Extravehicular Activity (EVA) Standard Interface Control Document

International Space Station Program

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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.

/s/ Denny A. Kross 4–30–96

Program Manager *(or delegated authority)* Date
International Space Station

INTERNATIONAL SPACE STATION PROGRAM

EXTRA VEHICULAR ACTIVITY
INTERFACE CONTROL DOCUMENT

FEBRUARY 7, 1997

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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	Chemical Conversion Coatings on Class 3 Aluminum and Class 3 Aluminum Alloys
Reference	3.6.1.4.2, 3.6.3.4.2, 3.6.4.4.2, 3.6.5.4.2
NSTS 07700	Space Shuttle System Payload Accommodations, Volume 14, Appendix 7, Rev.J, 29 March 1988
Reference	3.0
SSP 30219	Space Station Reference Coordinate Systems
Reference	3.1.1
SSP 30233E	Space Station Requirements for Materials and Processes
Reference	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	Space Station Electrical Bonding Requirements
Reference	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	Space Station Electromagnetic, Ionizing Radiation and Plasma Environment Definition and Design Requirements June 18, 1993
Reference	3.1.5.2
SSP 30425B	Space Station Program Natural Environment Definition for Design
Reference	3.1.5.1
SSP 30550	Robotics Systems Integration Standards
Reference	3.2.6
SSP 41162	Segment Specification for the U.S. On–Orbit Segment
Reference	1.2, 3.0
ICD–2–19001	Shuttle Orbiter/Cargo Standard Interfaces
Reference	3.1.5.2

2.2 NON–GOVERNMENT DOCUMENTS

Document Number	**Title**
ANSI Y14.5M–1982	Geometric Dimensioning and Tolerancing
Reference	3.1.2
D684–10018–1	International Space Station Program United States On–Orbit Segment Prime Contractor Interface Control Plan
Reference	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/ 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 (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 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/ Handhold– Primary Translation Path	220 lb_f	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/ Handhold Moment– Primary Translation Path	F=100 lb_f 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/ Handhold– Secondary Translation Path	187 lb_f	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_f	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, Push–Off Force of Tethered Crew Member	200 lb_f	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 crew member is using the hardware to provide a reaction point during translation.

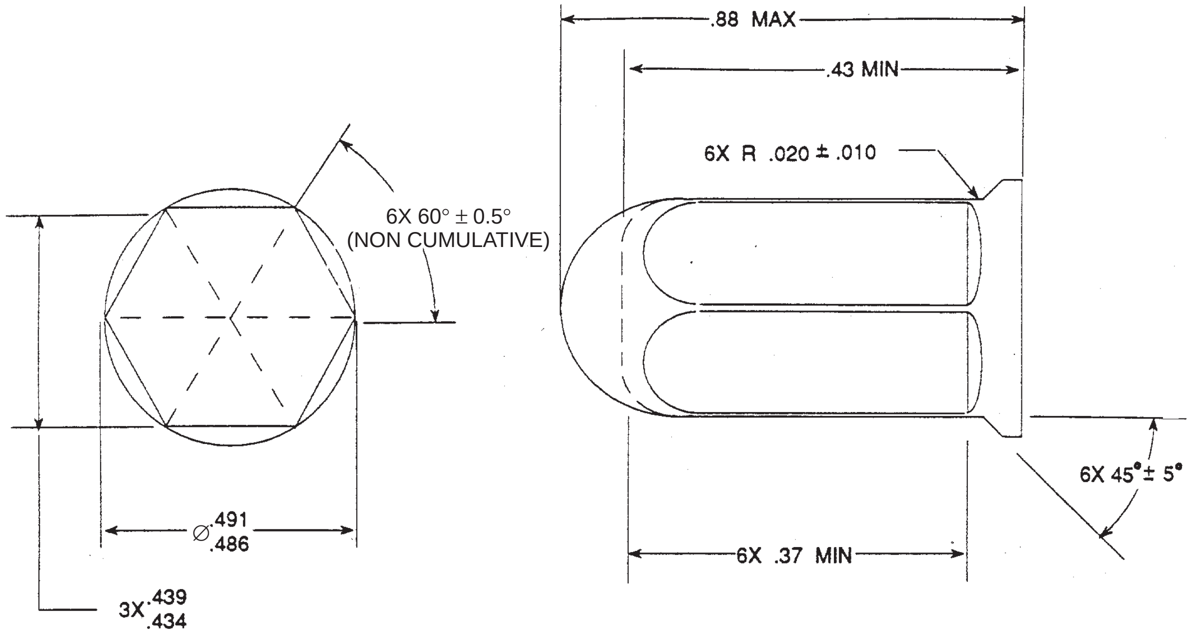
TABLE 3.1.3–1 EVA INDUCED LOADS (CONT'D)

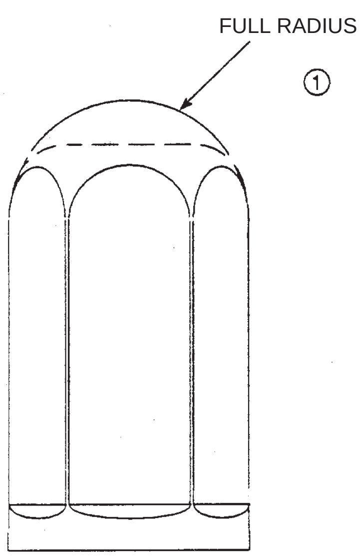
DESIGN LIMIT LOAD TYPE	LIMIT LOAD	TYPE OF LOADING	DIRECTION	CATEGORY OF STRUCTURE	APPLICATION COMMENTS
Inadvertent kick, bump	125 lb_f	Quasi–static, concentrated load over a 0.5 inch diameter circular area	Any direction	Secondary structure near (within 24") a translation path or worksite	This is an accidental impact. It should be applied to hardware near (within 24") translation paths and/or worksites.
Force Application (EVA Handling Load)	45 lb_f (35 in–lb_f 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_f force; 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_f	Concentrated load–pull (tension)	Any direction	Any structures supporting tool tether attach points	
Hatches	187 lb_f	Quasi–static concentrated load over a 3.0 inch diameter circular area at worst location	Any direction	Hatches	
Tool Impact	125 lb_f	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

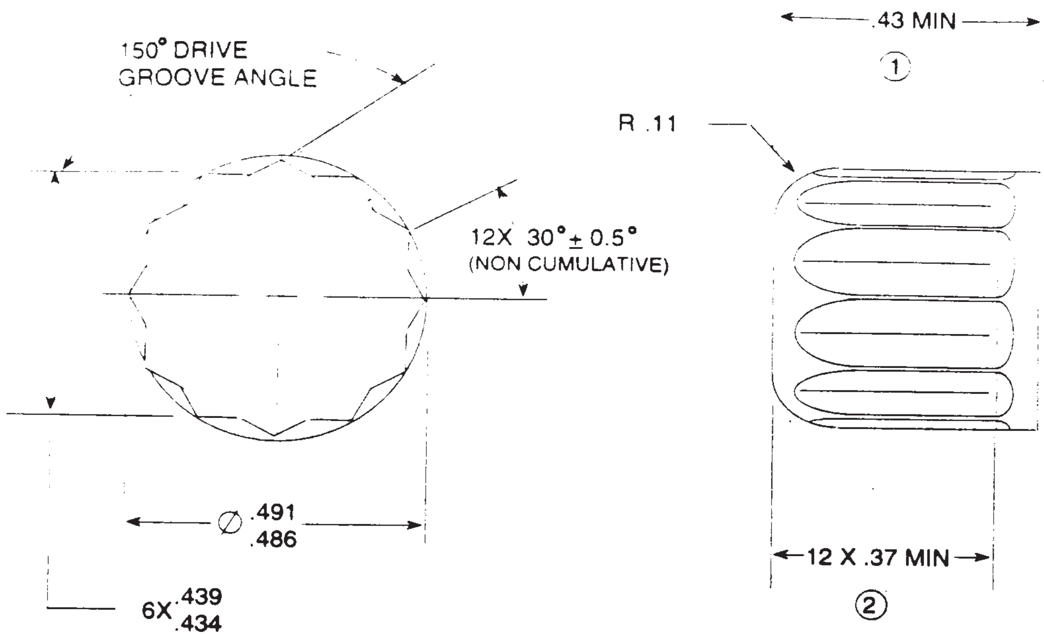
① .11 EDGE RADIUS MAY BE SUBSTITUTED FOR .25 SPHERICAL RADIUS WHEN CO-LOCATED WITH MICRO CONICAL FITTINGS

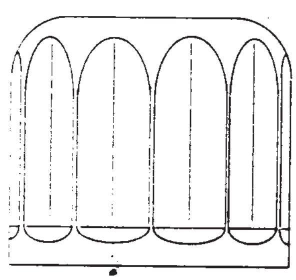
HEX BOLT SHOULDER MAY BE REMOVED TO ACCOMMODATE MECHANISM ACTIVATION AT BASE OF THE BOLT HEAD

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:

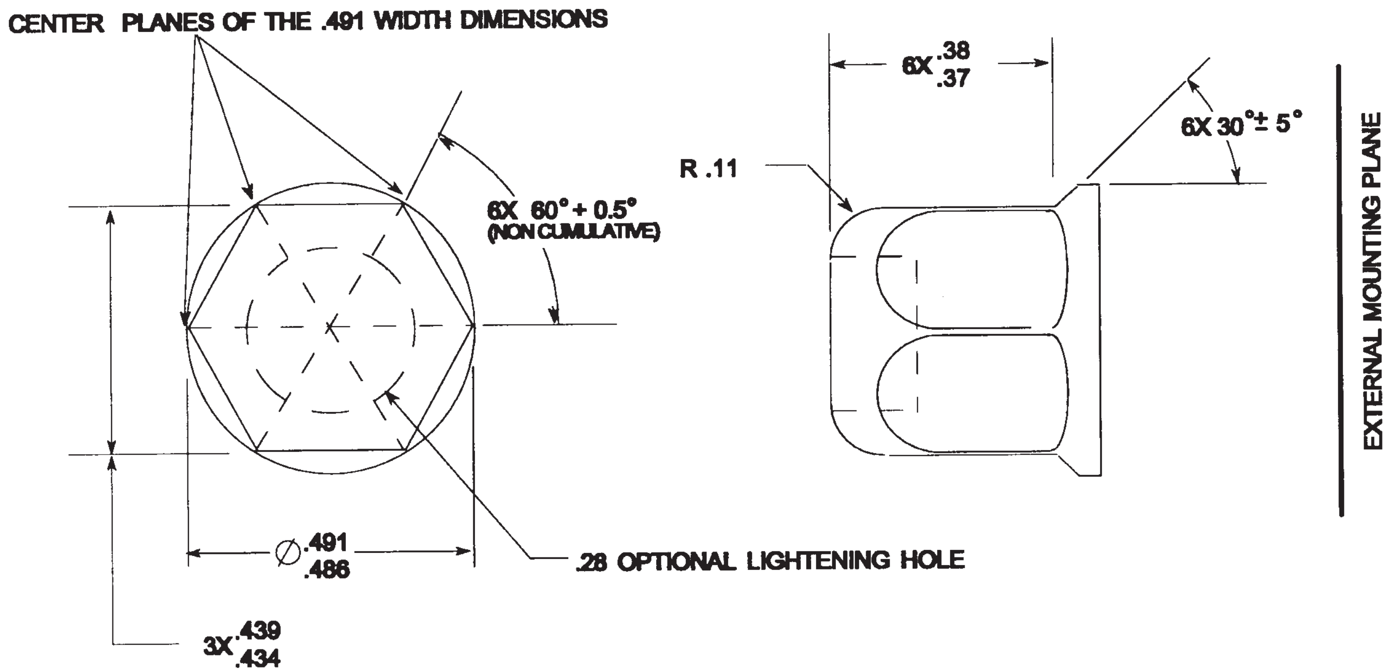
ALL DIMENSIONS IN INCHES

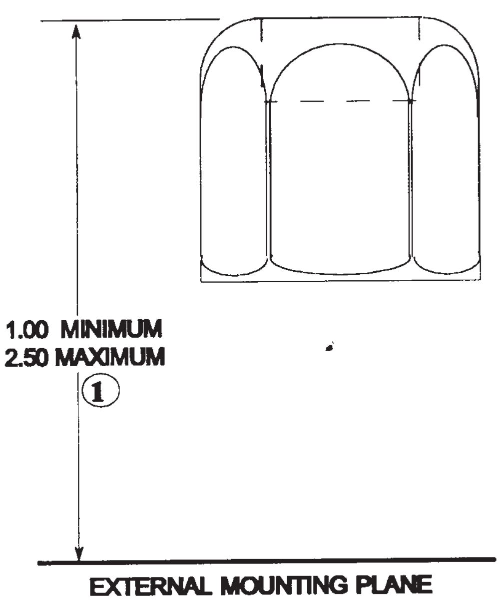
① RECOMMENDED DIMENSIONS .43 TO .45

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





NOTES:

LINEAR DIMENSIONS

.X	±.02
.XX	±.01
.XXX	±.005

ANGLES ± 1/2 °

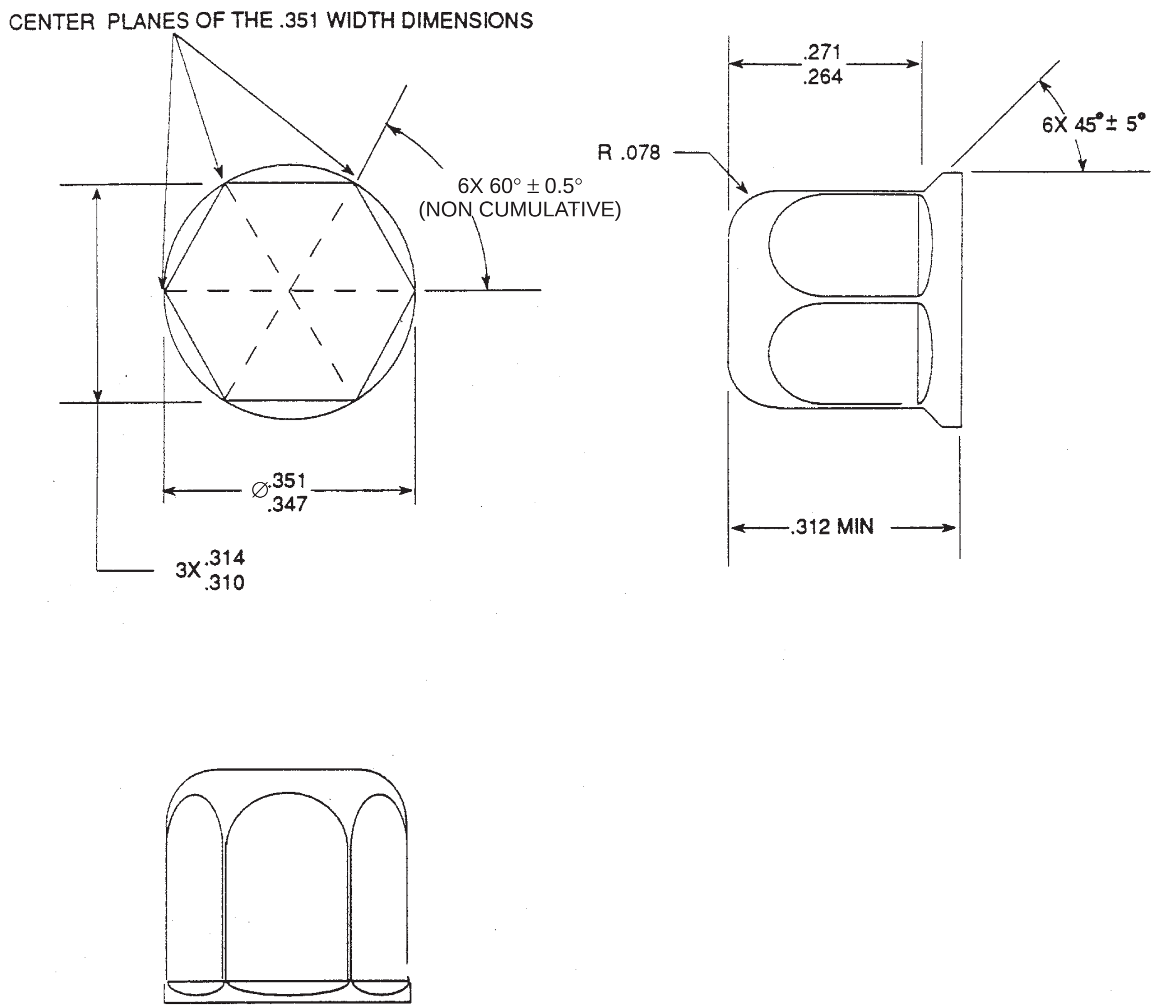
RUNOUT .010 TIR

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

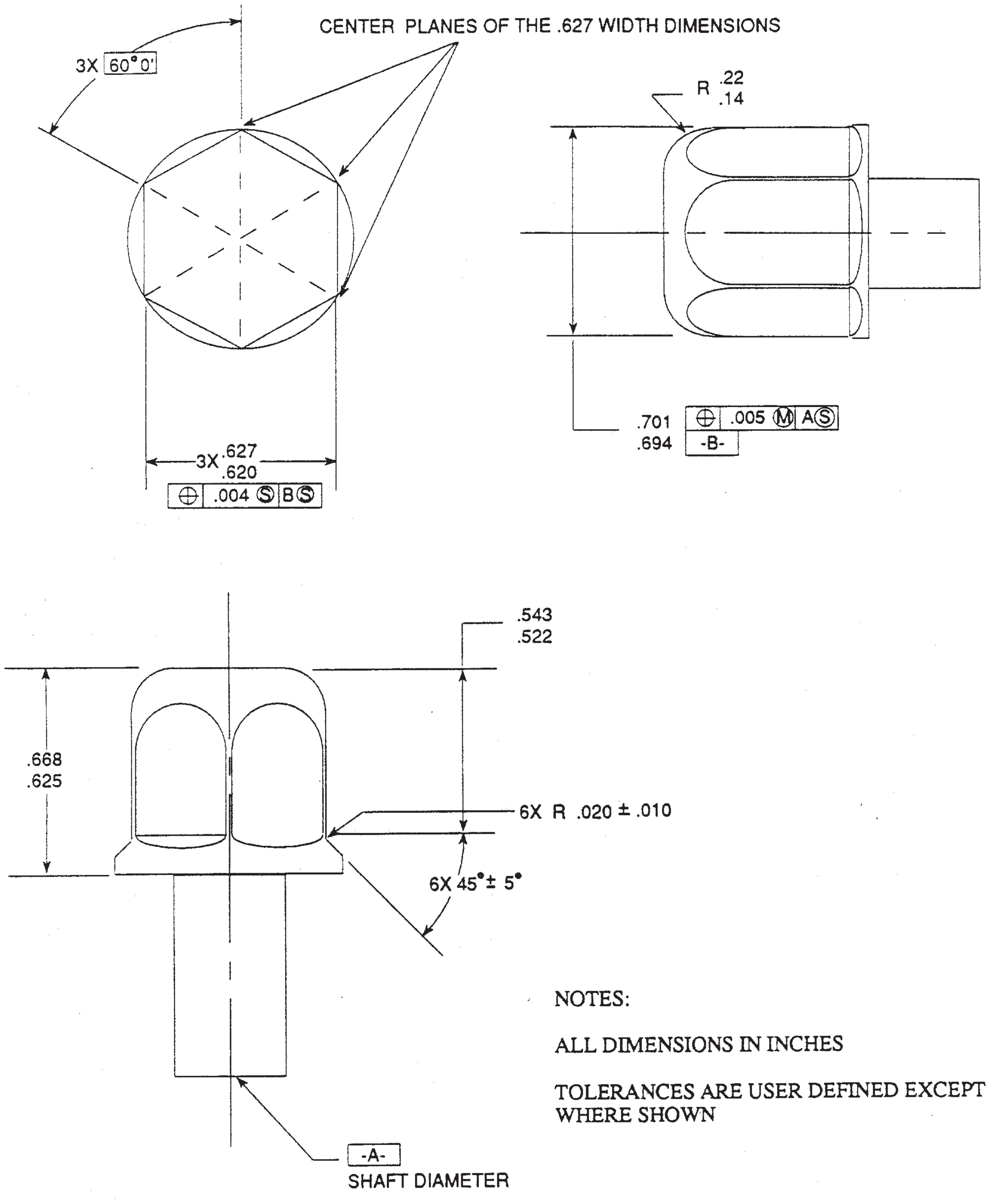


NOTES:

