.6.3.6 ELECTRICAL BONDING**

The slidewire (docking plate) to user hardware interface will satisfy a class S bond per SSP 30245, Space Station Electrical Bonding Specification, in its entirety.

## **3.6.4 WORKSITE INTERFACE (WIF) – PASSIVE HALF**

### **3.6.4.1 WORKSITE INTERFACE – PASSIVE HALF**

The WIF is comprised of a passive half, which generally resides on the structure, and an active half, which generally resides on the EVA hardware itself. The active half, while replaceable,



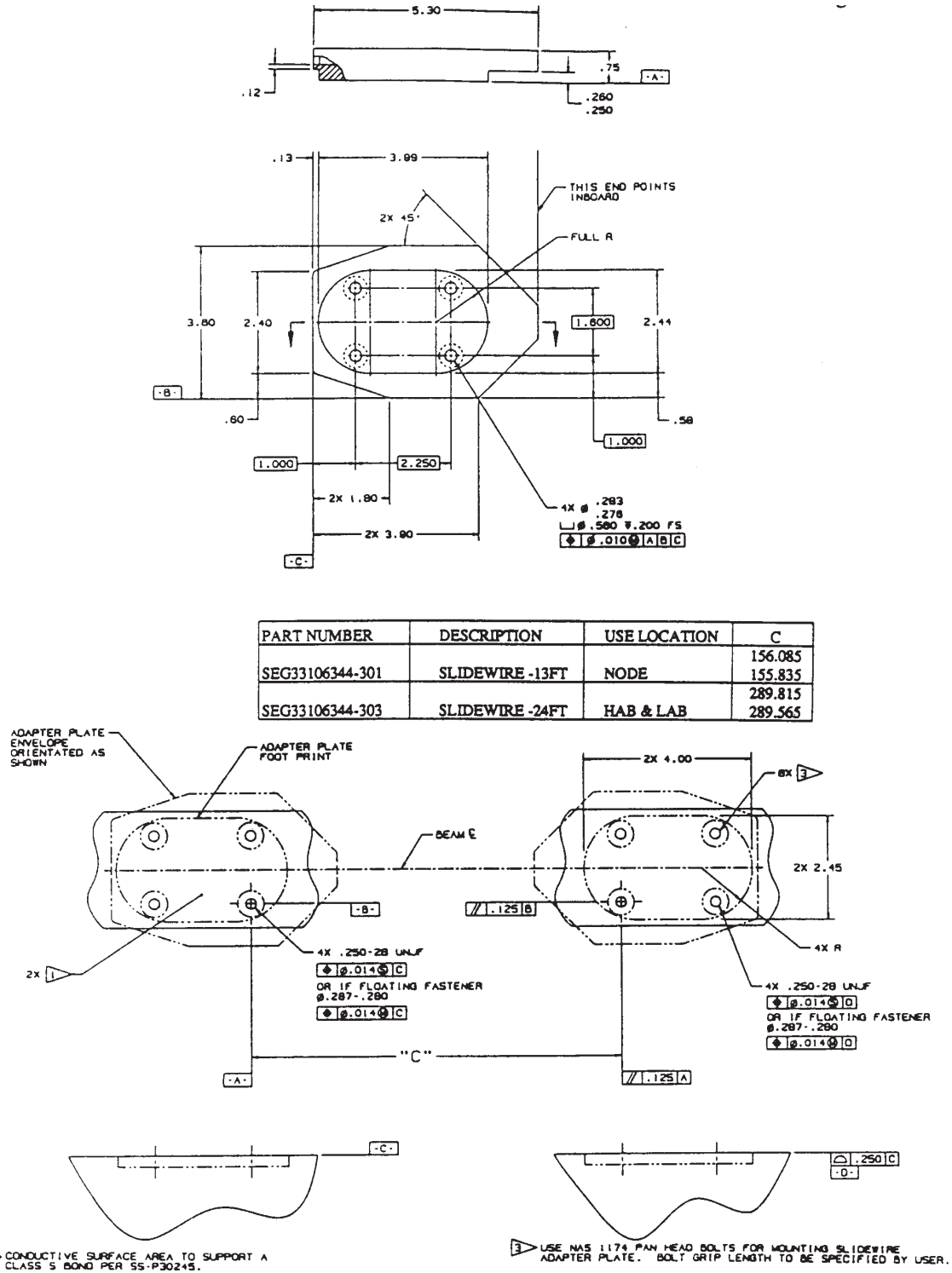


FIGURE 3.6.3.4.1-1 SLIDEWIRE ADAPTER PLATE ENVELOPE AND INTERFACE

will be integrated into the design of the hardware. The discussion of the active half of the WIF will reside in the section which covers the hardware onto which it is installed.

Only the passive half of the WIF will be discussed in this section. The passive half of the WIF will provide a means to interface structure, the CETA, or the TERA with EVA hardware such as the APFR, the OTD, and the TERA.

There are four different types of WIFs. The top mounted and side mounted, part number (P/N) SEG33106859-301 and SEG33106860-301, respectively, which are ground installed, an on-orbit installed top mounted type, P/N SEG33106861-301, with a ground installed adapter plate, P/N SEG33106862-701, and a passive adapter, P/N SEG33106863-301, which will interface between the Shuttle-style PFR socket and the active WIF.

### **3.6.4.2 ENVELOPE**

#### **3.6.4.2.1 HARDWARE**

Hardware envelope dimensions for each WIF are referenced in Figures 3.6.4.2.1-1 through 3.6.4.2.1-3. The hardware envelope dimensions for the on-orbit installed WIF Adapter Plate are referenced in Figure 3.6.4.2.1-4. Figure 3.6.4.2.1-5 provides the overall hardware envelope once the on-orbit installed WIF is mounted on the Adapter Plate. Figure 3.6.4.2.1-6 shows the current Shuttle-style PFR socket to WIF adapter.

#### **3.6.4.2.2 EVA CLEARANCE**

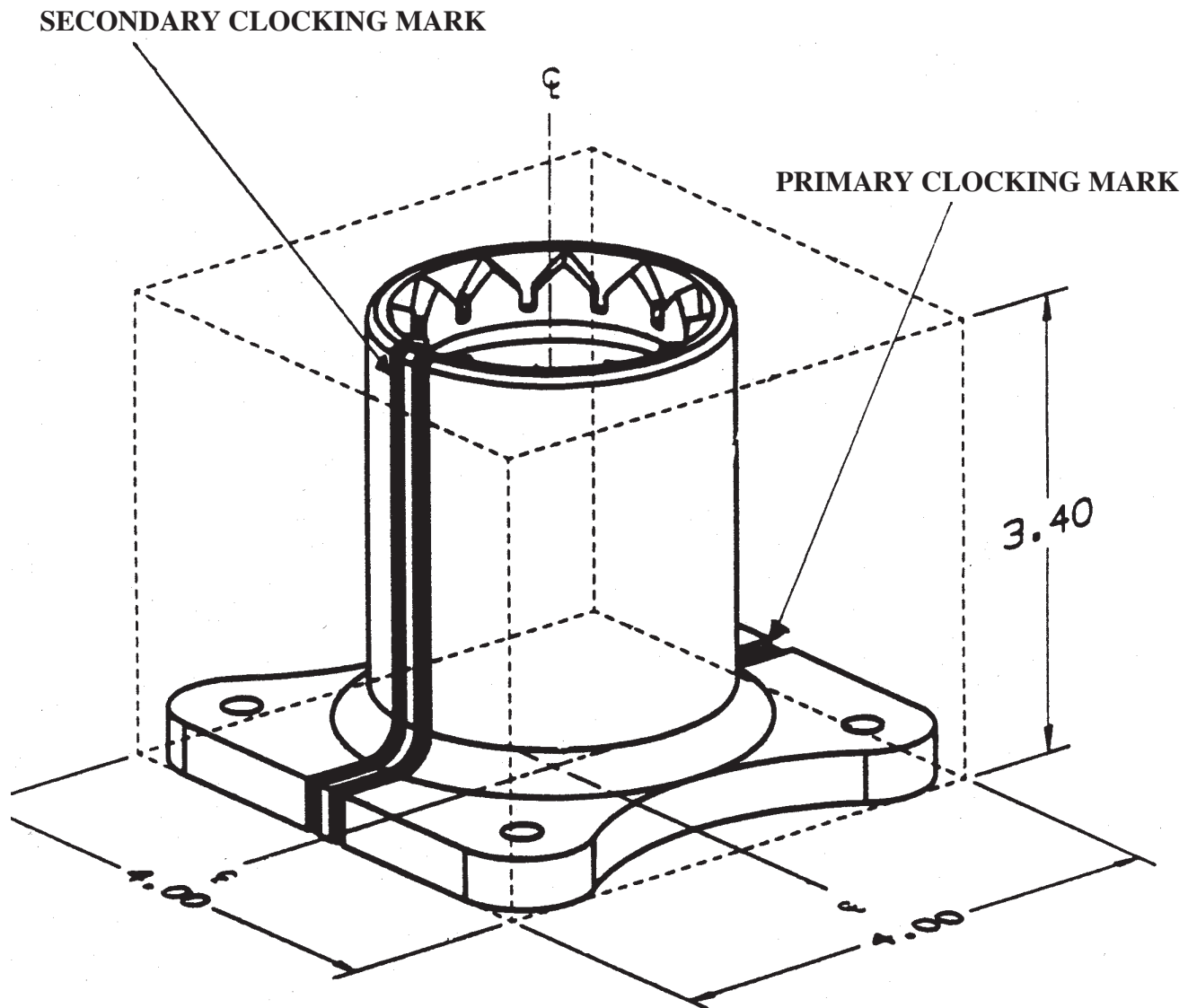
Figures 3.6.4.2.2-1 through 3.6.4.2.2-4 define the EVA clearance envelope around the WIF necessary for a crewmember to install and remove the APFR. Similar clearance envelopes are necessary for the installation and removal of each unique piece of EVA hardware outfitted with an active WIF. The hardware specific envelopes are included in the sections describing the respective hardware items. Figure 3.6.4.2.2-5 defines the EVA clearance envelope around the on-orbit installed WIF adapter plate necessary for the crewmember to install the on-orbit installed WIF socket. Figure 3.6.4.2.2-6 defines the EVA clearance envelope around the Shuttle-type PFR socket necessary to install and remove the passive WIF Adapter.

### **3.6.4.3 STRUCTURAL**

#### **3.6.4.3.1 RESERVED**

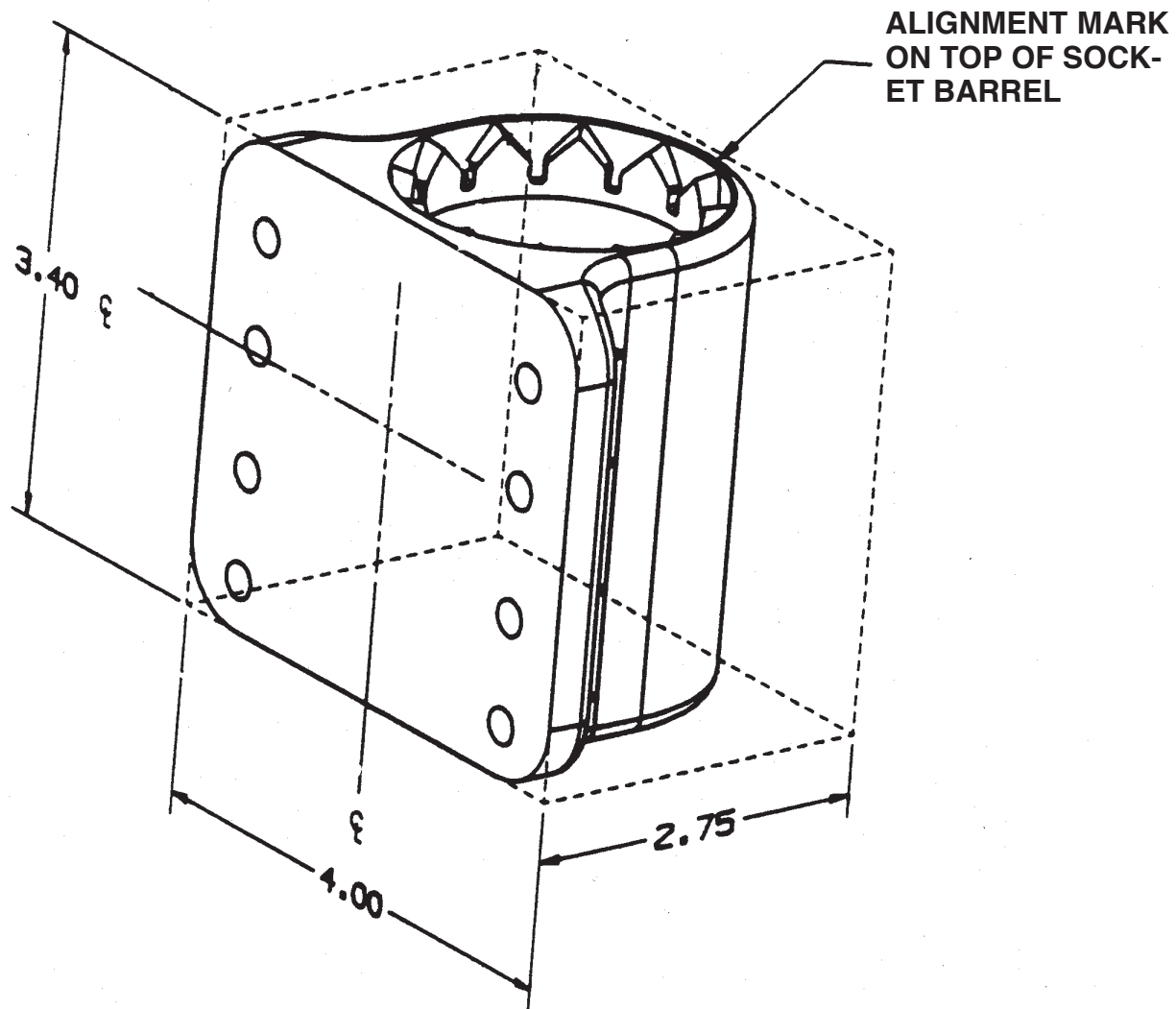
#### **3.6.4.3.2 LOADING**

The load limit at the WIF to structure interface is 274 lbs force in any direction and a moment of 4200 in-lbs in any direction, simultaneously. Figures 3.6.4.3.2-1 and 3.6.4.3.2-2 give additional information.



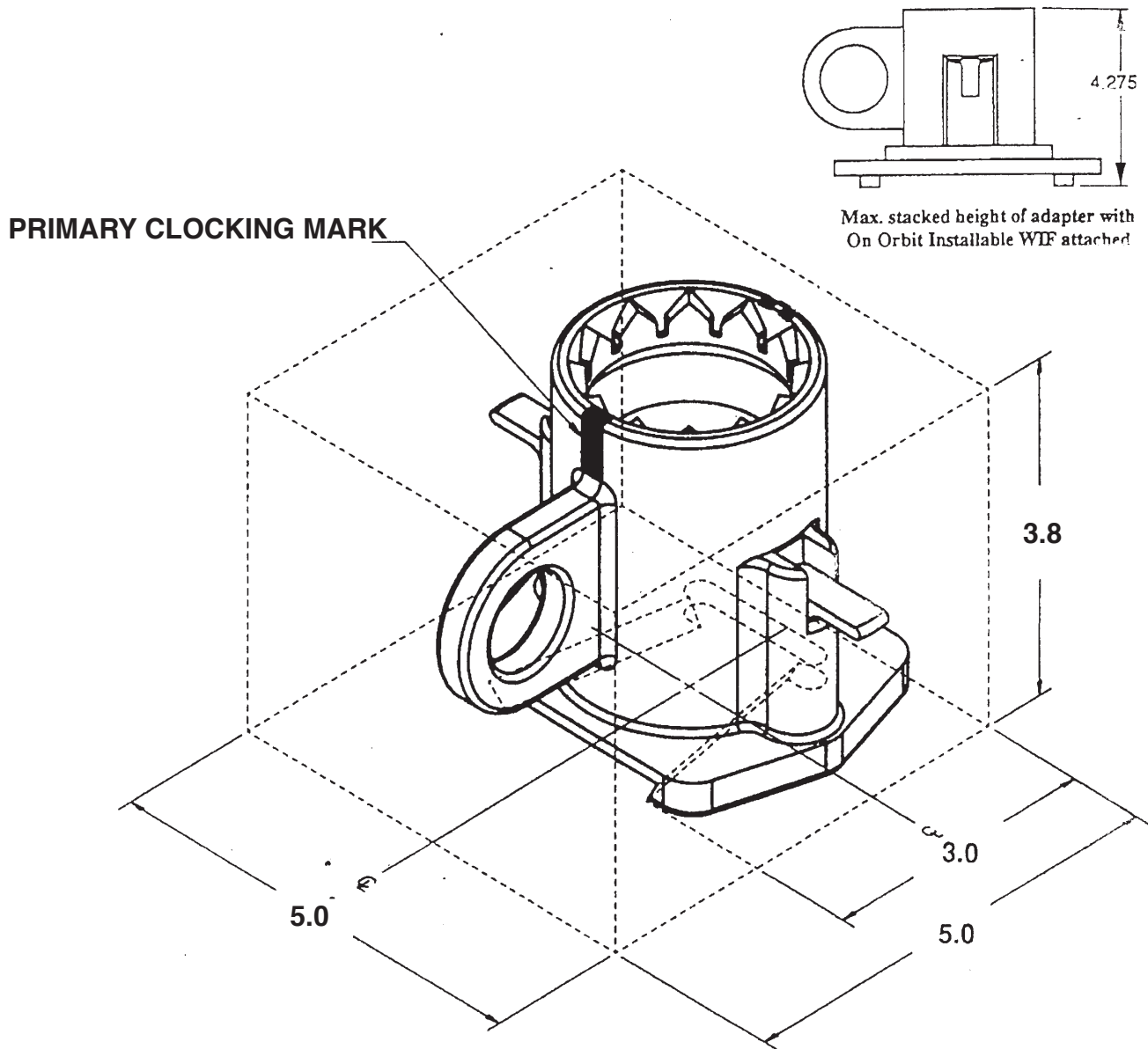
**ALL DIMENSIONS ARE MAXIMUM  
MATERIAL DIMENSIONS UNLESS  
OTHERWISE NOTED.**

**FIGURE 3.6.4.2.1-1 TOP MOUNTED WORKSITE INTERFACE PASSIVE HALF HARDWARE  
ENVELOPE WITH CLOCKING MARK INDICATED**



ALL DIMENSIONS ARE MAXIMUM MATERIAL DIMENSIONS UNLESS OTHERWISE NOTED.

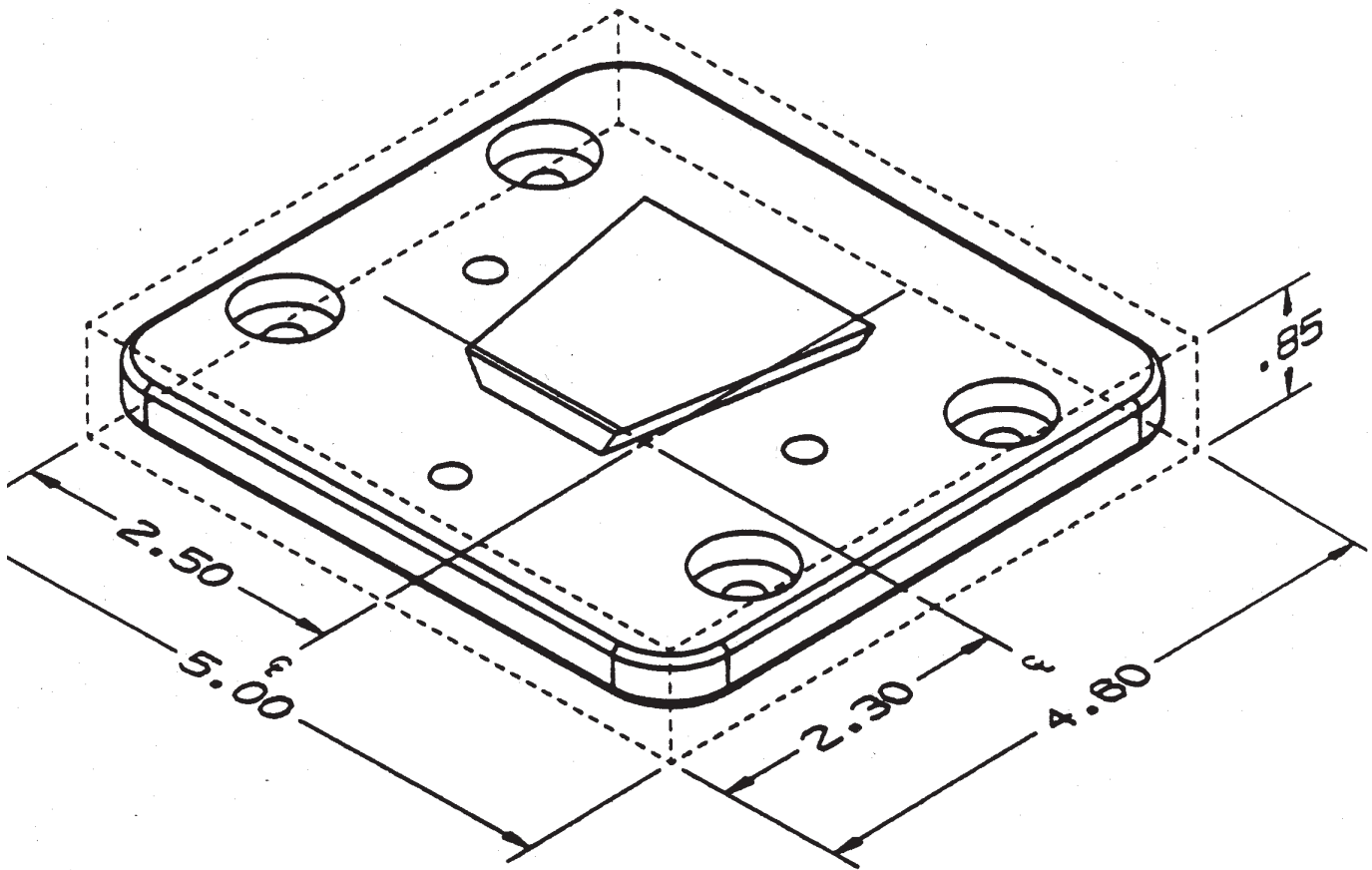
FIGURE 3.6.4.2.1-2 SIDE MOUNTED WORKSITE INTERFACE PASSIVE HALF HARDWARE ENVELOPE WITH CLOCKING MARK INDICATED



ALL DIMENSIONS ARE MAXIMUM MATERIAL DIMENSIONS UNLESS OTHERWISE NOTED.

