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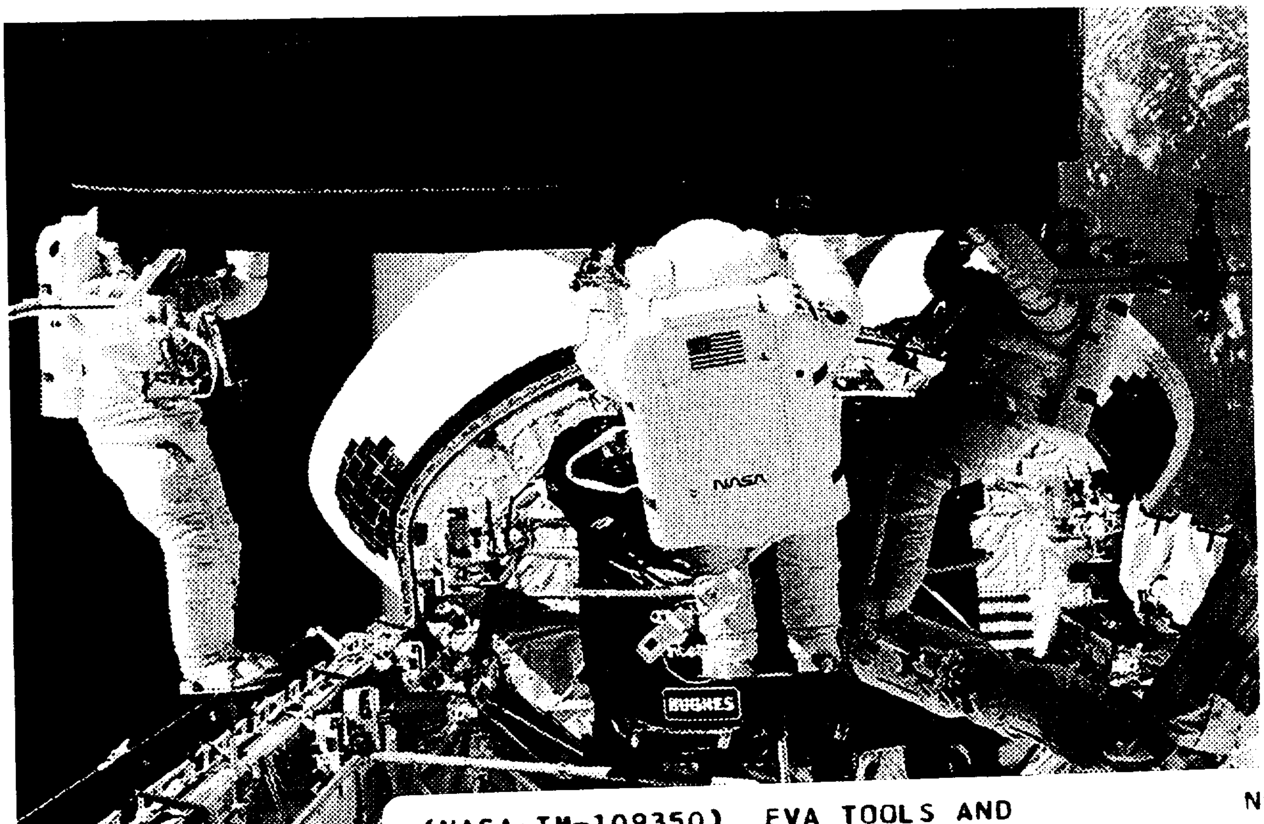
JSC-20466
Rev. B

p-7

EVA Tools and Equipment Reference Book

(Formerly EVA Catalog Tools and Equipment)



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National Aeronautics and
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Lyndon B. Johnson Space Center
Houston, Texas

November 1993

JSC-20466
Rev B

EVA Tools and Equipment Reference Book

November 1993

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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HOUSTON, TEXAS

PREFACE

Since the last publication of this document, 116 new EVA items have been added and all previous writeups have been revised. Some of the new additions were flown on the scheduled EVA missions in 1991, 1992, and 1993 (e.g., EDFE, Intelsat, and ASEM). Items flown for recent missions involving unscheduled payload EVA support are also included (GRO, UARS, ACTS/TOS, EURECA, TSS, SPARTAN). Several items have been included to update the tool inventory for Hubble Space Telescope maintenance. Data from the previous edition have also been updated and expanded, especially for part numbers, load ratings, availability, and operational use applications. Metric dimensions are now included for each drawing. Changes to previous writeups are indicated with boldface type.

Comments and suggestions from a user survey were incorporated into this revision. The format of each tool description remains essentially unchanged except for better standardization. The overall sequencing of the equipment descriptions has, however, been changed from simple alphabetic order to one based upon availability and grouped alphabetically in separate sections. Tool titles are now based upon the type of tool to make each item easier to locate. For example, what was "waist tether" is now "tether, waist" and "adjustable wrench" is now "wrench, adjustable." Hopefully, this is a more logical means of reference. The appendix has been expanded to include additional indexes with page numbers to aid in locating an individual writeup.

For insight into current and proposed space station EVA equipment, a separate section has been created. It lists existing GFE tools baselined for station use. It also describes the new hardware being developed to suit unique station requirements. Though soon to be superceded by other documents, the EVAS ACD is the controlling document for official station EVA tools and takes precedence over this catalog. EVA designers and planners should refer to other documents for updates to the list of station EVA tools and equipment.

Because of the many changes, the previous edition of this document (JSC–20466, rev A, April 1989) is now obsolete. A separate document, JSC–22976, Servicing Equipment Catalog, can be referred to for information on orbiter to payload interface hardware. It generally complements the EVA reference book, but JSC–20466 is more reliable when conflicting information is presented. Users must remember that neither document should be used except as a general reference. Up to date engineering data must be obtained from the technical engineer responsible for the hardware.

In an effort to expand distribution of the EVA equipment data, simplify and speed the rate of information update, and take advantage of new technology, the information has been converted to computer format on Interleaf. It will soon be available to users on a computer network. The computerized revision will have all the data found in the paper version except the photograph images (which require excessive memory and slow down data access). It will feature sort and search functions to allow rapid data retrieval. Users will have read–only privileges, but may print out needed text and graphics.

Additional hard copies of JSC–20466 can be obtained directly from the book manager or through the JSC payload customer service center at 713–483–3355.

ACKNOWLEDGEMENTS

The assistance of Lockheed Engineering and Science Corporation and Rockwell Space Operations Company, Integrated Documentation Support Division is greatly appreciated. In addition to those individuals who worked on the previous editions, the following contractor support personnel have made this edition possible.

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INTRODUCTION

A wide range of groups should find this document useful in the pursuit of EVA hardware information. Designers can **follow** the construction of recommended items based on existing hardware. Payload customers may be able to take advantage of tools presently in NASA inventory and save the expense of "reinventing the wheel." Crews and flight controllers at JSC can use the information as a basic reference and training guide. Users should be aware that while every reasonable effort has been made to provide accurate data, specific technical information, **applicability to new users,** and availability should be obtained from those persons listed as contacts for each item.

Those who wish to design new EVA equipment should refer to System Description and Design Data–EVA, appendix 7 of NSTS 07700, volume XIV, **and NASA STD 3000 Manned Systems Integration Standards**. These documents contain requirements and guidelines for approved EVA tool design practices.

This document contains a mixture of tools and equipment used throughout the space shuttle–based EVA program. Promising items which have reached the prototype stage of development are also included, but should not be considered certified ready for flight. Each item is described with a photo, a written discussion, technical specifications, dimensional drawings, and points of contact for additional information. Numbers on the upper left–hand corner of each photo may be used to order specific pictures from NASA and contractor photo libraries. Points of contact have been classified as either operational **or** technical. An operational contact is **an engineer from JSC Mission Operations Directorate who is** familiar with the basic function and on–orbit use of the tool. A technical contact would be the best source of detailed technical specifications and is typically the NASA subsystem manager. The technical information table for each item uses the following terms to describe the availability or status of each hardware item:

Standard – Flown on every mission as standard manifest

Flight specific – Potentially available for flight, not flown every mission **(flight certification cannot be guaranteed and recertification may be required)**

Reference only – Item no longer **in active inventory or not recommended for future use, some items may be too application–specific for general use**

Developmental – In the prototype stage only and not yet available for flight

The current availability **and certification** of any flight–specific tool should be verified with the technical point of contact. Those tools built **and fit checked** for Hubble Space Telescope maintenance are program dedicated and are not available to other customers. Other customers may have identical tools built from the existing, already certified designs **as an optional service**.

Comments or questions regarding the format or content are welcome and may be submitted using the **user questionnaire** in appendix A.

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CONTENTS

STANDARD/FLIGHT SPECIFIC

This section is reserved for items which are either currently flight certified or were certified for previous missions. Some items are in active inventory, while others are not available and must be procured specially for new applications. Availability is also restricted by the day–to–day utilization of a limited inventory which must simultaneously cover launch vehicle processing and a variety of ground test events. Since the flight certification and availability cannot be guaranteed for future applications, customers and users must always consult the NASA subsystem manager for each item.

Some items are constrained because the Hubble Space Telescope program has sponsored the development and fabrication of numerous items that were fit checked to the telescope prior to its deployment. Since these items are now irreplaceable, they are reserved for exclusive use for HST maintenance missions. This restriction is flagged in the technical table of each tool description. New users can have additional hardware built to the existing designs. Again, users must consult the NASA subsystem manager for the availability of each item.

The intention of this section is to describe the tools and equipment that may be available to users to minimize costs before seeking to develop new items. Ideally, hardware that is already onboard as part of the standard manifest should be relied upon. If this is inadequate, the next option may involve off–the–shelf flight unique hardware to be used within its existing certification. Upgrades to the certification of existing hardware by retest or analysis are preferred before considering requests for physical modifications. If the existing "as–is" inventory is still inadequate, modifications should be pursued before the costly development of new hardware.

It may be inappropriate to apply any item from this document to each new application. Since STS EVA has historically been targeted for infrequent contingency support, many items are not optimized for user friendliness or to minimize utilization overhead. Flight experience with individual items is generally limited and may not cover new applications. Even though the design requirements found in NSTS–07700 Volume XIV Appendix 7 and NASA–STD–3000 provide guidelines for approved EVA tool design practices, the combined expertise of JSC Mission Operations Directorate and Crew and Thermal Systems Division engineers should be relied upon for an exact determination of tool design and use requirements.

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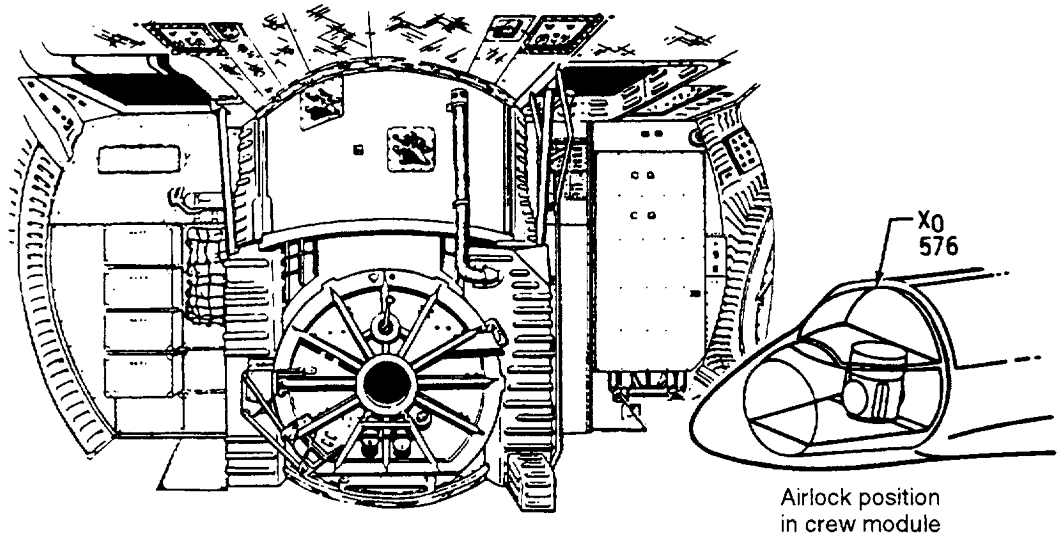
AIRLOCK



OVERVIEW

The primary purpose of the airlock is to eliminate the need for cabin decompression for EVA. **It** provides a means of transferring between the crew module and payload bay **pressurized modules or the orbiter exterior**. The baseline airlock location is inside the middeck compartment, allowing maximum use of cargo bay volume.