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



NOTES:

ALL DIMENSIONS IN INCHES

TOLERANCES ARE USER DEFINED EXCEPT WHERE SHOWN

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/ 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/ 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

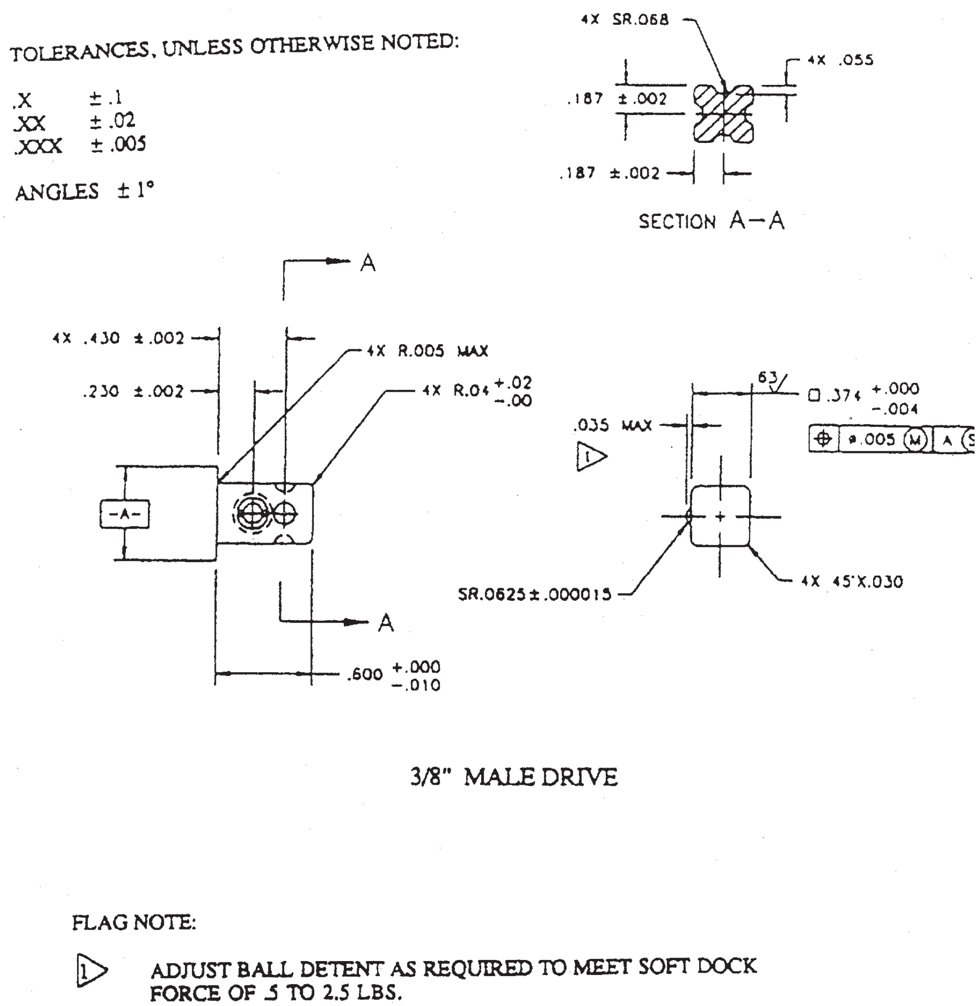


FIGURE 3.2.1.1–1 PISTOL GRIP TOOL TO EVA SOCKET EXTENSION INTERFACE

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 +/– 15 % for torque settings up to and including 90 in–lbs and +/– 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.

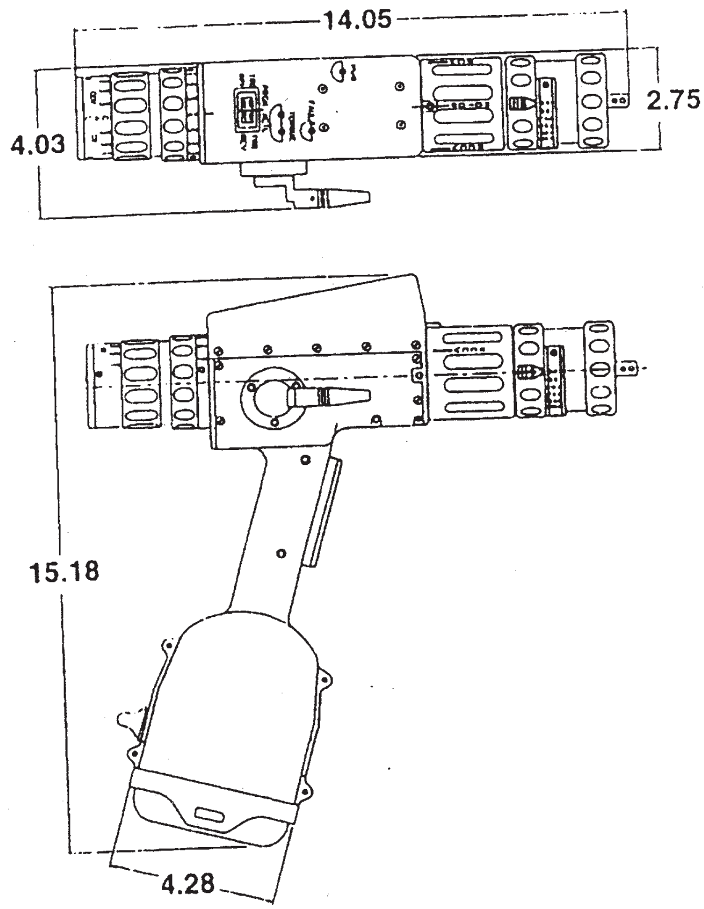


FIGURE 3.2.1.2–1 PISTOL GRIP TOOL ENVELOPE

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.

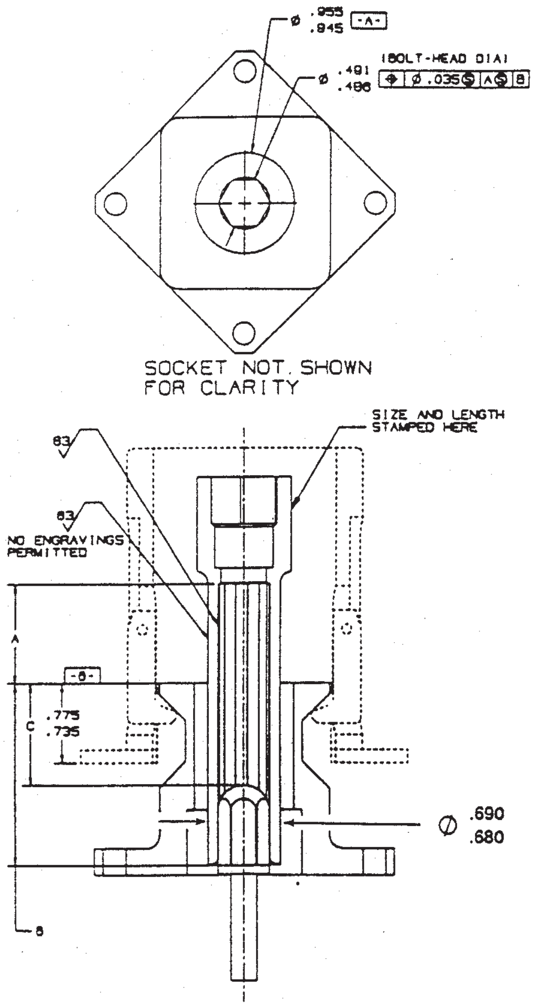
3.2.3.3 MASS PROPERTIES

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.

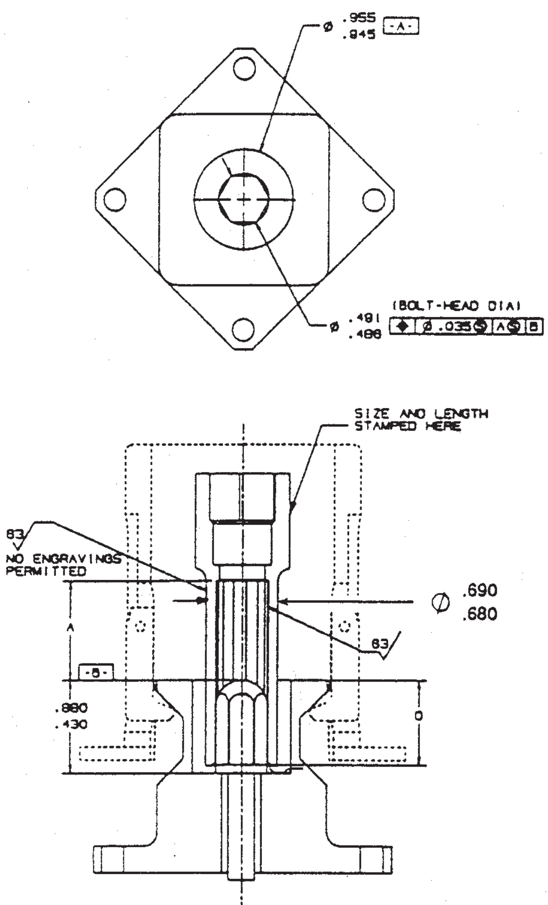


Micro installations that exceed the torque
multiplier concentricity capability will require that use of an EVA socket and the torque wrench or the cheater bar to apply the required torque.

A	.948	MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)
B	1.789 1.689	MAXIMUM TO ALLOW FULL .300 ENGAGEMENT OF SSP 30256 BOLT-HEAD 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



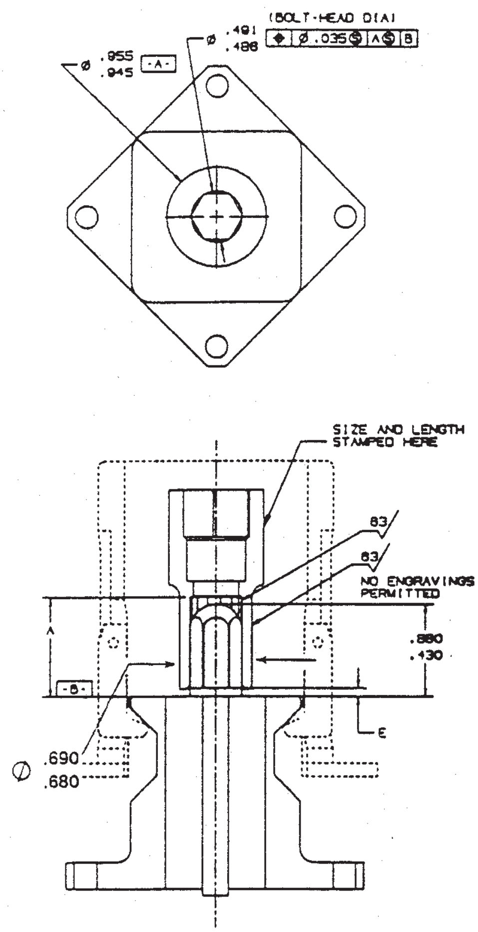
A	.948	MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)
D	.900	MAXIMUM TO ALLOW FULL .300 ENGAGEMENT OF SSP 30256 BOLT-HEAD
	.800	MINIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)

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.

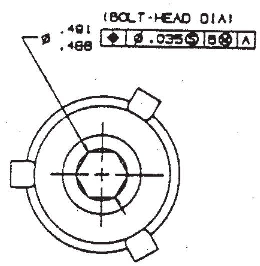


A	.948	MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)
E	.080 .010	MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW) MINIMUM TO ALLOW FULL .300 ENGAGEMENT OF SSP 30256 BOLT-HEAD

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.

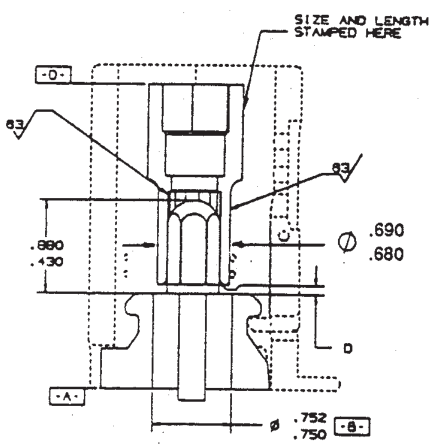
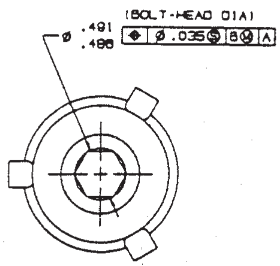
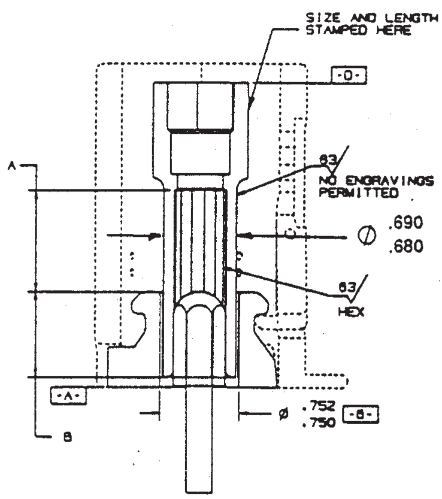


FIGURE 3.2.3.1–4 MICROCONICAL TORQUE MULTIPLIER TO MICROCONICAL INTERFACE – PROTRUDING 7/16 BOLT HEADS



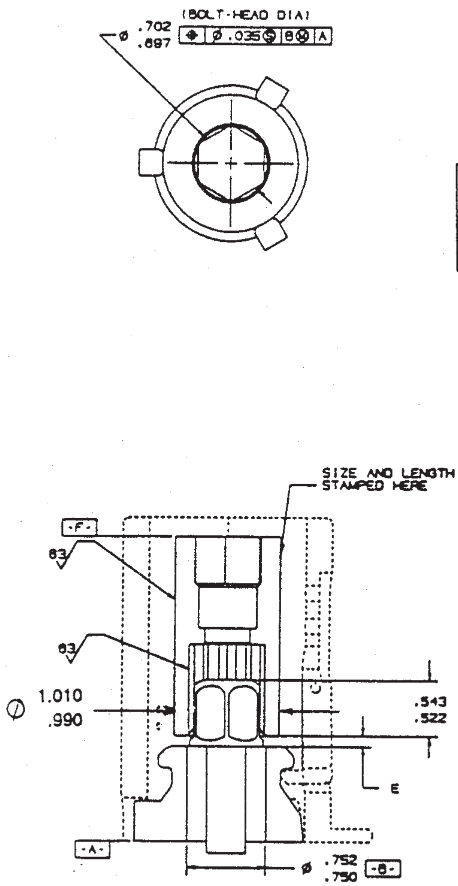
A	.960	MAXIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)
B	.830 .800	MAXIMUM TO ALLOW FULL .300 ENGAGEMENT OF SSP 30256 BOLT-HEAD MINIMUM TO ALLOW FULL .875 TRAVEL WITH TM (SEE NOTE BELOW)