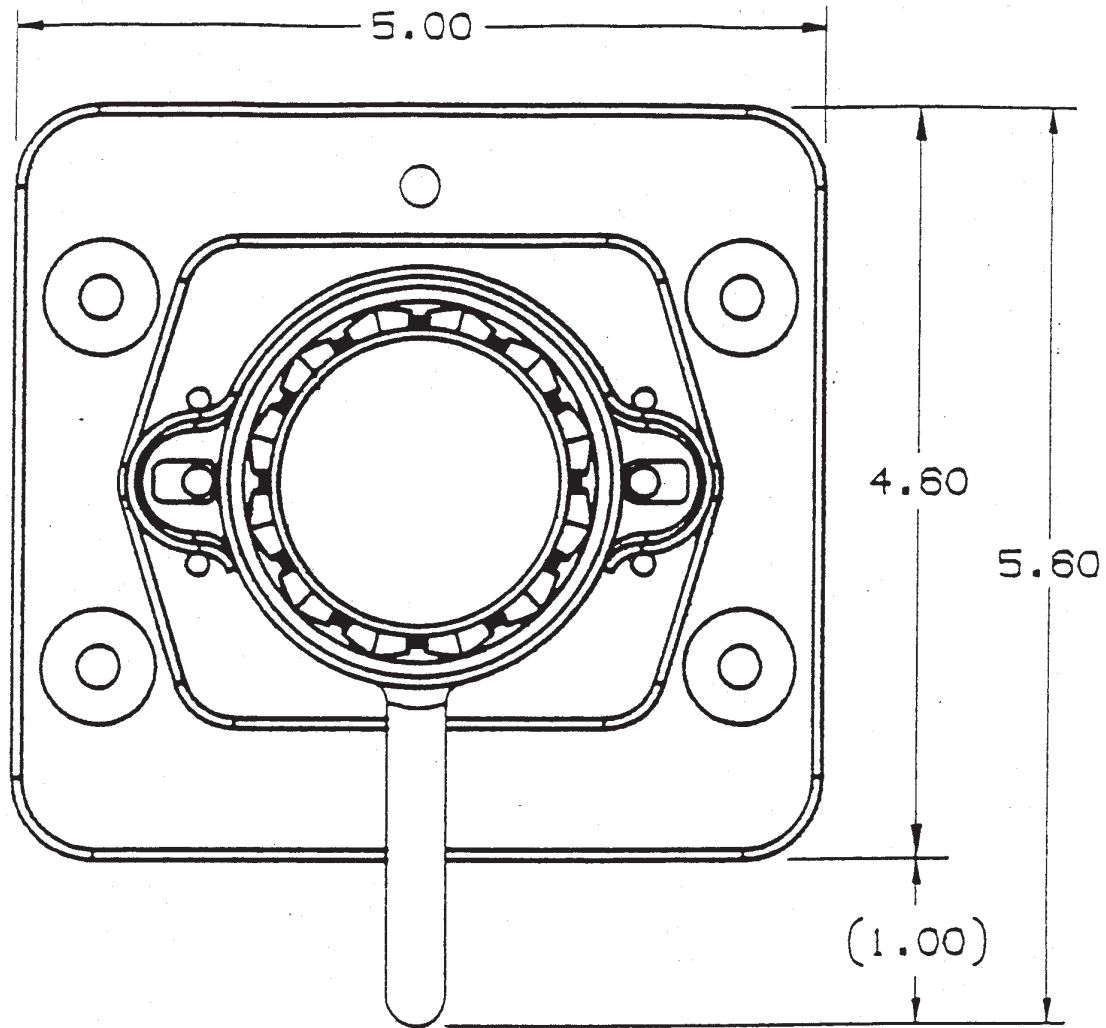
FIGURE 3.6.4.2.1-3 ON-ORBIT INSTALLED WORKSITE INTERFACE PASSIVE HALF HARDWARE ENVELOPE WITH CLOCKING MARK INDICATED

4 EACH SPACERS ARE INCLUDED IN THE ENVELOPE BUT ARE NOT SHOWN. SEE FIGURE 3.6.4.4.1-3 FOR SPACER LOCATION.



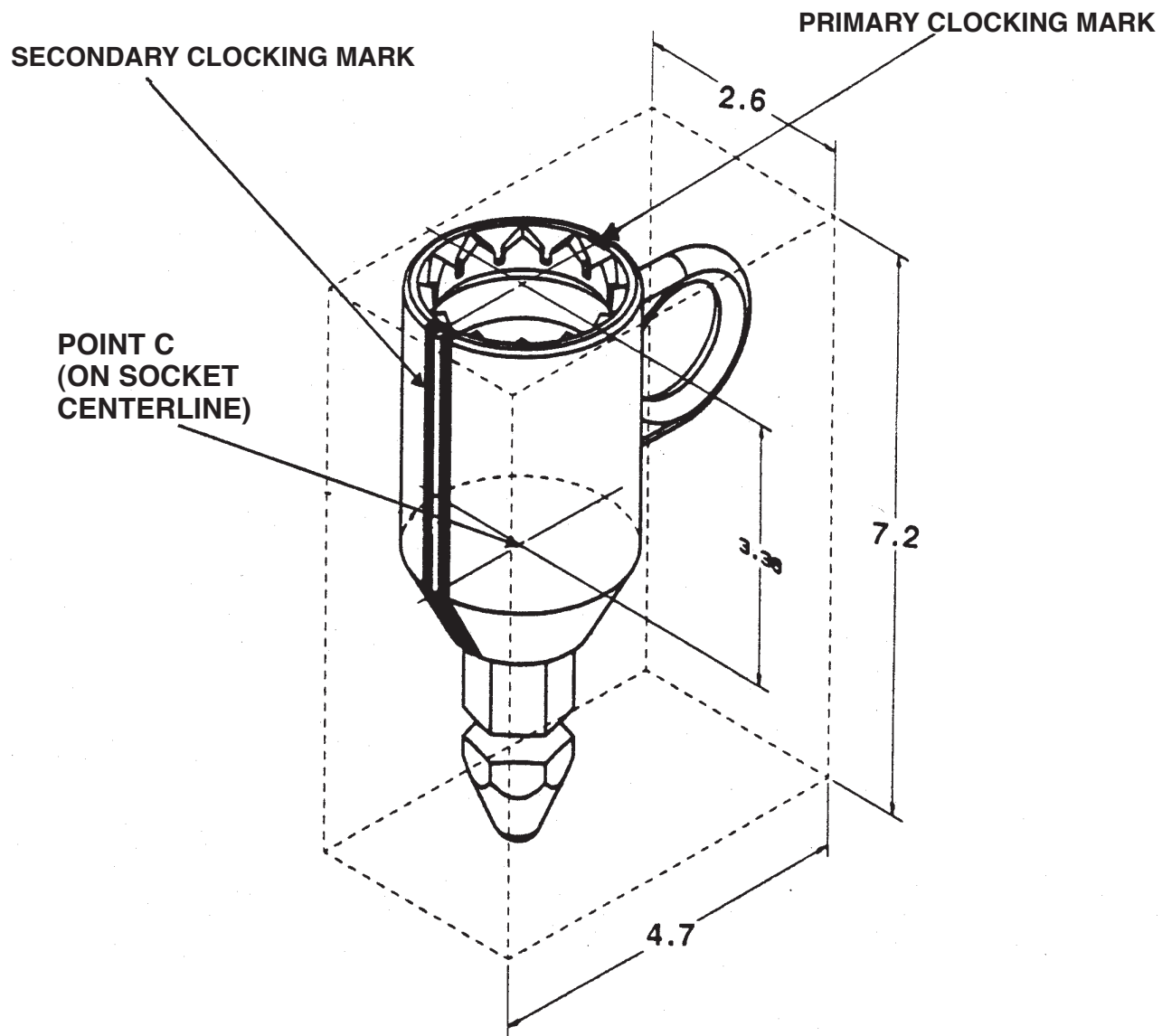
ALL DIMENSIONS ARE MAXIMUM MATERIAL DIMENSIONS UNLESS OTHERWISE NOTED.

FIGURE 3.6.4.2.1-4 ON-ORBIT INSTALLED WORKSITE INTERFACE ADAPTER PLATE HARDWARE ENVELOPE



NOTE: DIMENSIONAL TOLERANCES ARE +/- .01

**FIGURE 3.6.4.2.1-5 AS INSTALLED ON-ORBIT INSTALLED WORKSITE INTERFACE FOOTPRINT**



**ALL DIMENSIONS ARE MAXIMUM  
MATERIAL DIMENSIONS UNLESS  
OTHERWISE NOTED.**

**FIGURE 3.6.4.2.1-6 WORKSITE INTERFACE PASSIVE ADAPTER ENVELOPE WITH  
CLOCKING MARK INDICATED**



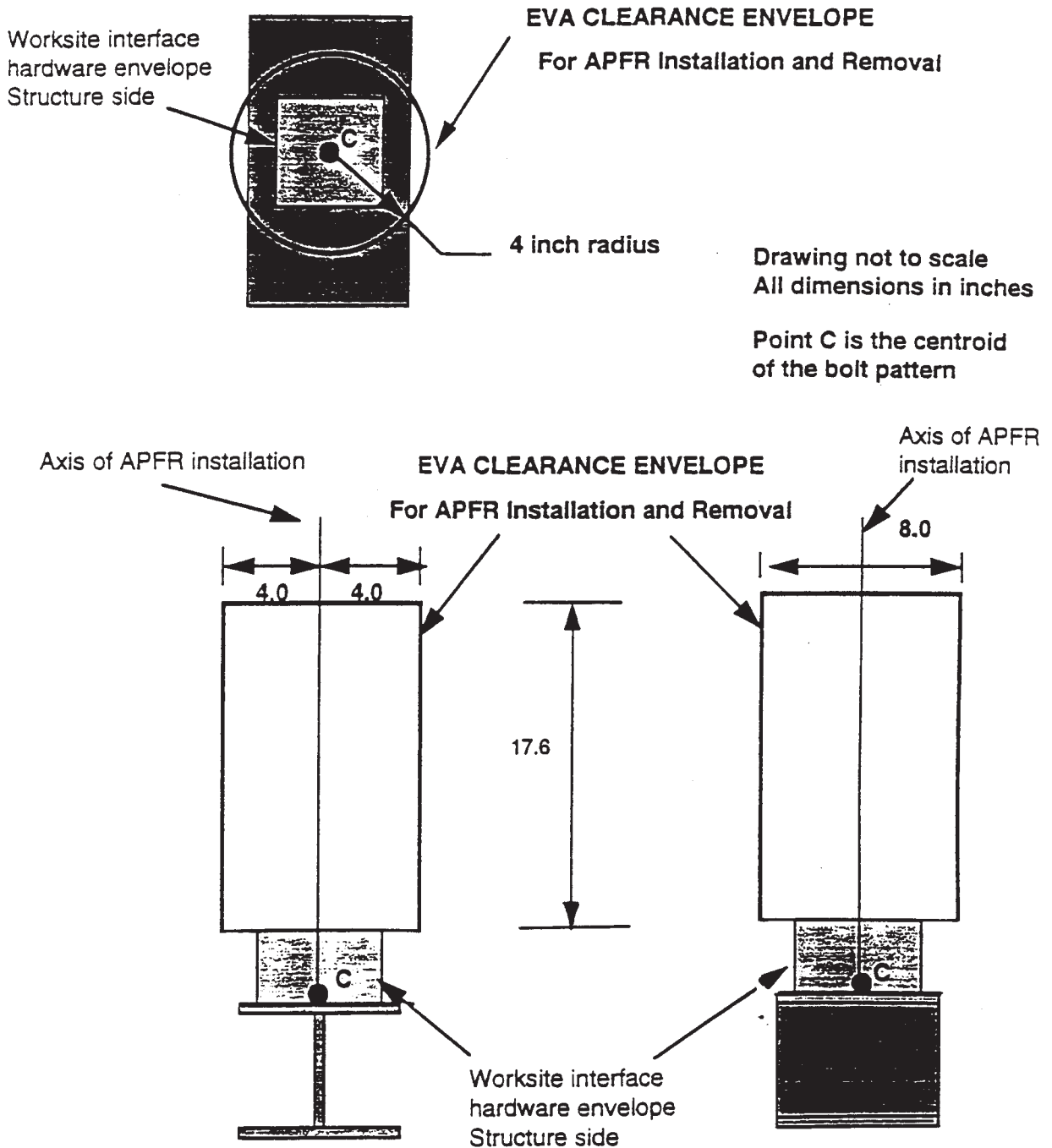
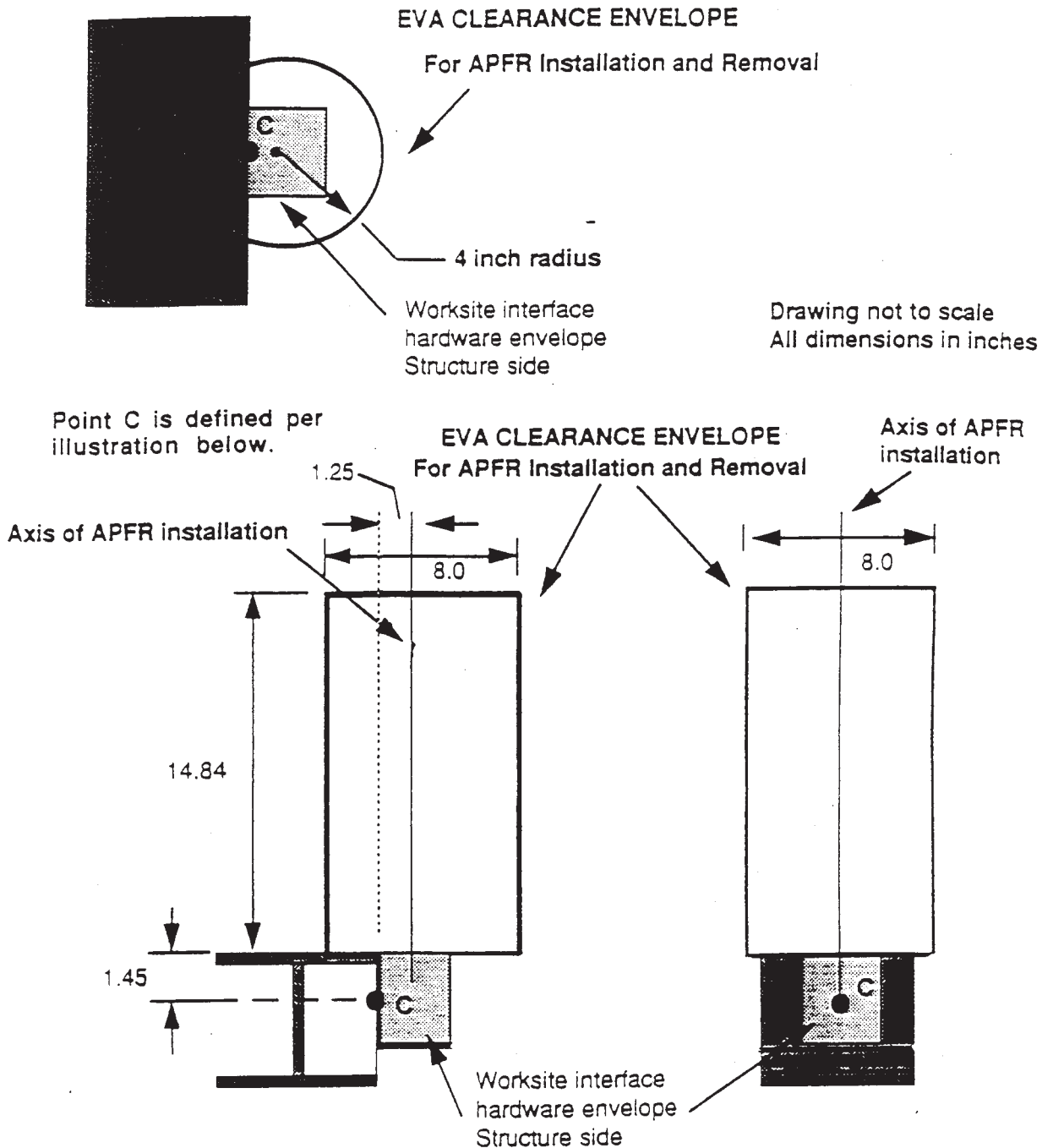


FIGURE 3.6.4.2.2-1 APFR INSTALLATION/REMOVAL EVA CLEARANCE ENVELOPE – TOP MOUNTED WORKSITE INTERFACE



**FIGURE 3.6.4.2.2-2 APFR INSTALLATION/REMOVAL EVA CLEARANCE ENVELOPE – SIDE MOUNTED WORKSITE INTERFACE**

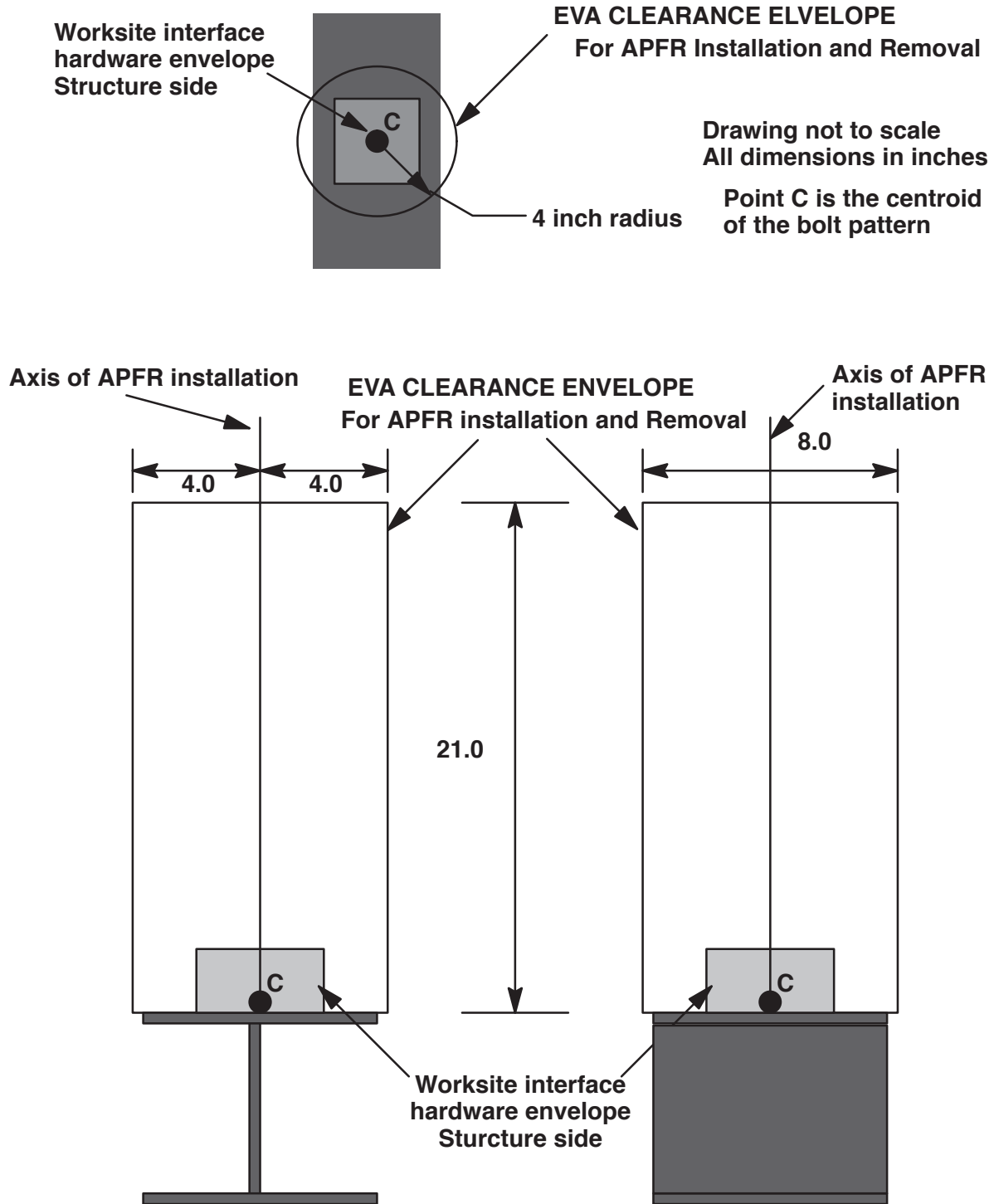
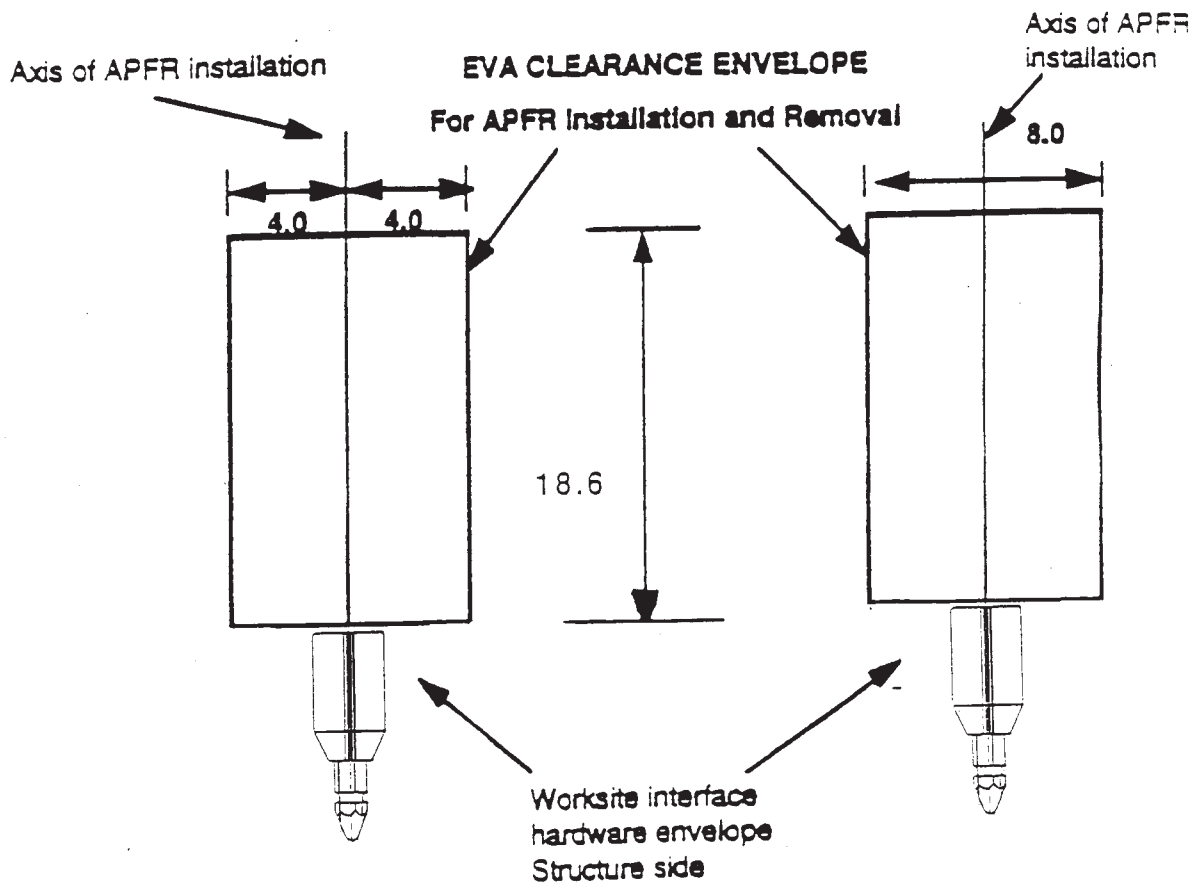
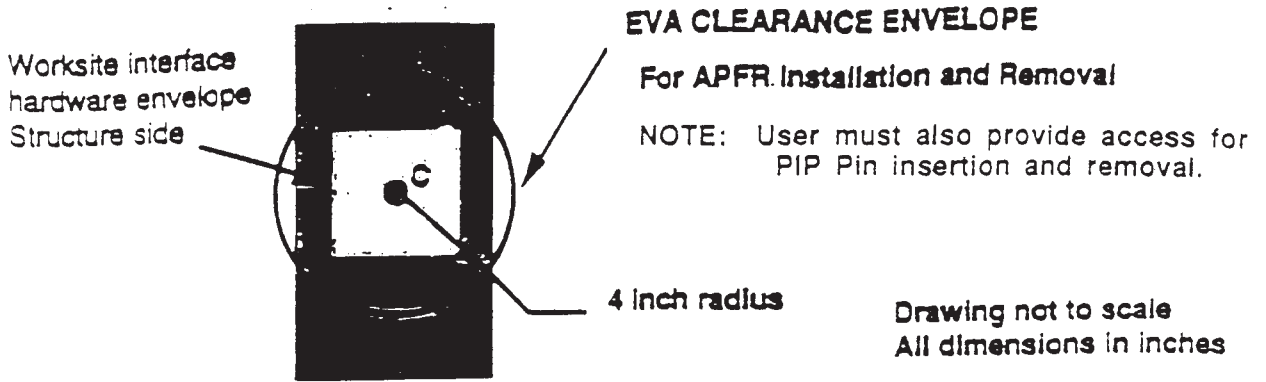
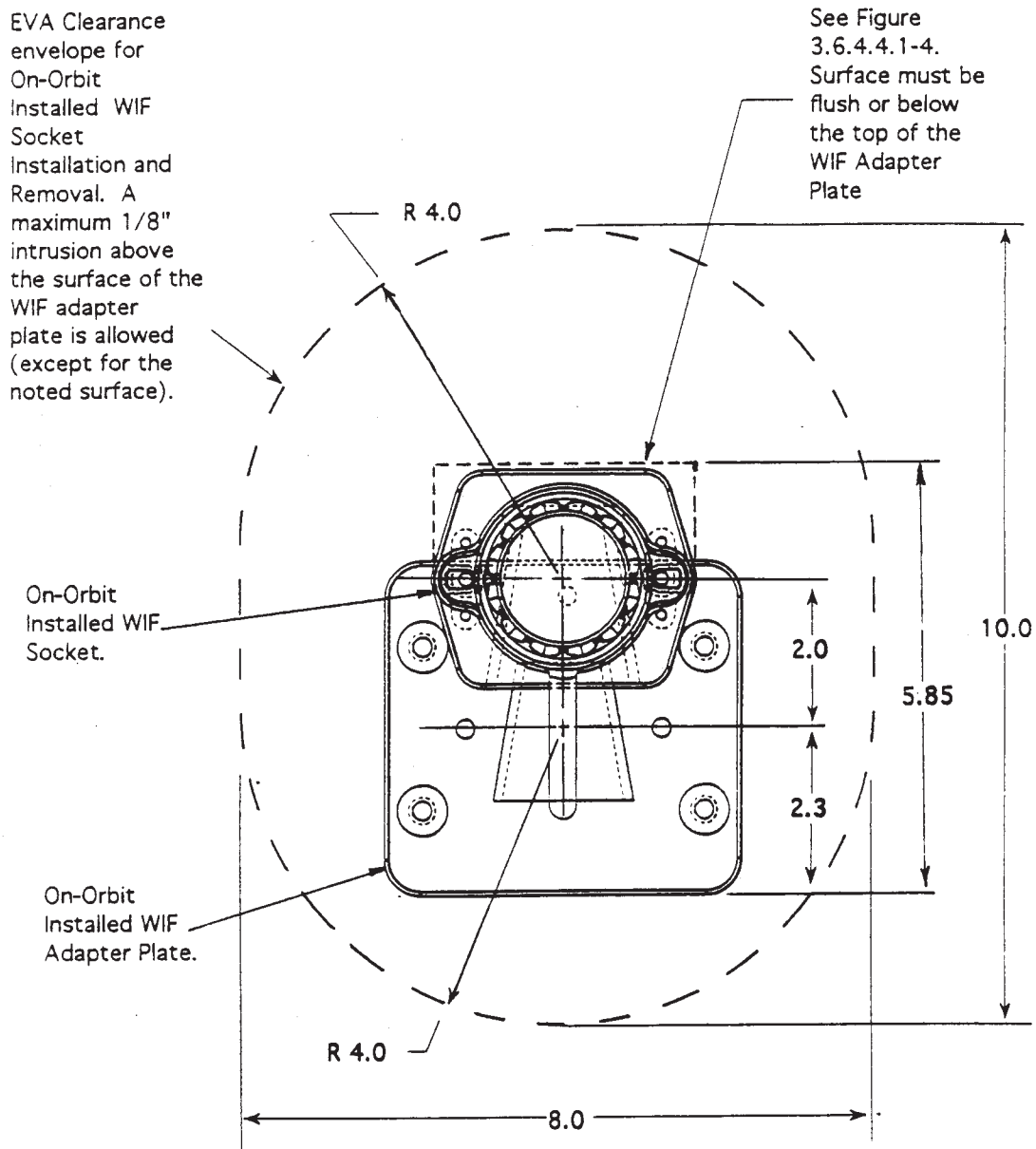