OPERATIONAL COMMENTS

In addition to being a compartment which can be depressurized and repressurized to accommodate EVA access to the payload bay, the airlock supports EVA preparation and post–EVA activities by providing

- Handholds and restraints for crewmember translation and position maintenance in zero gravity. **The ceiling–mounted foot restraint is no longer standard equipment, but can be manifested as a crew option.**
- Displays and controls for all airlock functions.
- Mounting provisions for up to **four** extravehicular mobility units (EMU's). Two–EMU stowage is standard. **When the third EMU is flown, extra cabin stowage volume can be provided with a large palletized stowage bag on the airlock floor.**
- Two umbilicals for EMU servicing. Each umbilical provides cooling water, high pressure oxygen, power for battery recharge, power for EMU operation, and hardline communication.

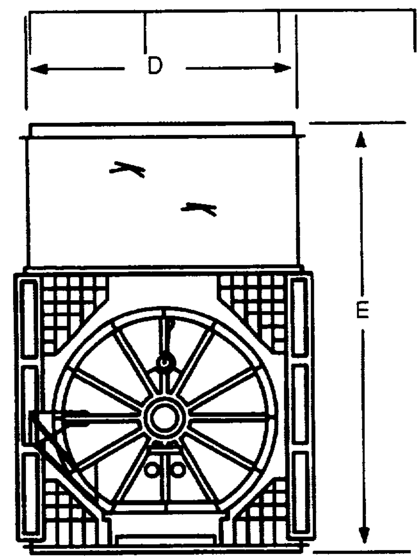
CONTACTS

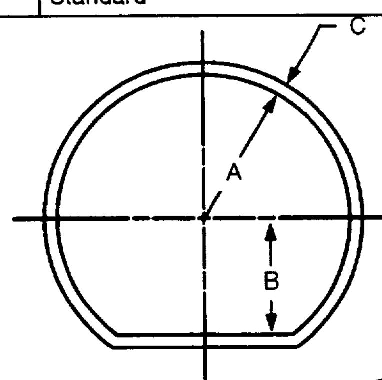
Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical (General): H. A. Rotter, NASA/EC3, (713) 483–9249
Technical (Structural): **K. Edelstein, NASA/ES, (713) 483–8850**
Technical (ECLSS): **M. Hoy, NASA/EC3, (713) 483–6208**

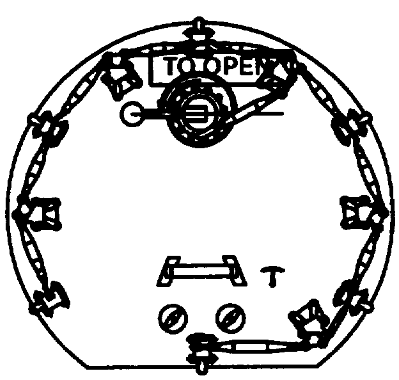
AIRLOCK

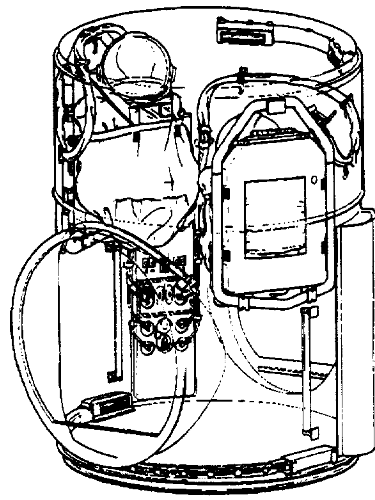
Technical Information	
Part number	**M072–643300 (ECLSS installation)** **V070–643200 (ECLSS line routing)** **V075–643335 (air duct strap)** **SAD32102603 (internal Velcro)**
Weight	825 lb (empty total), 72 lb (per hatch)
Material/ construction	**Upper section aluminum honeycomb**
Internal free volume	150 ft^3 (no EMU's) 130 ft^3 (two EMU's) 120 ft^3 (three EMU's)
Load rating	300–lb **wall hang weight limit** **187–lb bonded handrails** **587–lb safety tether point** 68–80 in–lb EMU mount bolt torque
Temperature range	
Quantity flown	**One**
Stowage	**Middeck**
Usable umbilical length	10 ft
Availability	Standard

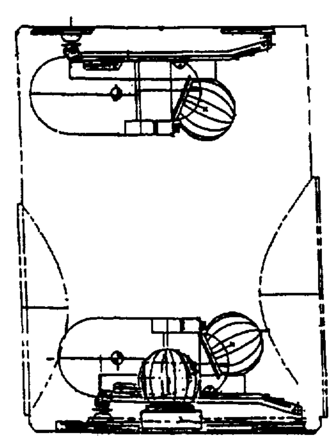
Dimensional Data		
	inches	cm
A	20.00	50.80
B	16.00	40.64
C	1.75	4.45
D	63.00 (ID)	160.02
E	83.00	210.82





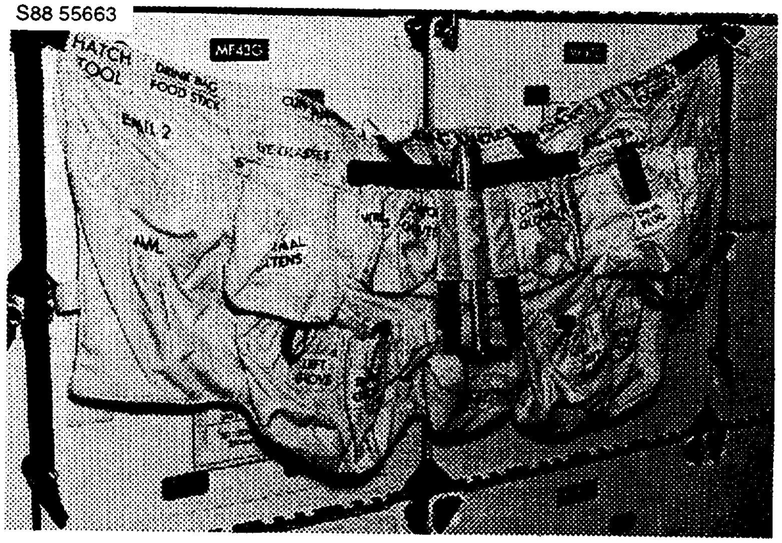






BAG, AIRLOCK STOWAGE

S88 55663



OVERVIEW

The airlock stowage bag is a Nomex bag used to store and transfer items used in EVA preparation activities. When in use, it may be attached **to the forward middeck lockers by pip pins through strap eyelets or** inside the airlock over the inner hatch by Velcro straps and adjustable straps with small snap hooks. The airlock bag has labeled, elasticized pockets of various sizes with Velcro strap closures.

OPERATIONAL COMMENTS

The airlock bag **was designed so** that each crewmember's personal items are on **separate** sides and within reach **of each** crewmember **in the airlock after donning** the upper torso of the extravehicular mobility unit (EMU). The back of the airlock bag has several large pockets for stowing additional equipment. **If used in the airlock,** this bag and its contents are removed from the airlock prior to depress to vacuum.

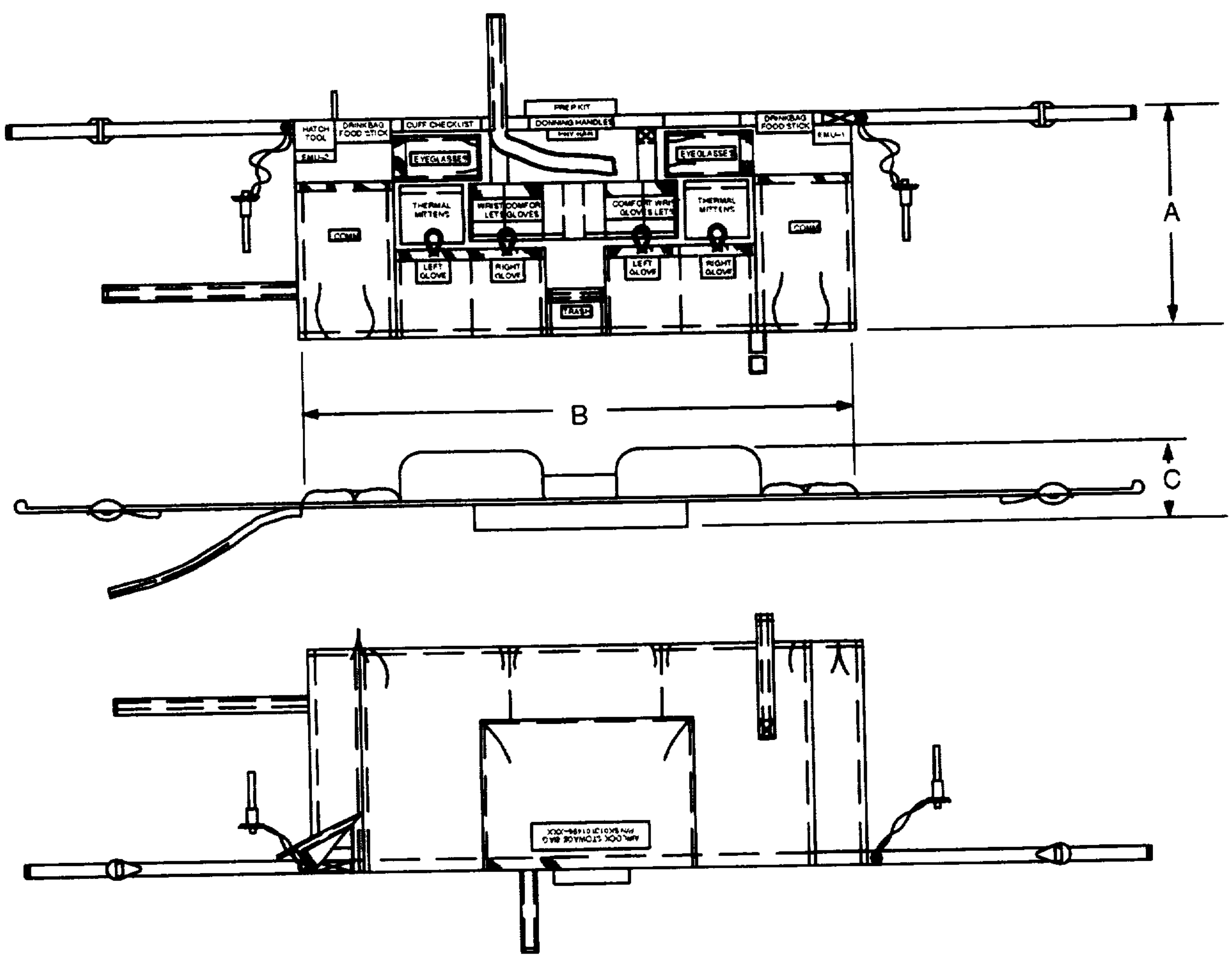
CONTACTS

Operational: **R. K. Fullerton**, NASA/DF42, (713) 483–**2589**
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

BAG, AIRLOCK STOWAGE

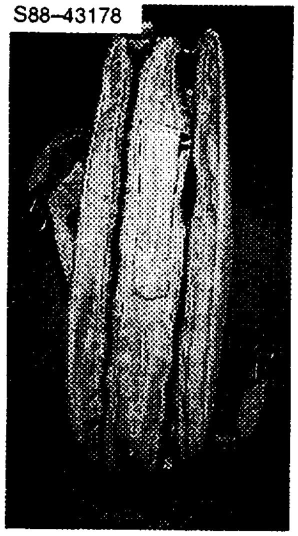
Technical Information	
Part number	SKD13101496–306
Weight	1.77 lb
Material/ construction	Nomex
Load rating	
Temperature range	
Contents during launch	Two pairs of EV glasses (if required), one EMU prep kit, donning handles, two drink bags, one drink bag syringe, one pry bar, **two SOP checkout fixtures (std), one SOP c/o fixture (if EMU3 flown), no SCOF (if 4 EMU's flown)**
Quantity flown	One
Stowage	Volume H locker
Availability	Standard

Dimensional Data		
	inches	cm
A	14.25	36.20
B	37.00	93.98
C	7.00	17.78



BAG, CENTERLINE LATCH TOOL

S88–43178



S83–42156

OVERVIEW

The centerline latch tool bag is used to store the centerline latch tools. It is equipped with two hooks for tether attachment to an EVA handrail near the worksite.