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

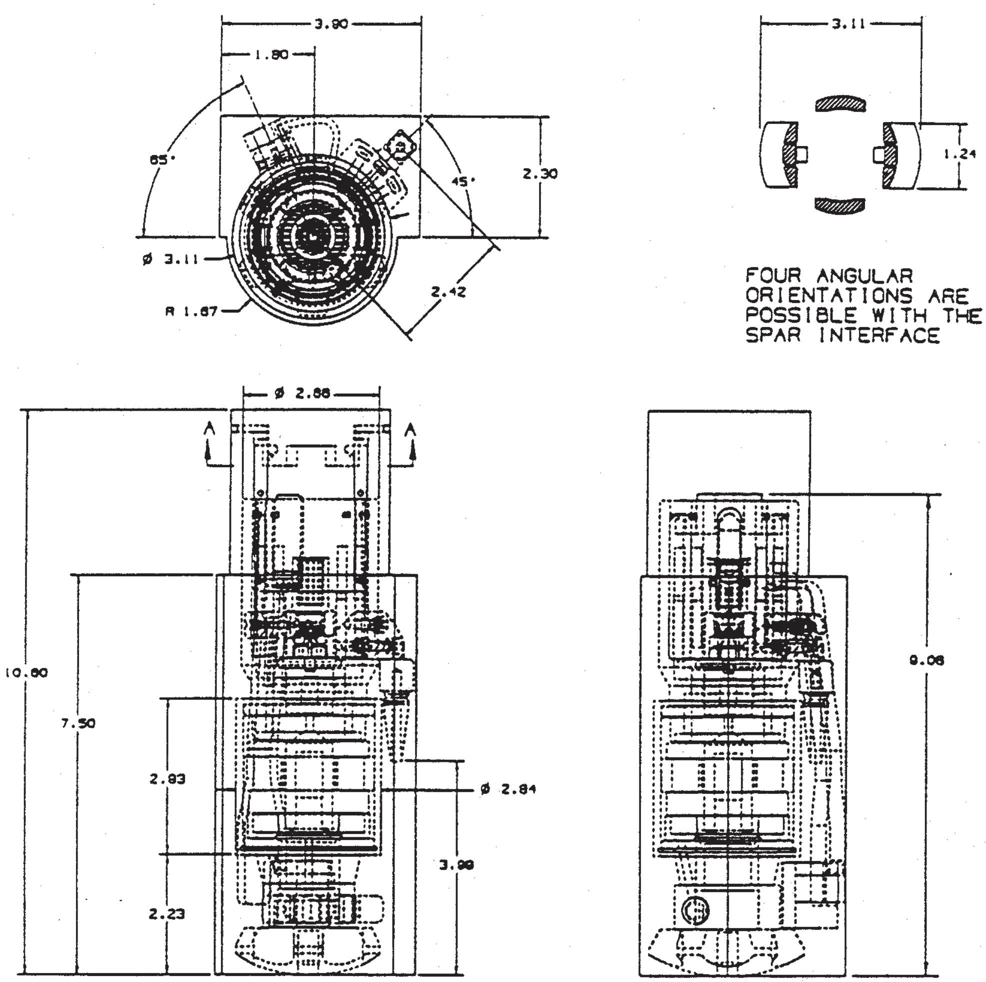


FIGURE 3.2.3.2–1 MICRO TORQUE MULTIPLIER ENVELOPE

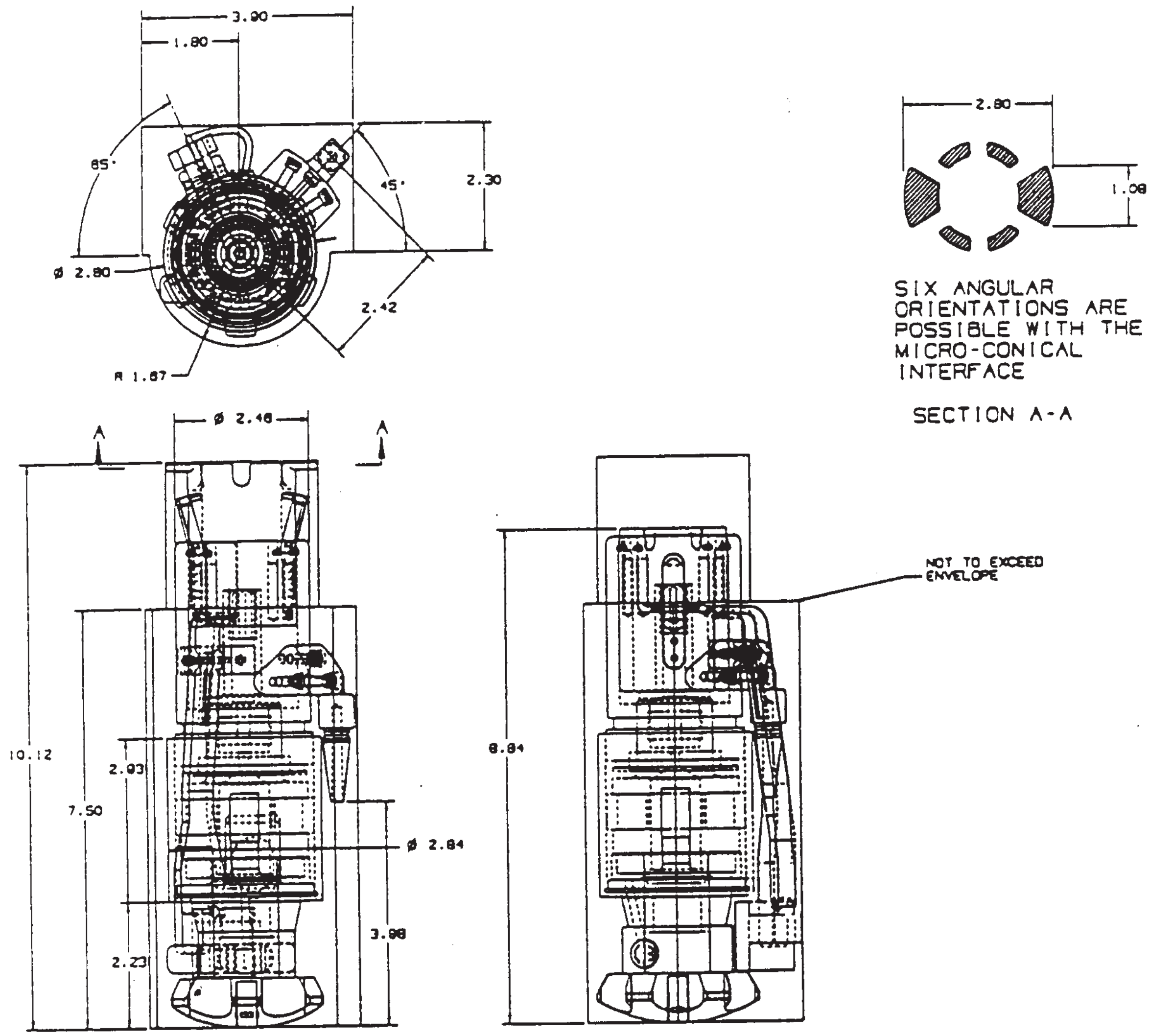


FIGURE 3.2.3.2–2 MICROCONICAL TORQUE MULTIPLIER ENVELOPE

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.

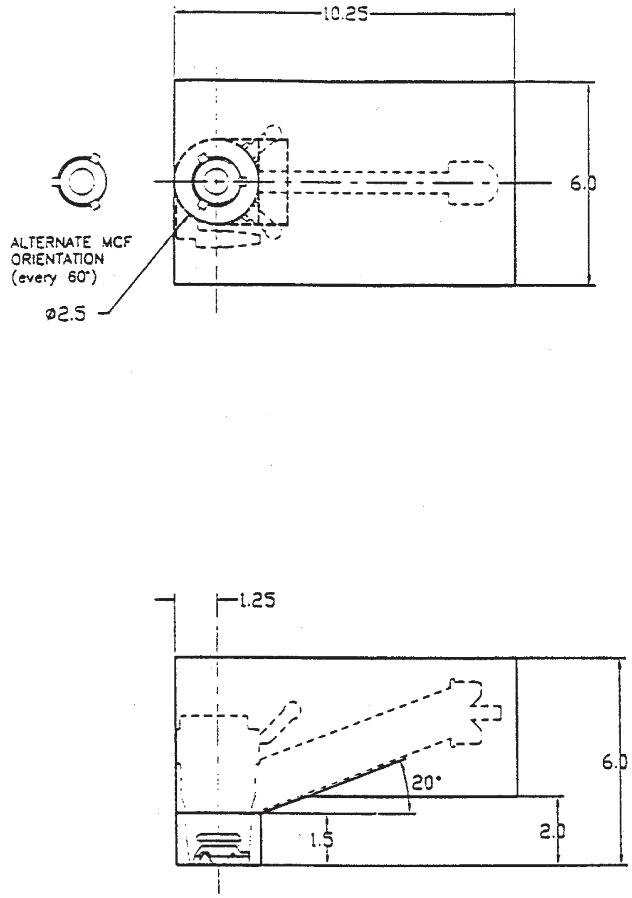
3.2.5 MICROCONICAL FITTINGS (MCF)

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

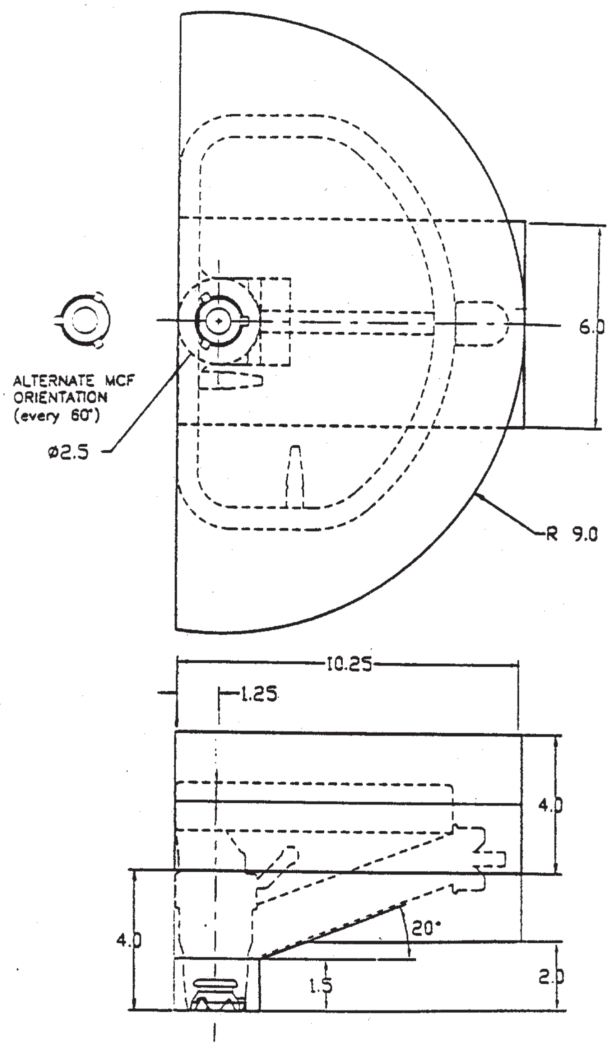
There are three MCF configurations. One unit has a 0.75 in. center hole and a flange base with four counterbored holes for cap screws for mounting. A second unit also has a 0.75 in. center hole, but no flange, and mounts to the ORU via six bolts screwed into the bottom of the fitting with the boltheads 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 ORUs :
< 150 lbs and 6 cu ft
and max. mass moment of inertia
about the primary handling interface
< 8.0 Slug ft^2

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 ORU Volumes
> 150 lbs or 6 cu ft
or max. mass moment of inertia
about the primary handling interface
> 8.0 Slug ft²

FIGURE 3.2.4.2–2 MICROCONICAL COMBINED TOOL ENVELOPE

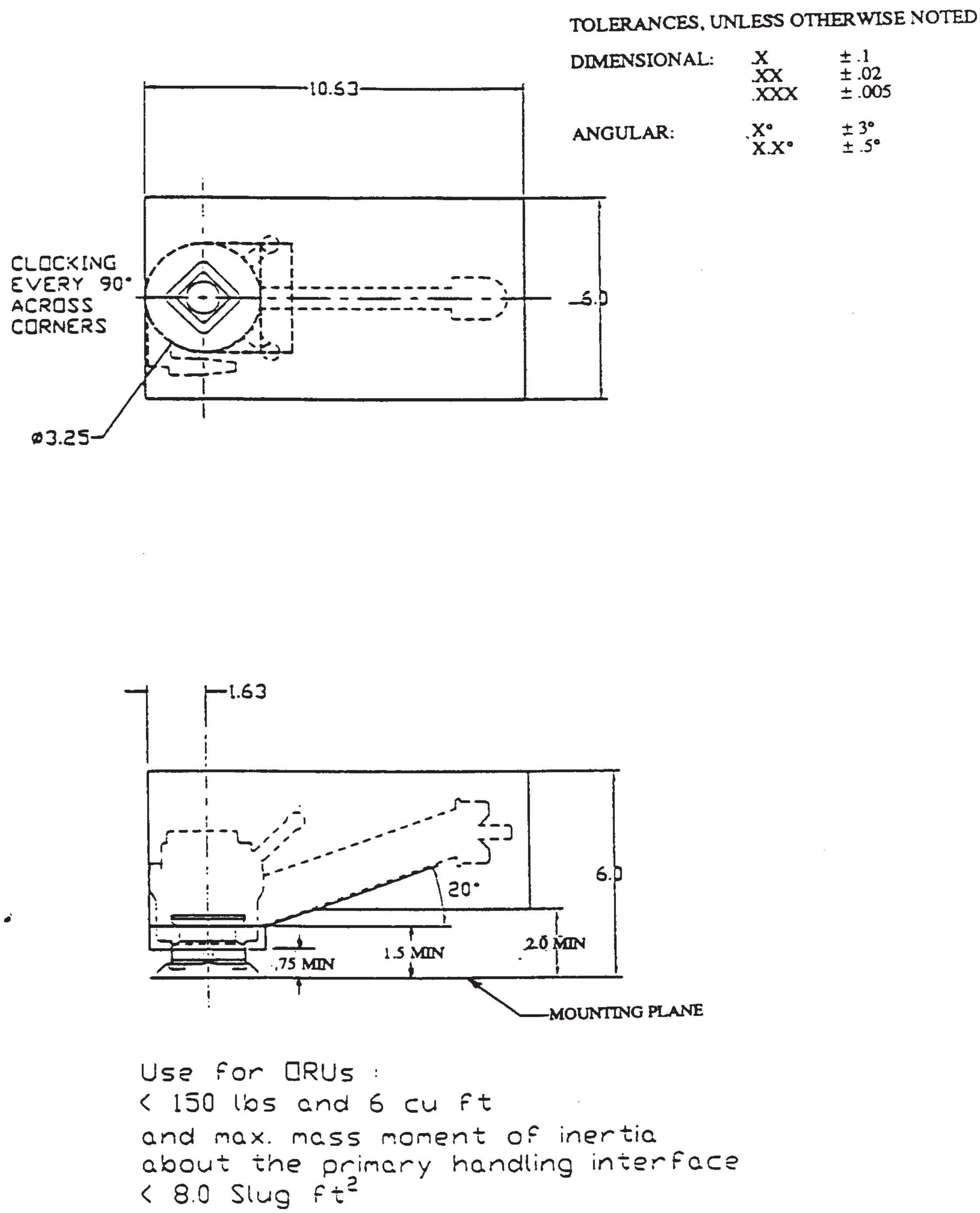
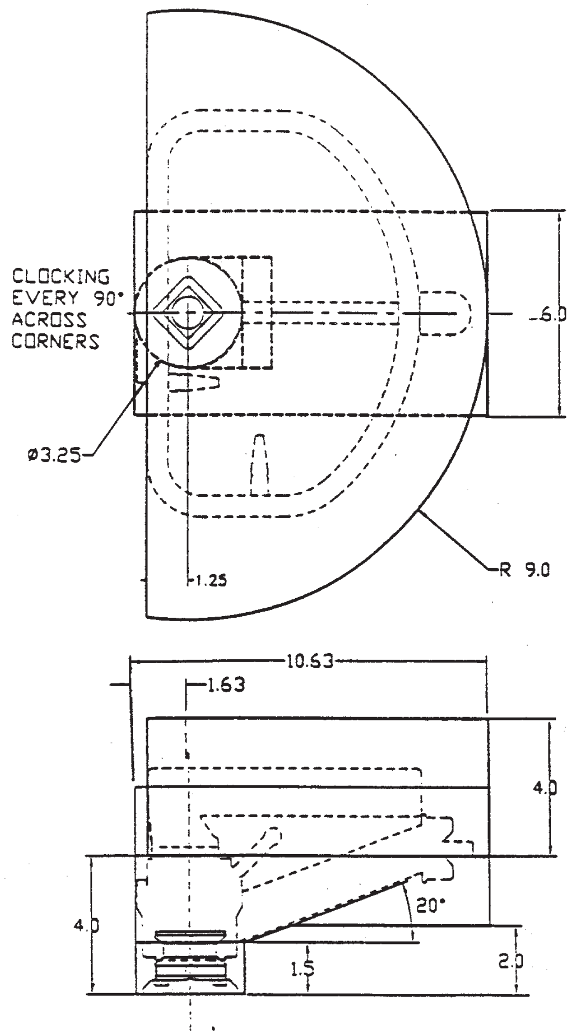