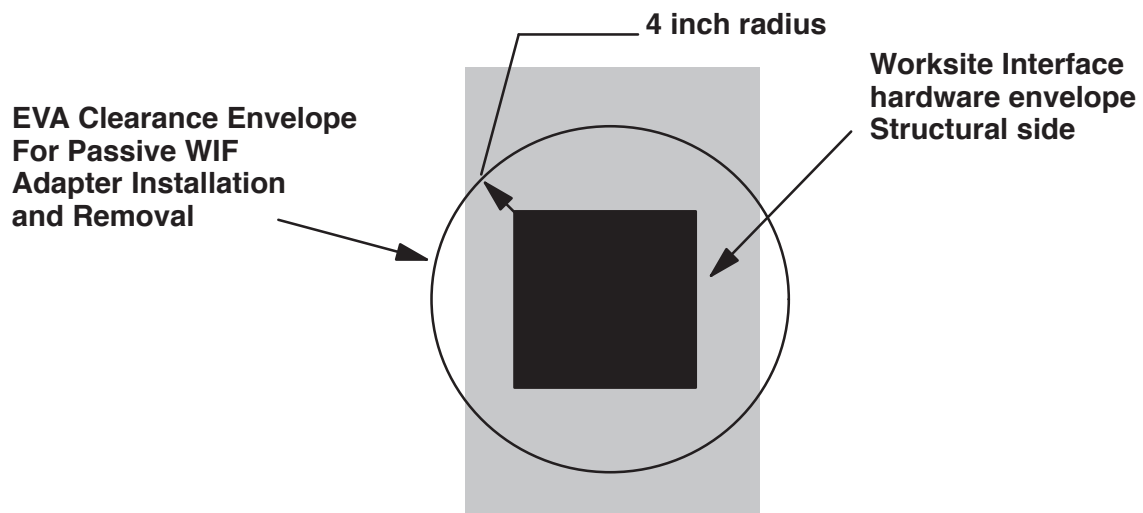
FIGURE 3.6.4.2.2-3 APFR INSTALLATION/REMOVAL EVA CLEARANCE ENVELOPE – ON-ORBIT INSTALLED WORKSITE INTERFACE



**FIGURE 3.6.4.2-4 APFR INSTALLATION/REMOVAL EVA CLEARANCE ENVELOPE – WIF PASSIVE ADAPTER**



**FIGURE 3.6.4.2.2-5 ON-ORBIT INSTALLED WIF SOCKET INSTALLATION EVA CLEARANCE ENVELOPE – ON-ORBIT INSTALLED WIF ADAPTER PLATE**



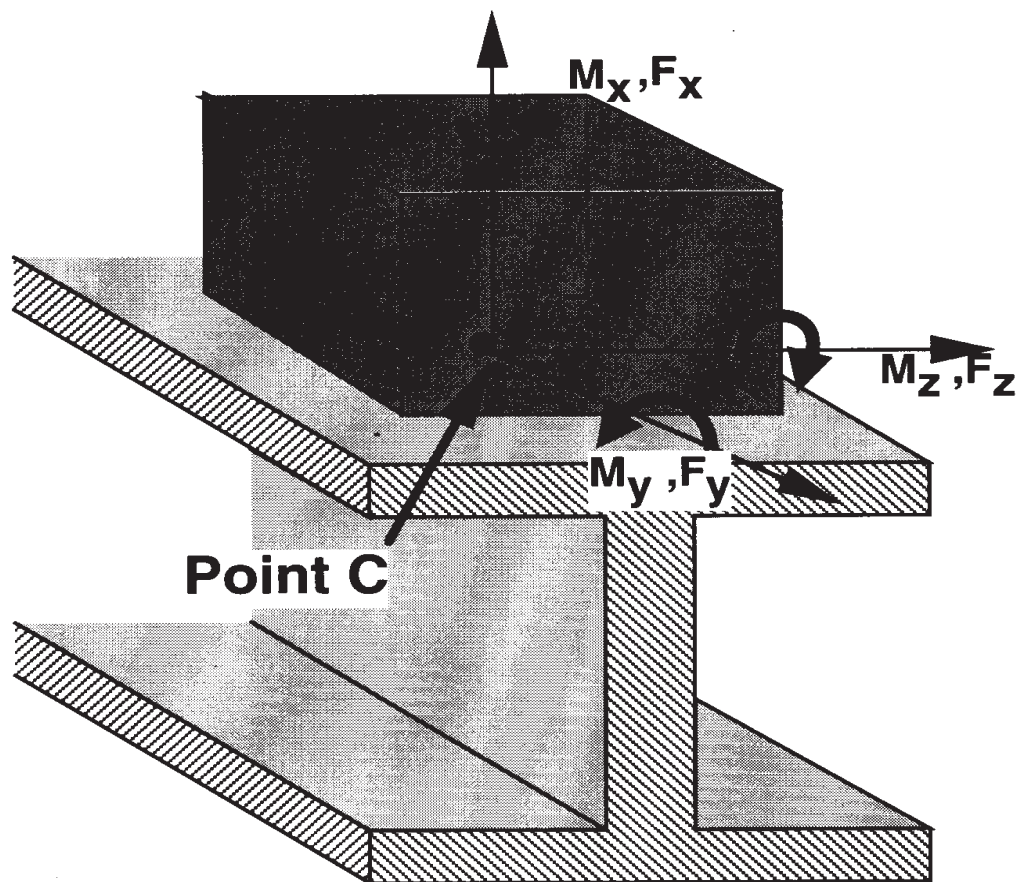
**DRAWING NOT TO SCALE  
ALL DIMENSIONS IN INCHES**

**FIGURE 3.6.4.2.2-6 WIF PASSIVE ADAPTER INSTALLATION/REMOVAL EVA CLEARANCE ENVELOPE – SHUTTLE-STYLE PFR SOCKET**

### Maximum Interface Loads

| Moment                       | Force                    |
|------------------------------|--------------------------|
| Any direction<br>4200 in lbs | Any direction<br>274 lbs |

Note: The above loads should be applied simultaneously.  
All loads are to be applied at Point C.



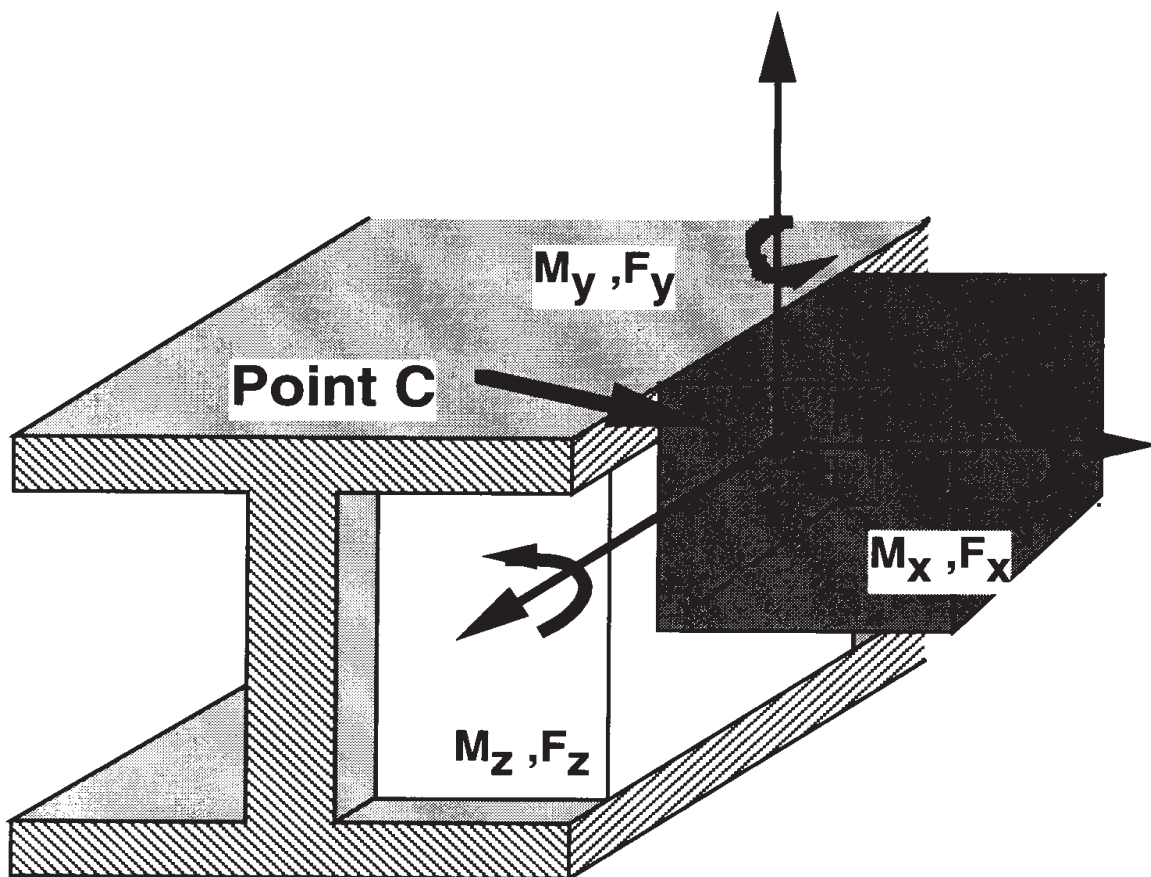
Point C, the force and moment origin, is located at the center of the bolt pattern at the mating interface

FIGURE 3.6.4.3.2-1 TOP MOUNTED AND ON-ORBIT INSTALLED WORKSITE INTERFACE WORKSITE PASSIVE HALF LOADING CRITERIA

### Maximum Interface Loads

| Moment                       | Force                    |
|------------------------------|--------------------------|
| Any direction<br>4200 in lbs | Any direction<br>274 lbs |

Note: The above loads should be applied simultaneously.  
All loads are to be applied at Point C.



Point C, the force and moment origin, is located at the center of the bolt pattern at the mating interface

FIGURE 3.6.4.3.2-2 SIDE MOUNTED WORKSITE INTERFACE PASSIVE HALF LOADING CRITERIA



### **3.6.4.3.3 MASS PROPERTIES**

The maximum weight of the top mounted ground installed WIF is 1.75 lbs, the side mounted ground installed WIF is 2.25 lbs, the on-orbit installed WIF is 2.5 lbs and the on-orbit installed adapter plate is 2.0 lbs. The maximum weight of the passive WIF adapter is 2.0 lbs. The center of mass of all configurations is at the centroid.

### **3.6.4.4 MECHANICAL**

#### **3.6.4.4.1 MOUNTING AND INSTALLATIONS**

The WIF hardware footprint and bolt pattern dimensions are shown in Figure 3.6.4.4.1-1 for ground installed top mounted, Figure 3.6.4.4.1-2 for ground installed side mounted, and Figure 3.6.4.4.1-3 for the on-orbit installed WIF Adapter Plate. The location of WIFs on the systems and elements are user defined. Users of the WIFs should apply these bolt patterns to their structure for the purpose of pre-drilling holes to install the passive half of the WIF. The passive WIF adapter to Shuttle style PFR socket interface requirements are shown in Figure 3.6.4.4.1-5.

The on-orbit installed WIF will require a unique clearance envelope to be installed onto the structure. Figure 3.6.4.4.1-4 provides the envelope necessary to allow for this installation.

The EVA clearance for installation/removal of the on-orbit installed WIF socket on the on-orbit installed WIF adapter plate, and the WIF adapter into the Shuttle-style PFR socket are shown in Figures 3.5.4.2.2-4, 3.6.4.4-5, and 3.6.4.2.2-6, respectively.

Clocking marks are provided on the WIFs as indicated in Figures 3.6.4.2.1-1, 3.6.4.2.1-2, 3.6.4.2.1-3 and 3.6.4.2.1-7 for user specified orientation of the WIF. The clocking marks allow for specific alignment of the APFR through the clocking indicator on the APFR load limiter.

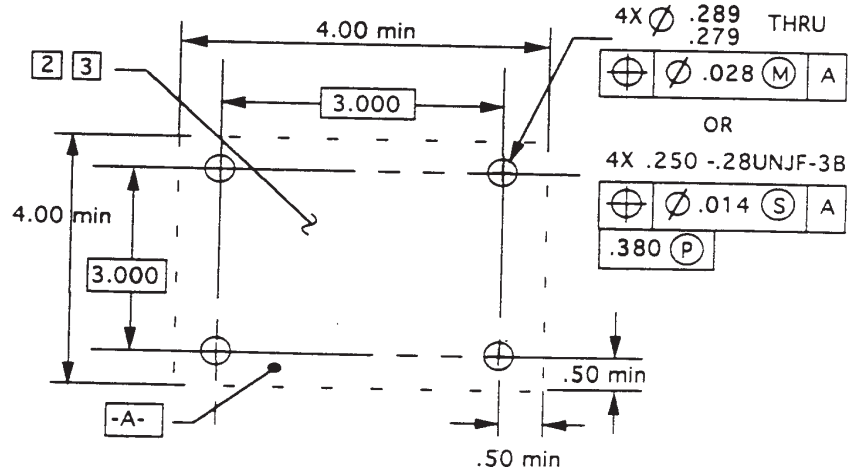
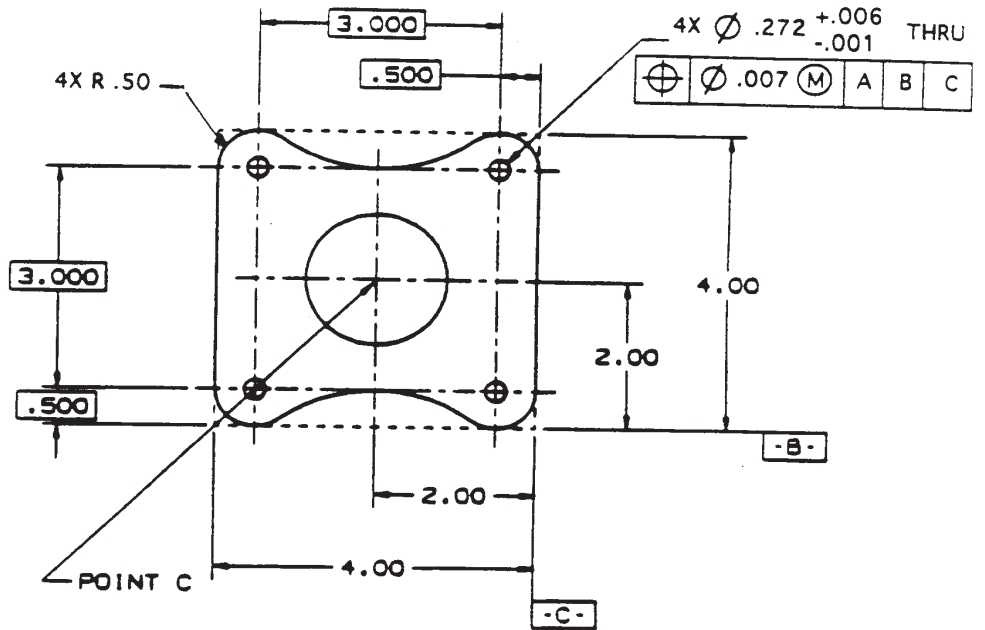
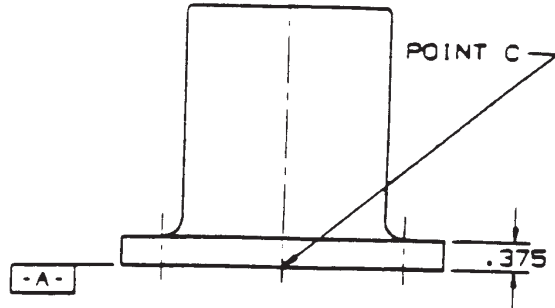
#### **3.6.4.4.2 SURFACE FINISH**

The WIFs meet the finish requirements found in SSP 30233, Space Station Requirements for Materials and Processes. The faying surface is chemical conversion coated per MIL-C-5541, Class 3, for electrical bonding.

#### **3.6.4.4.3 RESERVED**

#### **3.6.4.4.4 FASTENERS**

The user will provide associated fastener hardware that is compatible with the material and protective finish for the WIFs, and will specify fastener engagement depth on the installation drawing. The fasteners for the on-orbit installed WIF adapter plate will not protrude above the counterbore provided.

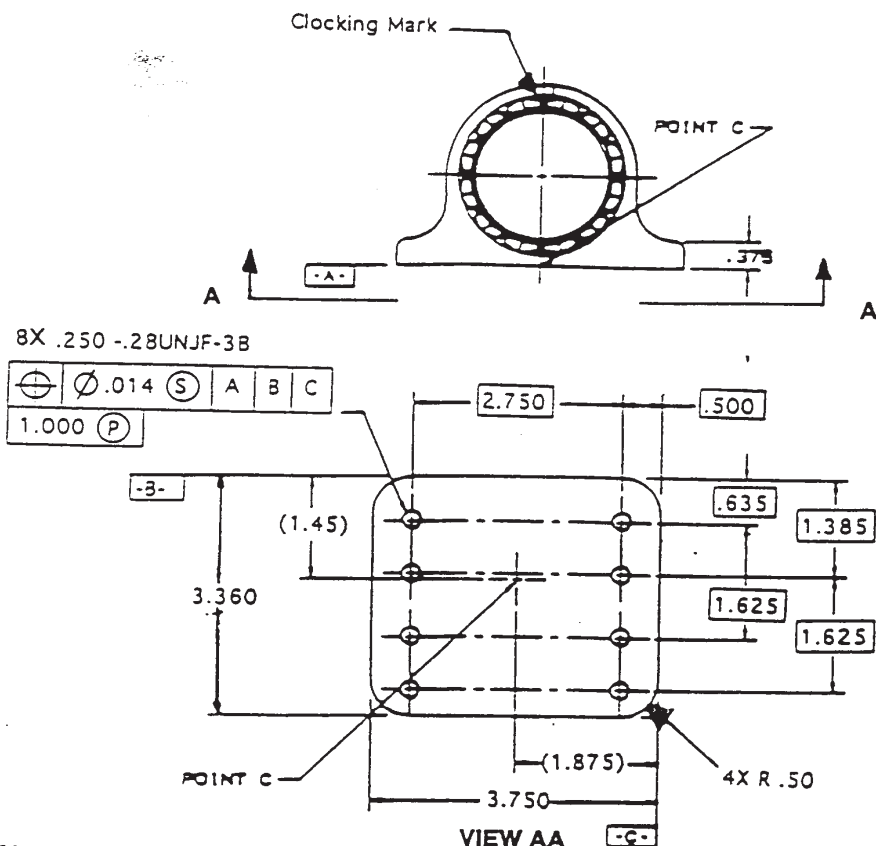


NOTES:

- 1 CHEMICAL FILM SURFACE PER MIL-C-5541, CLASS 3.
- 2 SURFACE SHALL SUPPORT CLASS S BOND PER SSP 30245.
- 3 .005 MISMATCH MAXIMUM NOT TO EXCEED LIMITS OF SIZE.

All dimensions are toleranced as follows unless stated otherwise:  
 .00 +/- .01  
 .000 +/- .005  
 angular +/- 1 degree

FIGURE 3.6.4.4.1-1 TOP MOUNTED WORKSITE INTERFACE PASSIVE HALF FOOTPRINT AND BOLT PATTERN (GROUND INSTALLED)



NOTES:

- 1 BACK ACCESS REQUIRED FOR INSTALLATION. FASTENER ENGAGEMENT SHOULD BE .375 MAXIMUM TO PREVENT EXPOSED THREADS.
- 2 CHEMICAL FILM SURFACE PER MIL-C-5541, CLASS 3.
- 3 SURFACE SHALL SUPPORT CLASS S BOND PER SSP 30245.
- 4 .005 MISMATCH MAXIMUM NOT TO EXCEED LIMITS OF SIZE.

All dimensions are toleranced as follows unless stated otherwise:  
 .00 +/- .01  
 .000 +/- .005  
 Angular +/- 1 degree

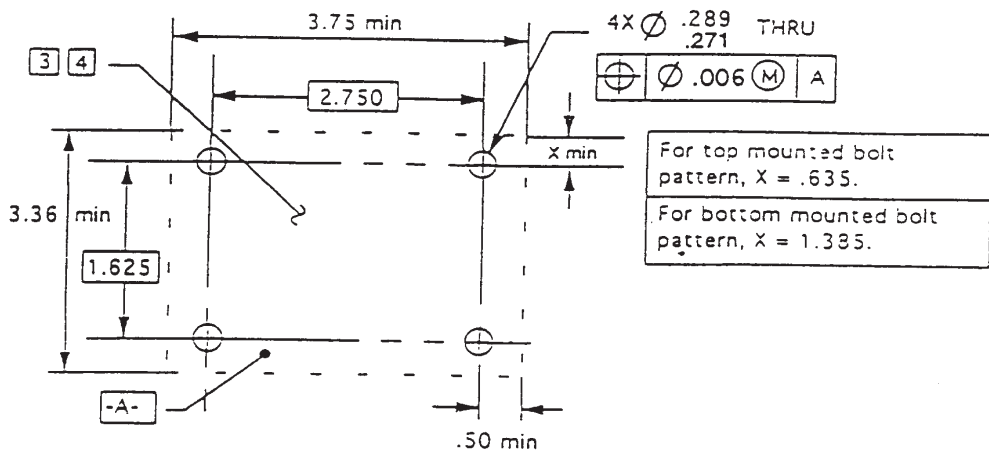
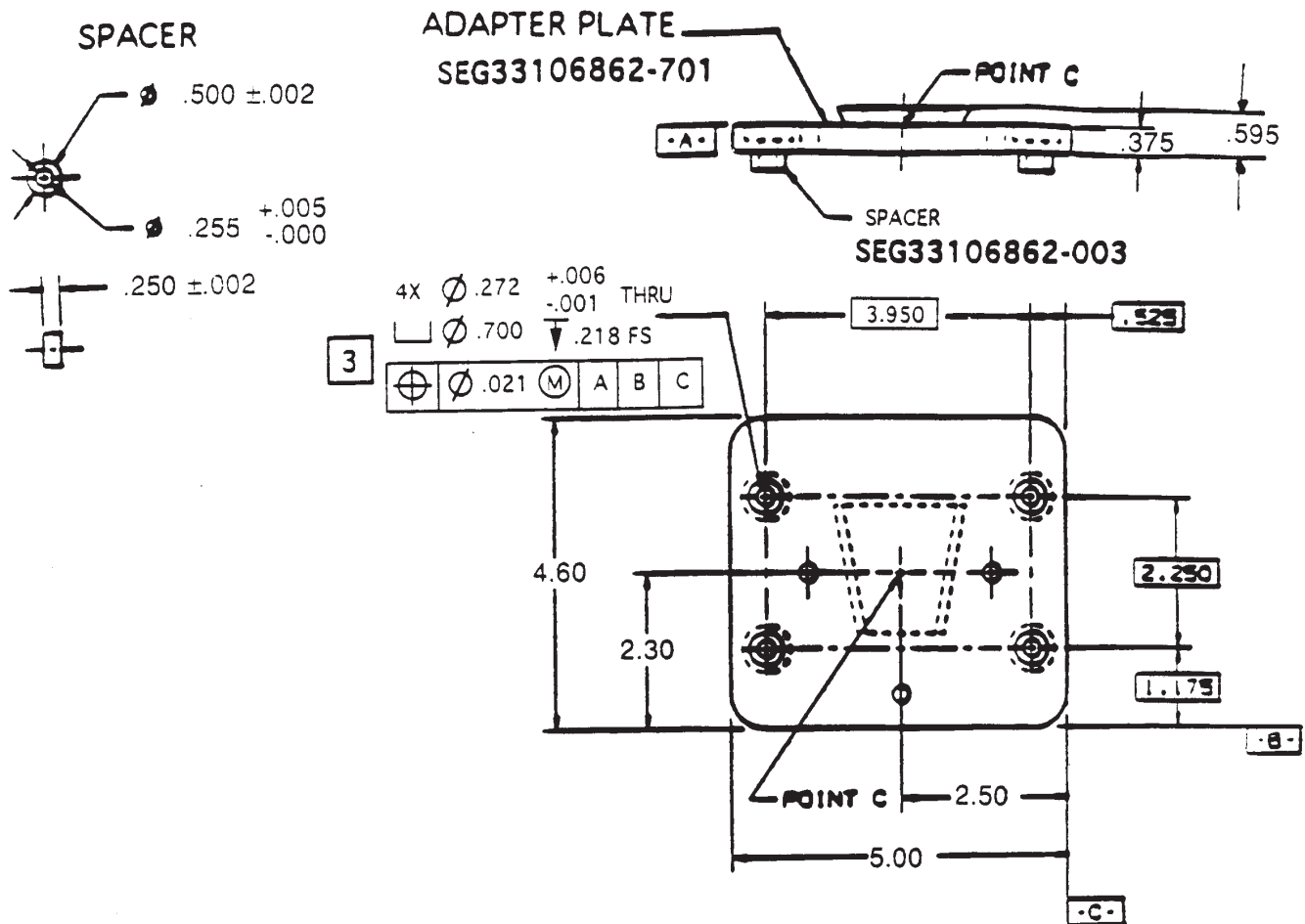


FIGURE 3.6.4.4.1-2 SIDE MOUNTED WORKSITE INTERFACE PASSIVE HALF FOOTPRINT AND BOLT PATTERN WITH CLOCKING MARK INDICATED



All dimensions are  $\pm .005$ ,  $\pm .01$  unless stated otherwise.

- 1 SURFACE SHALL SUPPORT CLASS S BOND PER SSP 30245
- 2 USE 7/16" HEX HEAD BOLTS. LENGTH TO BE SPECIFIED BY USER. BOLT HEAD SHALL NOT EXTEND ABOVE SURFACE A.
- 3 Counterbore Fillet Radii .02 Max.