OPERATIONAL COMMENTS

The two–pocket bag is part of the normally manifested orbiter equipment and is stowed in the port provisions stowage assembly (PSA). **A pair of two– pocket bags or** the four–pocket bag is flown for the first two flights of a new orbiter. **The centerline latch tools are stowed in these bags with the rear ladder up for use as tether points after the bag is opened.**

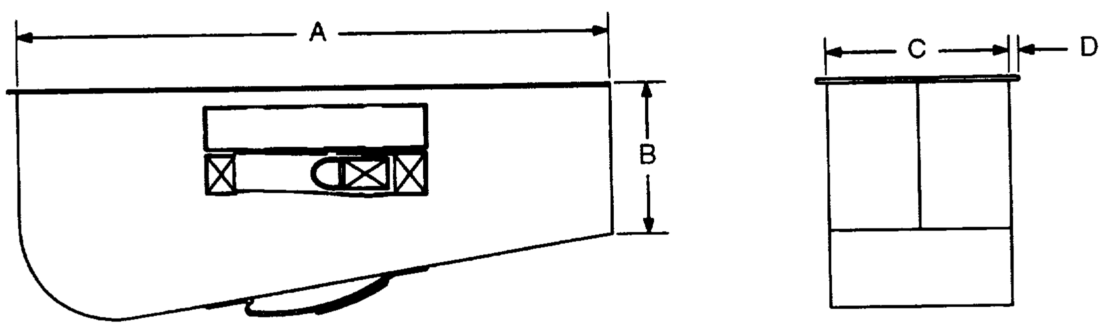
CONTACTS

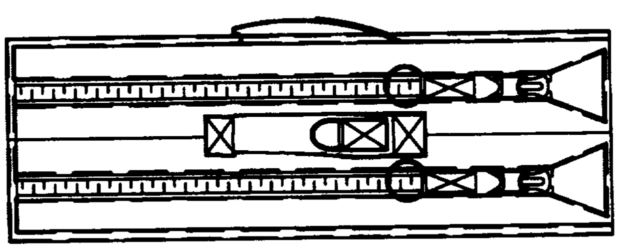
Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

BAG, CENTERLINE LATCH TOOL

Technical Information	
Part number	**V633–669310–037, SDD33103440–301 (two pockets V633–669310–001 (four pockets)**
Weight	2.7 lb (**two** pockets)
Material/ construction	Nomex fabric, reinforced with Armalon
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	One **(std)**
Stowage	Port PSA (std)
Availability	Standard

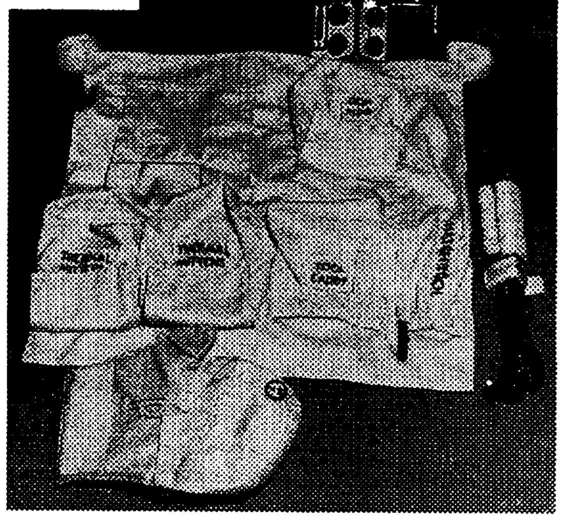
Dimensional Data		
	inches	cm
A	19.50	49.53
B	5.00	12.70
C	6.12	15.54
D	0.25	0.64





BAG, EVA

S84–29998



OVERVIEW

The EVA bag is used to stow various items in the airlock for possible use during EVA. It is fabricated from Nomex material and has snap and Velcro attachment points. A 27–1/2–in. Velcro strap is coiled up at each top corner of the bag.

OPERATIONAL COMMENTS

The EVA bag contains items on both sides of the main fabric base. Pockets on one side provide stowage for a camera, thermal mittens, a tool caddy, a display and control module (DCM) **water line** plug, and a set of contingency hatch tools. The reverse side has only one pocket, which holds EVA cue cards **or tools**. The crewmembers can use the Velcro straps to tether the bag where necessary. This bag is installed inside the airlock over the outer hatch during the EVA preparation period **and remains inside throughout the EVA**. It is fixed to the airlock wall by four push–on snaps.

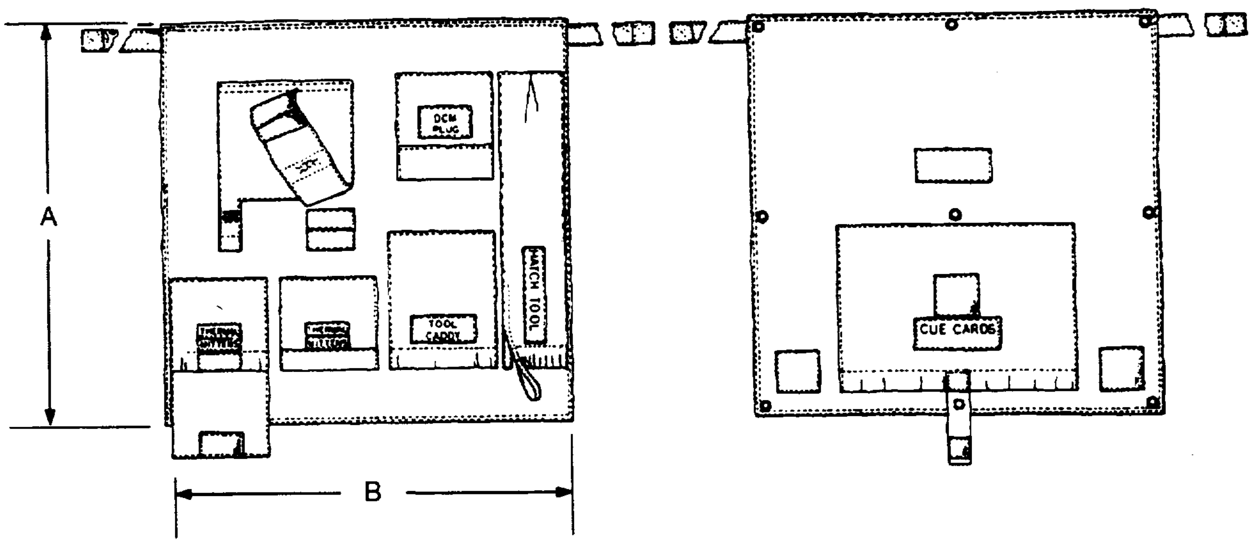
CONTACTS

Operational: **R. K. Fullerton,** NASA/DF42, (713) 483–2589
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

BAG, EVA

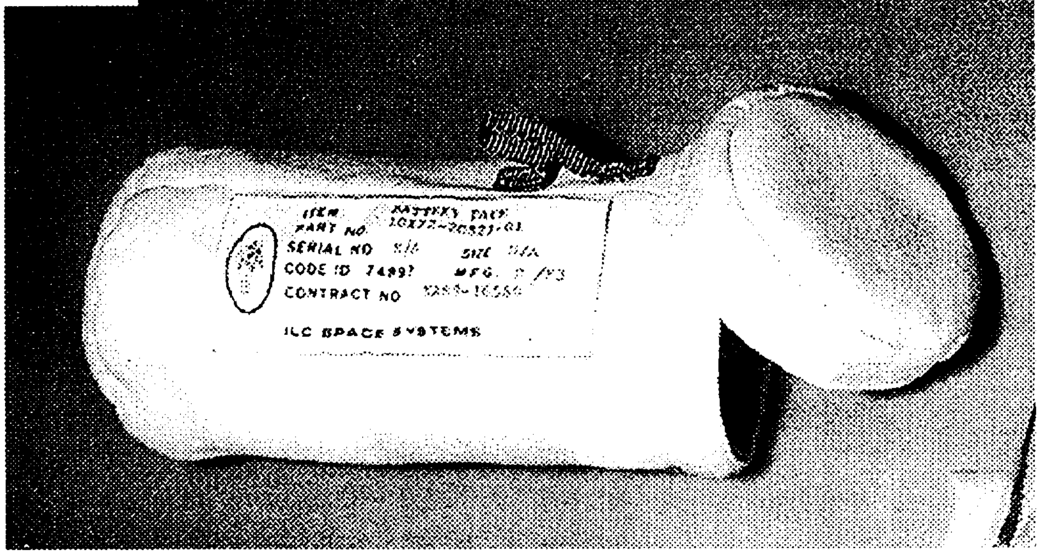
Technical Information	
Part number	10108–10081–01
Weight	0.72 lb
Material/ construction	Nomex
Load rating	
Temperature range	
Quantity flown	One
Stowage	Volume H locker
Availability	Standard

Dimensional Data		
	inches	cm
A	19.5	49.53
B	19.5	49.53



BAG, EVA POWER TOOL BATTERY

S83–44719



OVERVIEW

The EVA power tool battery bag is a protective **thermal garment and is used for** the storage and transfer of the EVA power tool battery to the worksite. **The lid is secured by Velcro and has a slot so that the battery tether point is accessible.** Two small tabs are located on the lid to facilitate opening the bag.

OPERATIONAL COMMENTS

The EVA power tool battery and bag are manifested together. The battery is removed from the bag by pulling open the lid. The battery is then inserted in the back of the EVA power tool and the bag is stowed. **The Teflon inner liner protects against direct shorts across the battery terminals.**

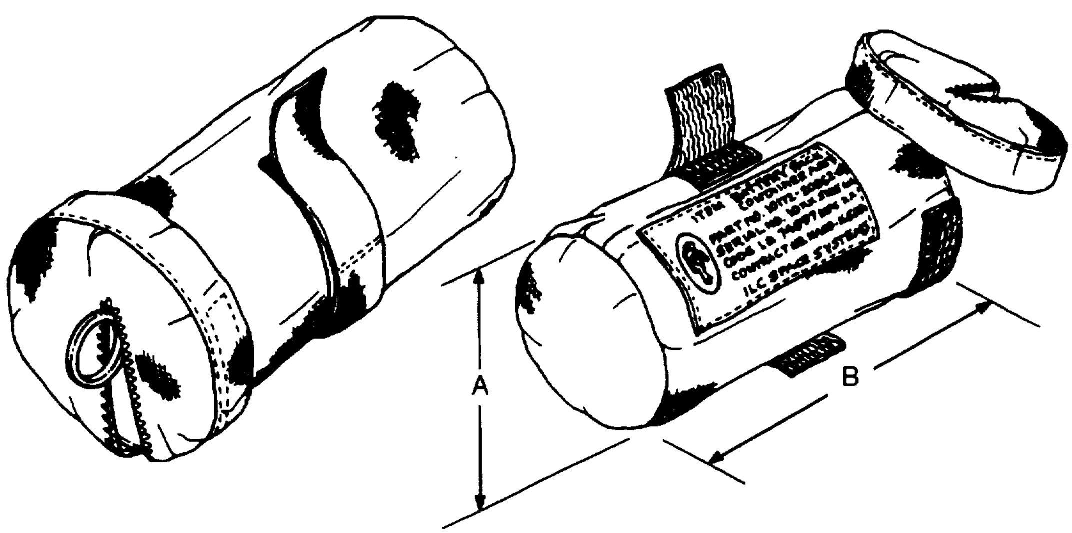
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1775
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