FIGURE 3.2.4.2–3 MICRO SCOOP ENVELOPE

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^2

FIGURE 3.2.4.2–4 MICRO COMBINED TOOL ENVELOPE

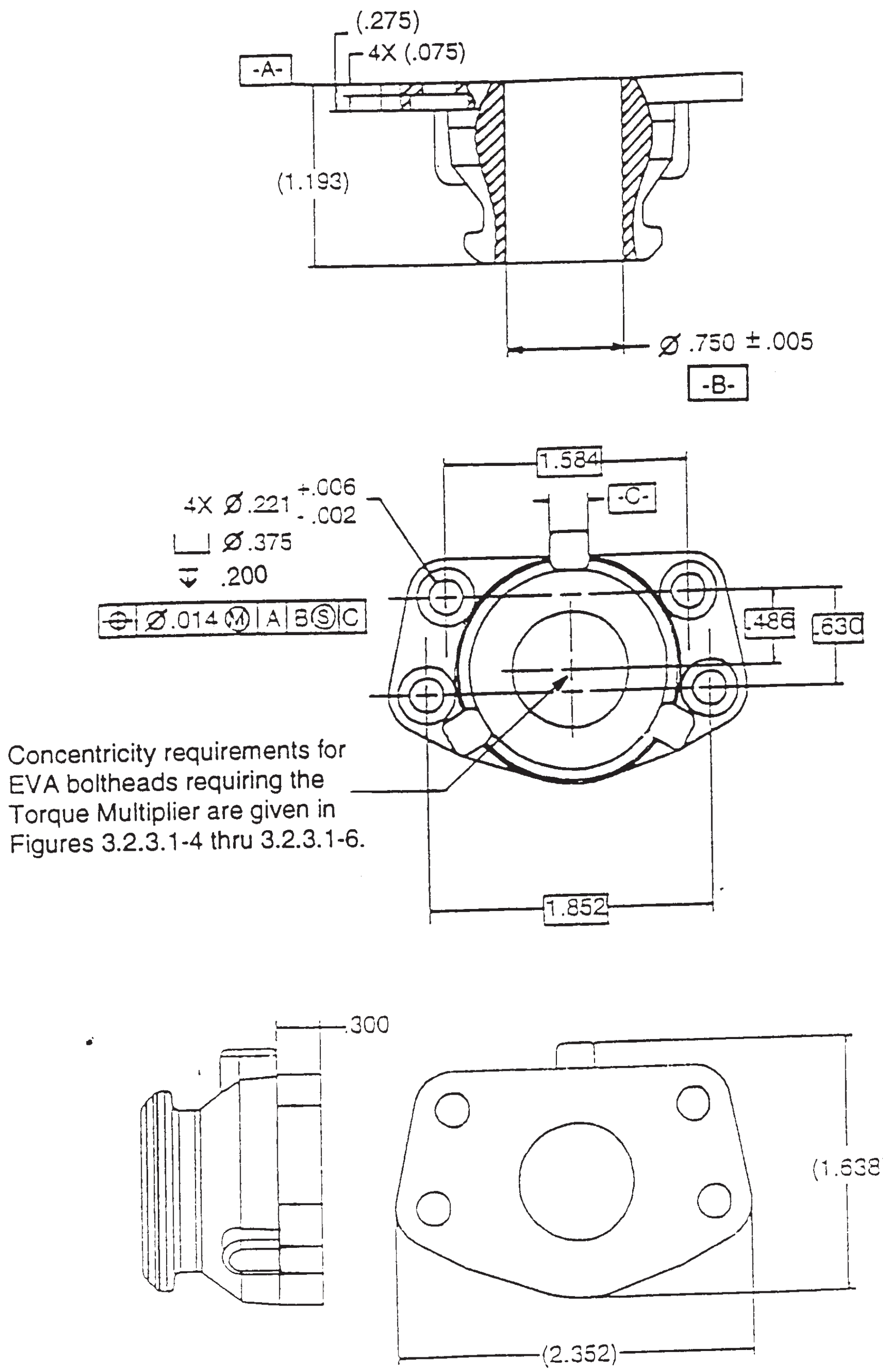


FIGURE 3.2.5.2–1 0006056 MICROCONICAL FITTING BOLTHOLE PATTERN AND FOOTPRINT

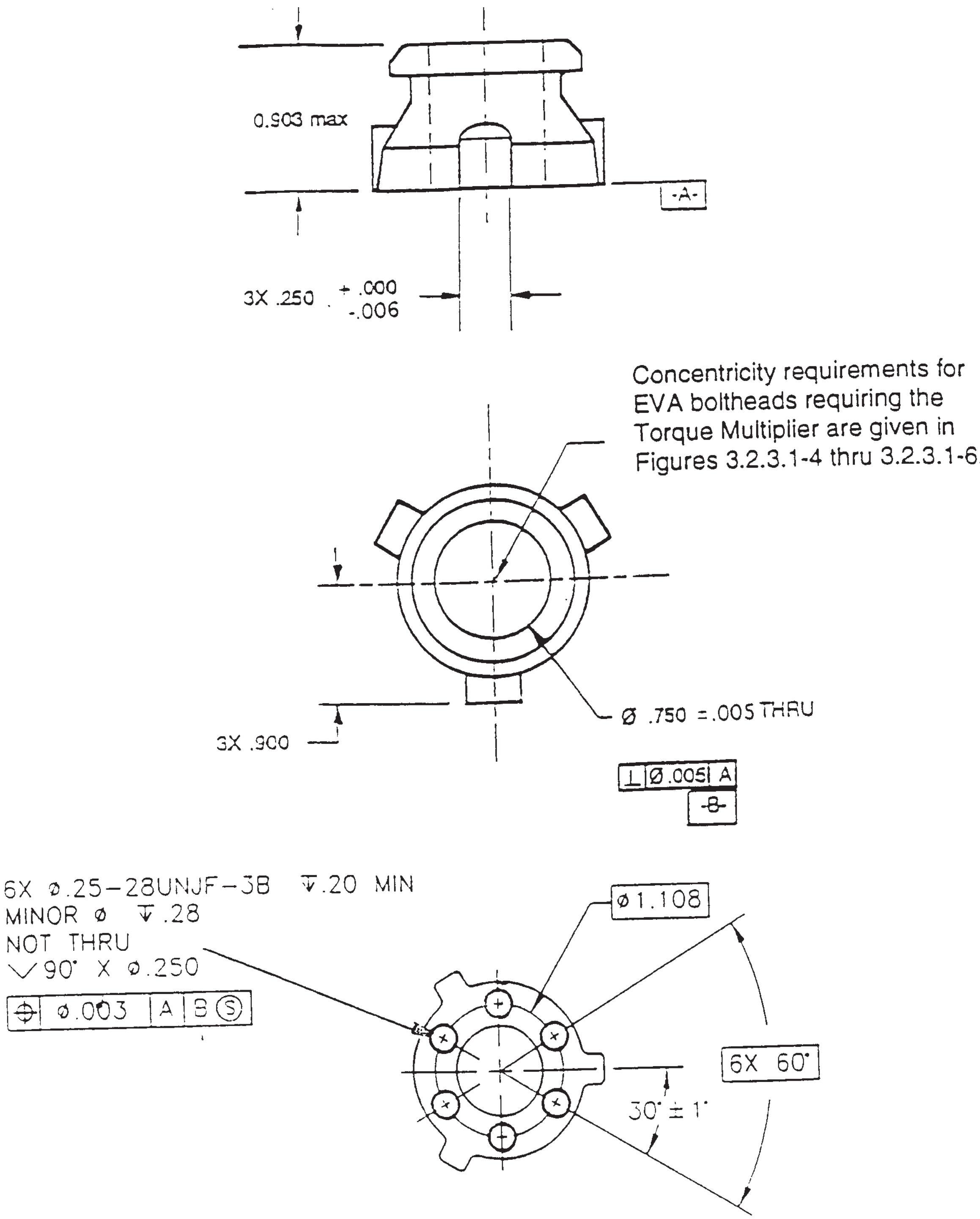


FIGURE 3.2.5.2–2 0006055 AND 0006057 MICROCONICAL FITTING BOLTHOLE PATTERN AND FOOTPRINT

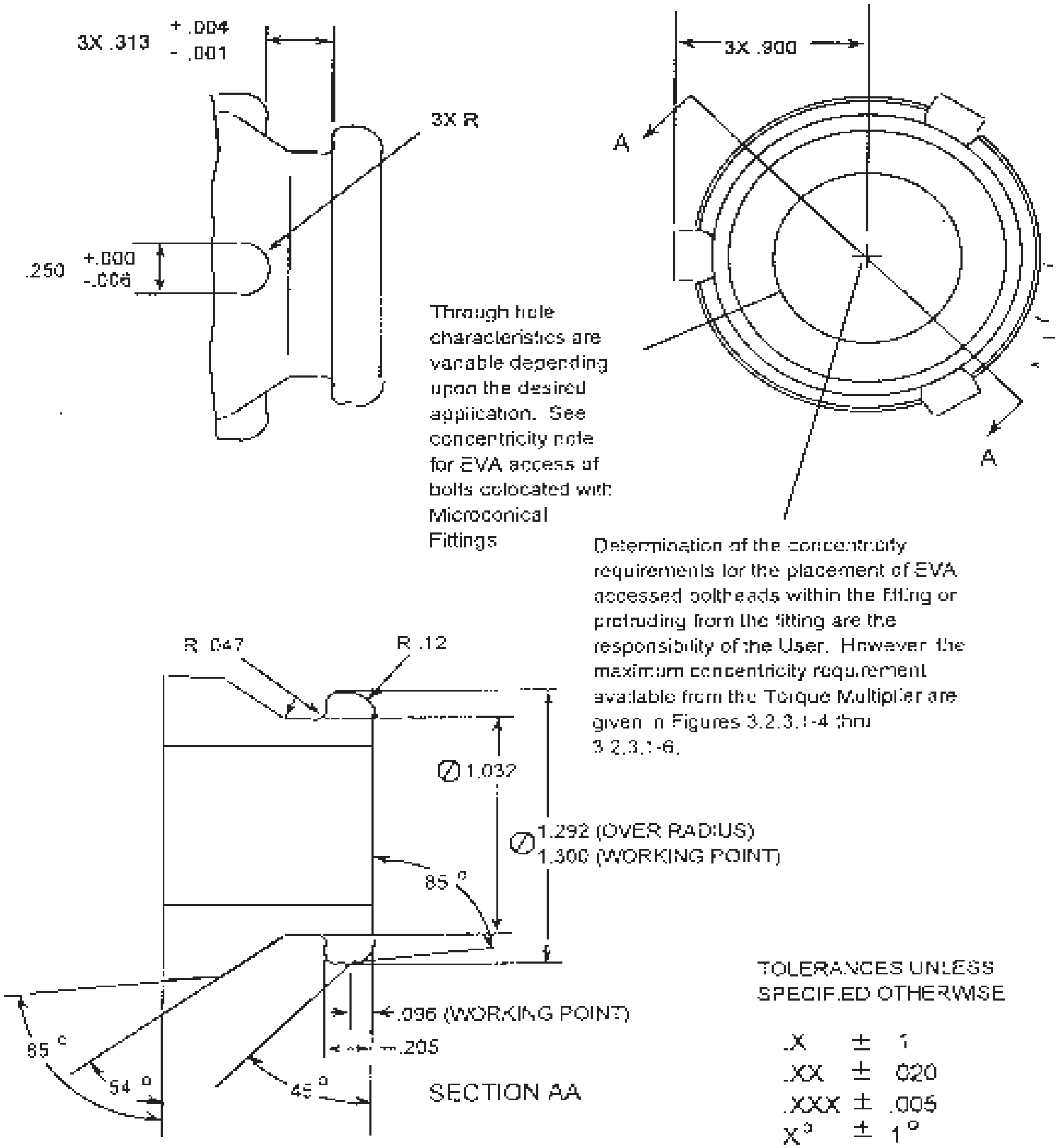


FIGURE 3.2.5.2–3 MICROCONICAL FITTING PROFILE INTERFACE

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.

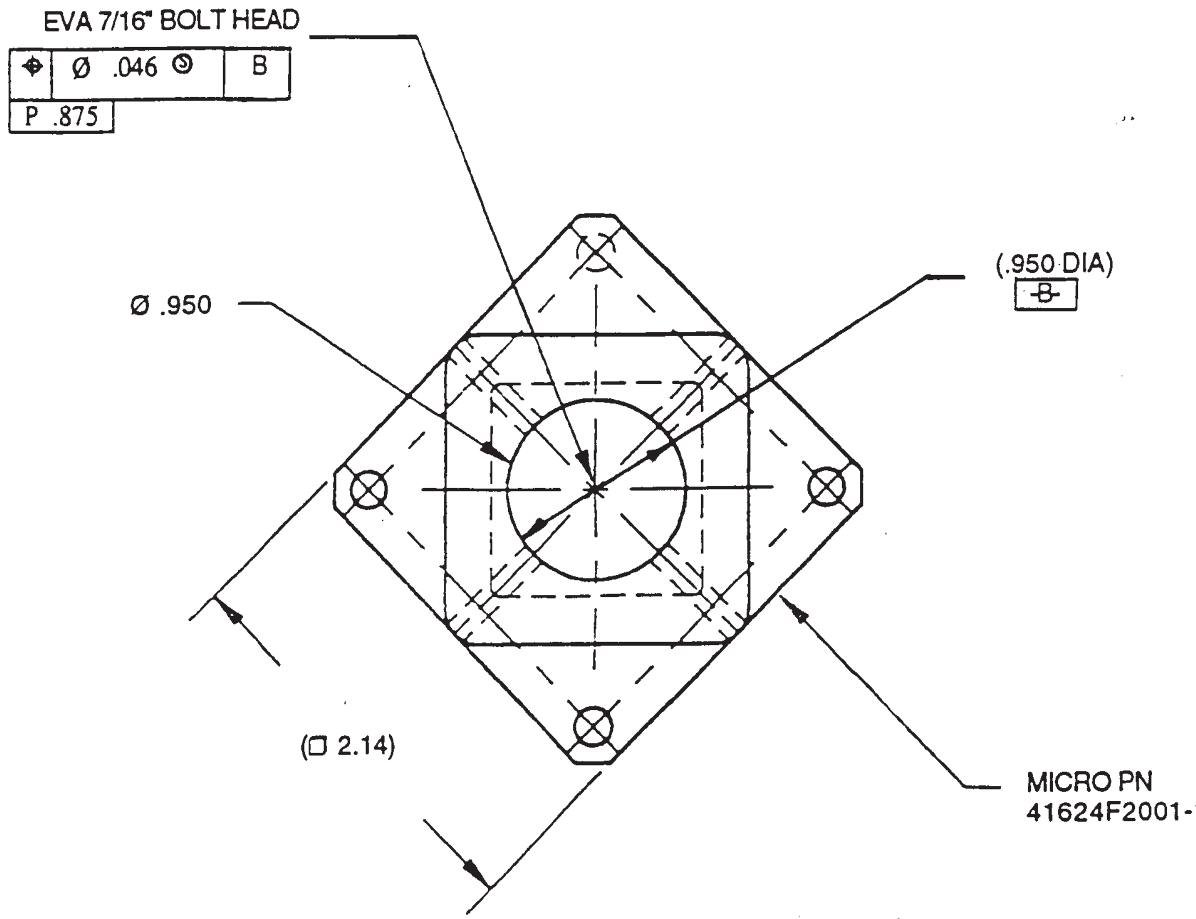
3.2.5.6 ELECTRICAL BONDING

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° (foot platform toward the worksite interface) to +90° prior to ingress. The APFR can be operated in settings from –72° to +90° with the –90° setting for storage and translation only. In addition, the EVA crewmember can articulate the foot platform +/– 90° in roll and 360° 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.