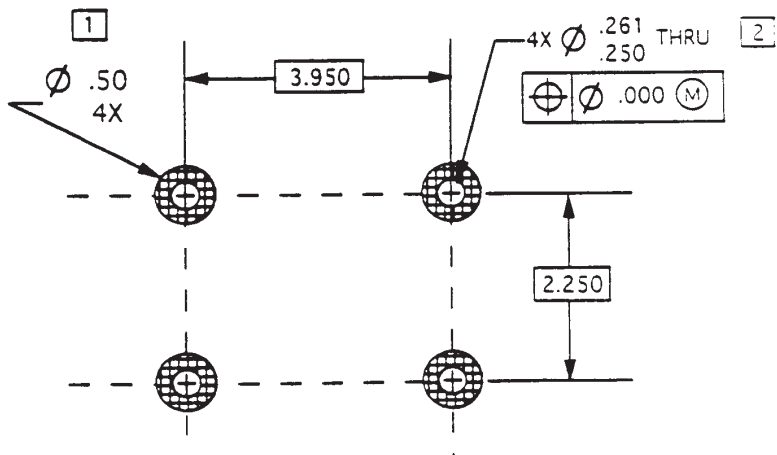


FIGURE 3.6.4.4.1-3 ON-ORBIT INSTALLED WORKSITE INTERFACE ADAPTER PLATE FOOTPRINT AND BOLT PATTERN

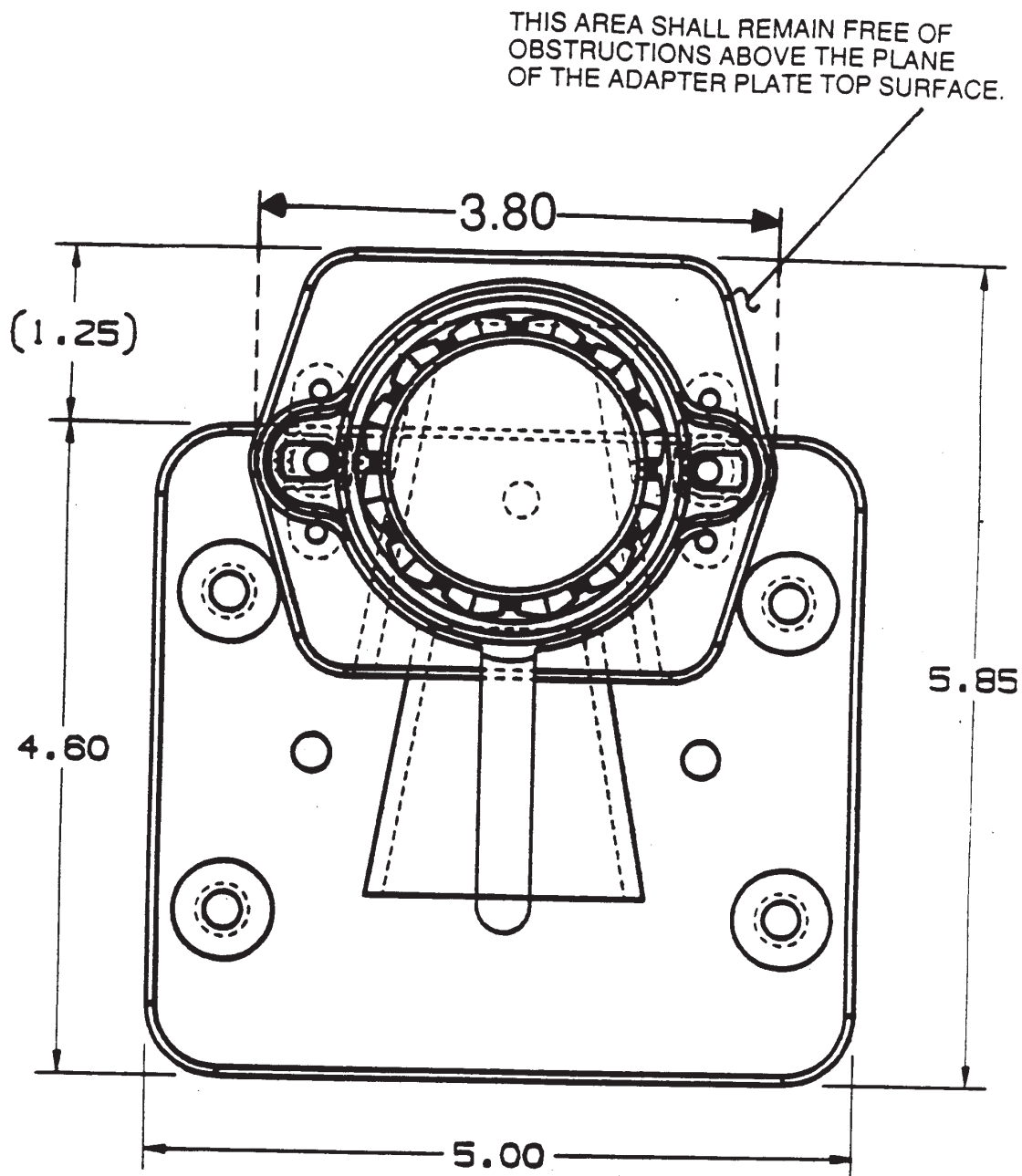
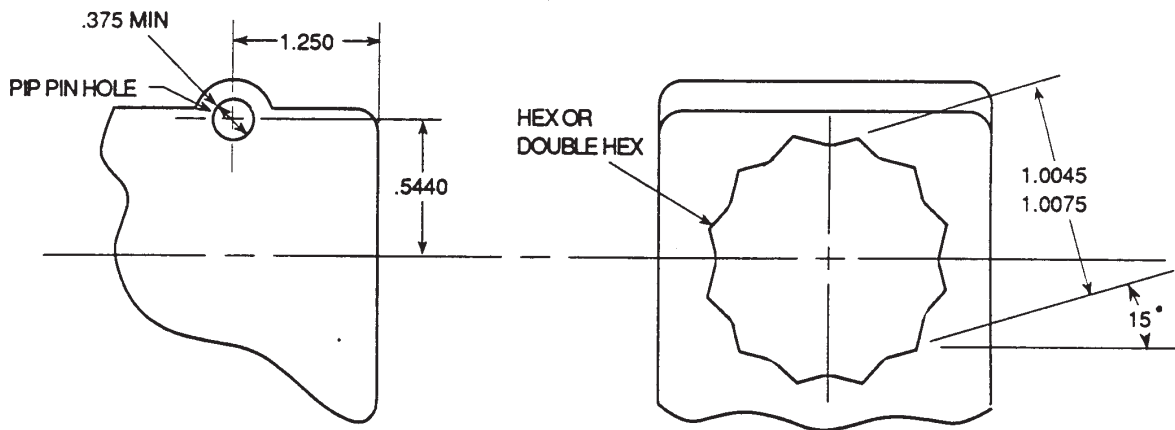
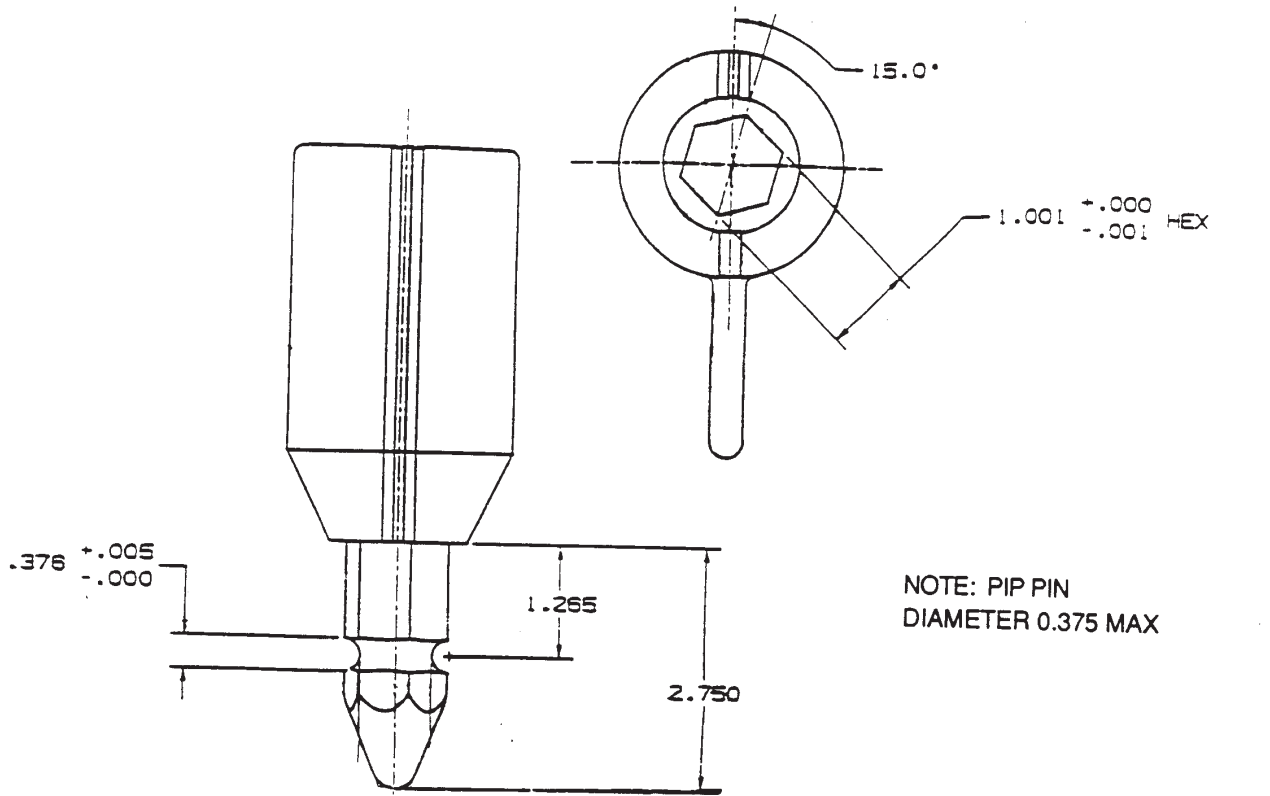


FIGURE 3.6.4.4.1-4 INSTALLATION ENVELOPE FOR ON-ORBIT INSTALLED WORKSITE INTERFACE



PFR SOCKET INTERFACE

FIGURE 3.6.4.4.1-5 WIF PASSIVE ADAPTER TO SHUTTLE-STYLE PFR SOCKET INTERFACE

#### **3.6.4.4.5 MATERIALS**

The predominant material of the Passive WIFs and on-orbit installed WIF adapter plate is 7075-T7351 aluminum alloy. The adapter plate spacer material is titanium.

#### **3.6.4.5 THERMAL**

The WIFs are designated “incidental contact” EVA crew interfaces. Thermal control of the WIFs is achieved by passive techniques.

#### **3.6.4.6 ELECTRICAL BONDING**

The WIF to user interface will satisfy a class S bond per SSP 30245, Space Station Electrical Bonding Specification, in its entirety.

### **3.6.5 HANDRAIL (ON-ORBIT INSTALLED)**

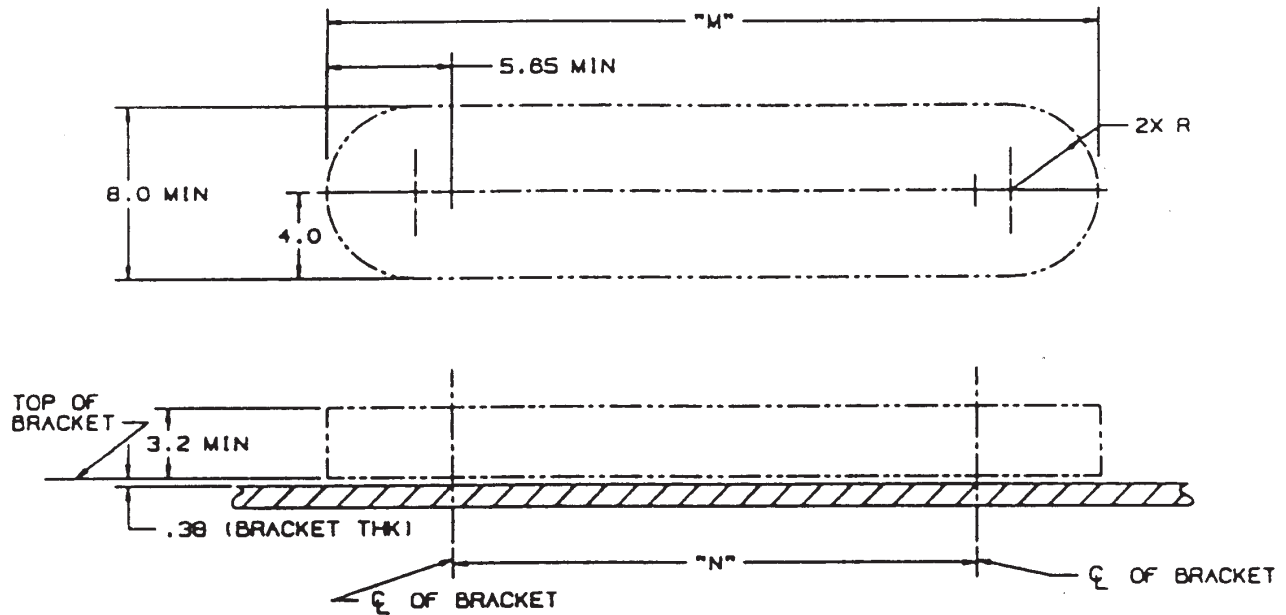
#### **3.6.5.1 INTERFACE DESCRIPTION**

EVA handrails will be supplied to facilitate translation and to provide restraint for a crewmember in a space suit on the exterior surface of Space Station elements. The handrails that are needed on the Space Station module longitudinal surfaces (e.g., Nodes, etc.) must be installed on-orbit due to the fact that the module diameter has been maximized to use the entire Shuttle payload bay. This section will describe the interface information for handrails that will be installed on-orbit. For ground installed handrails, see section 3.6.1.

#### **3.6.5.2 ENVELOPE**

##### **3.6.5.2.1 HARDWARE**

There are two on-orbit installed handrail configurations. The length of the standard on-orbit installed handrail is 24 in. between the stand-off seat track centers. The length of the dash 12 on-orbit installed handrail is 12 in. between the standoff seat track centers. Hardware envelope dimensions are shown in Figure 3.6.5.2.1-1.



| Part Number     | Description       | N           | M    |
|-----------------|-------------------|-------------|------|
| SEG33106351-301 | Handrail Assembly | 24.00 ± .06 | 35.3 |
| SEG33106351-305 | Handrail Assembly | 12.00 ± .06 | 23.3 |

FIGURE 3.6.5.2.1-1 ON-ORBIT INSTALLED HANDRAIL/HANDHOLD ENVELOPE  
(HARDWARE AND CLEARANCE)



### **3.6.5.2.2 EVA**

A 4 in. radial EVA clearance envelope around the handrail is necessary for a crewmember to use it as a translation aid. Figure 3.6.5.2.2-1 defines the cross-section of the on-orbit installed handrail.

### **3.6.5.3 STRUCTURAL**

#### **3.6.5.3.1 LOADING**

The loading criteria of the on-orbit installed handrail is that it must support a 220 lbs hand induced limit load or a 200 lbs EVA tether limit load in any direction. These loads will not occur simultaneously. The worst load case will produce a maximum limit load of 220 lbs shear/tension combined with a maximum bending moment at the stand-off interface of 800 in-lbs on the primary path. The worst load case will produce a maximum limit load of 187 lbs shear/tension combined with a maximum bending moment at the stand-off interface of 500 in-lbs on the secondary path.

#### **3.6.5.3.2 MASS PROPERTIES**

The maximum weight of the on-orbit installed handrails is 2.80 lbs.

### **3.6.5.4 MECHANICAL**

#### **3.6.5.4.1 MOUNTING AND INSTALLATIONS**

The design of the handrail brackets for the on-orbit installed handrail interface is shown in Figures 3.6.5.4.1-1 and -2.

#### **3.6.5.4.2 SURFACE FINISH**

The on-orbit installed handrails meet the finish requirements found in SSP 30233, Space Station Requirements for Materials and Processes. The surface finish color will be yellow. The faying surface is chemical conversion coated per MIL-C-5542, Class 3, for electrical bonding.

#### **3.6.5.4.3 FASTENERS**

The design of the on-orbit installed handrail includes the attachment device needed for the interfaces and requires no additional fasteners.

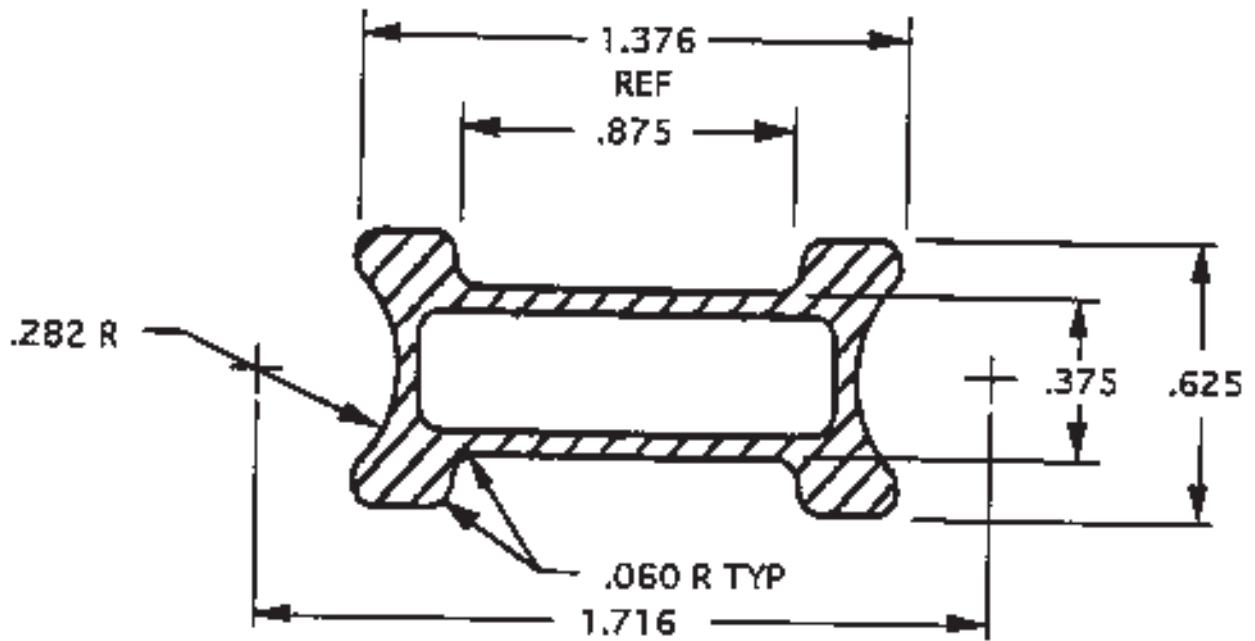
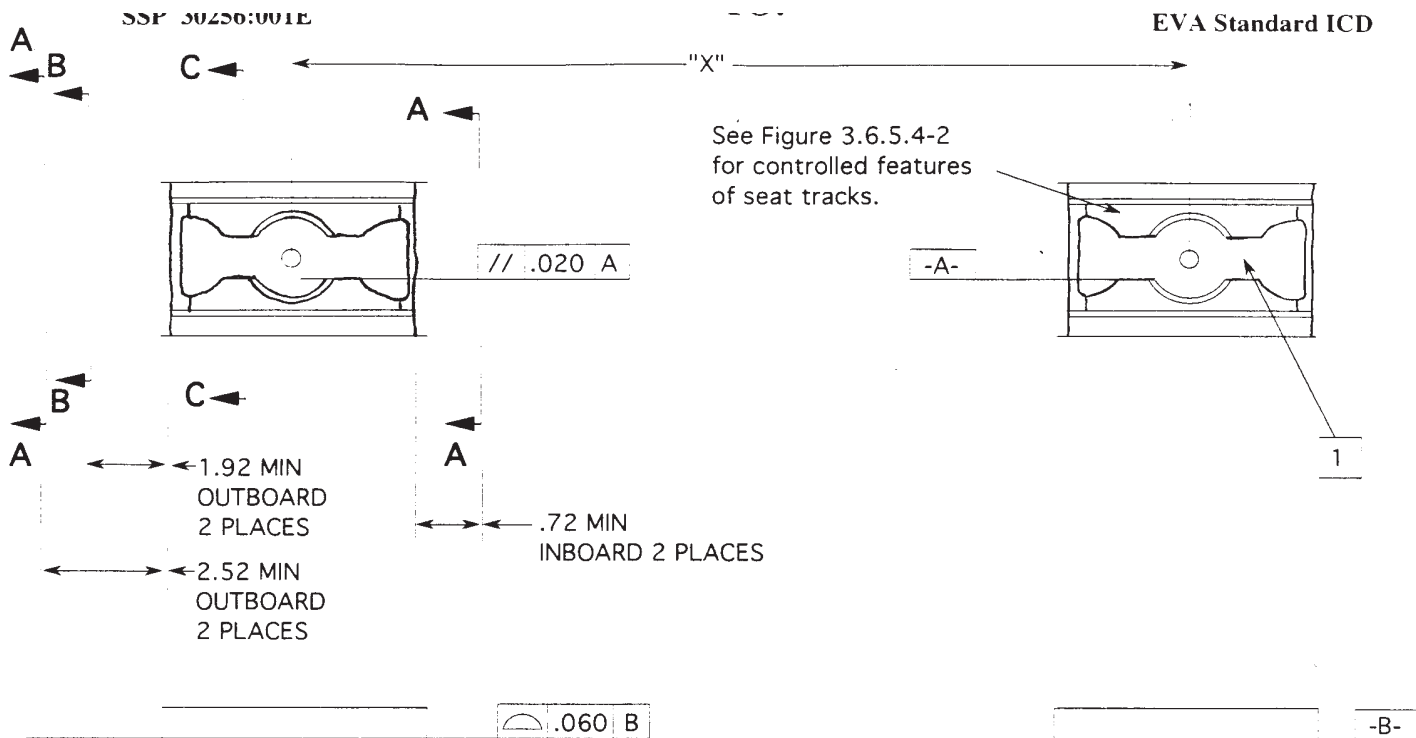
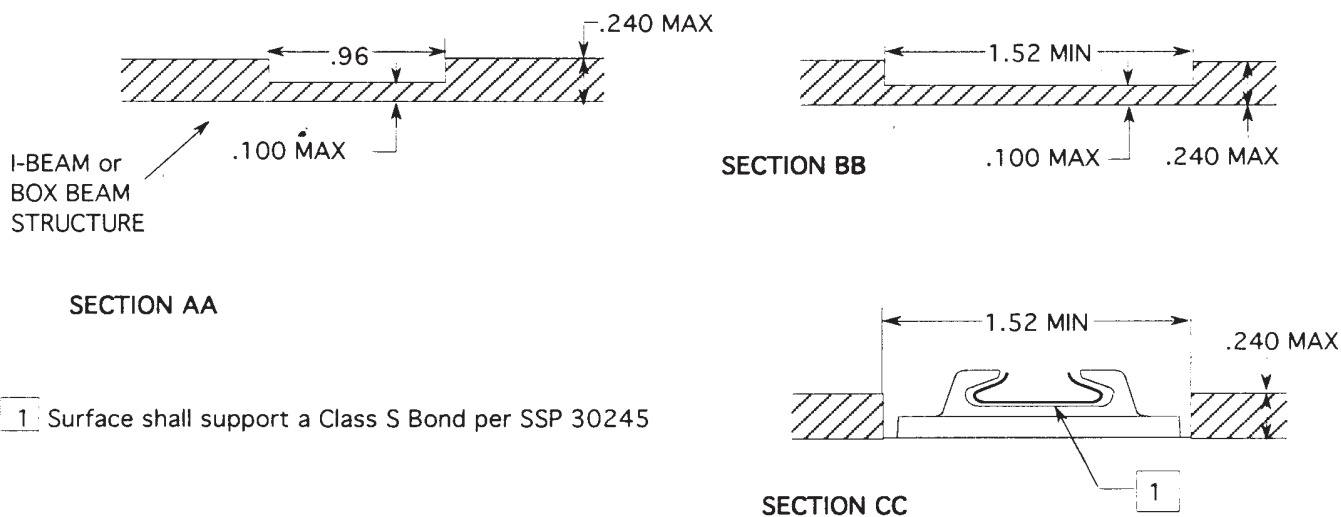


FIGURE 3.6.5.2.2-1 HANDRAIL CROSS SECTION (ON-ORBIT INSTALLED)



| Part Number      | Name        | X ± 0.06 |
|------------------|-------------|----------|
| SEG 33106351-301 | Handrail    | 24.00    |
| SEG 33106351-305 | Handrail-12 | 12.00    |

**Structure Side Hardware Stay Out Envelopes through Sections AA, BB, and CC**



**FIGURE 3.6.5.4.1-1 ON-ORBIT INSTALLED HANDRAIL TO HANDRAIL BRACKETS AND DEBRIS SHIELD INTERFACE**

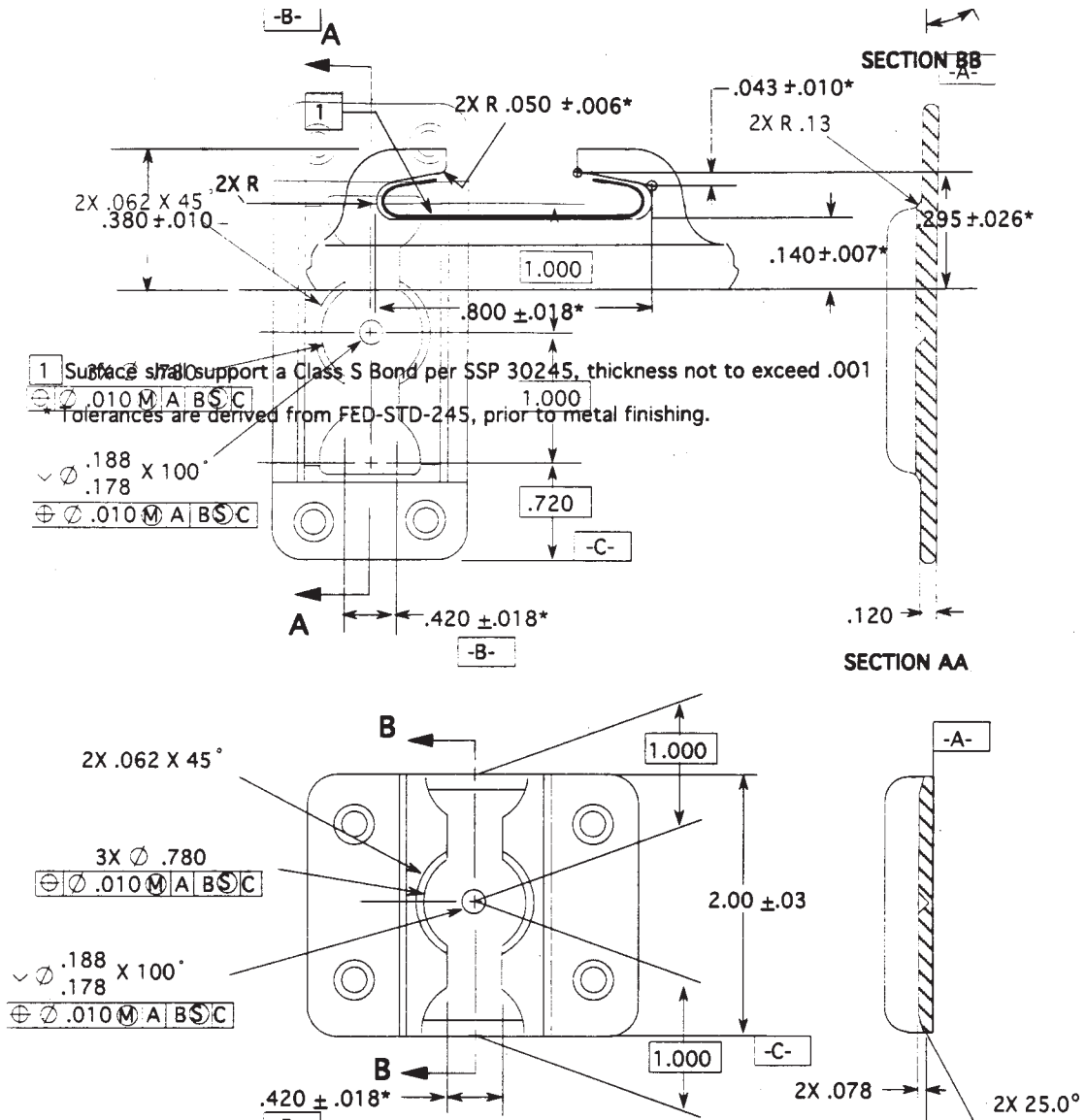


FIGURE 3.6.5.4.1-2 ON-ORBIT INSTALLED HANDRAIL BRACKET (SEAT TRACK) INTERFACE

#### **3.6.5.4.4 MATERIALS**

The handrail stand-off interface material is 7075-T7351 aluminum alloy.