BAG, EVA POWER TOOL BATTERY

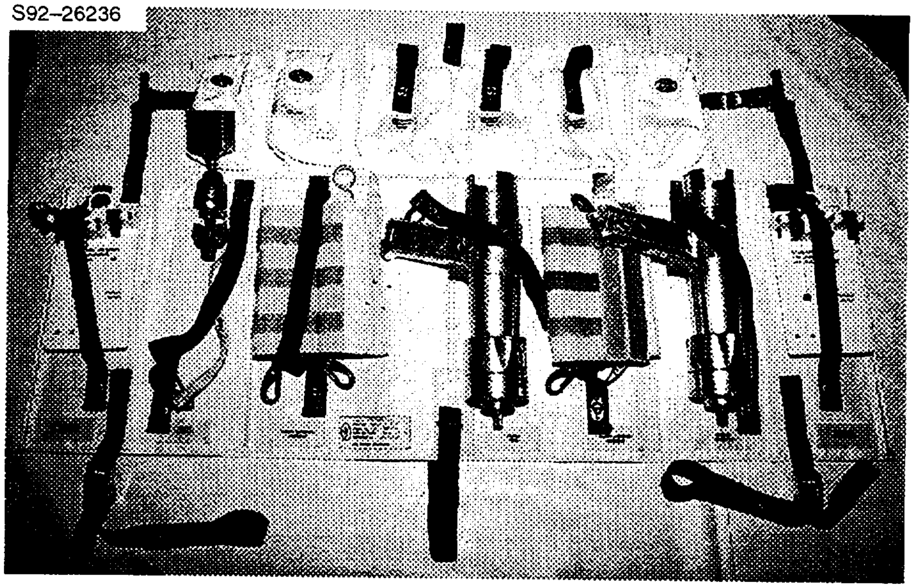
Technical Information	
Part number	10181–20025–02 10181–10037–02
Weight	**0.13** lb
Material/ construction	**Ortho outer layer, multilayer insulation, Teflon fabric inner layer** Velcro
Load rating	
Temperature range	–150° to +250° F (operational)
Quantity flown	One per battery
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	2.75	6.99
B	5.50	13.97



BAG, HST TOOL

S92–26236



OVERVIEW

The Hubble Space Telescope (HST) tool bag is a restraint for tools inside the orbiter airlock during EVA. It was designed specifically to hold selected HST tools, but can be and has been used for items related to other missions. It consists of a fabric panel with pockets, bayonet receptacles, and straps for equipment restraint. The straps have been customized to hold the HST power tool, tool caddies, and the small HST tool boards. Pockets are provided for power tool batteries and equipment tethers. Additional straps, buckles, and hooks allow the bag to be attached to the airlock wall. It is stowed empty in a middeck locker and the tools must be added to it by the EVA crew prior to EVA.

OPERATIONAL COMMENTS

For EVA use, this bag is installed inside the airlock above the hatch leading to the middeck. The upper straps and hooks attach to the airlock wall using the fittings for the EMU umbilical retention straps. The lower straps and hooks are secured to a handrail over the hatch and are cinched tight with the cam buckles. Since the tool board/ caddy straps were customized for one configuration, they do not retain other equipment as securely. All pockets/ straps are secured by small 1/4–turn fasteners. The bayonet receptacles have a ball detent that helps hold items in place, but it is not a substitute for a properly fitting strap or equipment tether to prevent loss overboard.

This bag was first flown on STS–31 to support the HST deployment mission. It has since been used on STS–37, STS–49 and STS–51 for the scheduled EVA's conducted on those missions. It is being modified to support the HST maintenance mission.

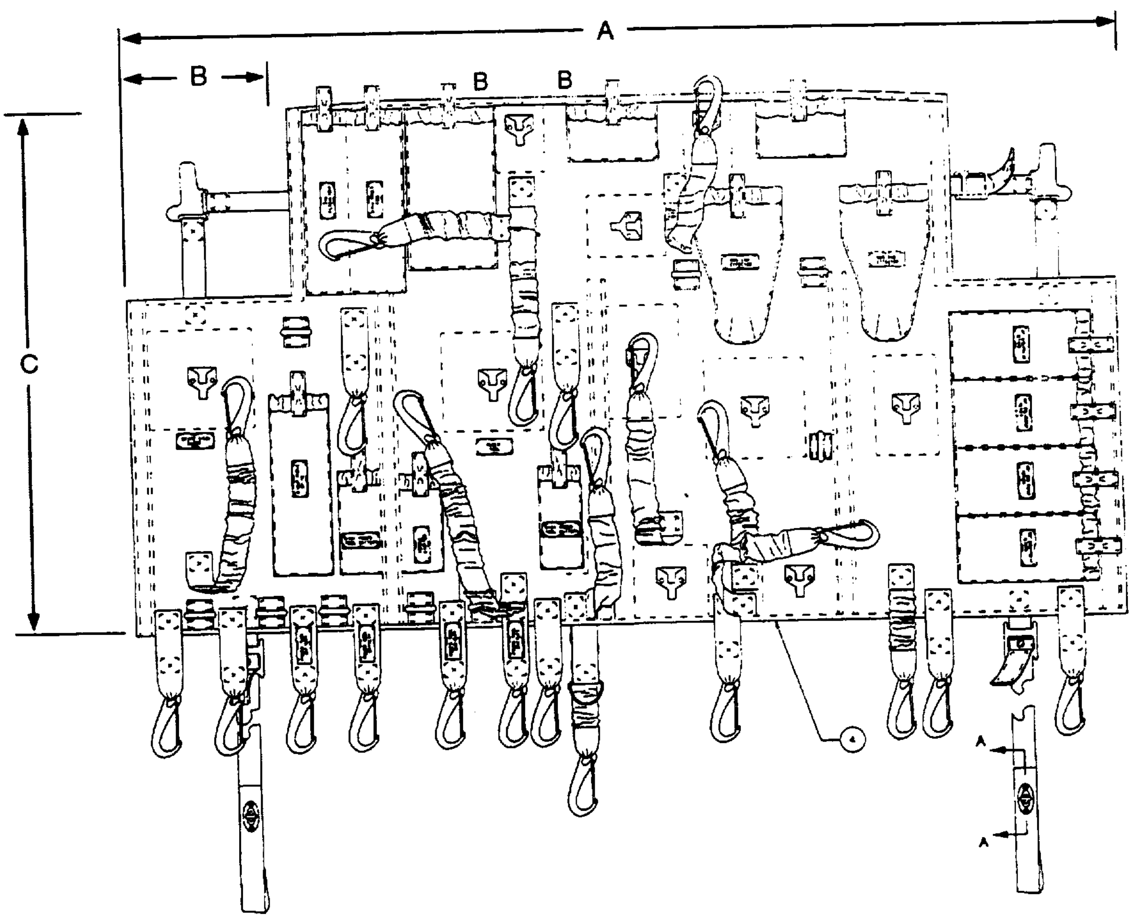
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. Marak, NASA/EC5, (713) 483–9144

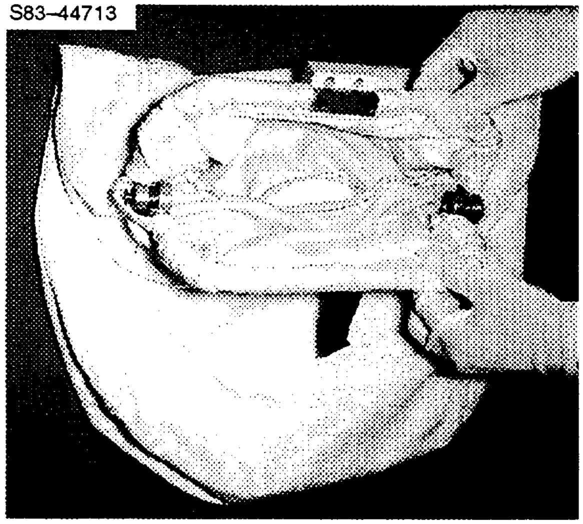
BAG, HST TOOL

Technical Information	
Part number	10181–10035–01 (original bag) SED33105530–301 (STS–61 bag)
Weight	6 lb
Material/ construction	Orthofabric, Nomex straps, aluminum/stainless mechanisms
Load rating	N/A
Temperature range	–120° to 250° F
Quantity flown	One STS–31, 37, 49, 51 (10181) One STS–61 (SED33105530)
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	39.5	100.3
B	6.5	16.5
C	26.75	67.9



BAG, LARGE TRASH



OVERVIEW

The large EVA trash bags are dual–layered containers for the stowage of tools and equipment discarded during an EVA. The bags are identical in dimensions, but differ in detail depending upon the particular needs of the mission.

OPERATIONAL COMMENTS

The 10173–20041 bag and the 10176–20157 bag (primary) both have overlapping baffles so that the bag restrains small items even when the closure is pulled open. The 10176–20157 bag has a Velcro strap **(–01) or a 1/4 turn fastener strap (–02)** on the back **that** can be wrapped around the **workstation** stanchion for stability. The 10176–20160 bag (secondary) is identical to the 10176–20157 bag without the Velcro strap and the baffle. Absence of the baffle allows insertion of large items.

The 10176–20157 bag was successfully flown on STS 51–I and restrained tool boards and other items removed from the Syncom F–3 satellite. The 10176–20160 bag was also flown on STS 51–I and contained a folded sheet of aluminum from the Syncom perigee kick motor nozzle. Both STS 51–I bags remained on top of the Leasat equipment stowage assembly for landing. The 10173–20041 bag was used for STS 41–C and STS 51–A.

All three bags are attached by means of a **mini–workstation** interface adapter pin. The attachment hardware must withstand launch loads when bags are empty and landing loads when items are stowed in the bags. **None of the bags** has a hold–open mechanism and **manual transport is not easy. An IVA bag (SEB13100134–304) known as the jettison stowage bag is always manifested, and is sometimes utilized instead of this EVA bag for contingency operations.**

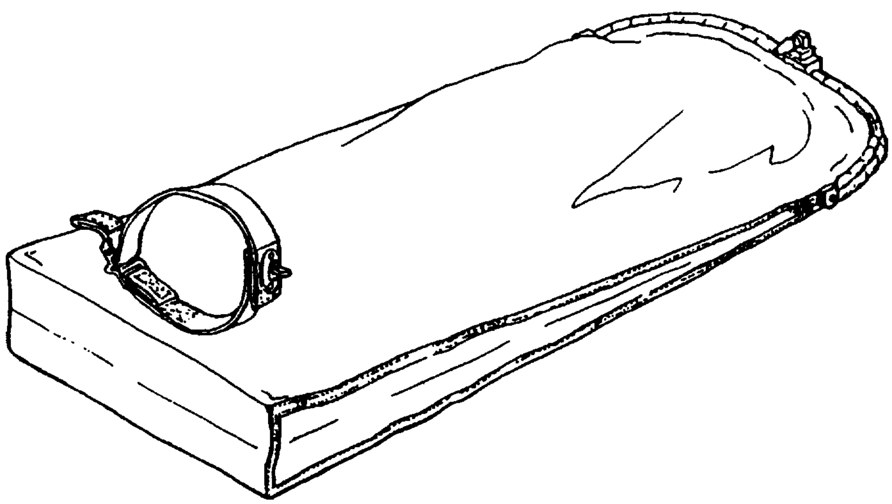
CONTACTS

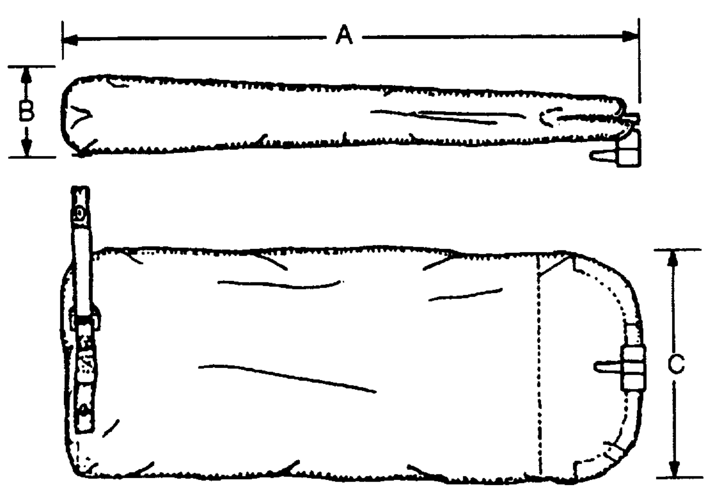
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