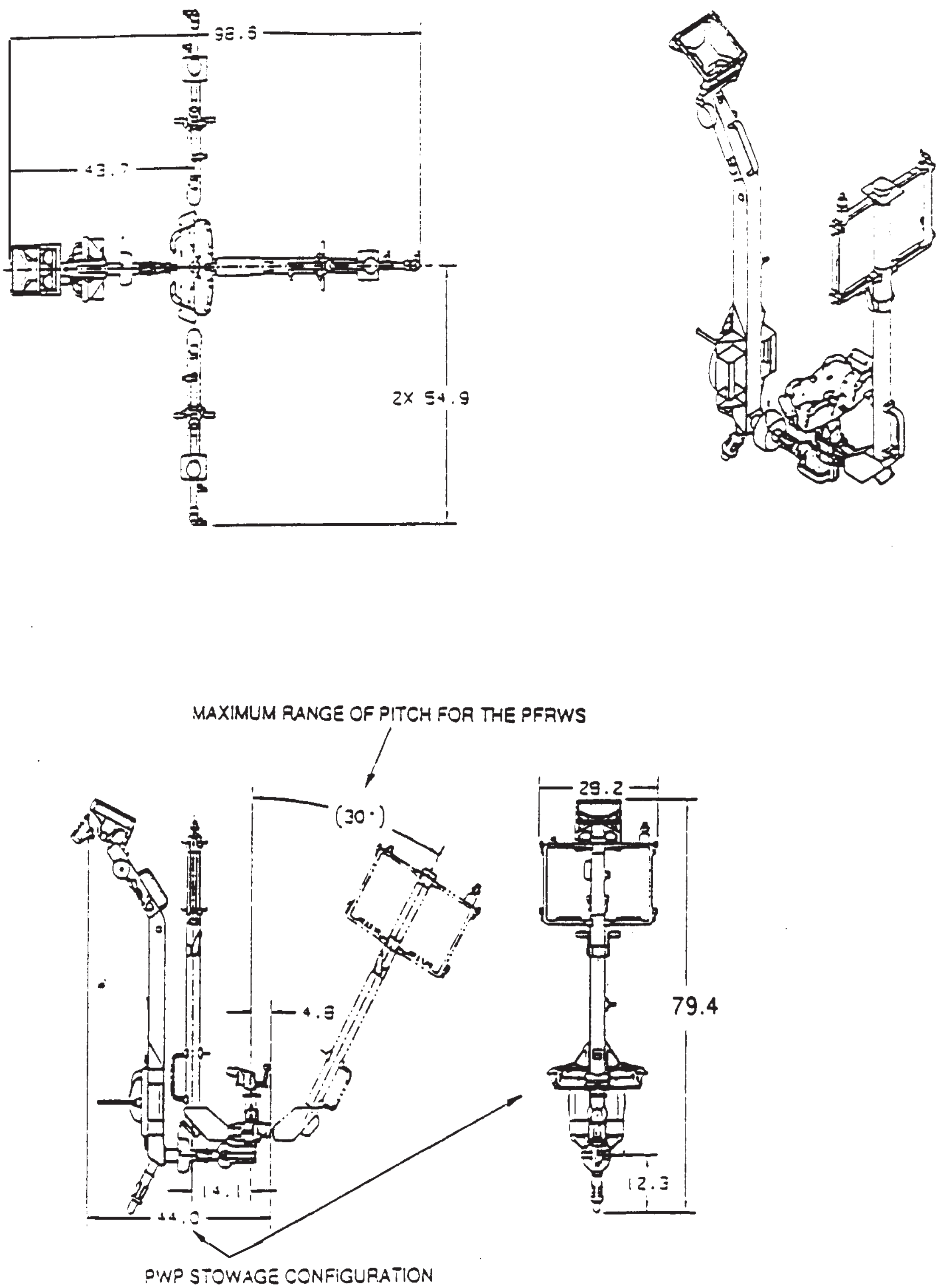


FIGURE 3.3–1 PORTABLE WORK PLATFORM (PWP) ASSEMBLY

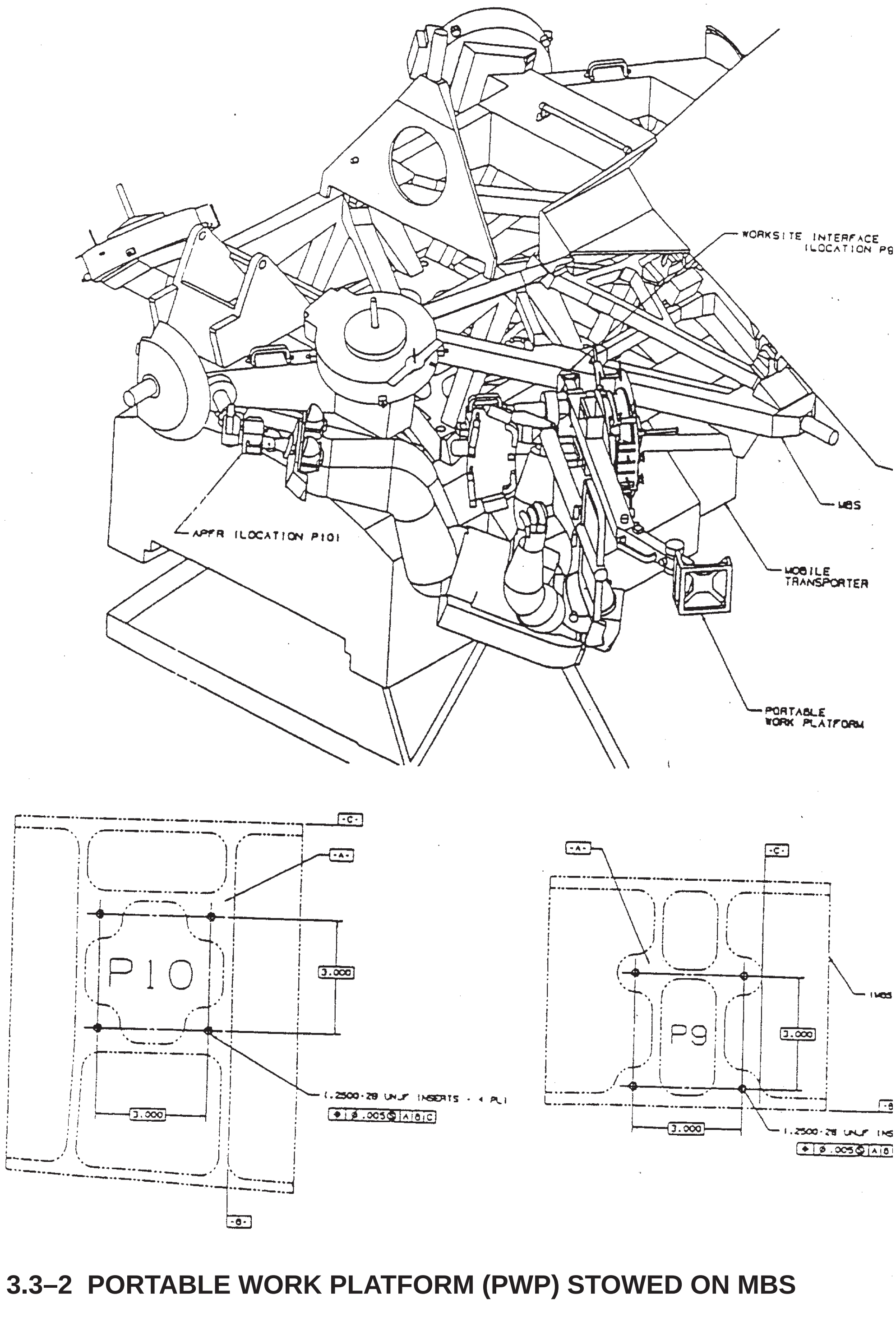


FIGURE 3.3–2 PORTABLE WORK PLATFORM (PWP) STOWED ON MBS

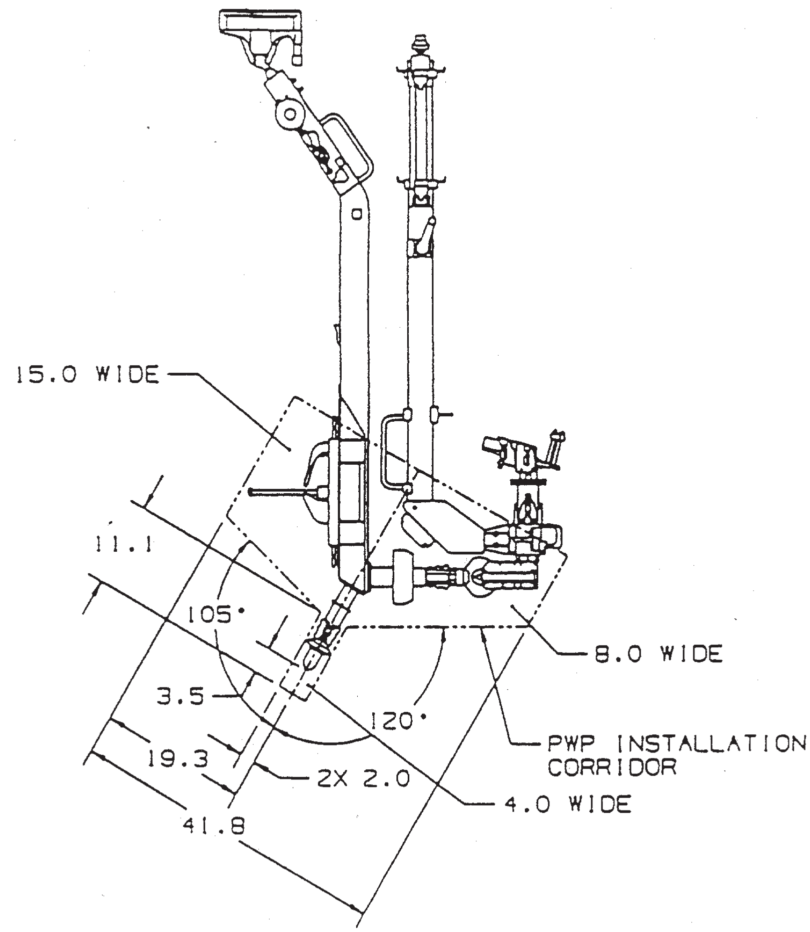


FIGURE 3.3–3 INSTALLATION AND REMOVAL ENVELOPE FOR THE PORTABLE WORK PLATFORM (PWP) ON THE MBS

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.

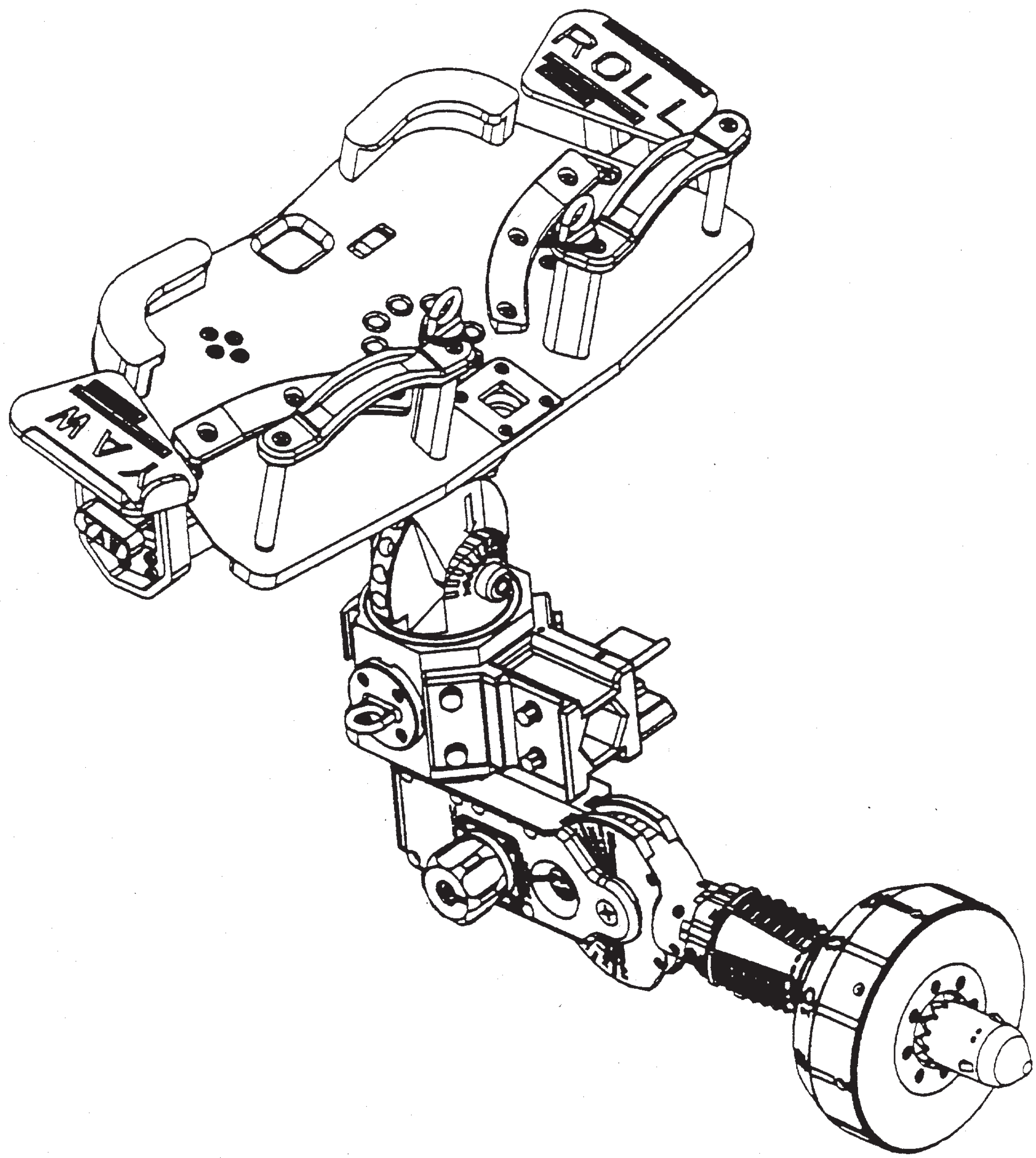


FIGURE 3.3.1–1 ARTICULATING PORTABLE FOOT RESTRAINT (APFR)

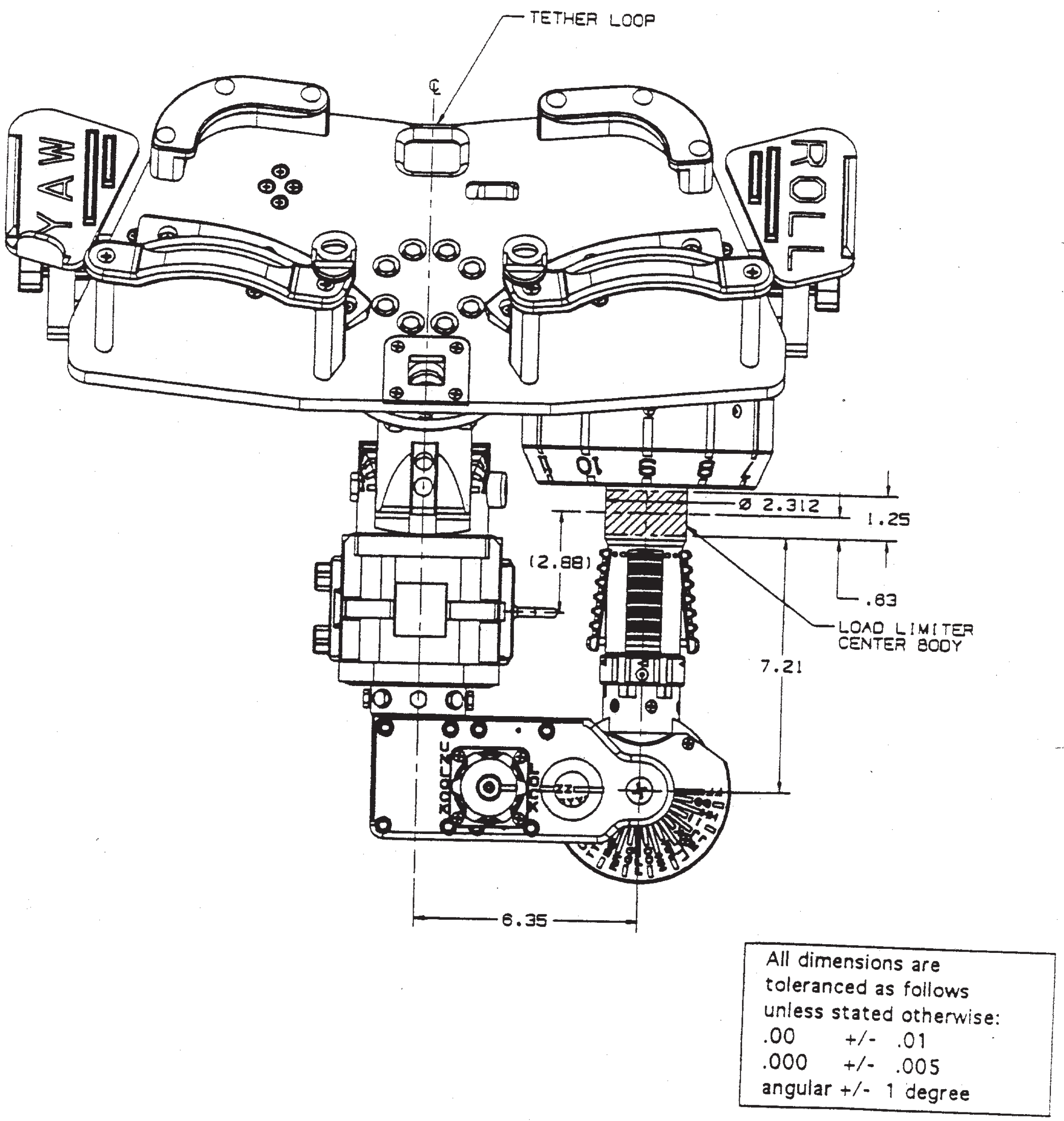


FIGURE 3.3.1.1–1 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) LAUNCH RESTRAINT ATTACHMENT LOCATION – LOAD LIMITER CENTER BODY