#### **3.6.5.5 THERMAL**

The on-orbit installed handrails are designated “unlimited contact” EVA crew interfaces. Thermal control of this hardware is achieved by passive techniques. The installation design activity is responsible for maintaining the heat transfer rates within the specified limits.

#### **3.6.5.6 ELECTRICAL BONDING**

The on-orbit installed handrail to user interface will satisfy a class S bond per SSP 30245, Space Station Electrical Bonding Specification, in its entirety.

### **3.7 AIRLOCK EVA TOOL STOWAGE DEVICE**

The Airlock EVA Tool Stowage Device (A/L ETSD) provides for the stowage of the EVA contingency tools listed in Table 3.2-2. Two A/L ETSDs will be mounted to and launched on the Joint Airlock.

#### **3.7.1 INTERFACE DESCRIPTION**

The Airlock to A/L ETSD interface definition is shown on Figure 3.7.1-1. The Airlock ETSD interface foot print definition is shown on Figure 3.7.1-2.

#### **3.7.2 ENVELOPE**

The Airlock ETSD maximum launch envelope is shown in Figure 3.7.2-1. The on-orbit working envelope is shown in Figure 3.7.2-2.

#### **3.7.3 STRUCTURAL**

##### **3.7.3.1 MASS PROPERTIES**

The maximum weight of each Airlock ETSD outfitted for launch is 270 pounds. The A/L ETSD center of gravity (CG) envelope is shown in Figure 3.7.2-1.

##### **3.7.3.2 STIFFNESS**

The Airlock ETSD will have a natural frequency of 35 Hz or greater.

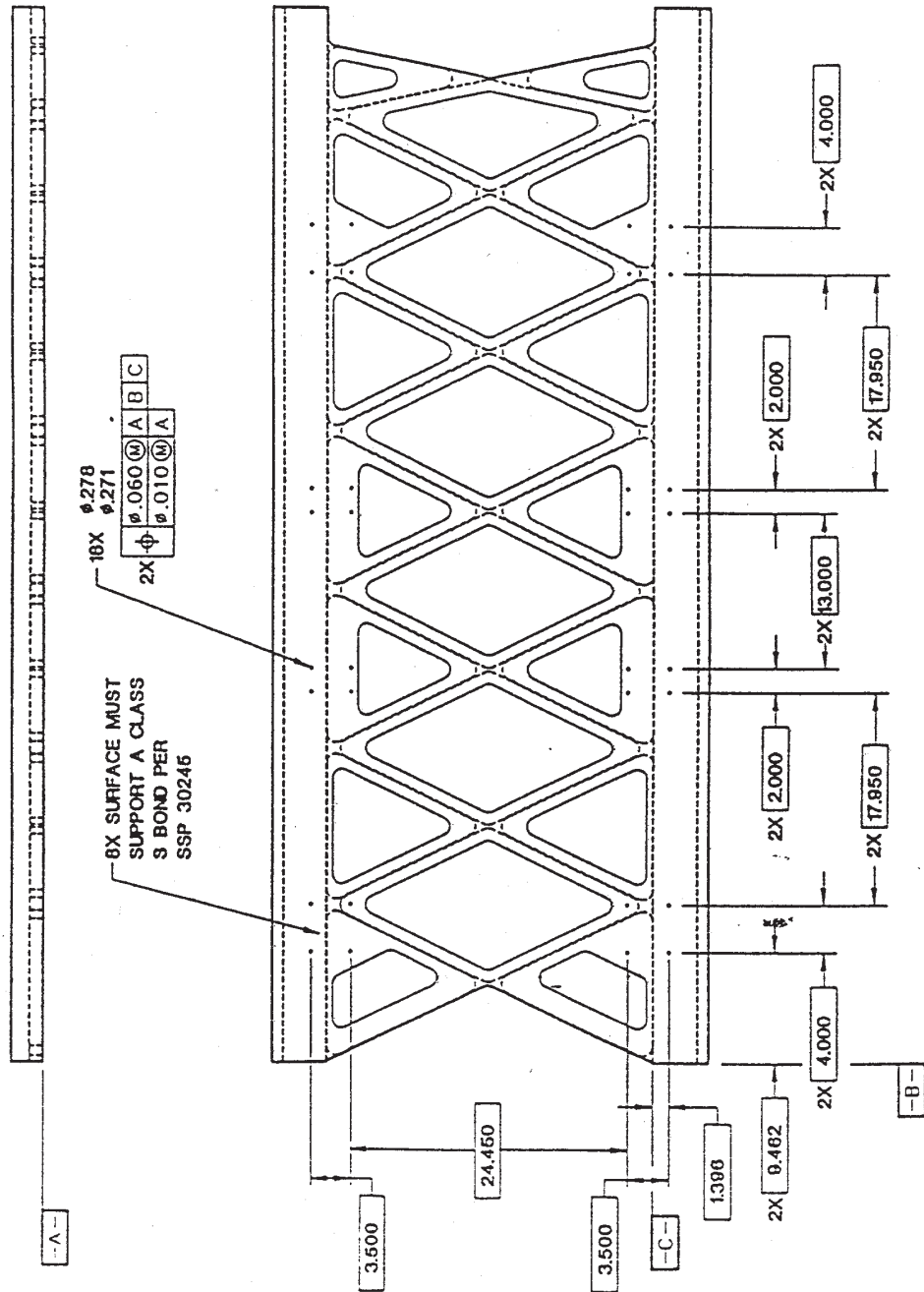
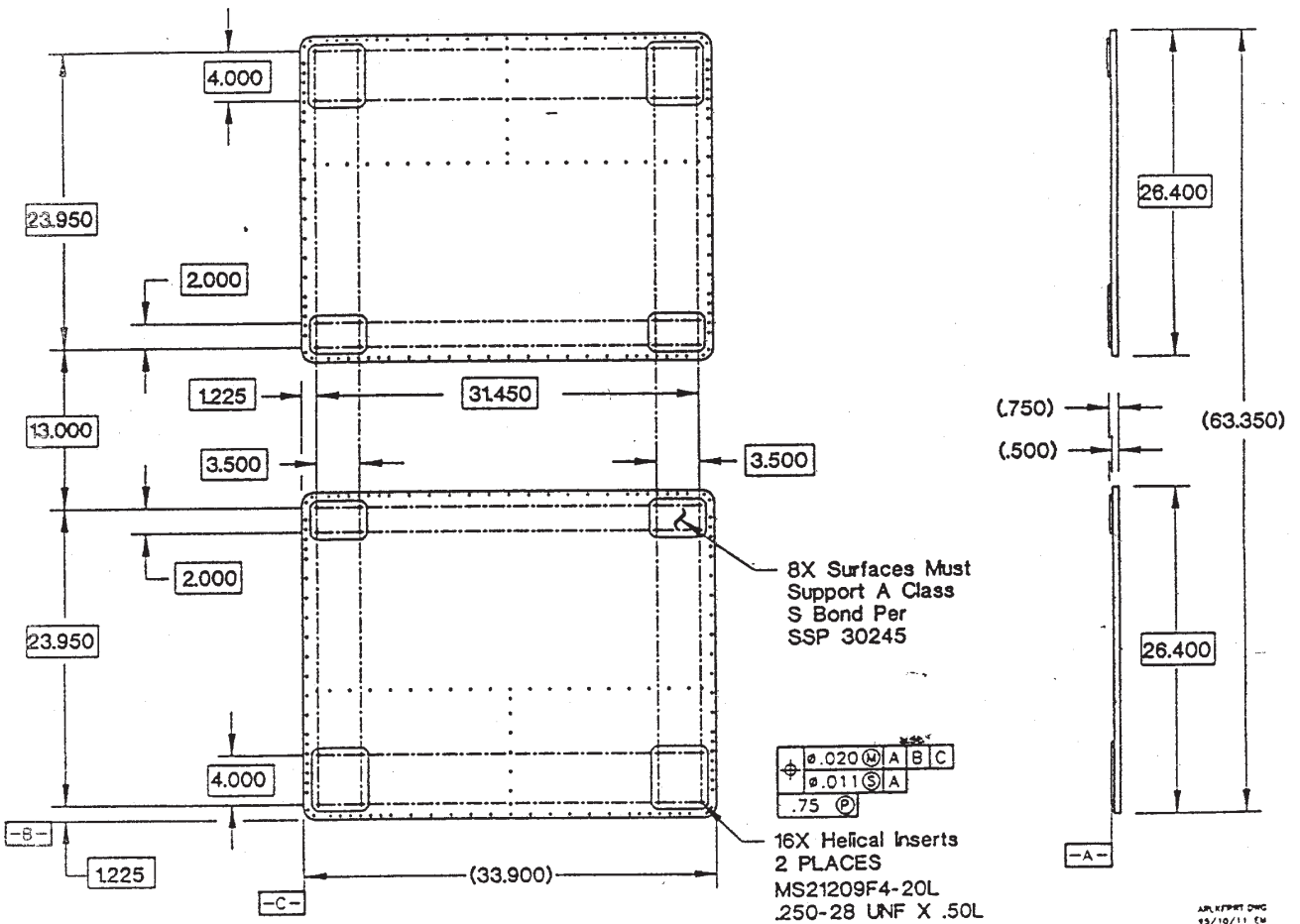


FIGURE 3.7.1-1 A/L STORAGE TO AIRLOCK INTERFACE DEFINITION



Note: User organization to provide fasteners  
**FIGURE 3.7.1-2 A/L ETS INTERFACE FOOTPRINT DEFINITION**

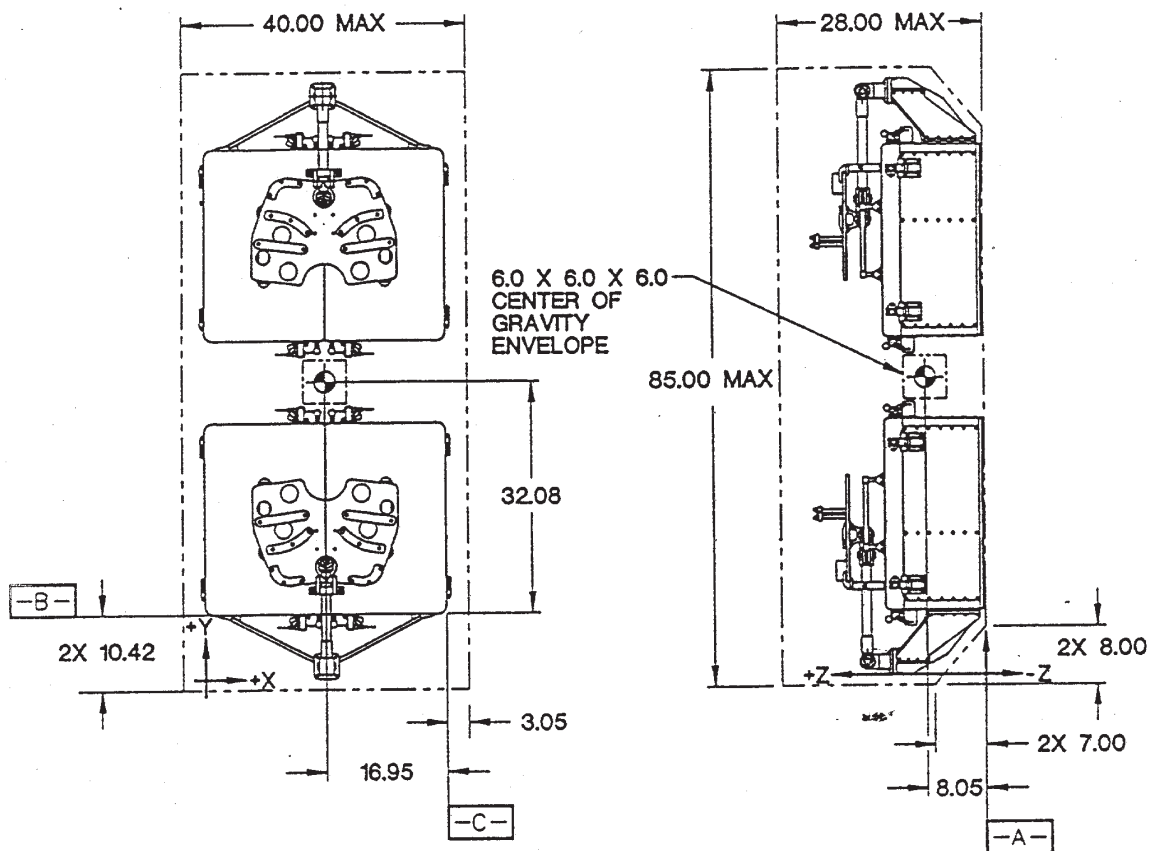


FIGURE 3.7.2-1 A/L ETSD LAUNCH ENVELOPE INTERFACE DEFINITION



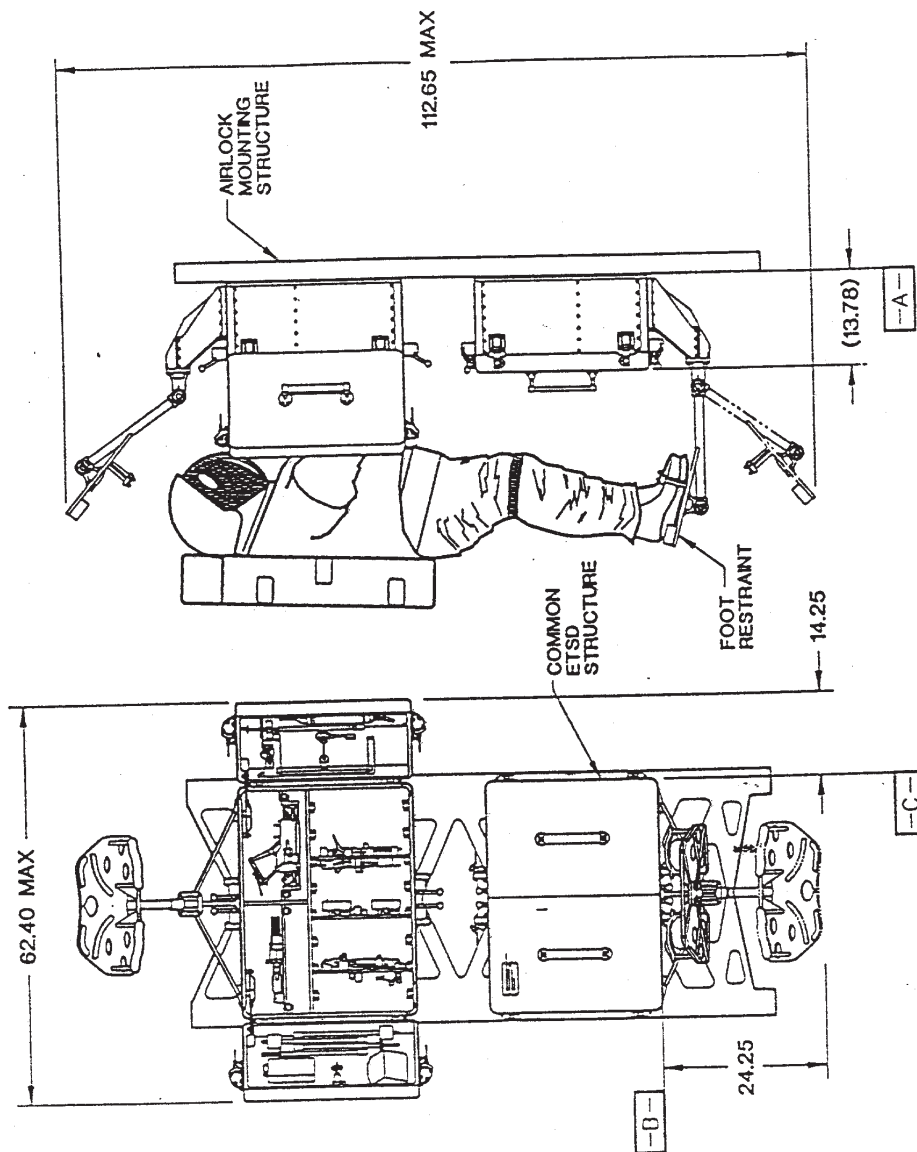


FIGURE 3.7.2-2 AL ETSD ON-ORBIT WORKING ENVELOPE INTERFACE DEFINITION

### **3.6.1.2.2 EVA**

A 4 in. radial EVA clearance envelope around each of the handrails/handholds is necessary for a crewmember to use them as translation aids. Figure 3.6.1.2.2-1 defines the profile of the ground installed handrail/handhold.

### **3.6.1.3 STRUCTURAL**

#### **3.6.1.3.1 LOADING**

The loading criteria of the ground installed handrails/handholds is that they must support a 220 lbs hand induced limit load or a 200 lbs EVA tether limit load in any direction. These loads will not occur simultaneously. The worst load case on the primary translation path will produce a maximum limit load of 220 lbs shear/tension combined with a bending moment limit at the interface of each handrail/handhold stand-off of 572 in-lbs for the top mounted, 1037 in-lbs for the short side mounted and 1191 in-lbs for the tall side mounted handrail. The worst load case on the secondary translation path will produce a maximum limit load of 187 lbs shear/tension combined with a bending moment limit at the interface of each handrail/handhold stand-off of 486 in-lbs for the top mounted, 882 in-lbs for the short side mounted and 1013 in-lbs for the tall side mounted handrail.

#### **3.6.1.3.2 MASS PROPERTIES**

The maximum weight of the ground installed handrails/handholds varies with stand-off type and rail length. The unit weights of the ground installed handrails/handholds are listed in Table 3.6.1.3.2-1.

### **3.6.1.4 MECHANICAL**

#### **3.6.1.4.1 MOUNTING AND INSTALLATIONS**

Bolt pattern dimensions for top mounted standard handrails and custom length handrails, without a center stand-off, are shown in Figure 3.6.1.4.1-1. The bolt pattern for the long custom length handrail with center stand-off and short custom length handrail are shown in Figure 3.6.1.4.1-3a and Figure 3.6.1.4.1-3b, respectively. Figure 3.6.1.4.1-4 shows the top mounted handhold bolt pattern. The tall and short side mounted handrail/handhold bolt patterns are shown by Figures 3.6.1.4.1-5 through 3.6.1.4.1-8. Users of handrails/handholds should apply these bolt patterns to their structure for the purpose of predrilling holes for hardware installation.

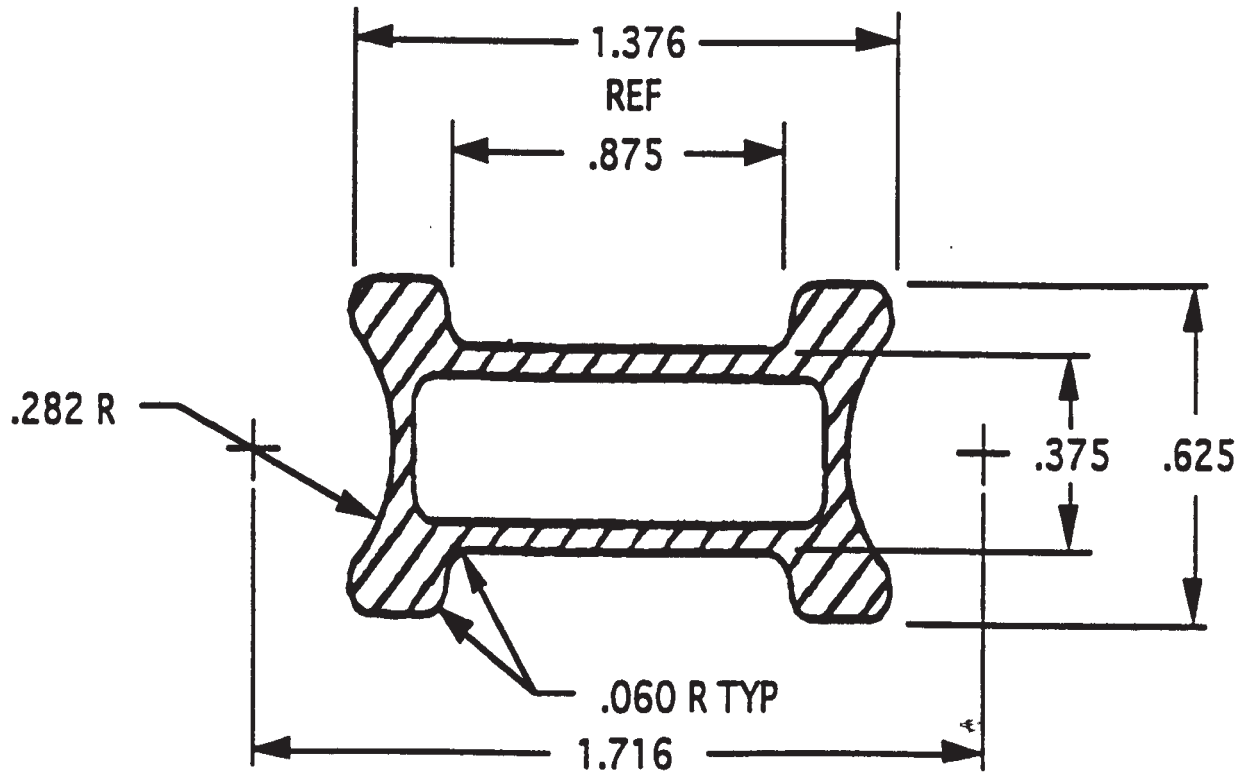
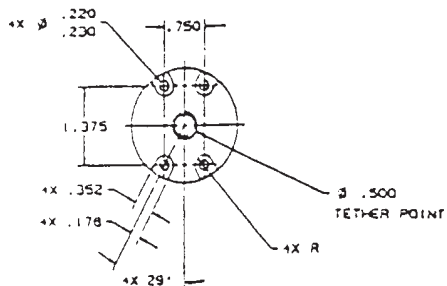


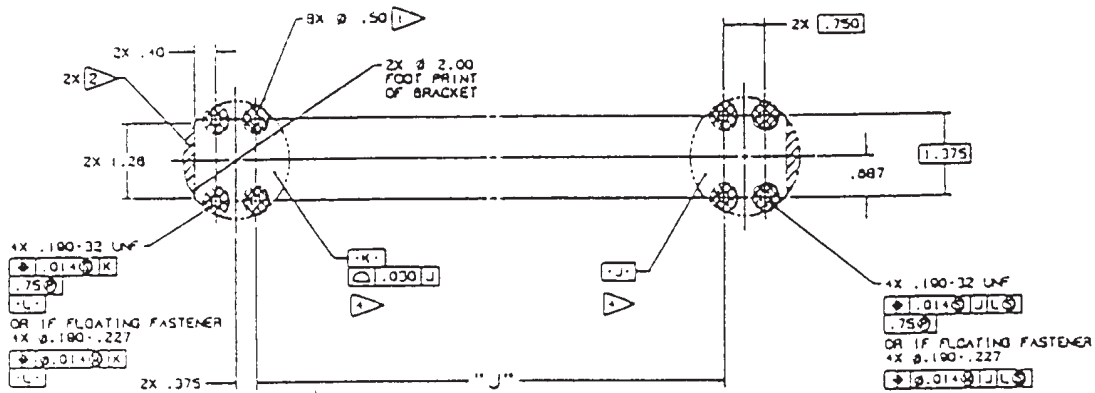
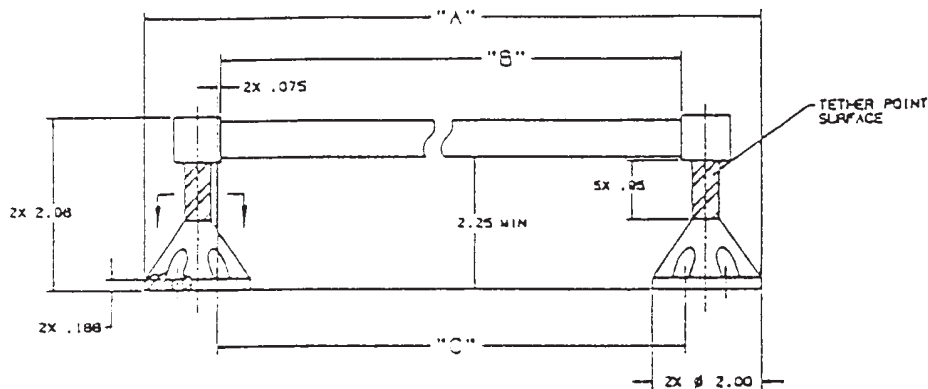
FIGURE 3.6.1.2.2-1 HANDRAIL/HANDHOLD CROSS SECTION (GROUND INSTALLED)