BAG, LARGE TRASH

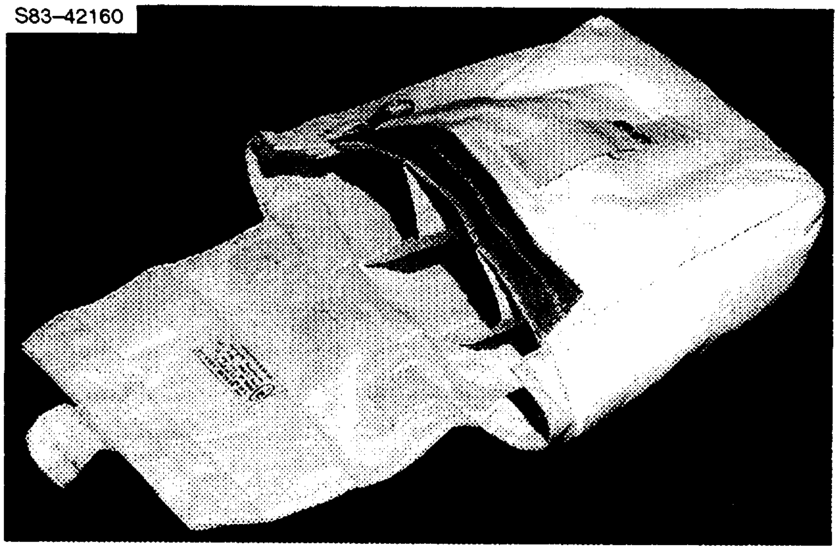
Technical Information	
Part number	10173–20041–01, 10076–20157–**01/02**, 10076–20160–01
Weight	2.2 lb
Material/ construction	Ortho and Teflon fabrics
Load rating	
Temperature range	–150° to +250° F
Maximum opening	10 in.
Quantity flown	**Two (STS 51–I), one (STS 41–C, STS 51–A and STS–61)**
Stowage	Payload bay
Availability	Flight specific

Dimensional Data		
	inches	cm
A	30.0	76.2
B	4.0	10.16
C	12.0	30.48





BAG, MMU BATTERY TRANSFER



OVERVIEW

The manned maneuvering unit (MMU) battery transfer bag is a multiple–layer insulated bag used for the **short distance manual** transfer and temporary stowage of up to three MMU batteries in the cargo bay.

OPERATIONAL COMMENTS

The MMU battery transfer bag is insulated with an alternating layup of aluminized Mylar and polyester scrim materials covered by Ortho. These protect the batteries from the effects of temperature extremes. Three separate compartments contain the batteries, and a Velcro restraint strap on each compartment keeps the batteries in the bag. A guide pull strap on one side provides one tethering point for the bag. A unidirectional snap strap can be used as a handle or as a wraparound strap for securing the bag.

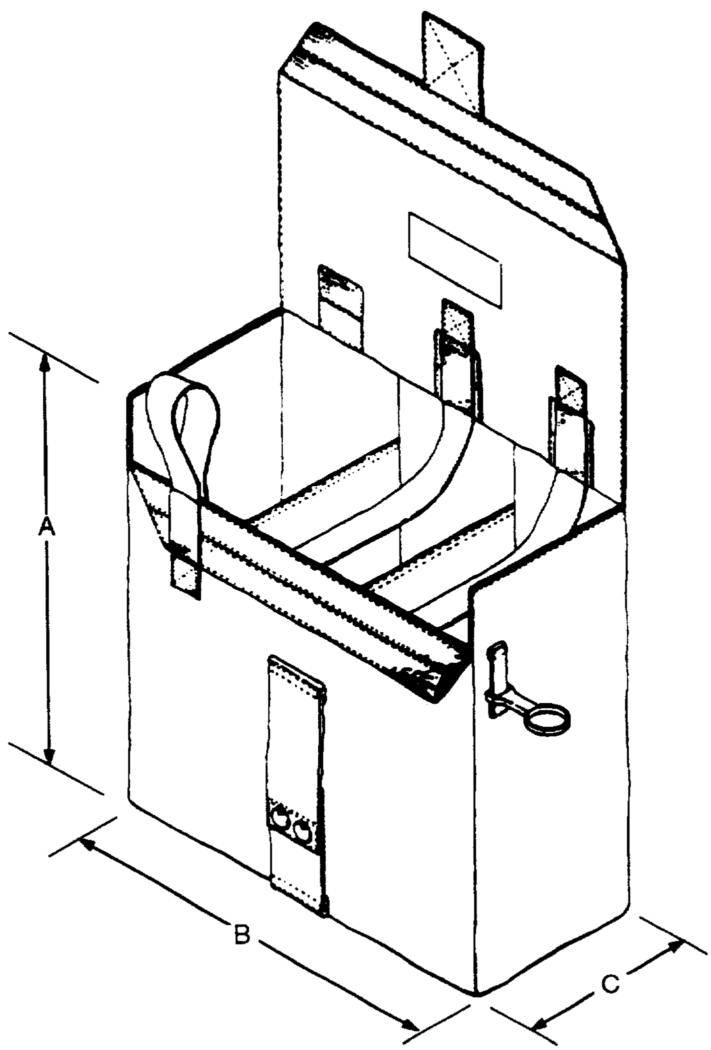
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. J. Marak, NASA/EC5, (713) 483–9114

BAG, MMU BATTERY TRANSFER

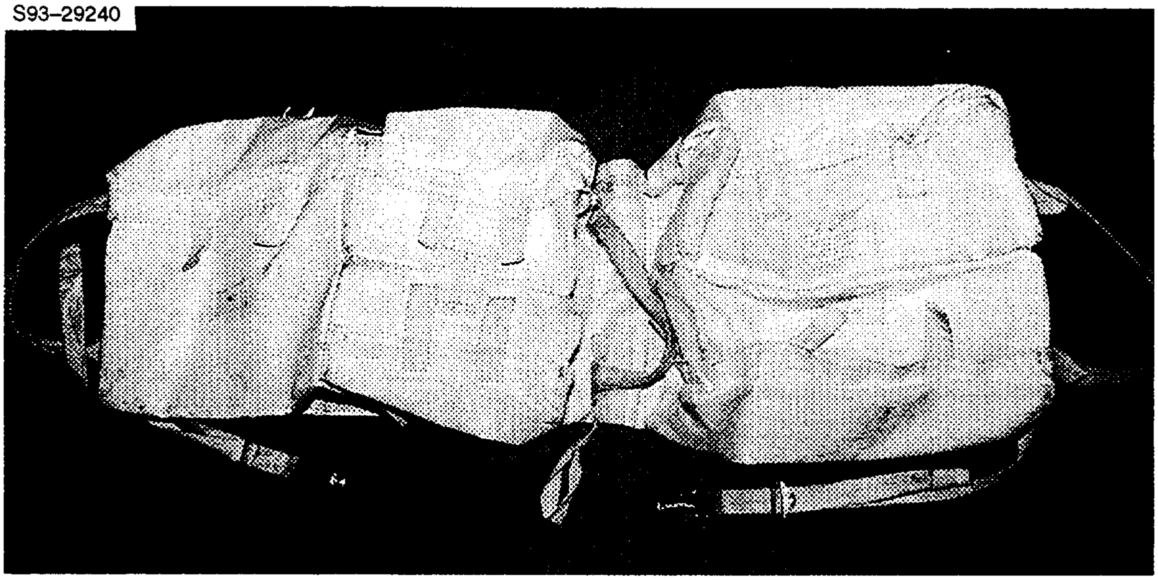
Technical Information	
Part number	10159-10003-01
Weight	1.93 lb
Material/ construction	Ortho, Teflon, aluminized Mylar, polyester scrim
Load rating	
Temperature range	
Quantity flown	One for STS 51-A
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	12.0	30.48
B	11.7	29.72
C	5.5	13.97



BAG, PSA TOOL STOWAGE

S93–29240



OVERVIEW

The provisions stowage assembly (PSA) tool stowage bag was developed to stow and transport selected essential EVA contingency tools. When both PSA tool boxes were a part of the standard manifest, the full complement of orbiter EVA tools was divided between the port and starboard boxes. On STS–35, the port box and its contents had to be demanifested to permit late vehicle repair beneath the tool box. Much of the contents of this box was stowed inside the cabin along with this bag.

OPERATIONAL COMMENTS

The PSA tool stowage bag contains five pockets for stowage of four payload retention devices, the rope reel, the large cable cutter, and the external tank (ET) door latch tool. Two of the payload retention devices were extra for flight–unique payload tasks. The bag and its tools were stowed separately in the middeck volume G locker. The bag has straps, buckles, and french hooks for restraint on the airlock wall and transport to the worksite.

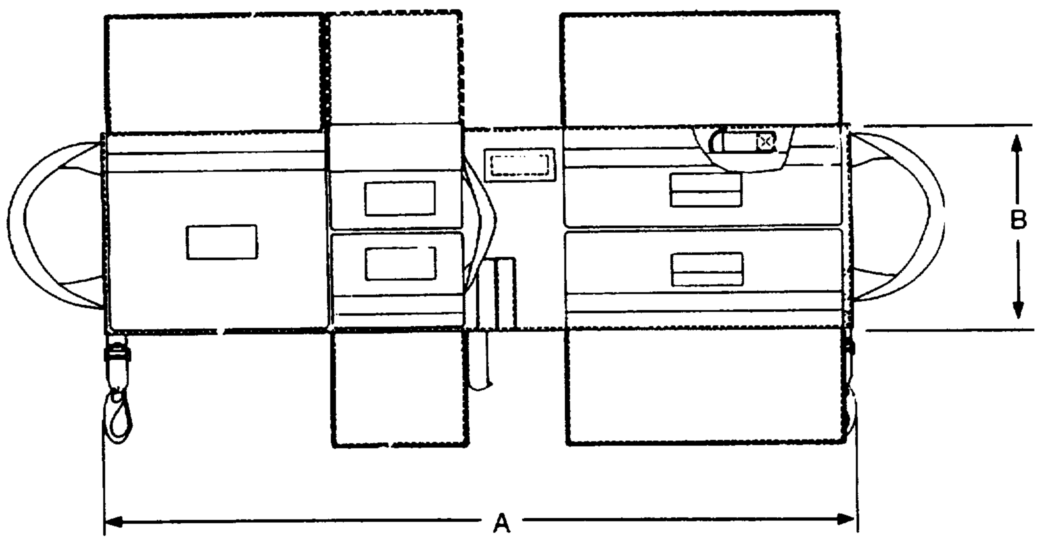
CONTACTS

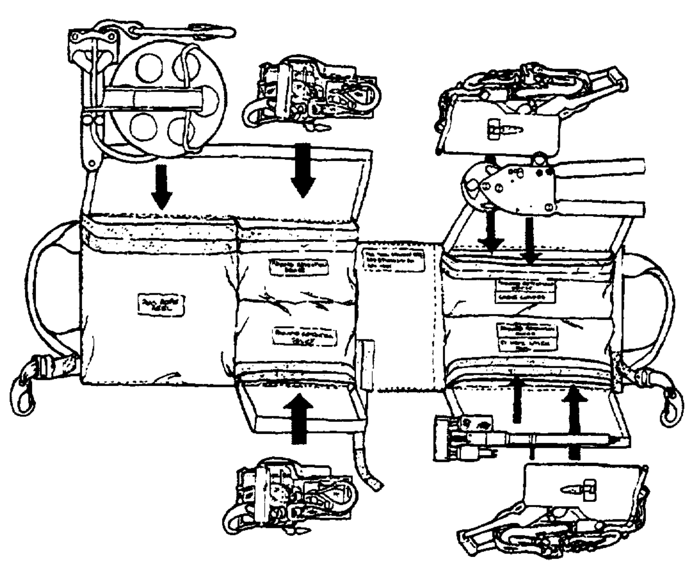
Operational: B. Adams, JSC DF42, (713) 483–2567
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

BAG, PSA TOOL STOWAGE

Technical Information	
Part number	SED33104034-301
Weight	7 lb
Material/ construction	Orthofabric reinforced with Armalon
Load rating	
Temperature range	–200° to 250° F (operational)
Quantity flown	One
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	40.0	101.6
B	11.0	28





BAG, SMALL TRASH

S82–35971

OVERVIEW

The small trash bag, also known as the EVA trash bag, is used on the mini–workstation (MWS) to contain discarded nuts, bolts, and small trash items during EVA.