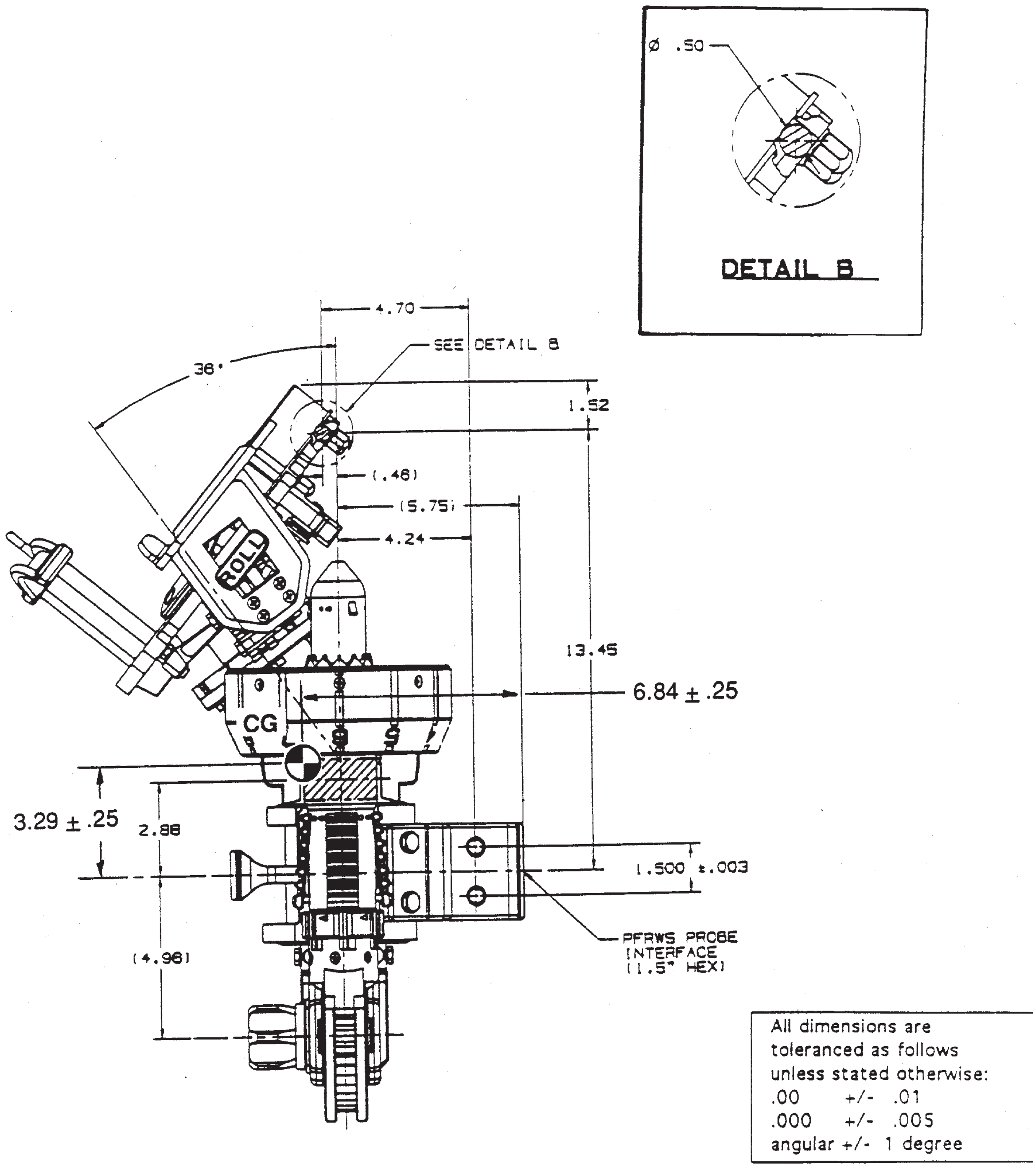


FIGURE 3.3.1.1–2 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) LAUNCH RESTRAINT LOCATION – TETHER LOOP

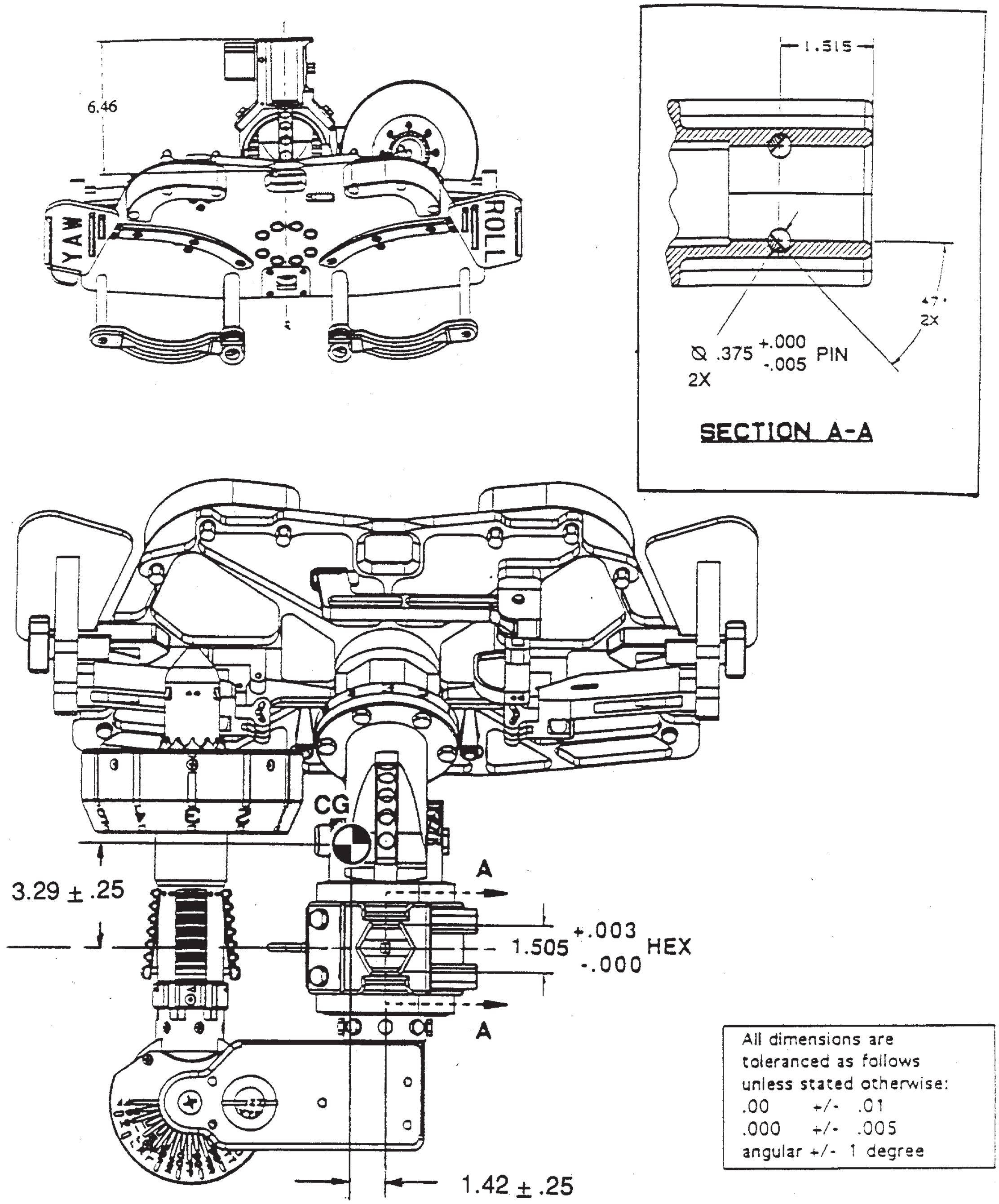


FIGURE 3.3.1.1–3 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) LAUNCH RESTRAINT LOCATION – HEX RECEPTABLE

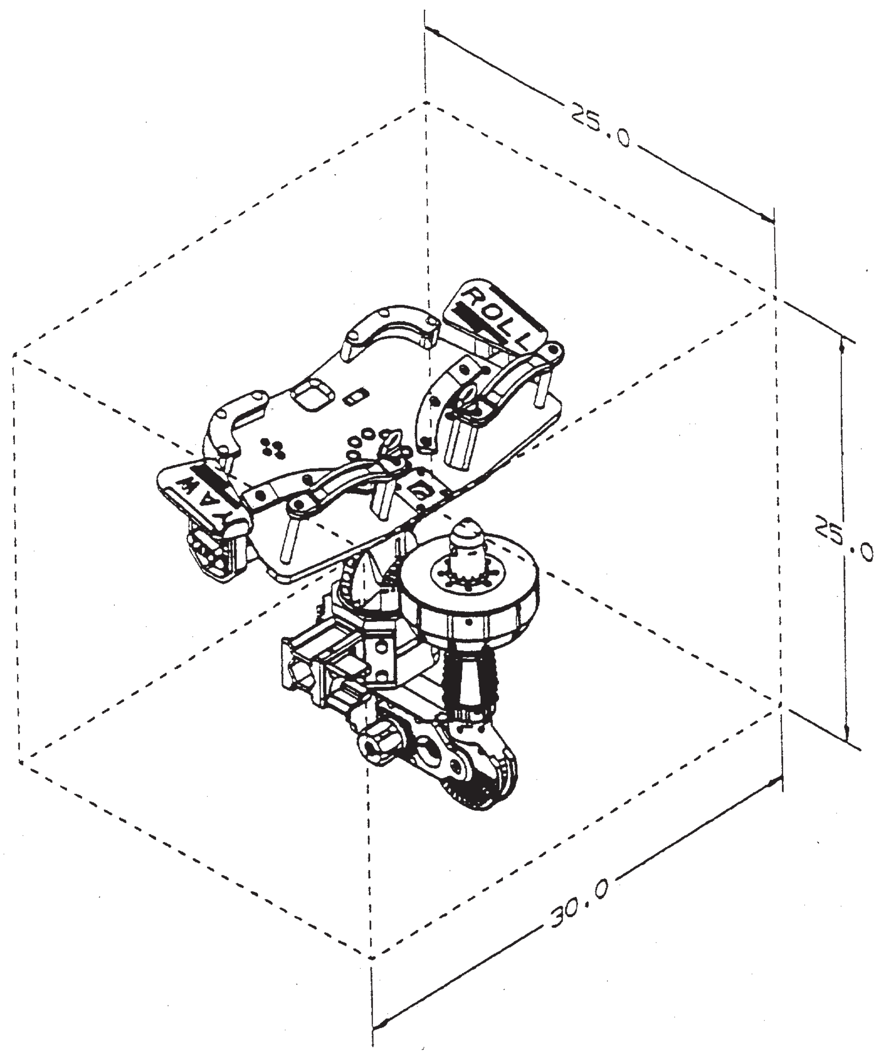


FIGURE 3.3.1.2–1 MINIMUM ARTICULATING PORTABLE FOOT RESTRAINT (APFR) STOWAGE VOLUME

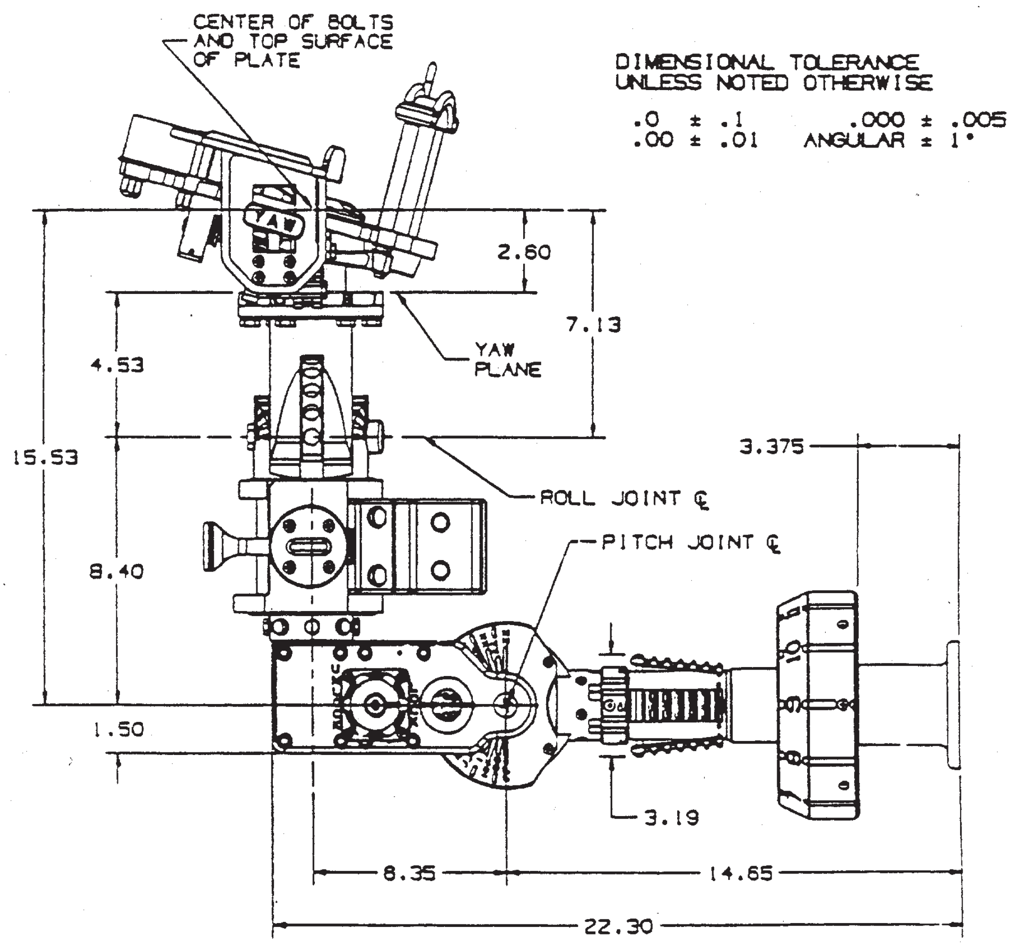


FIGURE 3.3.1.4–1 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) CRITICAL DIMENSIONS – SIDE VIEW

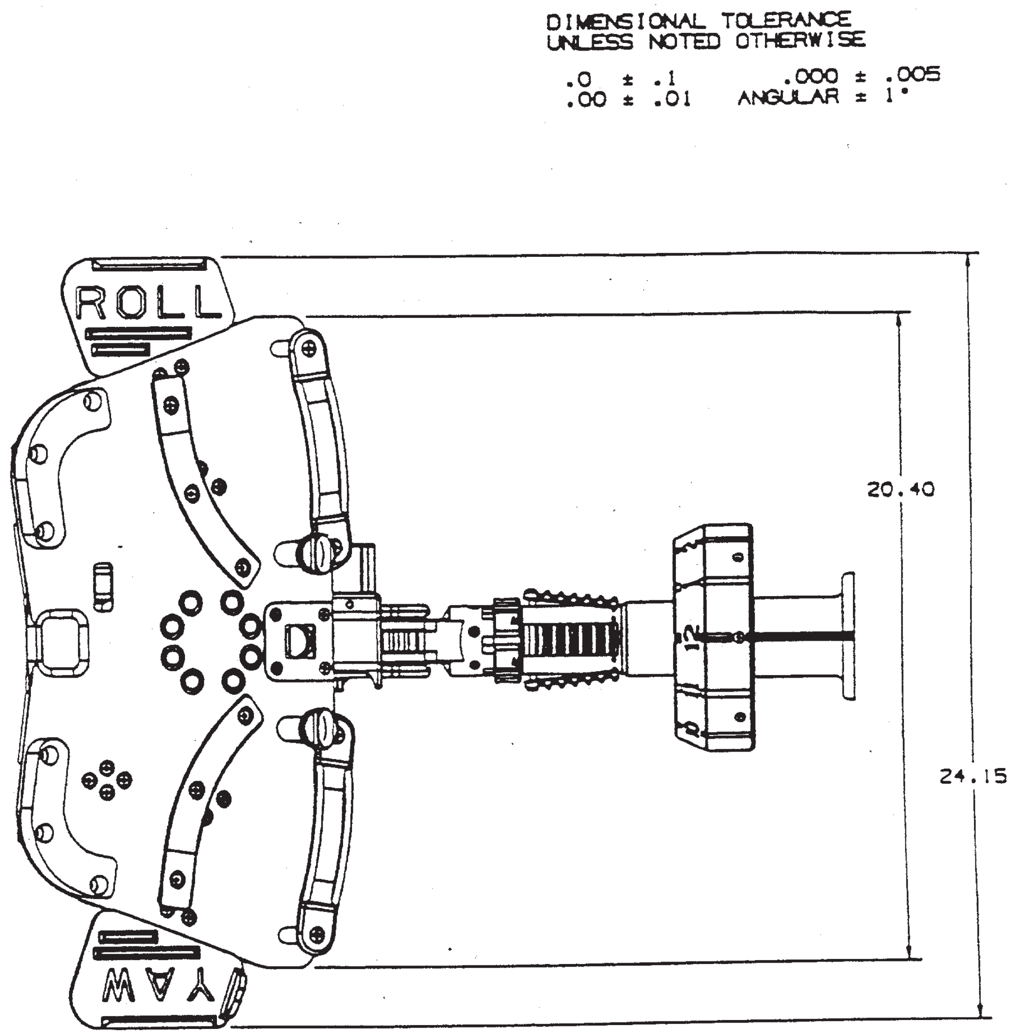
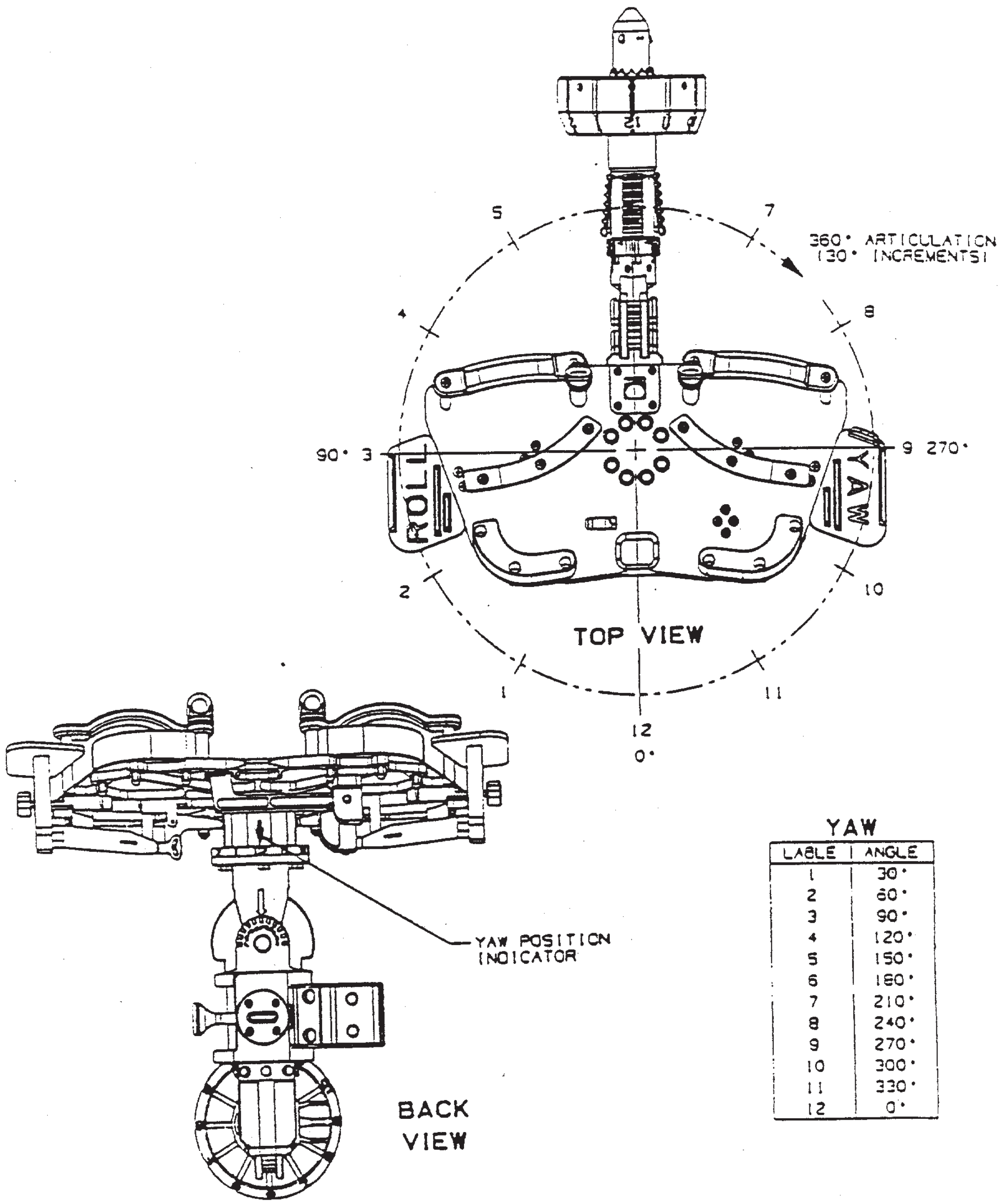


FIGURE 3.3.1.4–2 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) CRITICAL DIMENSIONS – TOP VIEW



YAW

LABLE	ANGLE
1	30°
2	60°
3	90°
4	120°
5	150°
6	180°
7	210°
8	240°
9	270°
10	300°
11	330°
12	0°

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

PITCH

LABLE	ANGLE
FF	+90°
GG	+81°
HH	+72°
II	+63°
JJ	+54°
KK	+45°
LL	+36°
MM	+27°
NN	+18°
OO	+9°
PP	0°
QQ	-9°
RR	-18°
SS	-27°
TT	-36°
UU	-45°
VV	-54°
WW	-63°
XX	-72°
YY	-81°
ZZ	-90°