**TABLE 3.6.1.3.2-1 GROUND INSTALLED HANDRAIL/HANDHOLD SPECIFICATION WEIGHTS**

| DESCRIPTION  | PART NUMBER                               | UNIT WEIGHT, LBS |
|--|---|------------------|
| Handrail Assembly, Side Mounted, Tall – ISS (25.53’’)    | SEG33106348 – 301<br>(Ref. 5848232 – 501) | 2.10             |
| Handrail Assembly, Side Mounted, Short – ISS (25.53’’) ) | SEG33106348 – 303<br>(Ref. 5848232 – 503) | 1.90             |
| Handhold Assembly, Side Mounted, Tall – ISS (8.53’’) )   | SEG33106350 – 301<br>(Ref. 5848233 – 501) | 1.70             |
| Handhold Assembly, Side Mounted, Short – ISS (8.53’’) )  | SEG33106350 – 303<br>(Ref. 5848233 – 503) | 1.50             |
| Handrail Assembly, Top Mounted – ISS (25.53’’) )         | SEG33106347 – 801<br>(Ref. 5835754 – 501) | 1.50             |
| Handrail Assembly, Top Mounted – ISS (15.441’’) )        | SEG33106347 – 811                         | 1.29             |
| Handrail Assembly, Top Mounted – ISS (21.941’’) )        | SEG33106347 – 803                         | 1.29             |
| Handrail Assembly, Top Mounted – ISS (22.625’’) )        | SEG33106347 – 805                         | 1.31             |
| Handrail Assembly, Top Mounted – ISS (25.606’’) )        | SEG33106347 – 843                         | 1.50             |
| Handrail Assembly, Top Mounted Custom (47.635’’) )       | SEG33106466 – 301                         | 2.33             |
| Handrail Assembly, Top Mounted Custom (15.441 + 6’’) )   | SEG33106466 – 313                         | 1.50             |
| Handrail Assembly, Top Mounted – ISS (8.53’’) )          | SEG33106347 – 807<br>(Ref. 5835755 – 501) | 1.10             |
| Handrail Assembly, Top Mounted – ISS (8.626’’) )         | SEG33106347 – 809                         | 0.94             |



| PART NUMBER                               | DESCRIPTION                                    | A<br>±.01 | B<br>±.01 | C<br>(REF) | D<br>±.06 |
|---|--|-----------|-----------|------------|-----------|
| SEG33106347 - 801<br>(Ref. 5835754 - 501) | Handrail Assembly, Top Mounted -ISS (25.53")   | 28.28"    | 25.38"    | 25.530"    | 25.530"   |
| SEG33106347 - 811                         | Handrail Assembly, Top Mounted - ISS (15.441") | 18.19"    | 15.29"    | 15.441"    | 15.441"   |
| SEG33106347 - 803                         | Handrail Assembly, Top Mounted - ISS (21.94")  | 24.69"    | 21.79"    | 21.941"    | 21.941"   |
| SEG33106347 - 805                         | Handrail Assembly, Top Mounted - ISS (22.625") | 25.38"    | 22.47"    | 22.625"    | 22.625"   |
| SEG33106347 - 843                         | Handrail Assembly, Top Mounted - ISS (25.606") | 28.36"    | 25.76"    | 25.606"    | 25.606"   |



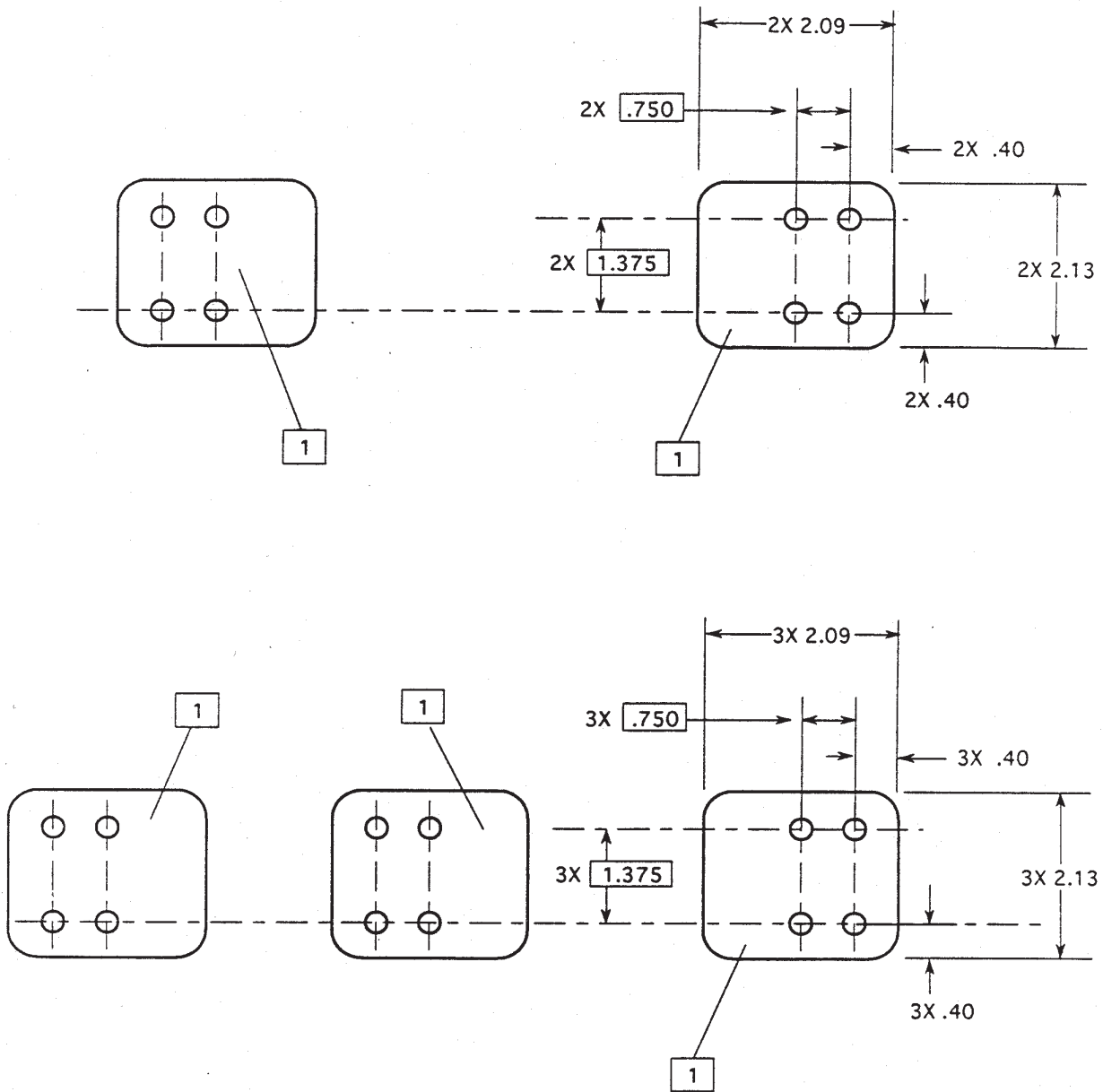
DIMENSIONAL TOLERANCES:  
(UNLESS OTHERWISE NOTED:)

|     |        |
|-----|--------|
| .0  | ± .1   |
| .00 | ± .01  |
| .00 | ± .005 |

PLG NOTES:

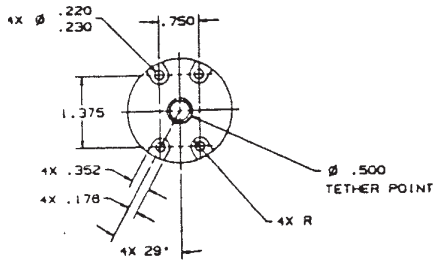
- MINIMUM ELECTRICAL CONDUCTIVE SURFACE ON CROSS-MATCHED AREAS, TO SUPPORT A CLASS 5 BOND PER SSP30245.
- STANOFF BRACKET FOOT PRINT ALLOWED TO BE UNSUPPORTED IN THIS AREA.
- USE MAS:DS1M, 10-32 UNF/8 SOCKET HEAD CAP SCREWS, LENGTH TO BE SPECIFIED BY USER.
- .005 MISMATCH MAX., NOT TO EXCEED LIMITS OF SIZE

FIGURE 3.6.1.4.1-1 TOP MOUNTED HANDRAIL ENVELOPE AND BOLT INTERFACE (GROUND INSTALLED)

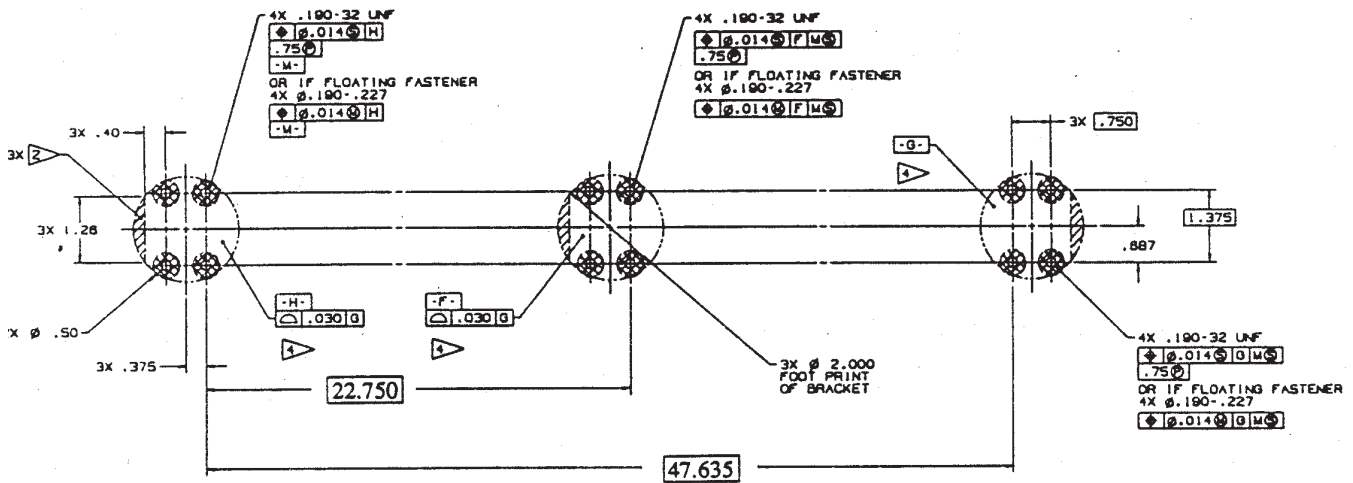
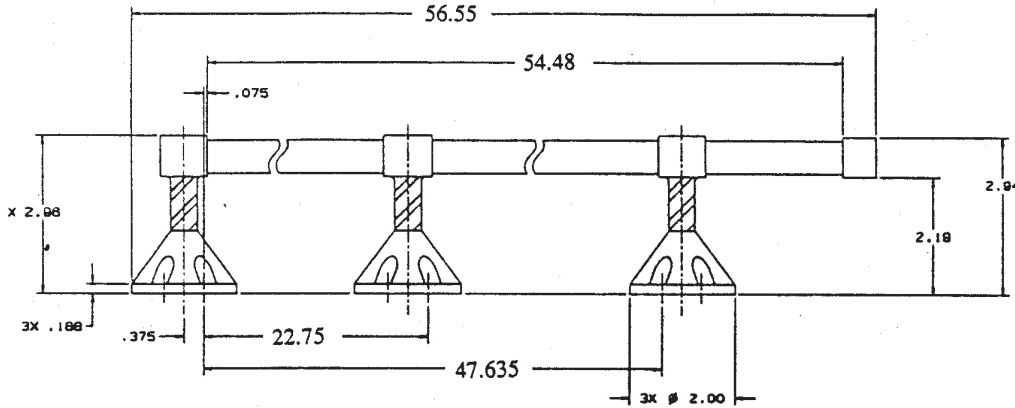


1 Electrical conductive surface to support a Class S Bond per SSP 30425

**FIGURE 3.6.1.4.1-2 ALTERNATE BONDING SURFACE TOP MOUNTED HANDRAILS/HANDHOLDS (GROUND INSTALLED)**



DIMENSIONAL TOLERANCES: .0 +/- .1  
 (UNLESS OTHERWISE NOTED) .00 +/- .01  
 .000 +/- .005



FLAG NOTES:

- 1 MINIMUM ELECTRICAL CONDUCTIVE SURFACE ON CROSS-HATCHED AREAS, TO SUPPORT A CLASS S BOND PER SSP30245.
- 2 STANDOFF BRACKET FOOT PRINT ALLOWED TO BE UNSUPPORTED IN THIS AREA.
- 3 USE NAS1351N, 10-32 UNF SOCKET HEAD CAP SCREWS, LENGTH TO BE SPECIFIED BY USER.
- 4 .005 MISMATCH MAX., NOT TO EXCEED LIMITS OF SIZE

FIGURE 3.6.1.4.1-3a TOP MOUNTED CUSTOM LENGTH HANDRAIL ACCESS ENVELOPE (GROUND INSTALLED - LONG)

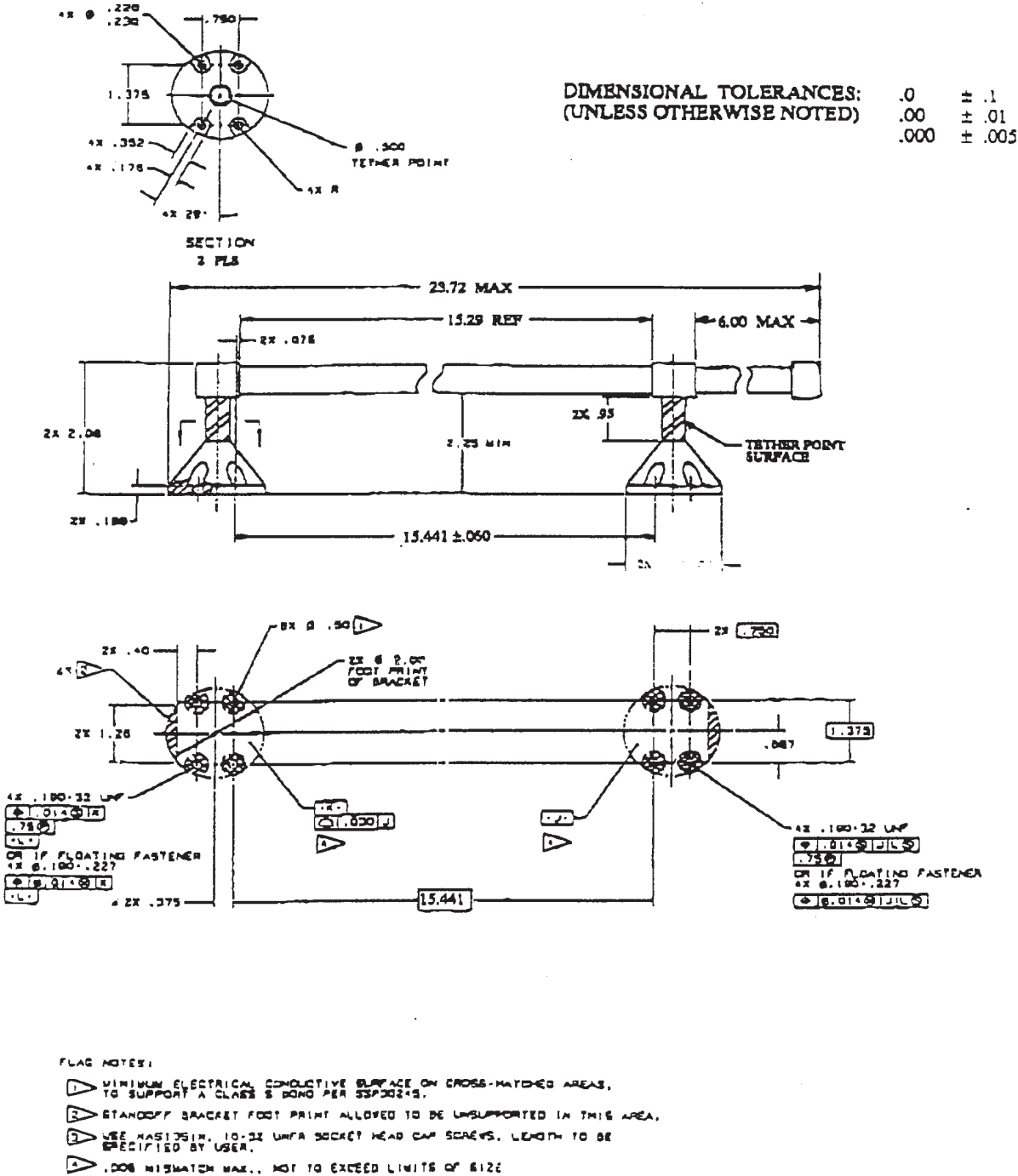
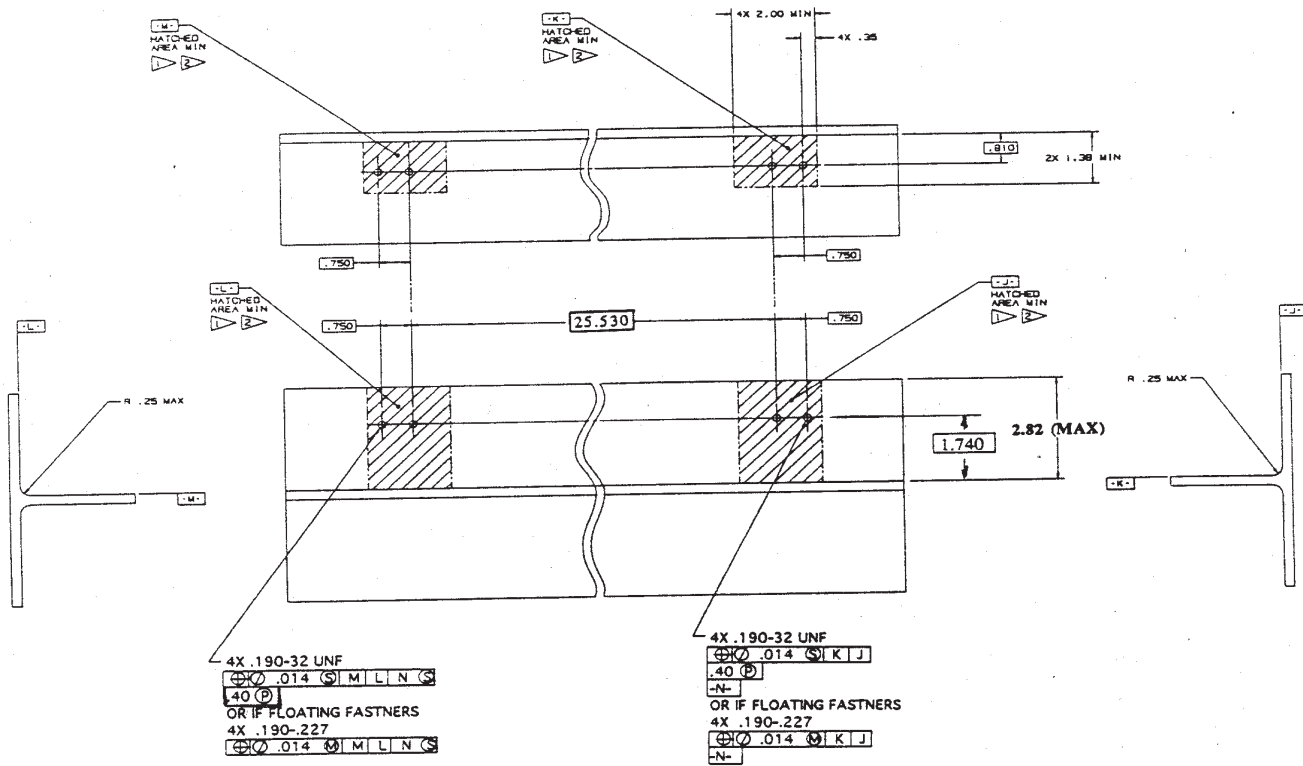


FIGURE 3.6.1.4.1-3b TOP MOUNTED CUSTOM LENGTH HANDRAIL ACCESS ENVELOPE (GROUND INSTALLED - SHORT)



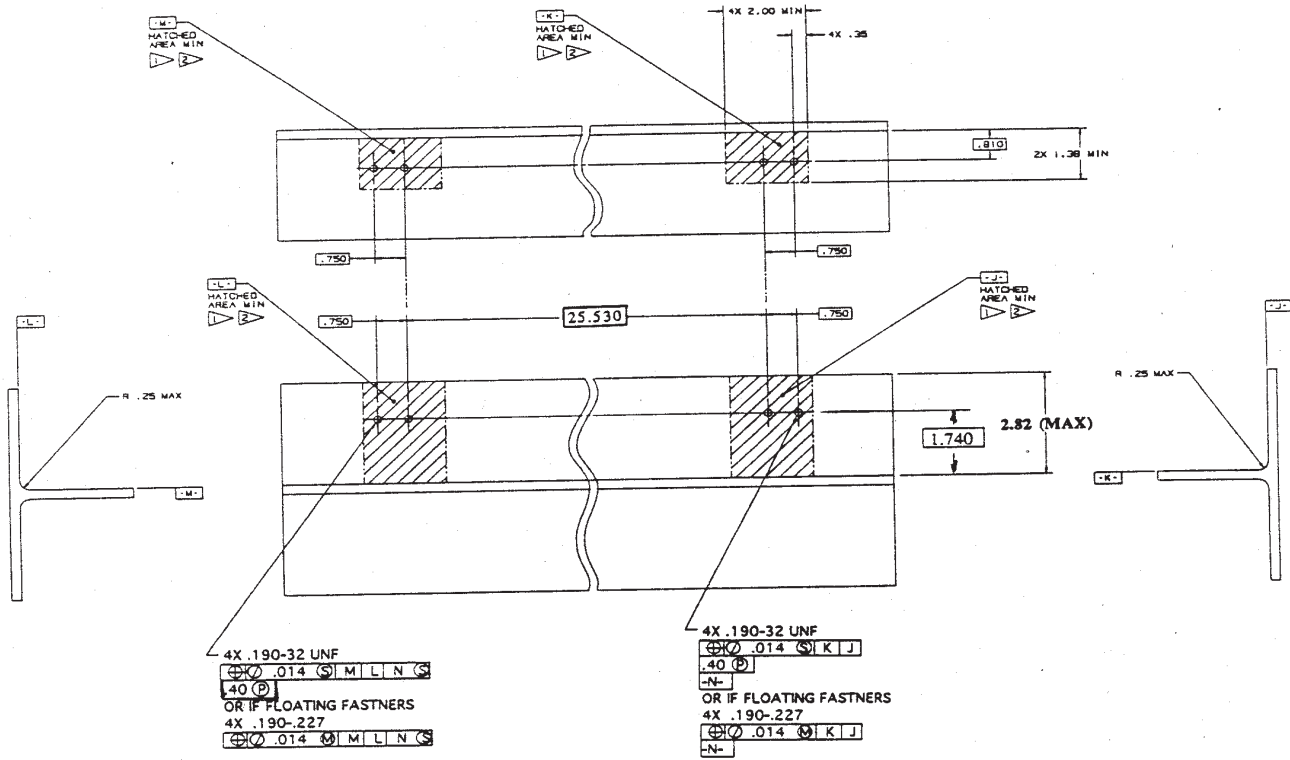




NOTES:

- > SURFACE MUST SUPPORT A CLASS "S" BOND PER SSP 30245.
- > .005 MISMATCH MAX., NOT TO EXCEED LIMITS OF SIZE.

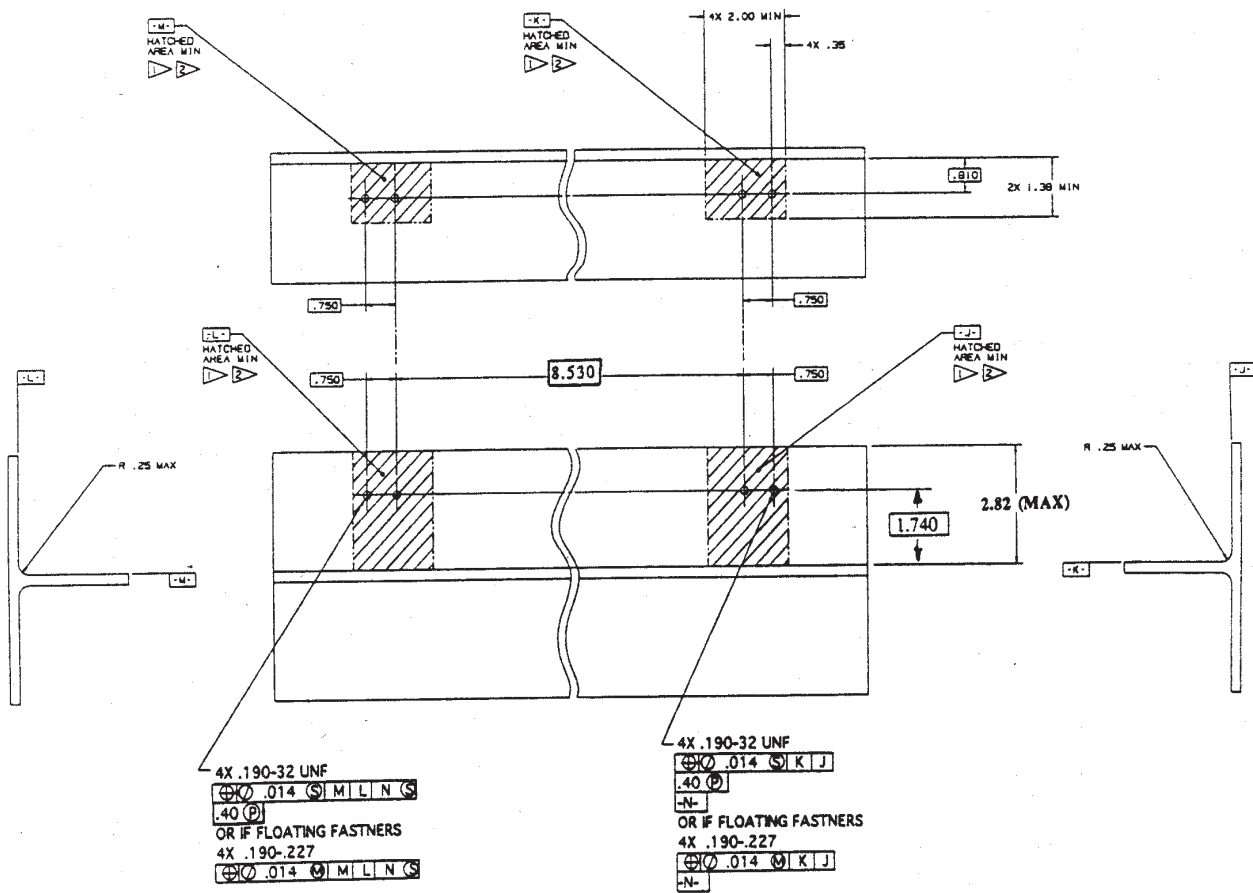
**FIGURE 3.6.1.4.1-5 TALL SIDE MOUNTED HANDRAIL BOLT INTERFACE (GROUND INSTALLED)**



NOTES:

- > SURFACE MUST SUPPORT A CLASS "S" BOND PER SSP 30245.
- > .005 MISMATCH MAX., NOT TO EXCEED LIMITS OF SIZE.