OPERATIONAL COMMENTS

The bag is fabricated of Nomex fabric and has a snap frame closure/**hold–open** device. The baffle opening at the top of the bag is fabricated from a blue Nomex fabric to facilitate visual recognition of the opening by the EVA crewmember. The bag has a tether ring and is secured to the MWS **or tool stanchion** by a **bayonet fitting** pin that locks into place.

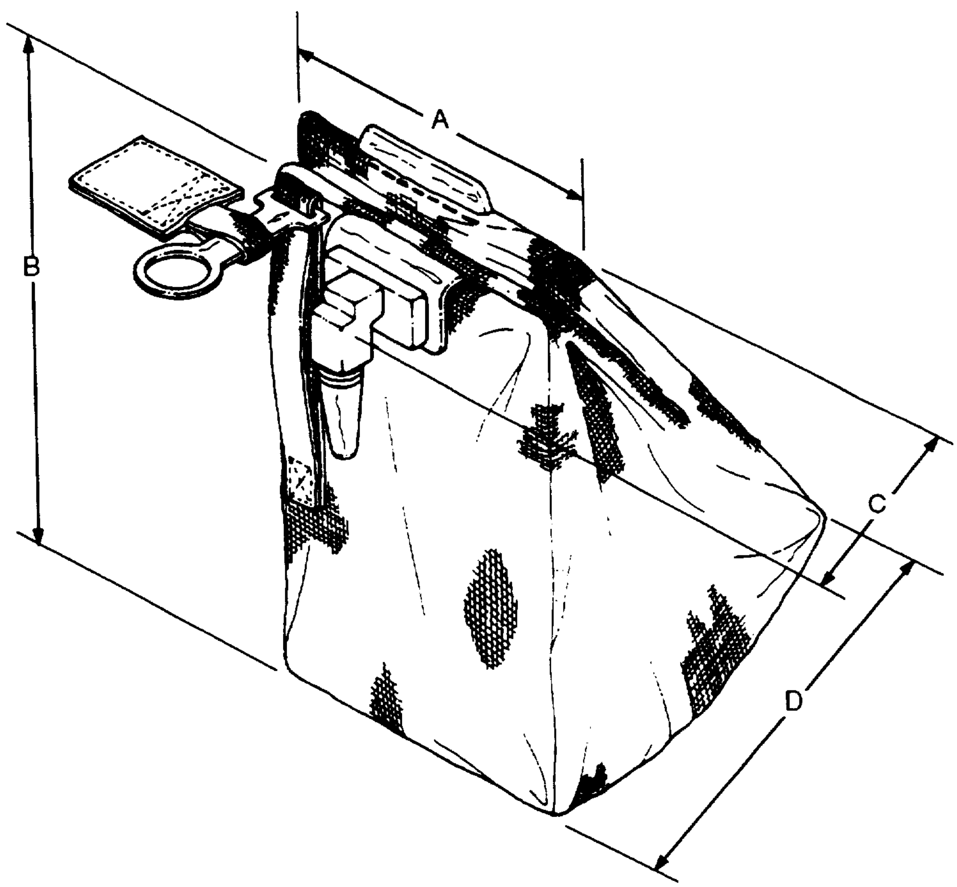
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

BAG, SMALL TRASH

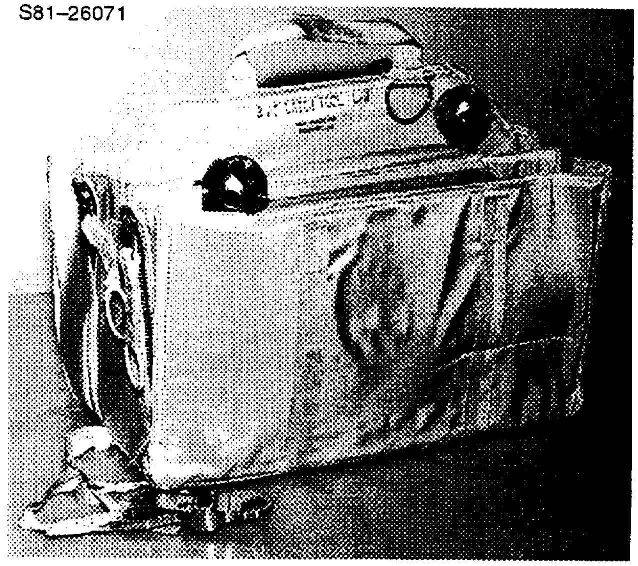
Technical Information	
Part number	10165–10065–03
Weight	1.0 lb
Material/ construction	
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Depth in open position	4.75 in.
Baffle opening	3.5 in.
Quantity flown	**One**
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	4.50	11.43
B	7.30	18.54
C	2.70	6.86
D	6.00	15.24



BAG, THREE–POINT LATCH TOOL

S81–26071



OVERVIEW

The three–point latch tool bag is used to carry the latch tools from the provisions stowage assembly (PSA) to the EVA worksite. Two types of this bag exist: one with two pockets, **designed to hold two of the three–point latch tools;** one with four pockets, designed to hold four of the three–point latch tools. The bags are made of Nomex fabric and reinforced with Armalon material. Both are equipped with rings and tethers for proper restraint and tethering.

OPERATIONAL COMMENTS

The two–pocket bag is part of the normally manifested orbiter equipment and is stowed in the port PSA. **A pair of two–pocket bags or the four–pocket bag is flown for the first two flights of a new orbiter.**

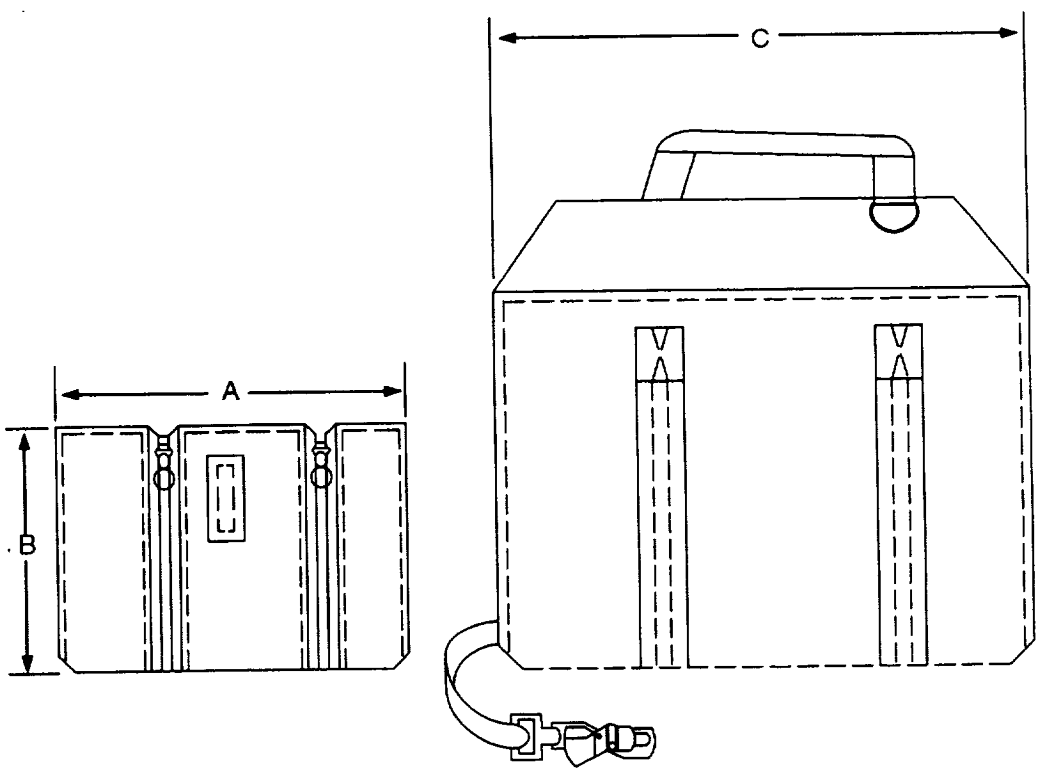
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood NASA/EC5, (713) 483–9247

BAG, THREE–POINT LATCH TOOL

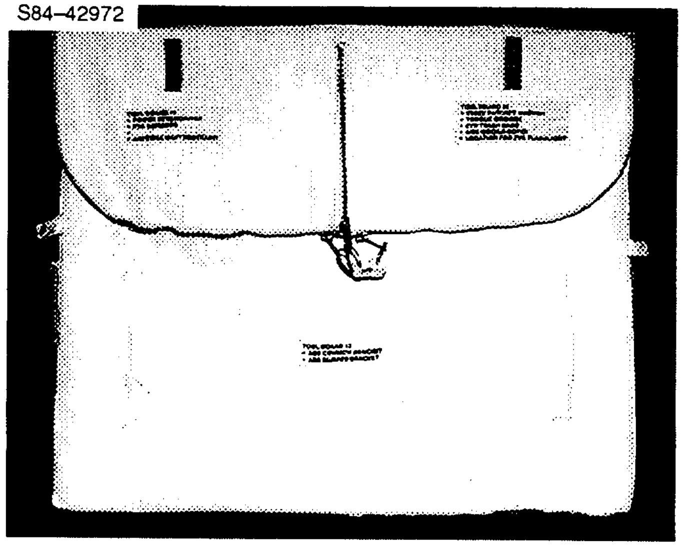
Technical Information	
Part number	**V633–669300–001, (four pockets) V633–669300–033, SDD 33103439–301 (two pockets)**
Weight	2.5 lb
Material/ construction	Fabric – Nomex, reinforced with Armalon
Load rating	
Temperature range	–200° to 250° F (operational), **+350°F (storage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	10.25	26.04
B	9.50	24.13
C	16.25	41.28



BAG, TOOL STOWAGE

S84–42972



OVERVIEW

The tool stowage bag, also called the equipment stowage container, stows and protects EVA tool boards and tools used during repair operations on Westar/Palapa–type satellites.

OPERATIONAL COMMENTS

The tool stowage bag is fabricated from Ortho and Armalon fabrics with two major zippered openings through which the tool boards can be accessed. The fabric top and sides are supported by an aluminum base, which is bolted into stowage position in the cargo bay. Fabric–covered Solemide foam dividers act as bumpers between tools and tool boards. All zipper pulls have ring tabs to **aid** EVA crewmember operation with gloved hands.

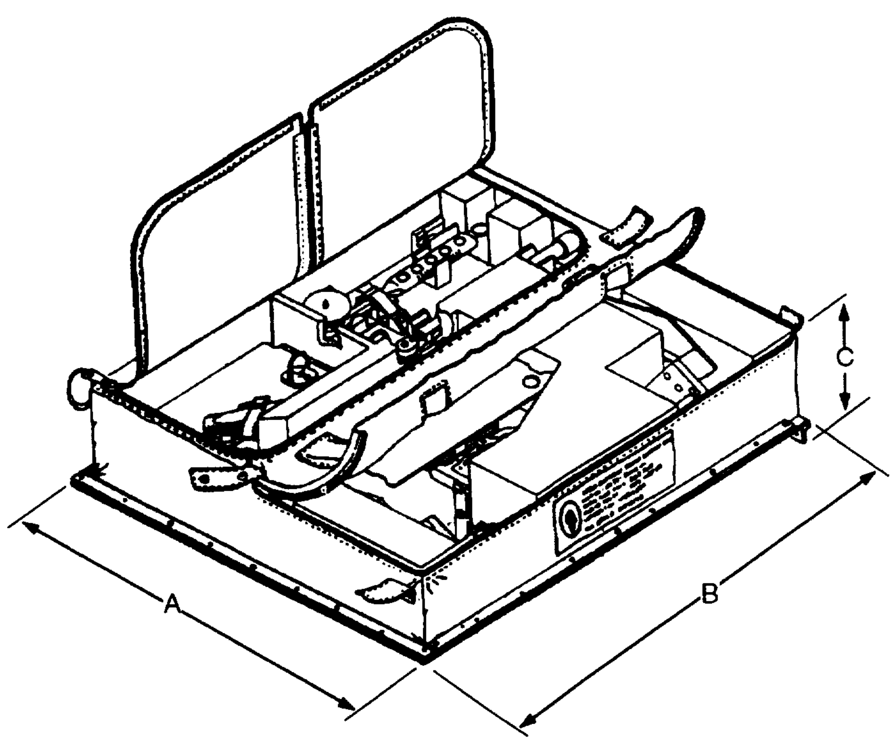
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