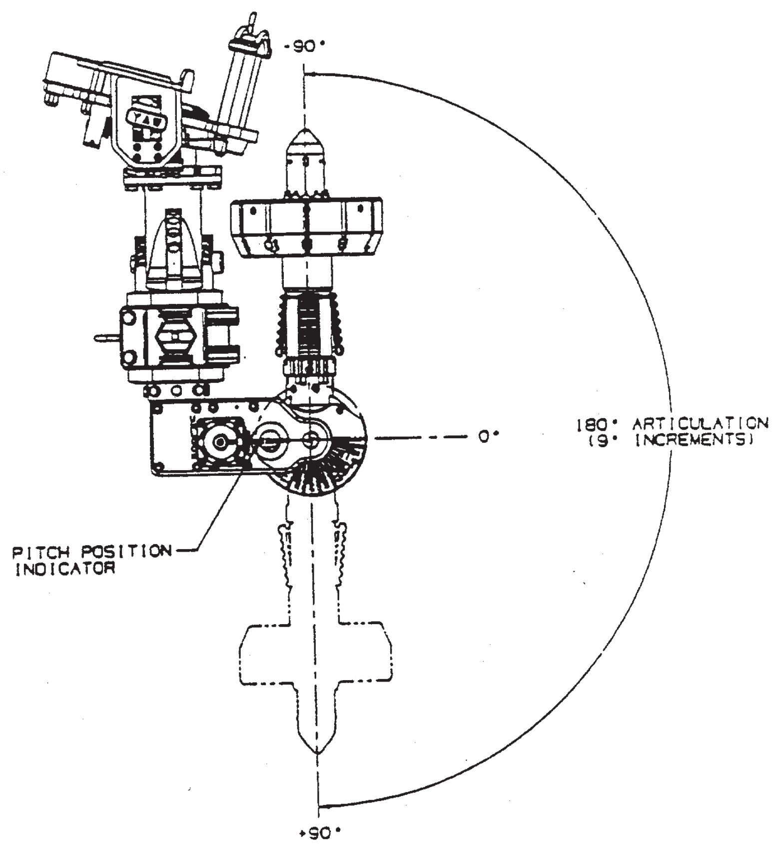
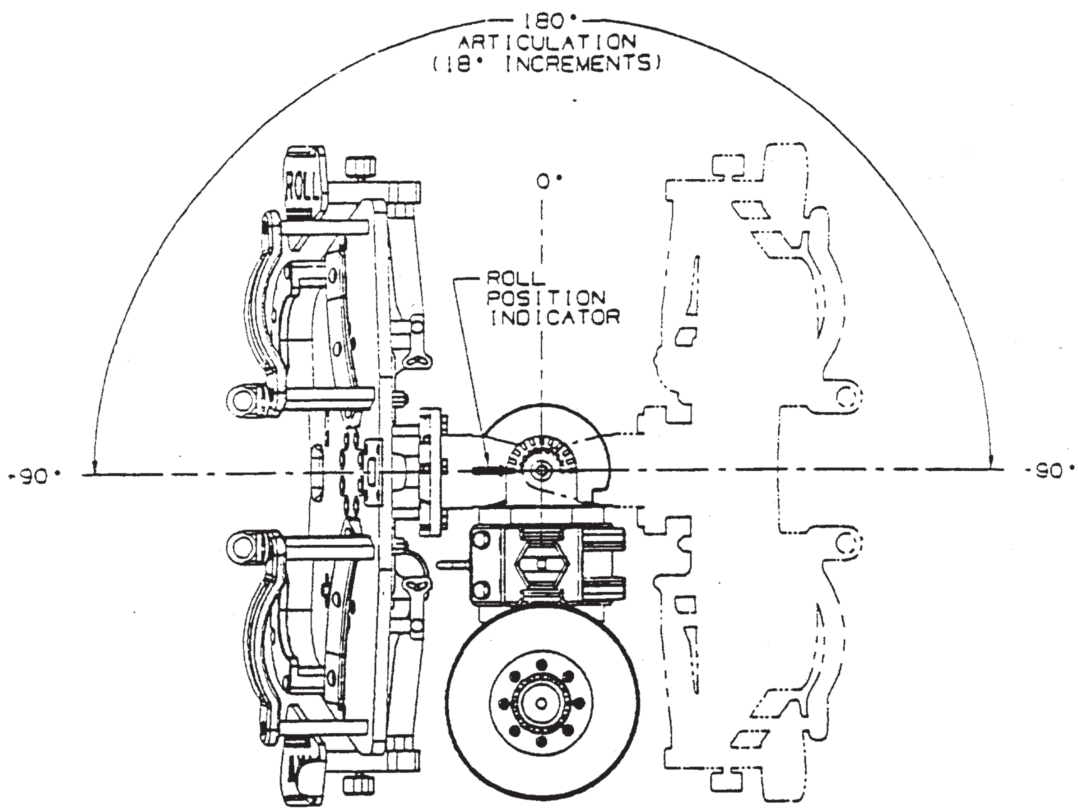


FIGURE 3.3.1.4–4 ARTICULATING PORTABLE FOOT RESTRAINT (APFR) FUNCTIONAL POSITIONS – PITCH



FRONT VIEW

ROLL

LABLE	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 ± .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 ± .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.

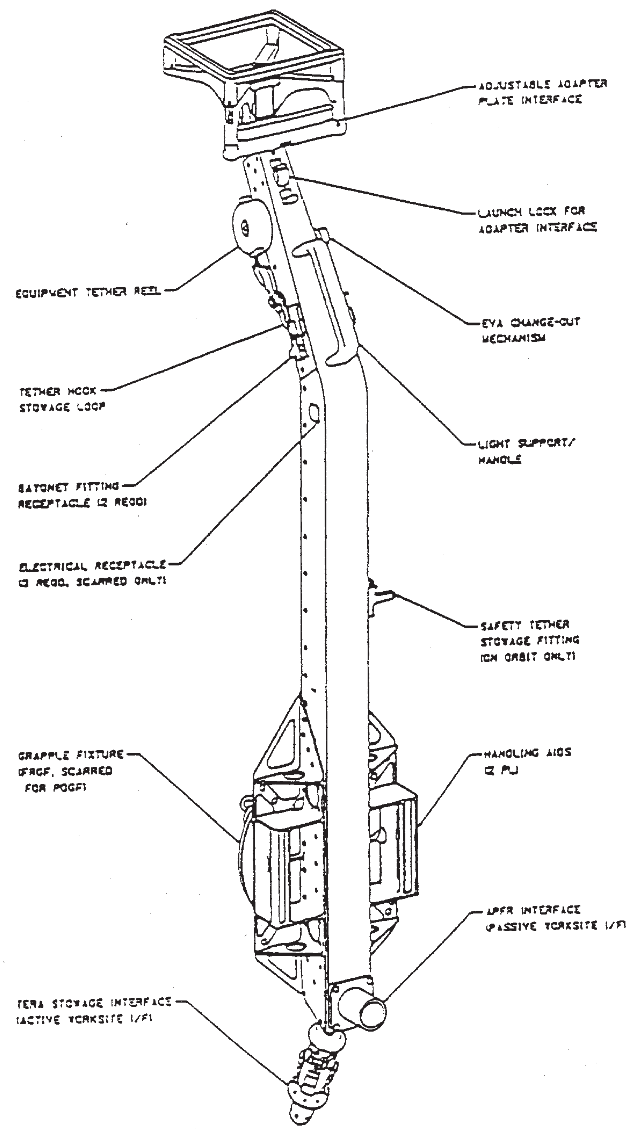


FIGURE 3.3.2–1 TEMPORARY EQUIPMENT RESTRAINT AID (TERA)

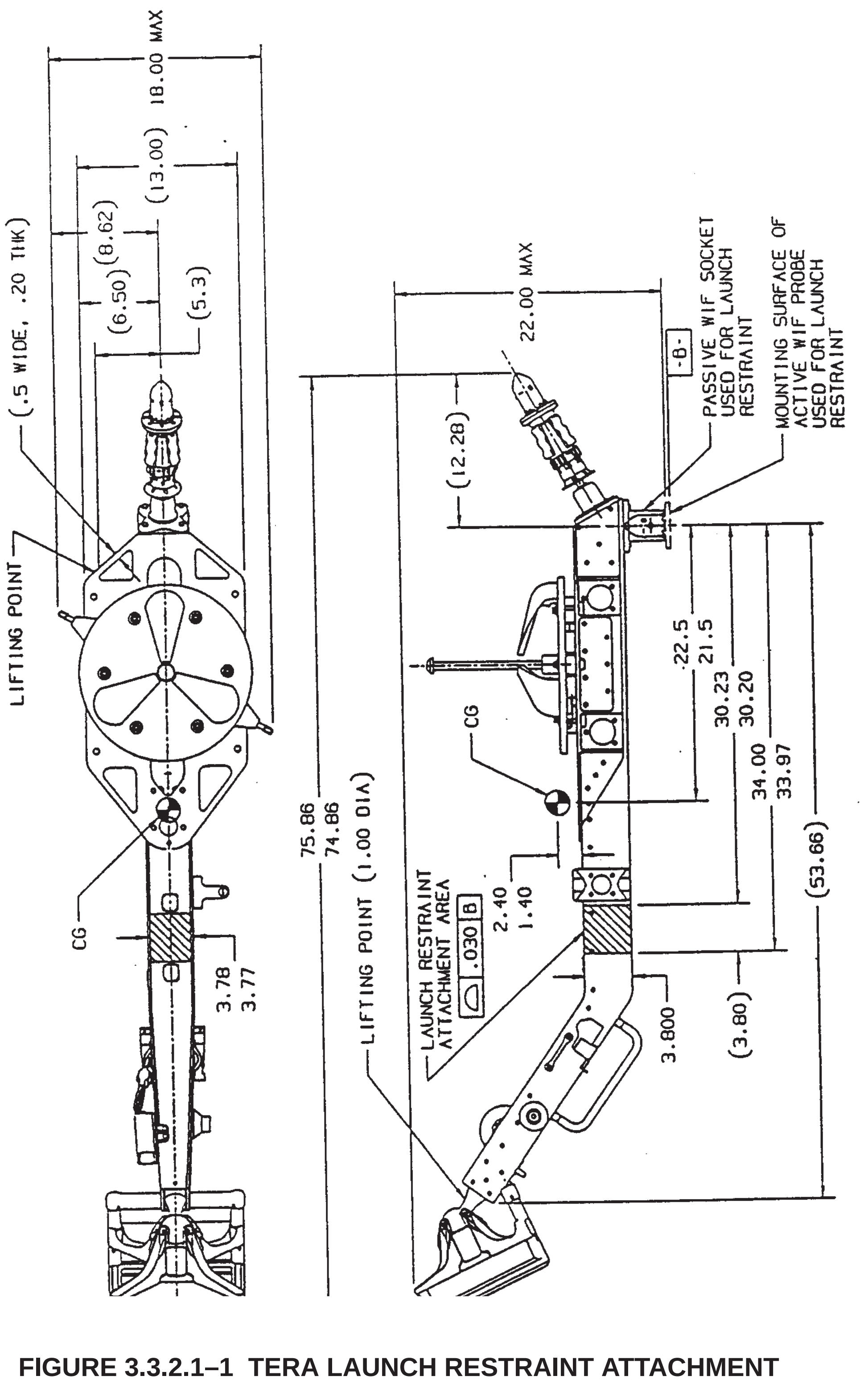


FIGURE 3.3.2.1–1 TERA LAUNCH RESTRAINT ATTACHMENT

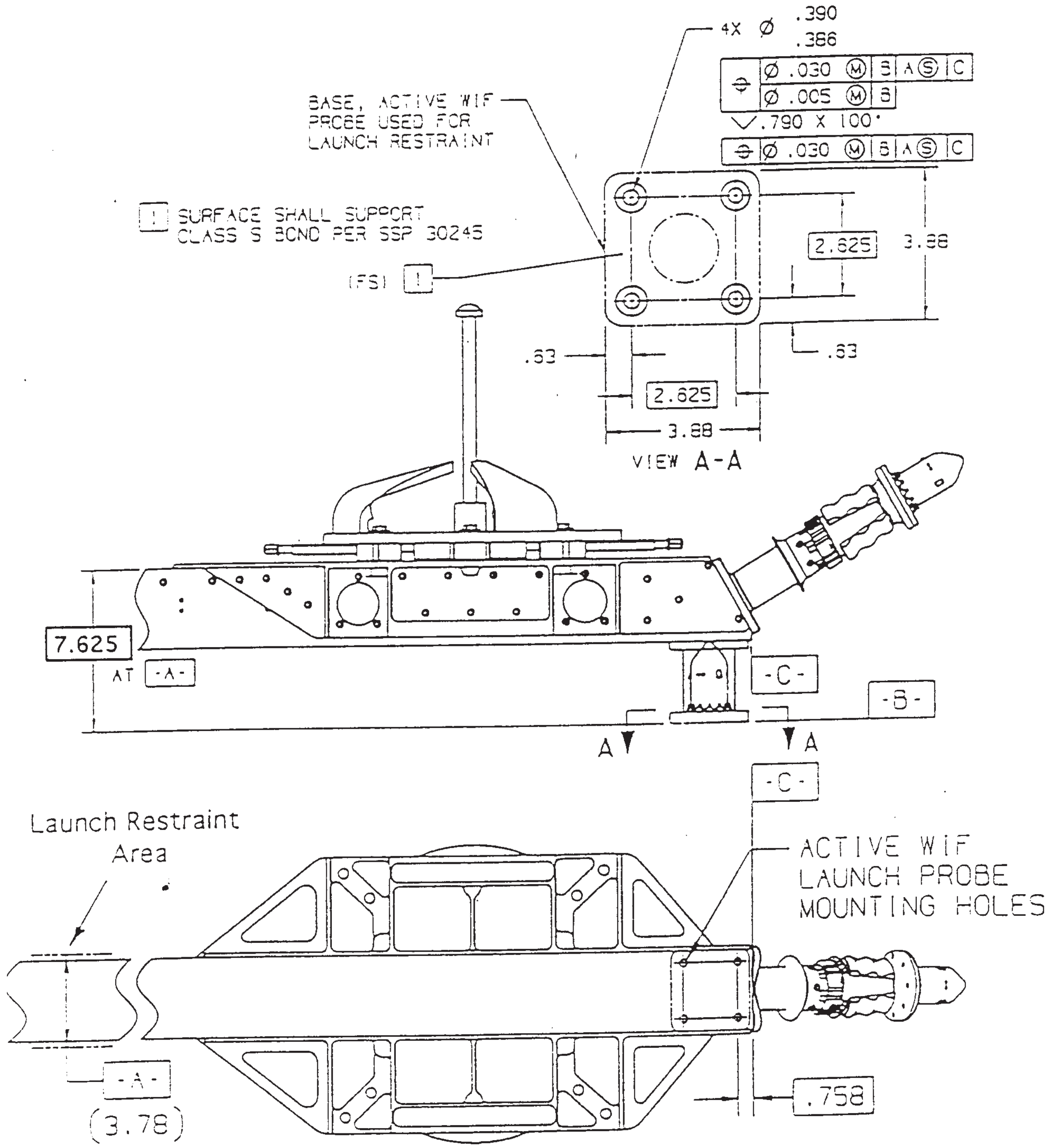


FIGURE 3.3.2.1–2 TEMPORARY EQUIPMENT RESTRAINT AID (TERA) WIF LAUNCH RESTRAINT ATTACHMENT DETAIL

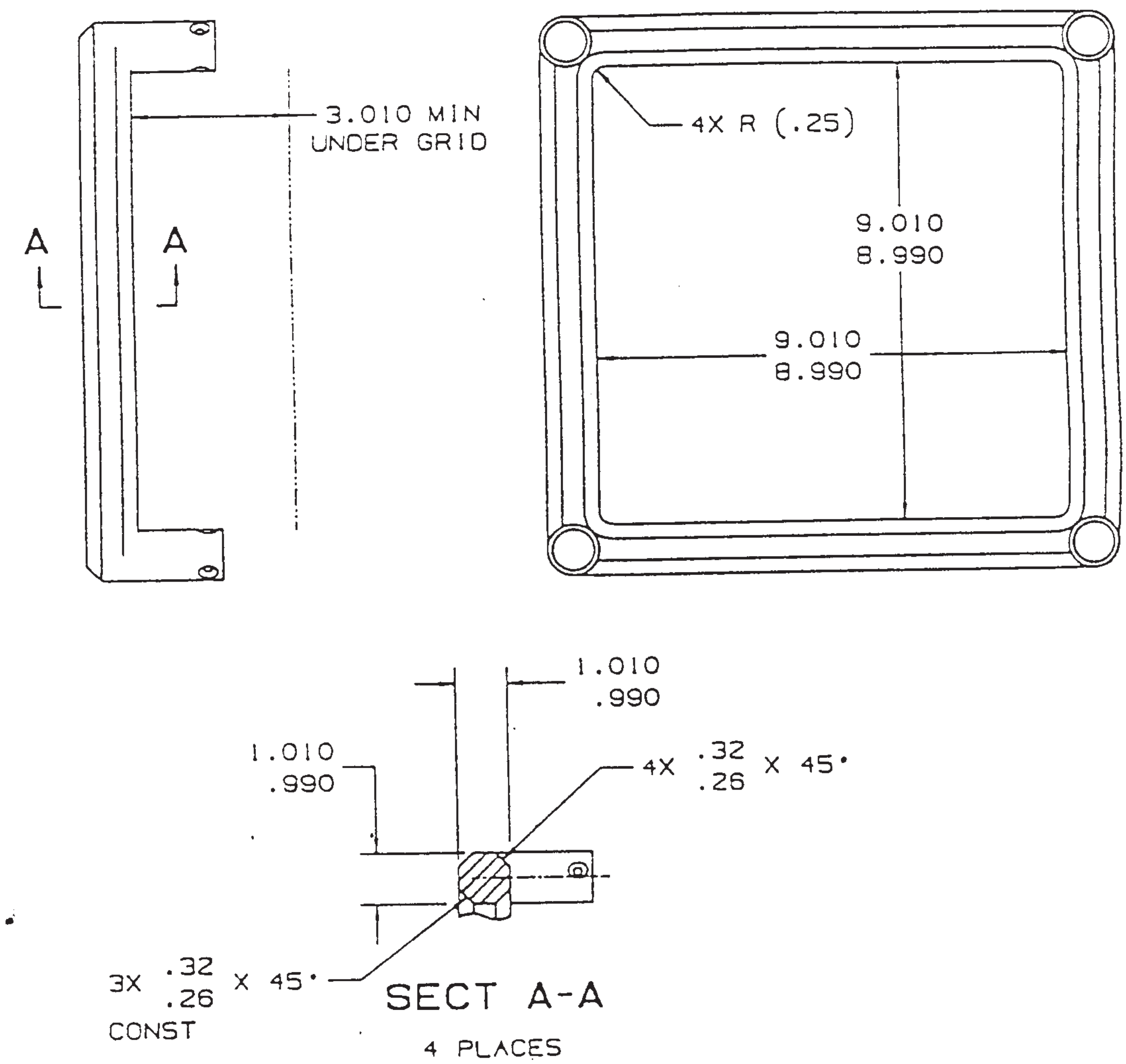


FIGURE 3.3.2.1–3 TERA ORU RESTRAINT GRID

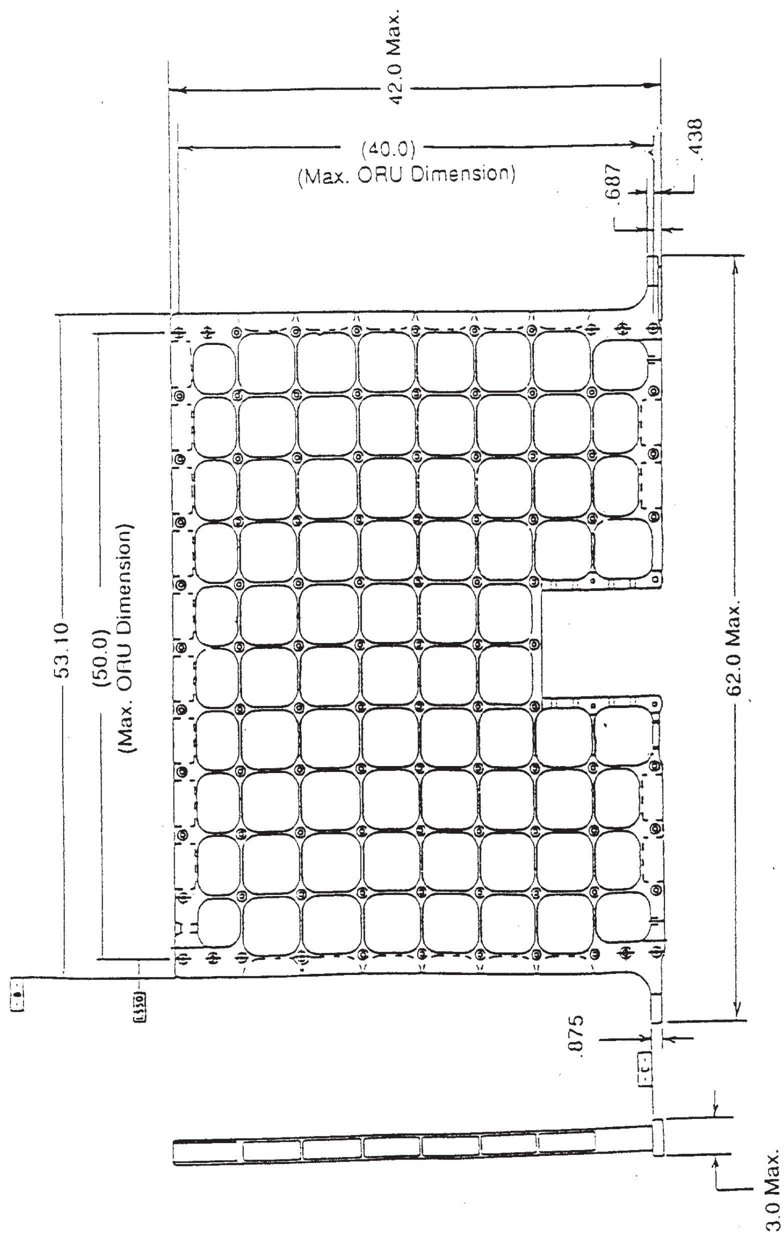


FIGURE 3.3.2.1–4 MAXIMUM CARGO PALLET ENVELOPE

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.