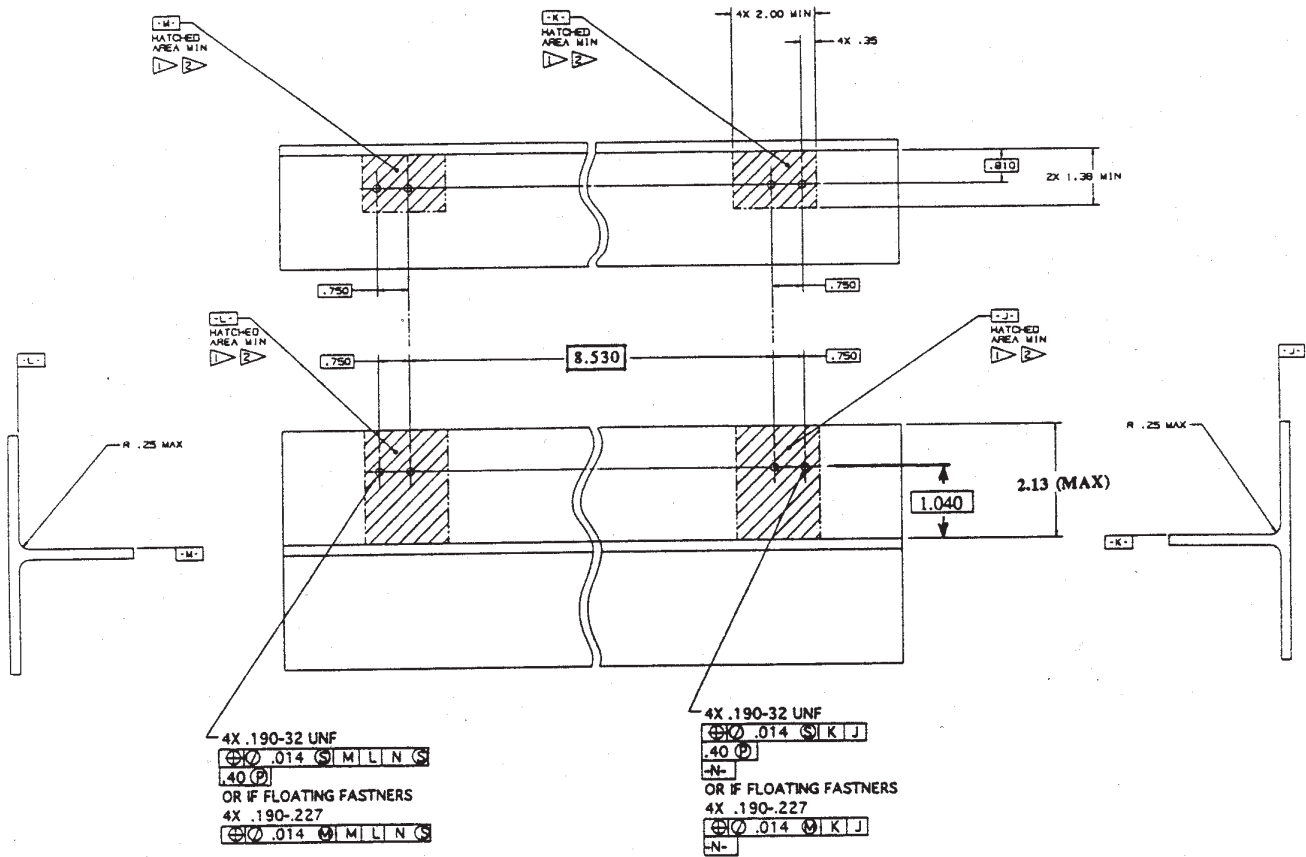
**FIGURE 3.6.1.4.1-6 TALL SIDE MOUNTED HANDHOLD BOLT INTERFACE  
 (GROUND INSTALLED)**



NOTES:

- 1 SURFACE MUST SUPPORT A CLASS "S" BOND PER SSP 30245.
- 2 .005 MISMATCH MAX., NOT TO EXCEED LIMITS OF SIZE.

FIGURE 3.6.1.4.1-7 SHORT SIDE MOUNTED HANDRAIL BOLT INTERFACE (GROUND INSTALLED)



NOTES:

- 1 SURFACE MUST SUPPORT A CLASS "S" BOND PER SSP 30245.
- 2 .005 MISMATCH MAX., NOT TO EXCEED LIMITS OF SIZE.

FIGURE 3.6.1.4.1-8 SHORT SIDE MOUNTED HANDHOLD BOLT INTERFACE  
 (GROUND INSTALLED)

### 3.7.3.3 LOADS

#### 3.7.3.3.1 LAUNCH LOADS

Launch load factors for the A/L ETSD are shown in the Table 3.7.3.3.1. These loads include the effects of mechanically transmitted and acoustically induced random vibration, as well as excitation from low frequency transients. The below listed load factors are to be applied in any axis, with a load factor of 25 % of the primary load applied to the remaining two orthogonal axes, simultaneously.

**TABLE 3.7.3.3.1 DESIGN LIMIT LOAD FACTORS FOR SECONDARY STRUCTURE**

| Weight, lb | Load Factor, g |
|------------|----------------|
| < 20       | 40             |
| 20 – 50    | 31             |
| 50 – 100   | 22             |
| 100 – 200  | 17             |
| 200 – 500  | 13             |

#### 3.7.3.3.2 ON-ORBIT LOADS

The A/L ETSD complies with secondary translation path loads of 187 lbf for handholds and handrails.

#### 3.7.3.4 MATERIAL COMPATIBILITY

The A/L ETSD and mounting structure are 7075-T7351 aluminum alloy and meet the requirements of SSP 30233, Space Station Requirements for Materials and Processes.

#### 3.7.4 THERMAL

The A/L ETSD is designated an unlimited contact EVA interface. Thermal control of this hardware is achieved by passive techniques. The installation design activity and the EVAGFE provider share responsibility for maintaining the heat transfer rate within the specified limits.

#### 3.7.5 ELECTRICAL BONDING

The A/L ETSD to Airlock interface must satisfy a Class S Electrical Bond per SSP 30245. The A/L ETSD electrical bonding interface is shown in Figure 3.7.1-1 and Figure 3.7.1-2.

### **3.8 EVA TOOL STOWAGE DEVICE**

The EVA Tool Stowage Device (ETSD) provides stowage for the nominal EVA tools on the tool boards listed in Table 3.0–1 during launch and on–orbit. Two ETSDs will be mounted on the SpaceLab Pallet for launch. Once on–orbit, the ETSDs will be transferred to the Z–1 Truss Structure until the CETA Carts are available. At that time, one each ETSD will be permanently relocated to each CETA Cart.

#### **3.8.1 INTERFACE DESCRIPTION**

The ETSD to Z–1 Truss interface definition is shown in Figure 3.8.1–1.

#### **3.8.2 ENVELOPE**

The ETSD maximum launch envelope is shown in Figure 3.8.2–1. The ETSD maximum on–orbit envelope is shown in Figure 3.8.2–2 and the clearance envelope required to open the ETSD doors and access the tools is shown in Figure 3.8.2–3.

#### **3.8.3 STRUCTURAL**

##### **3.8.3.1 MASS PROPERTIES**

The maximum weight of each ETSD outfitted for launch is 208 lbs. The CG envelope for the ETSD is shown in Figure 3.8.2–1.

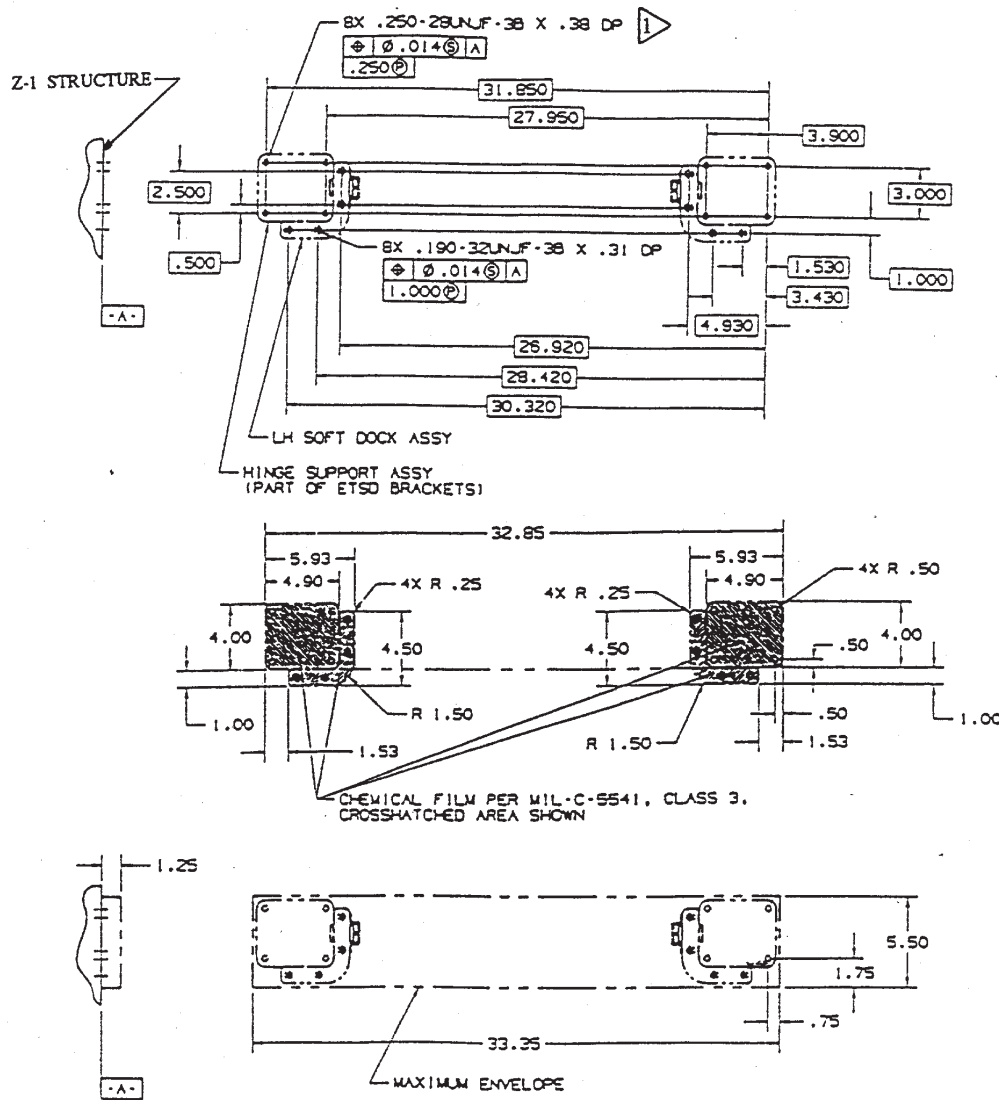
##### **3.8.3.2 STIFFNESS**

The CETA ETSD will have a natural frequency of 35 Hz or greater.

##### **3.8.3.3 LOADS**

###### **3.8.3.3.1 LAUNCH LOADS**

Launch load factors for the ETSD are shown in the Table 3.8.3.3.1. These loads include the effects of mechanically transmitted and acoustically induced random vibration, as well as excitation from low frequency transients. The below listed load factors are to be applied in any axis, with a load factor of 25 % of the primary load applied to the remaining two orthogonal axes, simultaneously.



Note: The ETSO bracket provider shall construct a drill template which shall be used to determine the true hold position for the softdock and the CETA-ETSD brackets located on the Z1 Truss segment.

FIGURE 3.8.1-1 EVA TOOL STOWAGE DEVICE TO Z1 INTERFACE DEFINITION



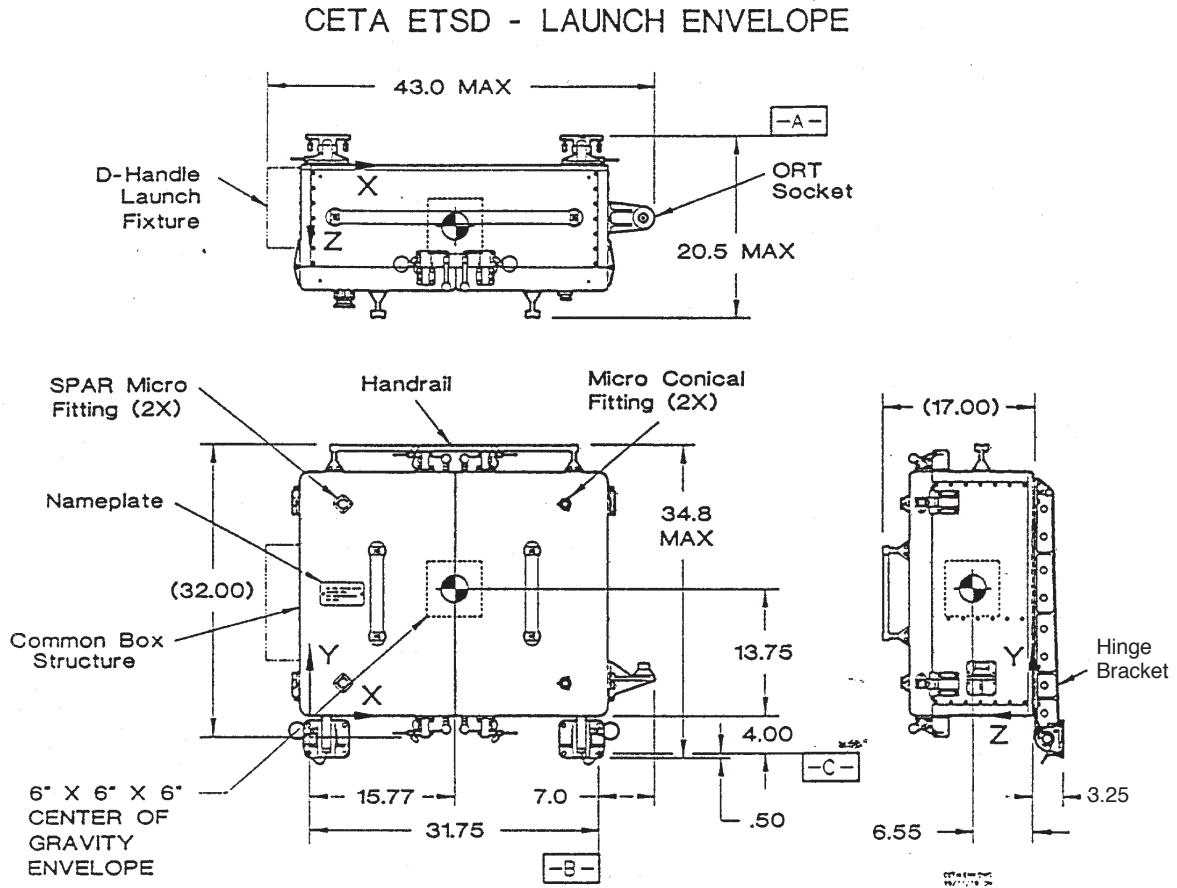


FIGURE 3.8.2-1 ETSD MAXIMUM LAUNCH ENVELOPE

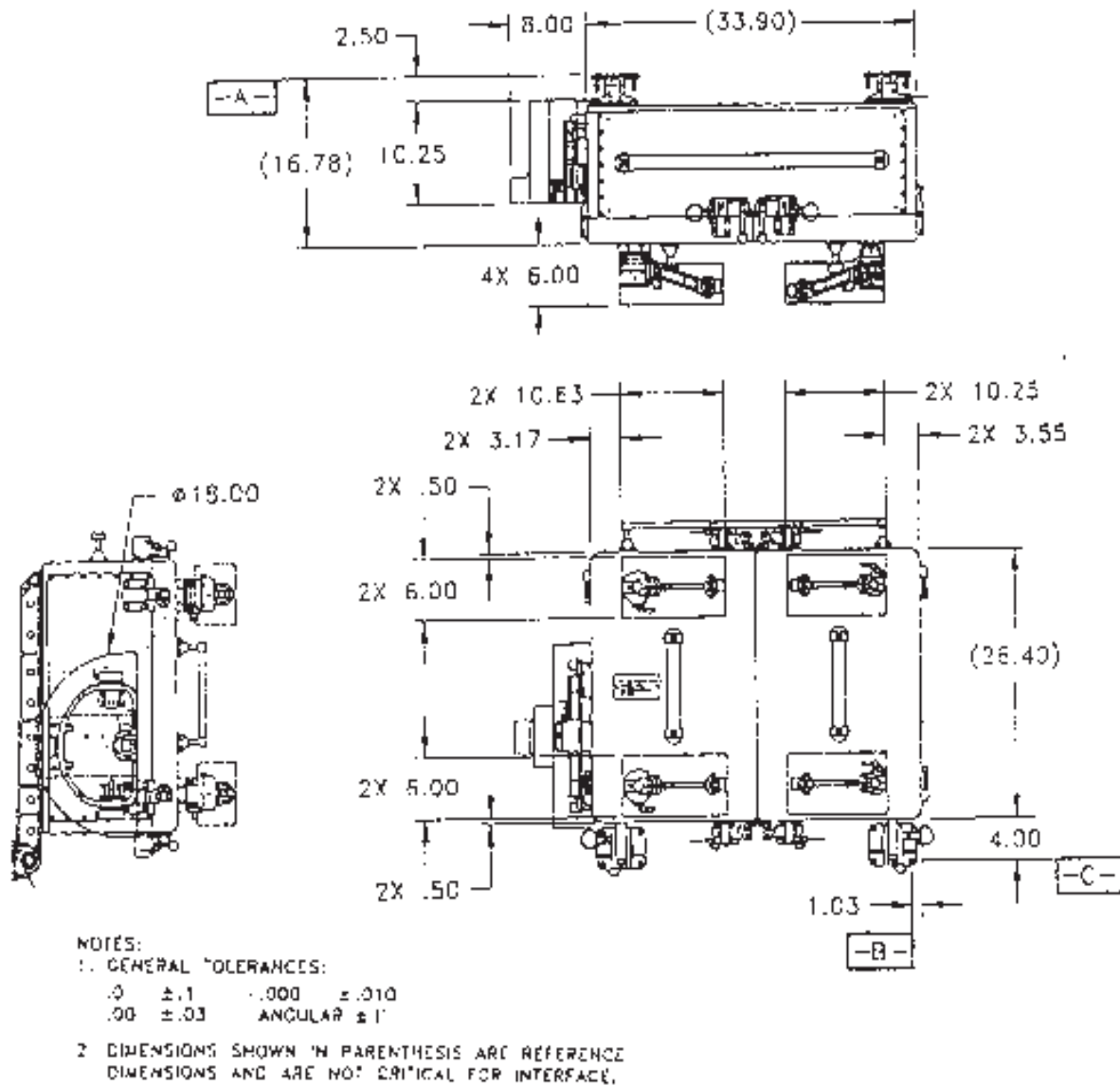


FIGURE 3.8.2-2 ETSD MAXIMUM ON-ORBIT ENVELOPE

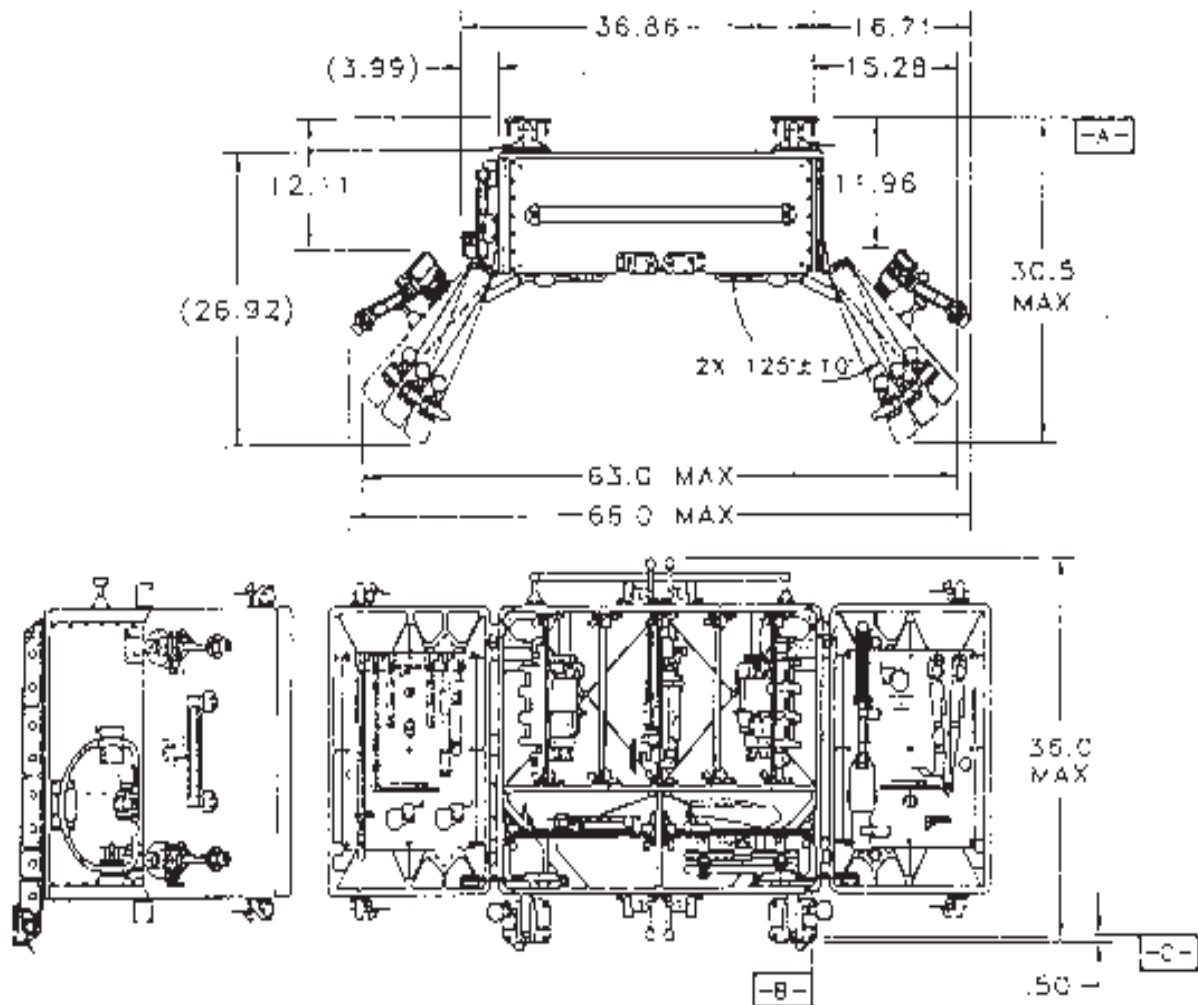


FIGURE 3.8.2-3 ETSD ACCESS AND CLEARANCE ENVELOPE

**TABLE 3.8.3.3.1 DESIGN LIMIT LOAD FACTORS FOR SECONDARY STRUCTURE**

| Weight, lb | Load Factor, g |
|------------|----------------|
| < 20       | 40             |
| 20 – 50    | 31             |
| 50 – 100   | 22             |
| 100 – 200  | 17             |
| 200 – 500  | 13             |

**3.8.3.3.2 ON-ORBIT LOADS**

The CETA ETSD complies with the secondary translation path loads of 187 lbf for handholds and handrails.

**3.8.3.4 MATERIAL COMPATIBILITY**

The ETSD and mounting structure are 7075–T7351 aluminum alloy and meet the requirements of SSP 30233, Space Station Requirements for Materials and Processes.

**3.8.4 THERMAL**

The ETSD is designated an unlimited contact EVA interface. Thermal control of this hardware is achieved by passive techniques. Responsibility for maintaining the heat transfer rates within specified limits is the responsibility of the ISS Prime with support from the installation design activity and the EVA GFE provider.

**3.8.5 ELECTRICAL BONDING**

The ETSD to SpaceLab Pallet and Z–1 Truss interfaces must satisfy a Class S Electrical Bond per SSP 30245 as shown in Figures 3.8.1–1 and 3.8.1–2. The ETSD electrical bonding interface is shown in Figure 3.8.1–1 and Figure 3.8.1–2.

**3.9 EVA PRIMARY TRANSLATION PATH**

The primary translation corridor requires a minimum diameter of 43 inches with no obstructions or intrusions into the path for hand–over–hand translation of an EVA crewmember. Figures 3.9–1 and 3.9–2 identify ISS elements. Figures 3.9–3 through 3.9–6 show the primary translation path for the US On–orbit Segment and for the International Partners at assembly complete. EVA primary translation paths on the Attached Pressurized Module (APM) and on the Centrifuge are not yet determined. However, the primary translation path interfaces between

Node 2 and these modules are defined. Translation path requirements for the Russian Segment are the responsibility of the NASA.

Data provided in the figures include the angular location of the primary translation handrail path on each module, and appropriate relative position of the slidewire with respect to the handrail path. EVA translation on the pressurized modules makes use of a safety tether connected to a slidewire that runs parallel to the handrail path. The envelope necessary for the primary translation path, the slidewire clearance, and the safety tether is shown in Figure 3.9-7. The primary translation corridor and the slidewire clearance envelope shall remain free of equipment protrusions. The gap between the slidewire and the handrail path shall remain free of equipment that can snag the safety tether.