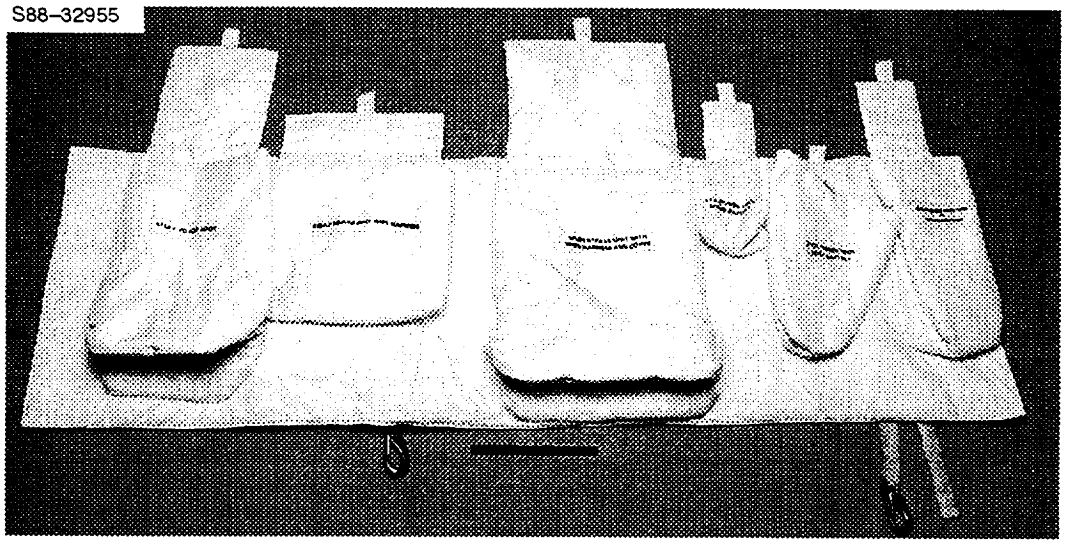
BAG, TOOL STOWAGE

Technical Information	
Part number	10174–20085–01
Weight	63.5 lb loaded
Material/ construction	Ortho, Armalon
Contents of stowage container:	
Tool board #1	Power screwdriver, EVA scissors, antenna mast restraint
Tool board #2	EVA 3/8–in. drive ratchet wrench, torque wrench, EVA trash bags, apogee kick motor nozzle cover, EVA flashlight
Tool board #3	Antenna bridge structure (ABS) common bracket, ABS bumper bracket
Load rating	
Temperature range	
Quantity flown	
Stowage	**On modified Spacelab pallet in cargo bay for STS 51–A**
Availability	Flight specific

Dimensional Data		
	inches	cm
A	27.75	70.49
B	31.75	80.65
C	7.50	19.05



BAG, TRANSFER



OVERVIEW

The transfer bag is a thermally protective bag for carrying tools and hardware used for satellite repair. Necessary equipment such as the spun bypass unit with wire harness and cover, the relay power unit, the relay power unit wire harness, the EVA power tool with battery, the EVA power tool spare battery, and the right angle drive tool or pin straightener are all stowed in individual pockets with flaps. Each pocket has a thermal protection layer and a layer of padding to minimize impact damage. The outer cover also provides thermal and impact protection as well as carrying handles and an adjustable strap and hooks for attaching the bag to available work space (e.g., the top of the tool stowage container).

OPERATIONAL COMMENTS

The transfer bag is rolled up and stowed inside the cabin during launch and during activities unrelated to satellite repair. During preparation for the repair part of the mission, the necessary equipment is packed into the appropriate pockets. The bags are then transferred into the airlock for use during the EVA. Two of these bags were successfully used on STS 51–I. Two bags were provided, one for redundancy.

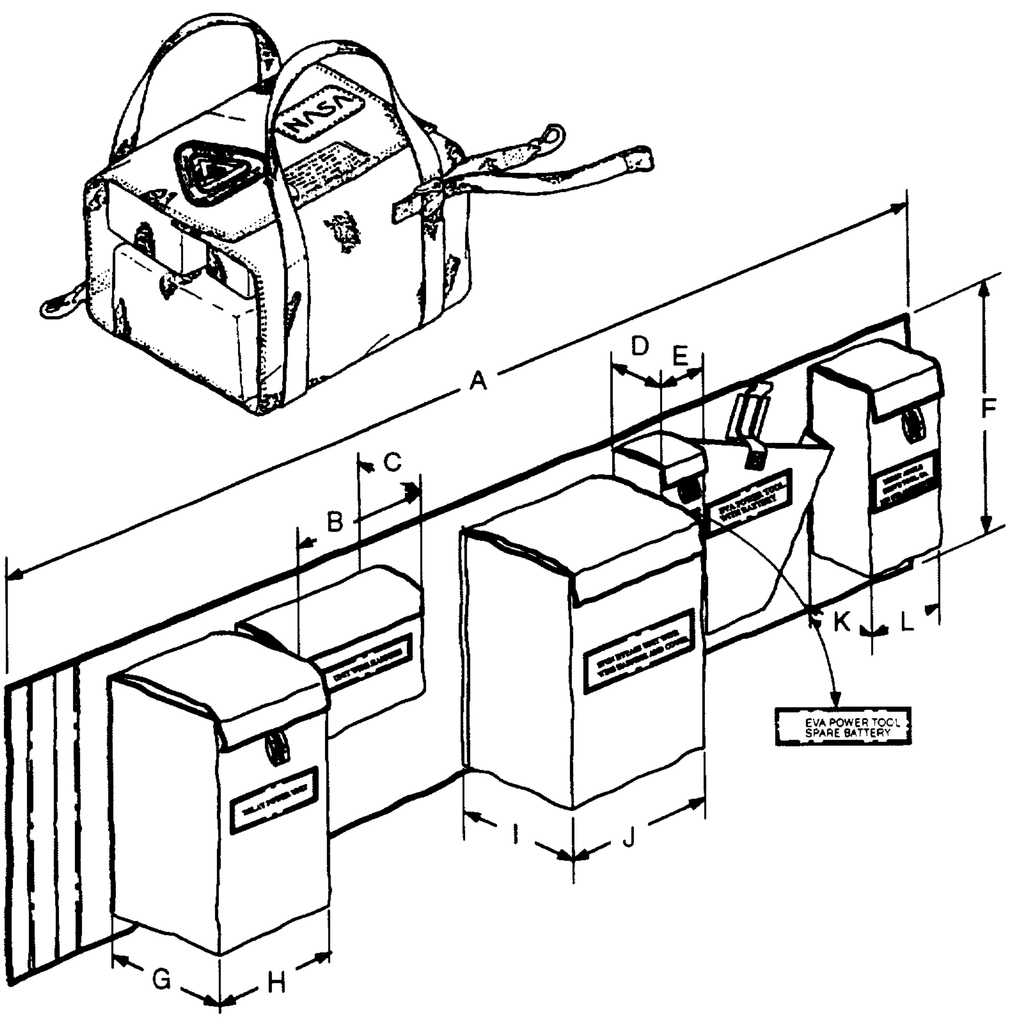
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

BAG, TRANSFER

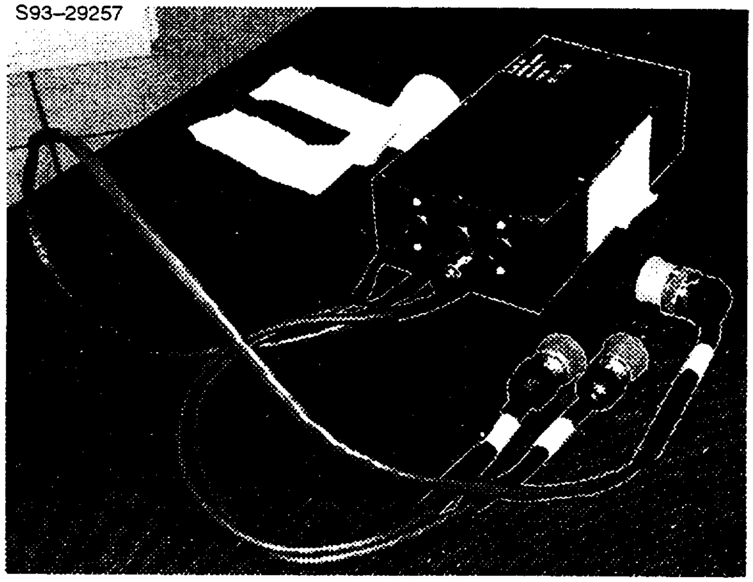
Technical Information	
Part number	10176–20006–01
Weight	6.6 lb
Material/ construction	Ortho, aluminized Mylar, polyester scrim, Nomex needle punch batting, Teflon
Load rating	
Temperature range	**–80° to + 180° F (operational)** **–95° to + 180° F (stowage)**
Quantity flown	Two for STS 51–I
Stowage	Cabin locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	55.00	139.7
B	9.50	24.13
C	2.00	5.08
D	2.50	6.35
E	3.00	7.62
F	16.50	41.91
G	7.25	18.42
H	6.00	15.24
I	7.50	19.05
J	9.50	24.13
K	3.00	7.62
L	3.25	8.26



BATTERY CHARGER, EMU MIDDECK

S93–29257



OVERVIEW

Normally, a pair of crewmembers will conduct extravehicular activity (EVA) sorties with a day of rest between. Given the limited on–orbit stay time of the orbiter at present, in order to perform a high number of EVA sorties, it is necessary to conduct them on consecutive days using two teams of two EVA crewmembers. Because a depleted extravehicular mobility unit (EMU) battery can take up to 20 hours to charge, and the normal airlock umbilical for battery charging is unavailable most of the time with EVA scheduled every day, an in–cabin charger is necessary. This in–cabin charger is referred to as the EMU middeck battery charger. Use of the EMU middeck battery charger minimizes the number of expensive batteries that must be manifested for a mission with this high number of EVA's. Each unit plugs into any orbiter dc utility outlet and recharges two EMU batteries. A pair is flown to ensure mission success. The EMU middeck battery charger is also known as the EMU silver zinc battery charger.

OPERATIONAL COMMENTS

Each charger has input and output fuse protection as well as automatic overvoltage and overcurrent cutoff for the output lines. The input line also has an automatic overvoltage cutoff circuit. Red and green indicator lights provide crew feedback on charger status. Red shows that charging is in progress, while green means that charging is complete. All lights are briefly activated together during initial powerup. Since the charger has an automatic cutoff circuit, maximum charge is best performed using the trickle charge inherent to the airlock umbilical charger for final topoff. Previous problems involving premature charge termination with a deeply discharged battery have been corrected.

While in use, the charger and batteries are best stowed in a small triangular space at the top of the forward lockers within reach of an overhead dc utility outlet. Velcro straps hold a pair of batteries to the charger for compact stowage during use. The 48–in. dc utility cable and the 24–in. battery cables have been sized for use with any middeck dc utility outlet and several in–use stowage locations. The charger itself was sized to fit in the standard middeck locker cushion for an EMU battery. The only control function is provided by the dc outlet switch that can be used to reset the unit after an input or output circuit automatic shutdown.