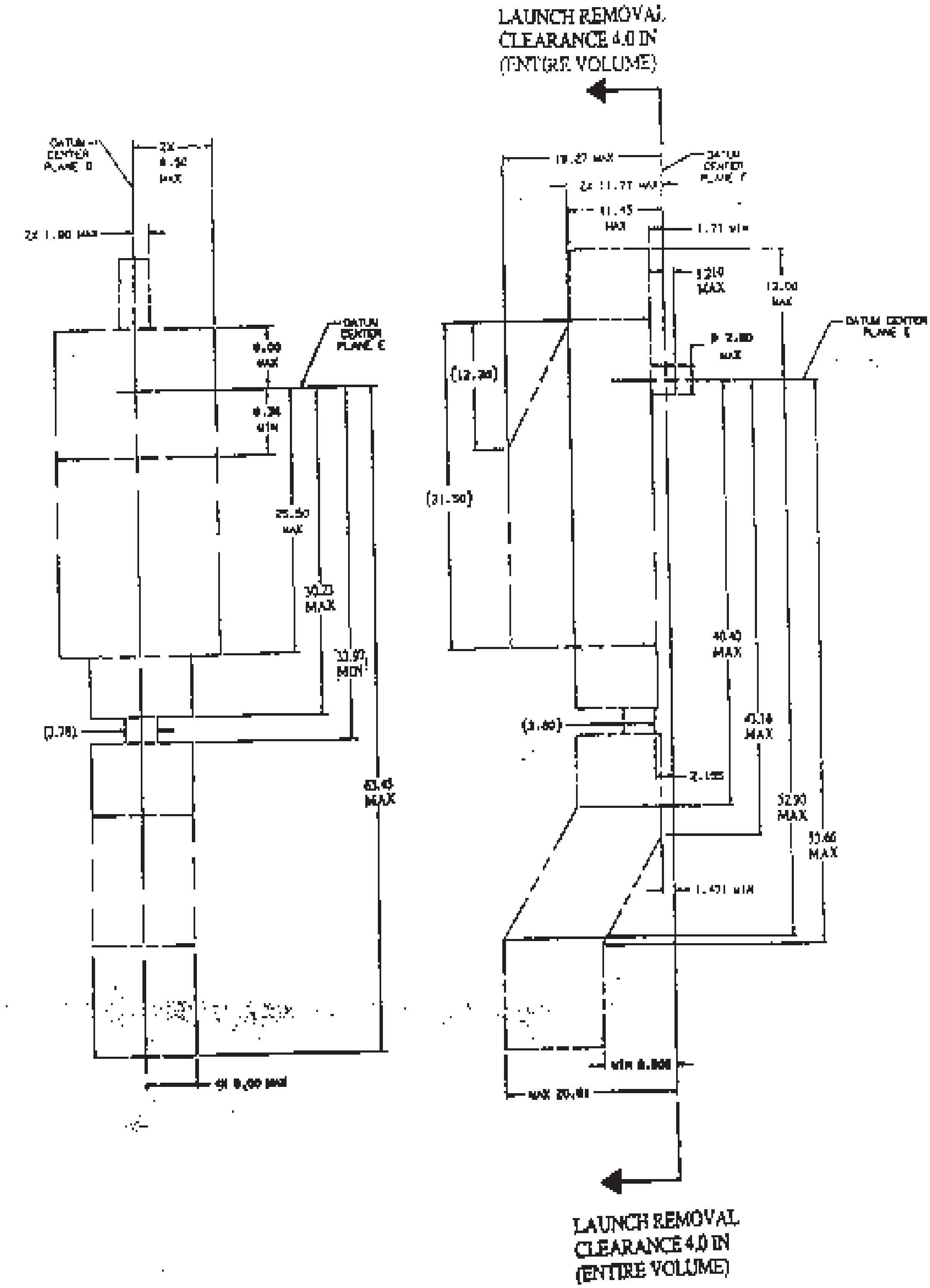


FIGURE 3.3.2.2–1 TEMPORARY EQUIPMENT RESTRAINT AID (TERA) MAXIMUM LAUNCH ENVELOPE

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 ± .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 +/– .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.

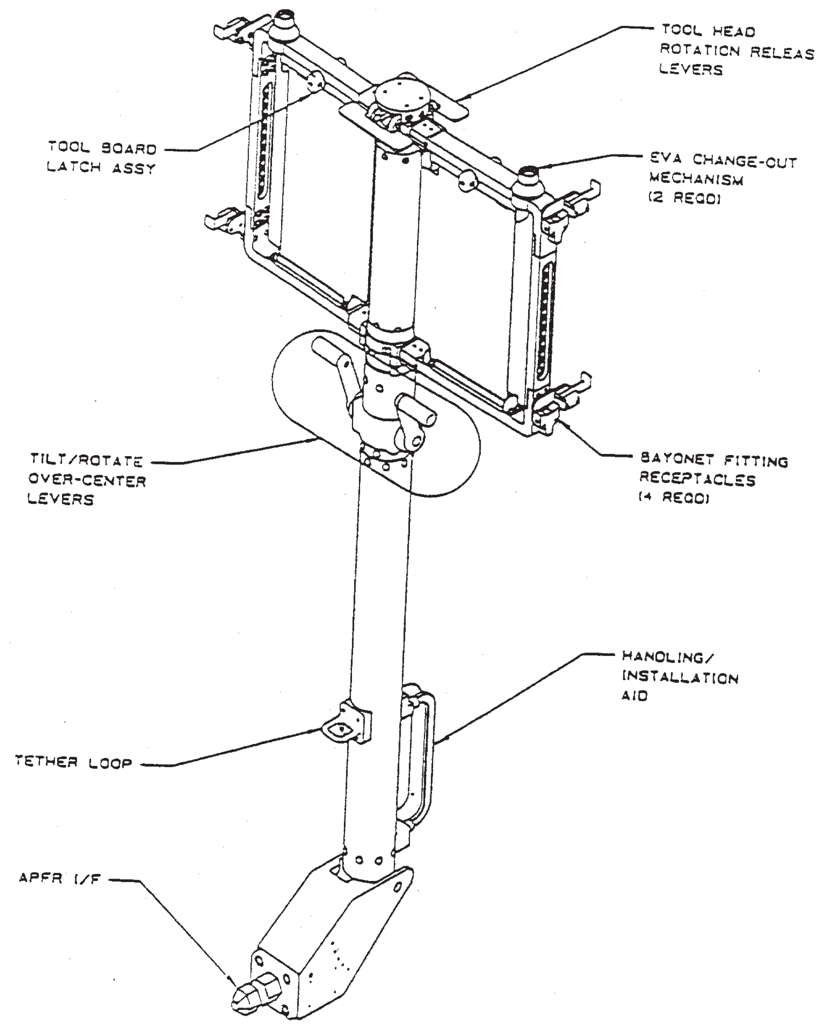


FIGURE 3.3.3–1 PORTABLE FOOT RESTRAINT WORKSTATION STANCHION (PFRWS)

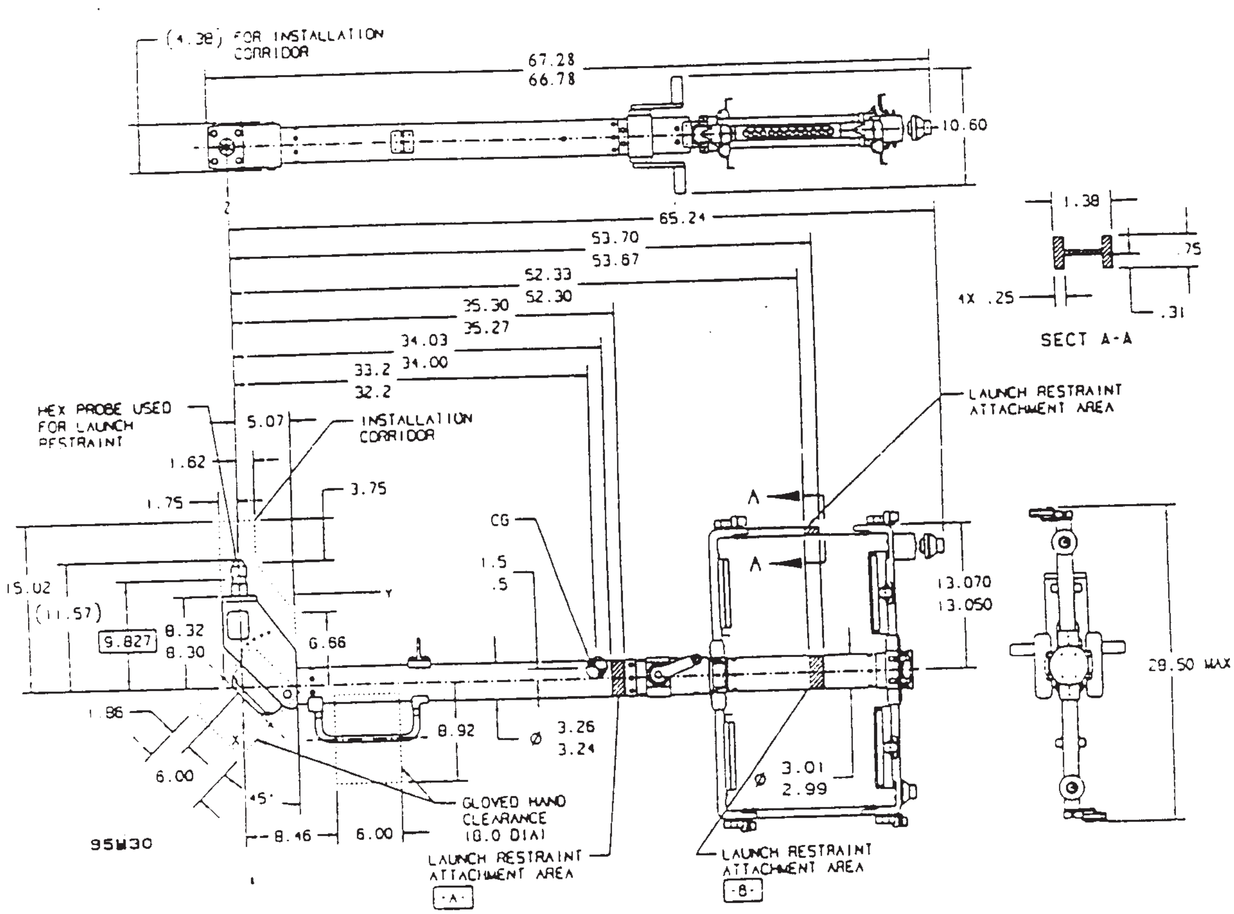
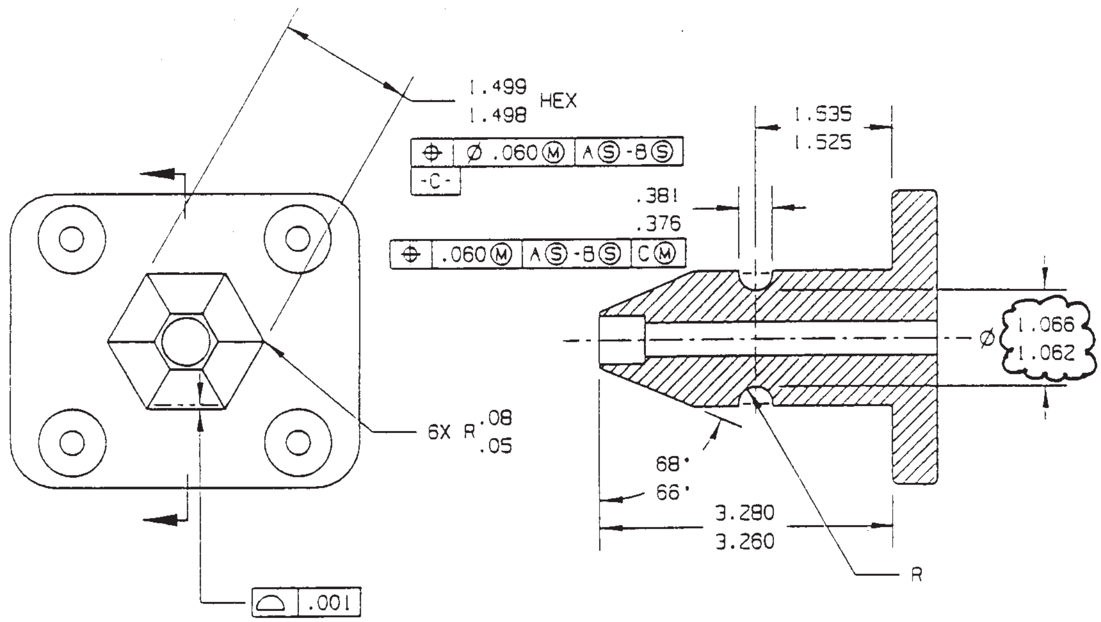


FIGURE 3.3.3.1–1 PORTABLE FOOT RESTRAINT WORKSTATION STANCHION (PFRWS) LAUNCH RESTRAINT ATTACHMENT



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

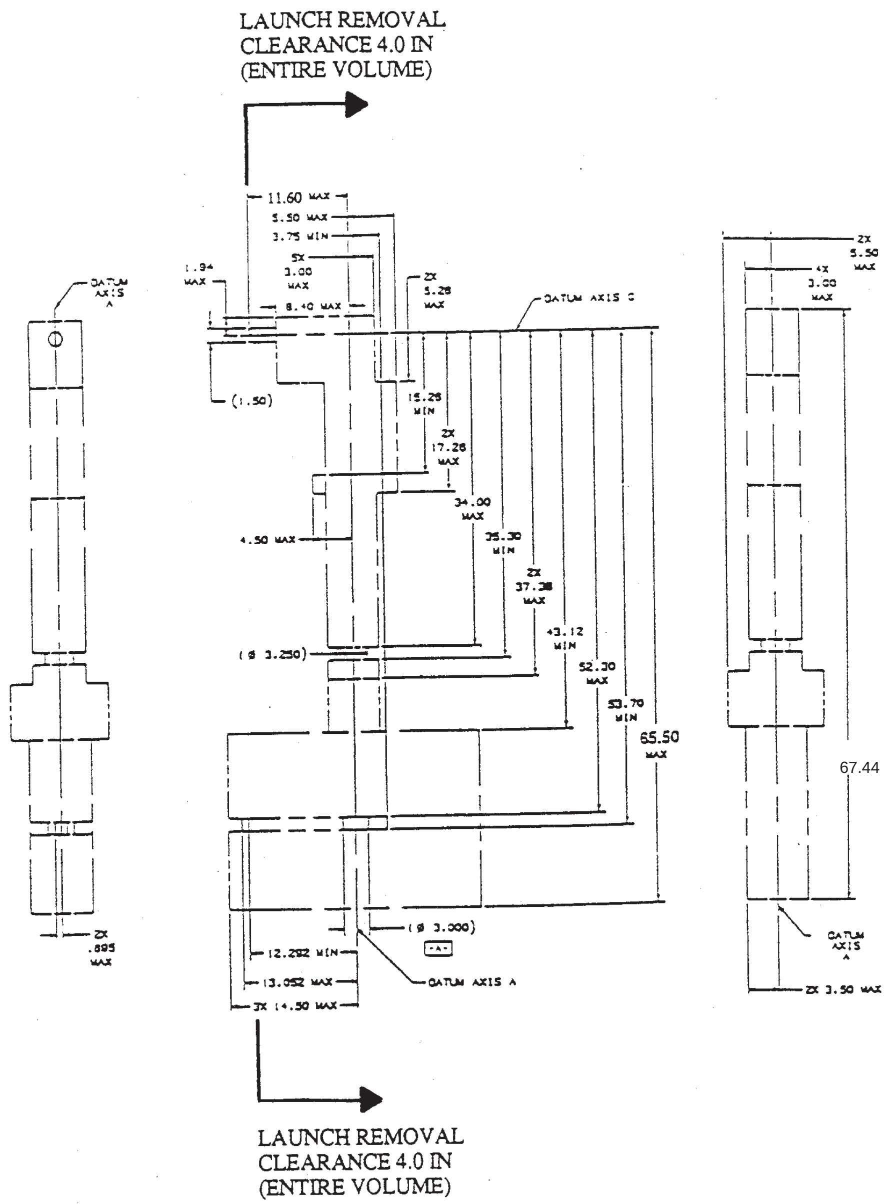


FIGURE 3.3.3.2–1 PORTABLE FOOT RESTRAINT WORKSTATION STANCHION (PFRWS) MAXIMUM LAUNCH ENVELOPE

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