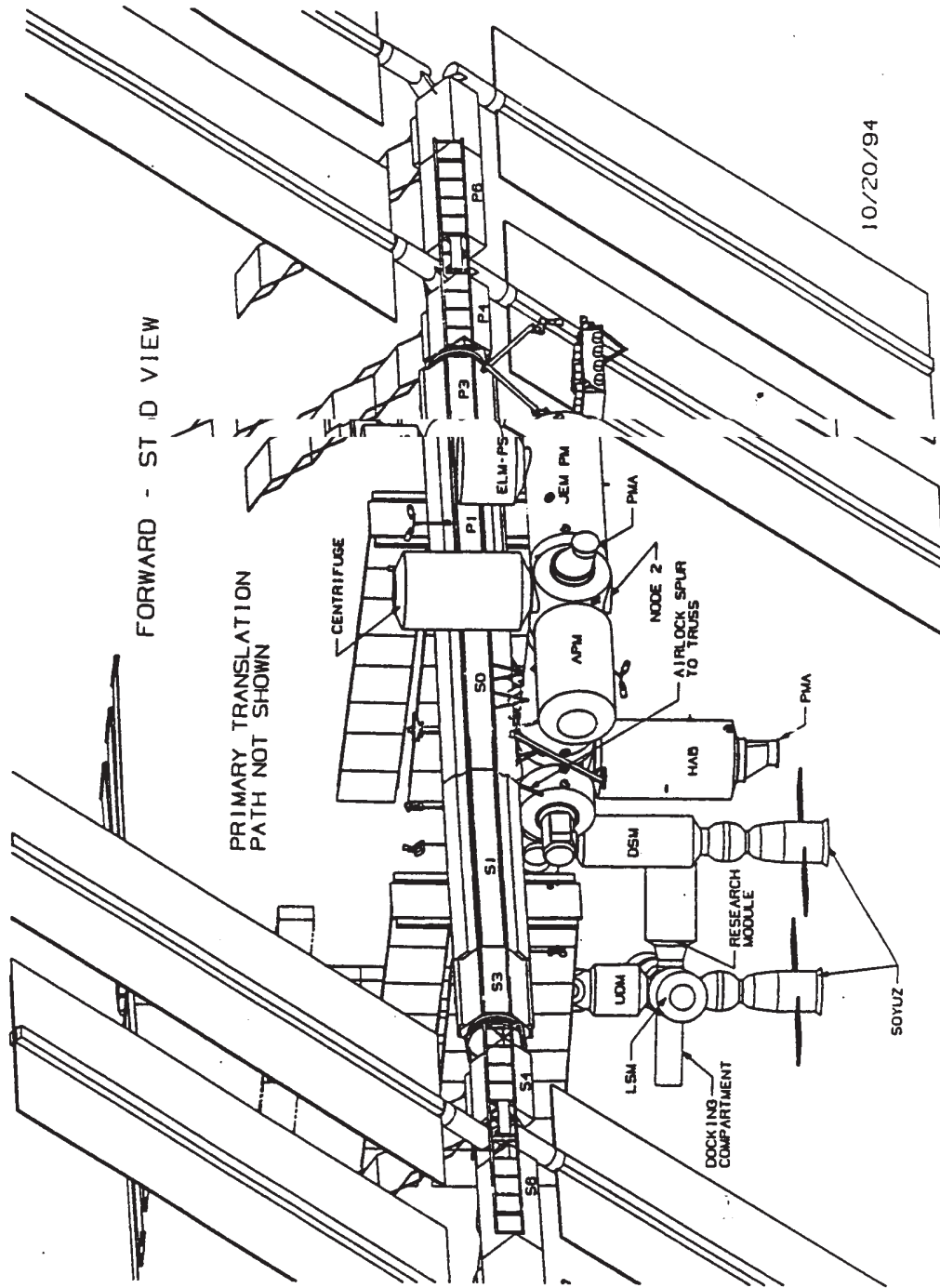


FIGURE 3.9-1 ISSA FORWARD – STARBOARD VIEW WITH MAJOR ELEMENTS IDENTIFIED

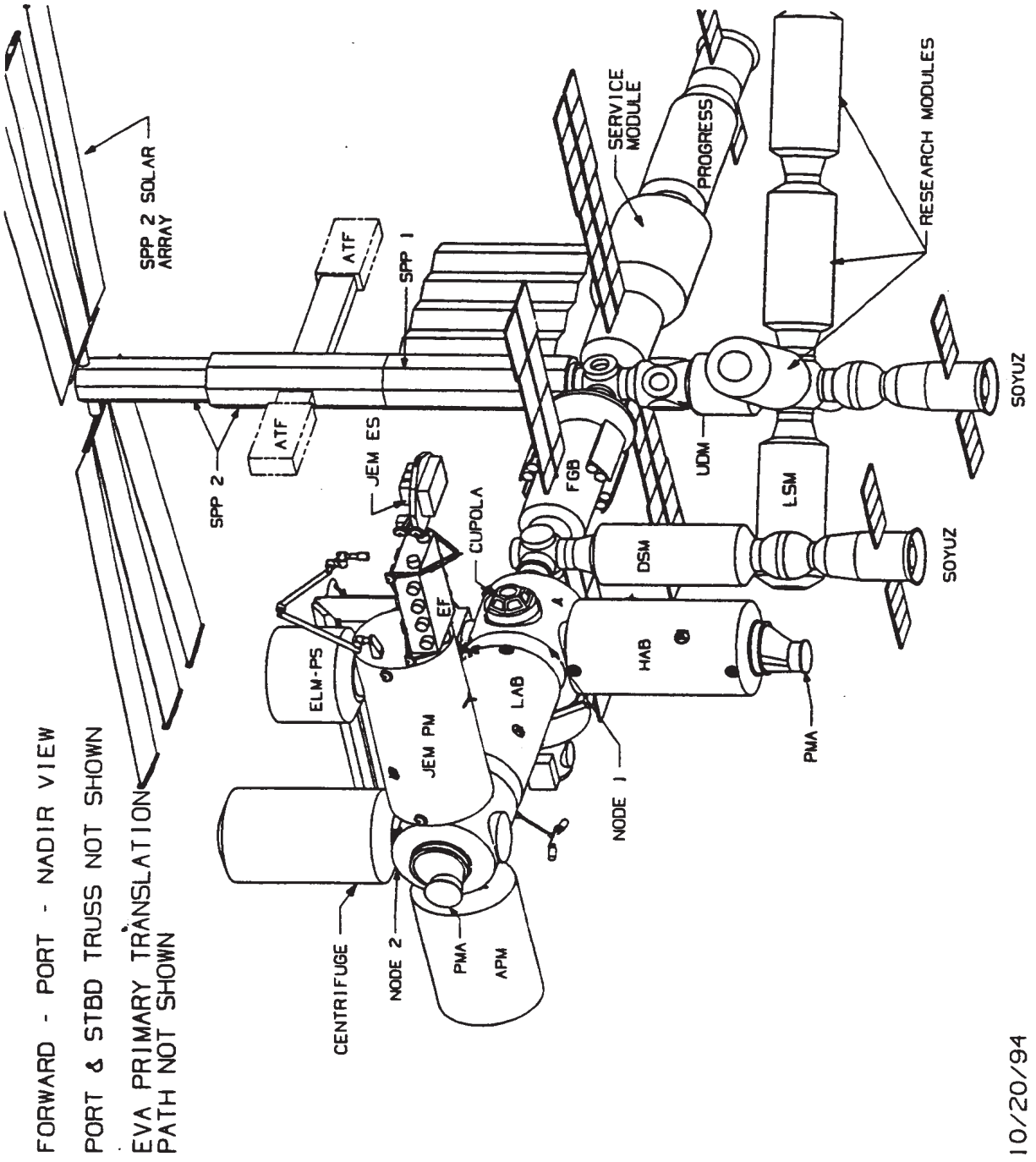


FIGURE 3.9-2 ISSA FORWARD - PORT - NADIR VIEW WITH MAJOR ELEMENTS IDENTIFIED

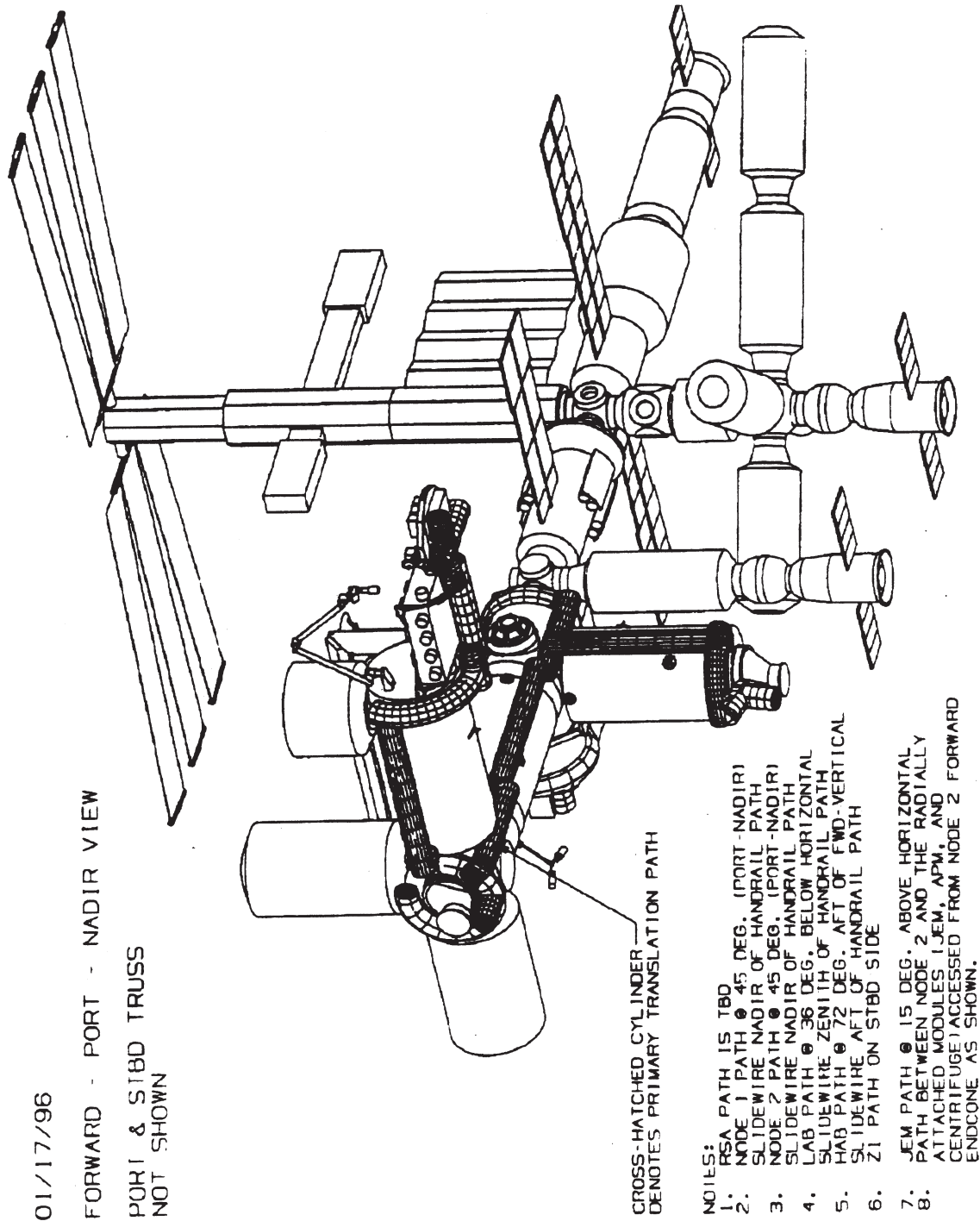


FIGURE 3.9-3 EVA PRIMARY TRANSLATION PATH FORWARD - PORT - NADIR VIEW



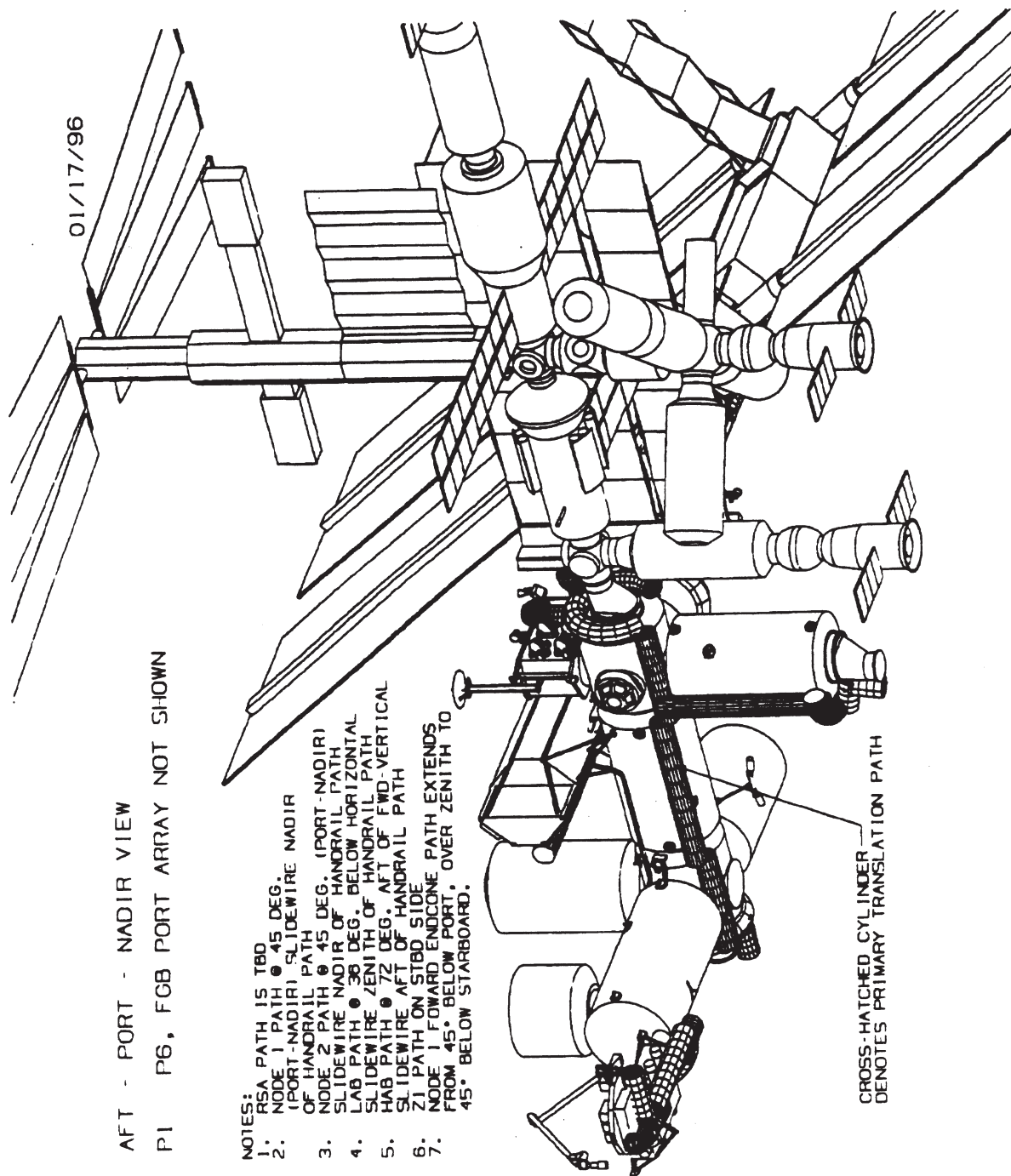


FIGURE 3.9-4 EVA PRIMARY TRANSLATION PATH AFT-PORT-NADIR VIEW

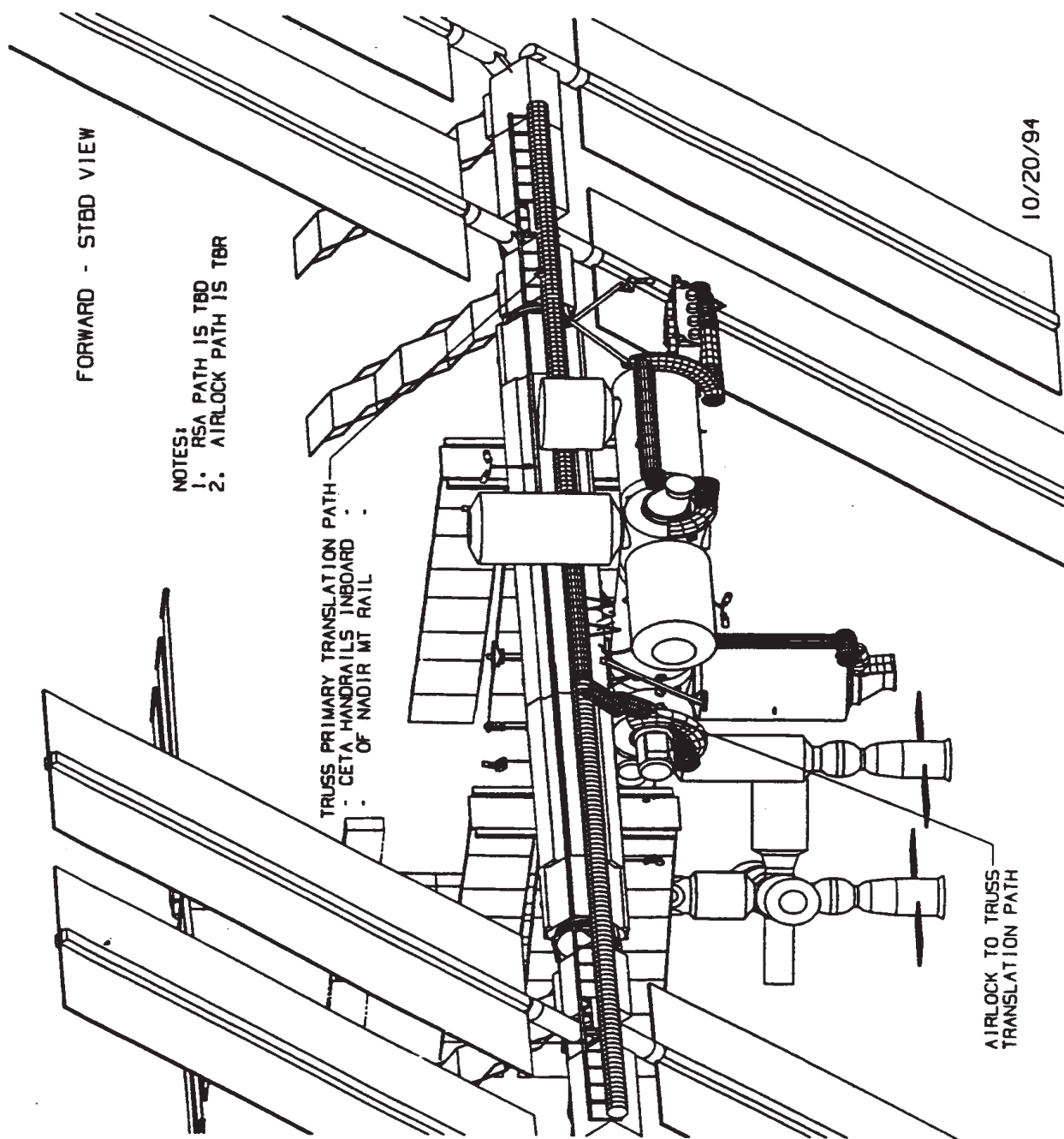


FIGURE 3.9-5 EVA PRIMARY TRANSLATION PATH FORWARD - STARBOARD VIEW

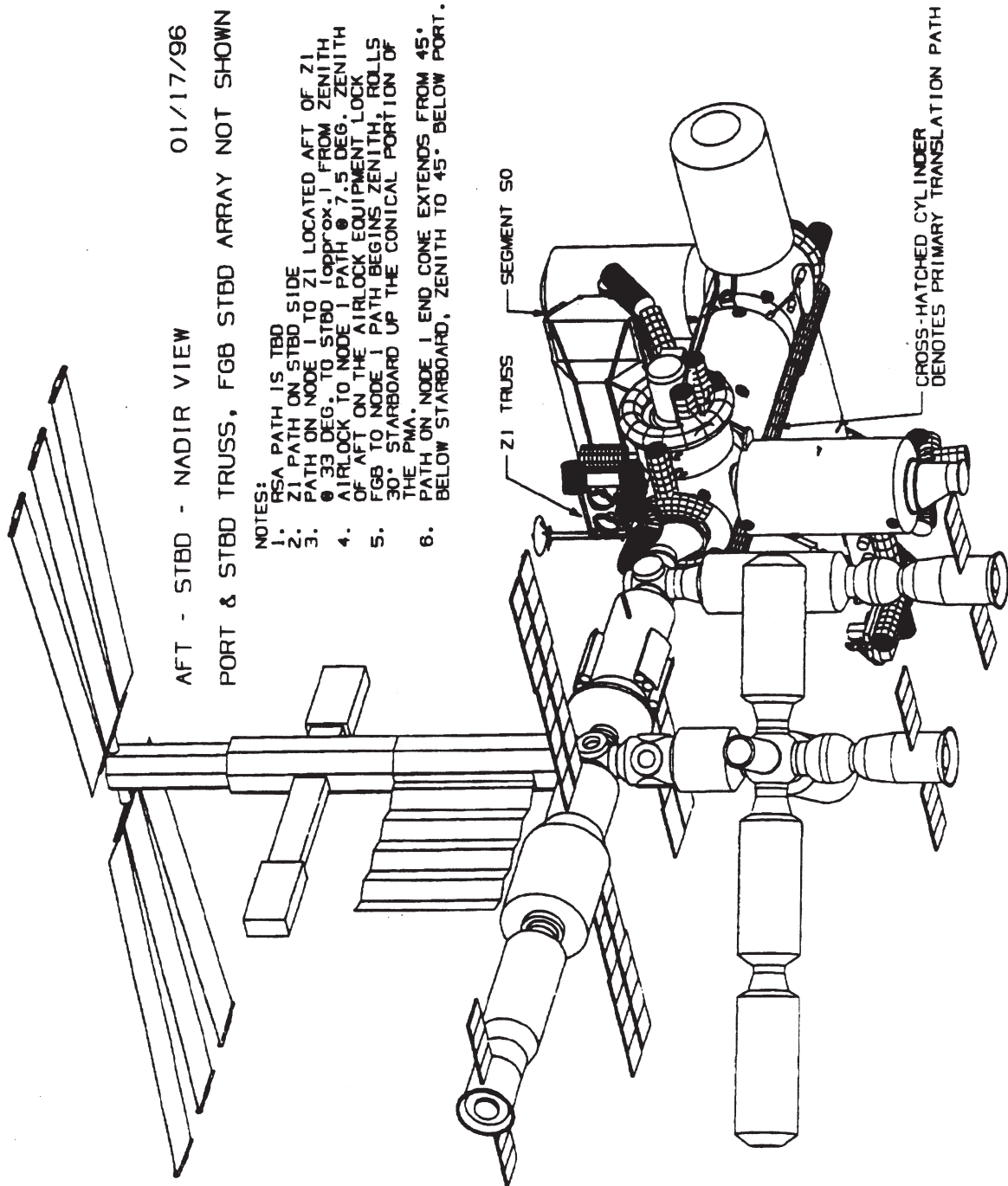


FIGURE 3.9-6 EVA PRIMARY TRANSLATION PATH AFT - STARBOARD - NADIR VIEW

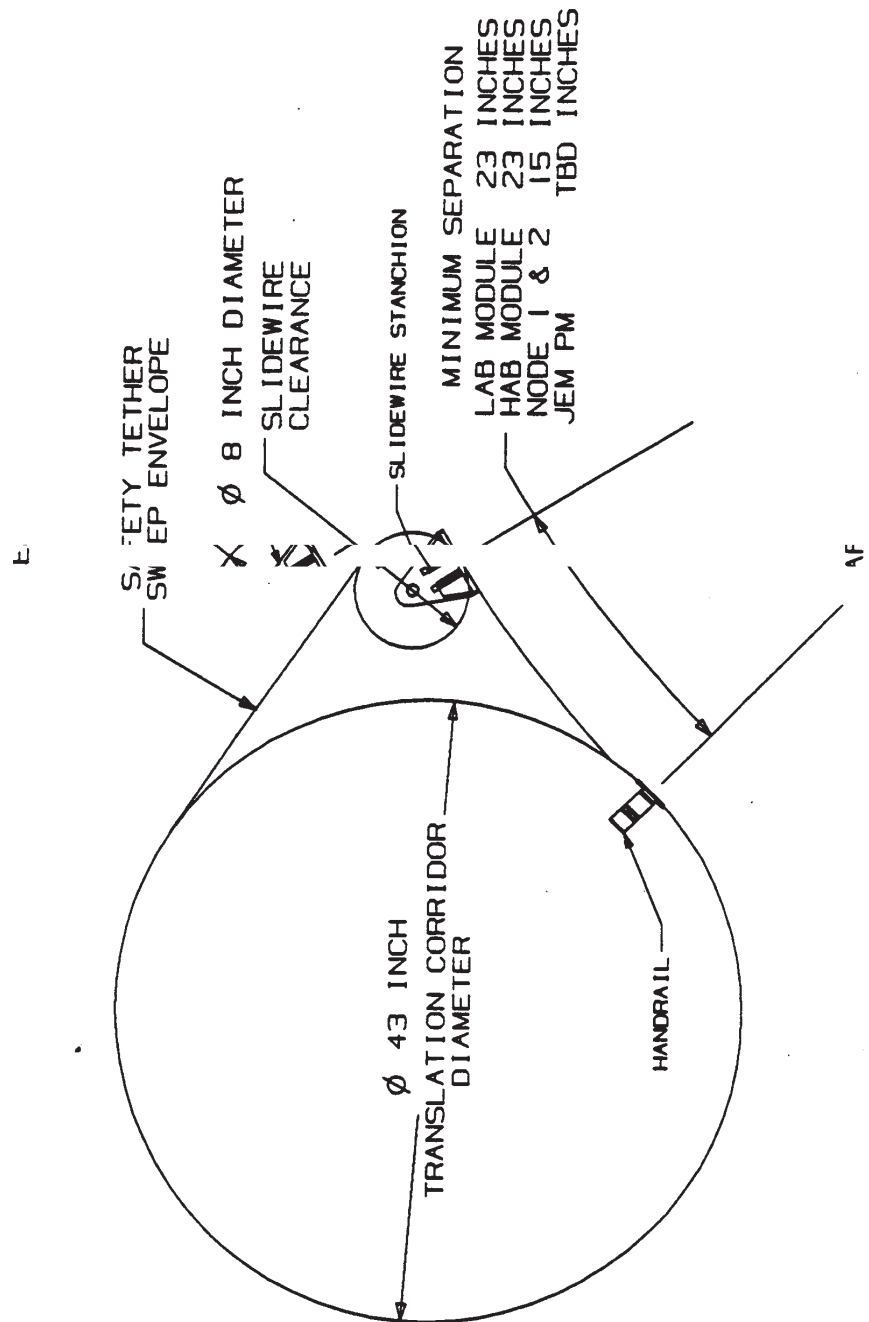


FIGURE 3.9-7 MODULE EVA PRIMARY TRANSLATION PATH, SLIDEWIRE, AND SAFETY TETHER ENVELOPE