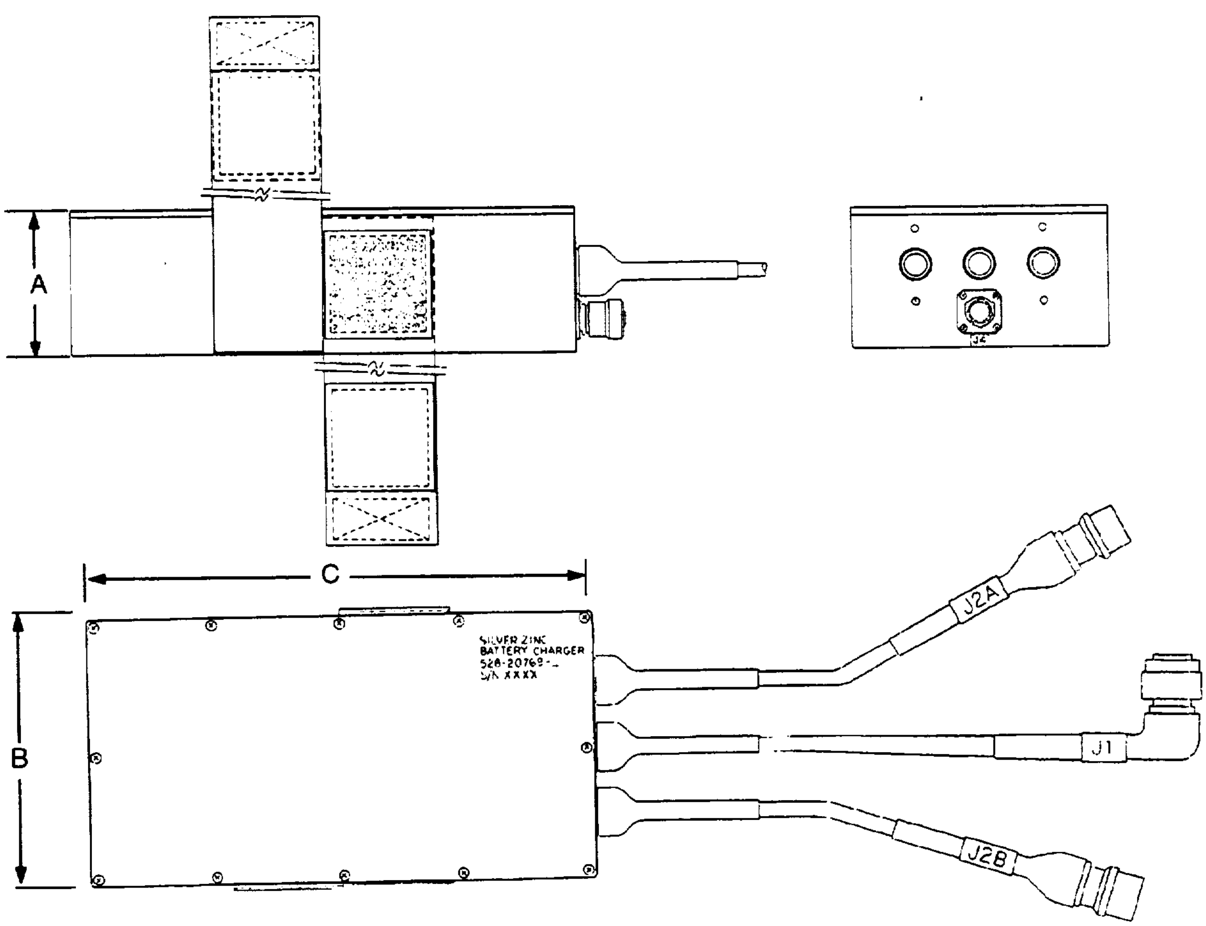
CONTACTS

Operational: S. Bleisath, NASA JSC/DF42, (713) 483–1756
Technical: G. Lutz, NASA JSC/DF42, (713) 483–9257

BATTERY CHARGER, EMU MIDDECK

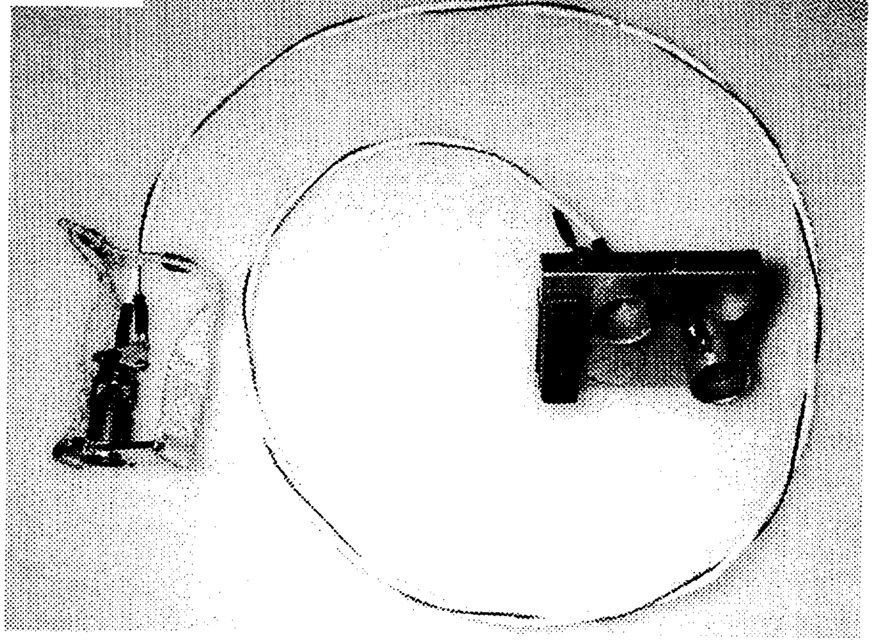
Technical Information	
Part number	528–20769–02
Weight	8 lb
Material/ construction	Aluminum housing, high thermal emissivity black paint, Nomex cord strain relief in cables
Load rating	1.55–A charge, cutoff at 21.8 V 25–V output overvoltage cutoff 2.26–A output overcurrent cutoff 37–V input overvoltage protection
Temperature range	35° to 120° F (operational) 110° F (worst case touch temp)
Quantity flown	Two on missions with consecutive EVA sorties
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	2.70	6.86
B	4.80	12.19
C	9.25	23.50



BATTERY RECHARGE CABLE, MMU

S83–44748



OVERVIEW

The manned maneuvering unit (MMU) battery recharge cable is used to recharge the MMU battery.

OPERATIONAL COMMENTS

The MMU battery recharge cable consists of a connector plug, which interfaces with the MMU battery, and a connector, which hooks up to an EMU servicing and cooling umbilical (SCU) in the airlock, connected by a four–conductor cable. Two straps on either side of the battery connector plug secure the plug to the battery. A 48–in. steel cable is entwined around the conductor cable to provide tension relief for the assembly. A replaceable fuse is planned as a future addition to the basic design.

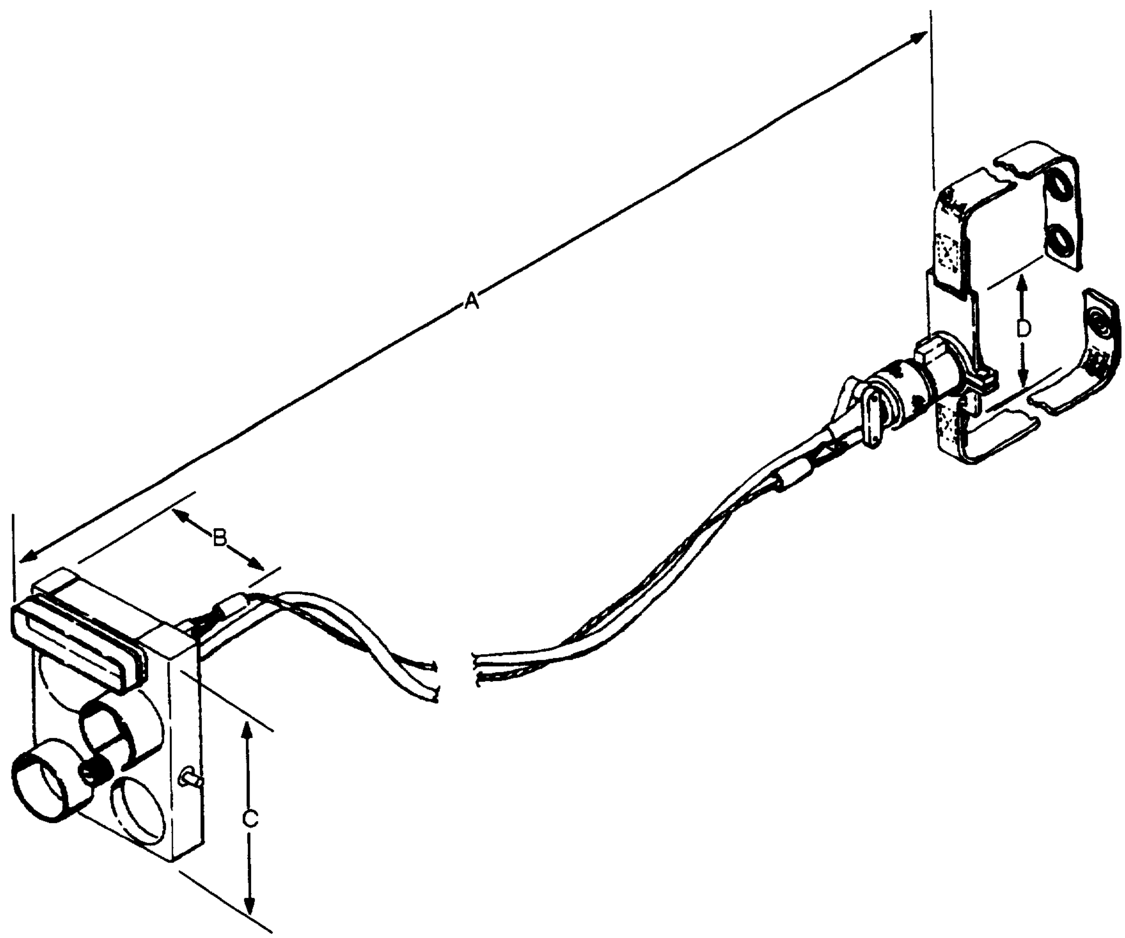
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: C. Hess, NASA/ER, (713) 483–9142

BATTERY RECHARGE CABLE, MMU

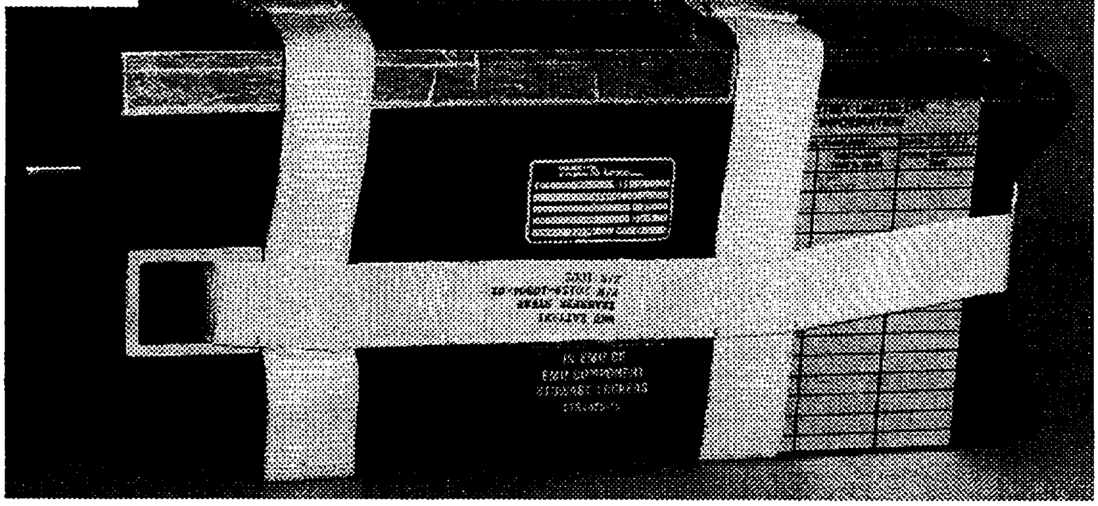
Technical Information	
Part number	10159–10005–01
Weight	1.12 lb
Material/ construction	Cable – Aluminum alloy
Load rating	
Temperature range	
Quantity flown	One for STS 51–A
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	52.760 in. true length	134.01
B	2.875	7.30
C	3.800	9.65
D	2.300	5.84



BATTERY TRANSFER STRAP, MMU

S84-29991



OVERVIEW

The manned maneuvering unit (MMU) and extravehicular mobility unit (EMU) batteries are identical except that the MMU battery casing is sturdier and has a built-in tether attachment point. The MMU battery transfer strap permits an EMU battery to be used as an MMU battery. This strap fits around the EMU battery to provide a tether point for transporting the battery to and from the MMU and securing the battery during removal and replacement. The strap is constructed of 1-in.-wide Kevlar webbing, fastened with a metal snap.

OPERATIONAL COMMENTS

The MMU battery transfer strap remains on the EMU battery while the battery is installed on the MMU. A metal bracket, securely sewn to and threaded onto the transfer strap, serves as a tether point. An EMU battery used in the MMU should not remain in the MMU for landing because of structural concerns.

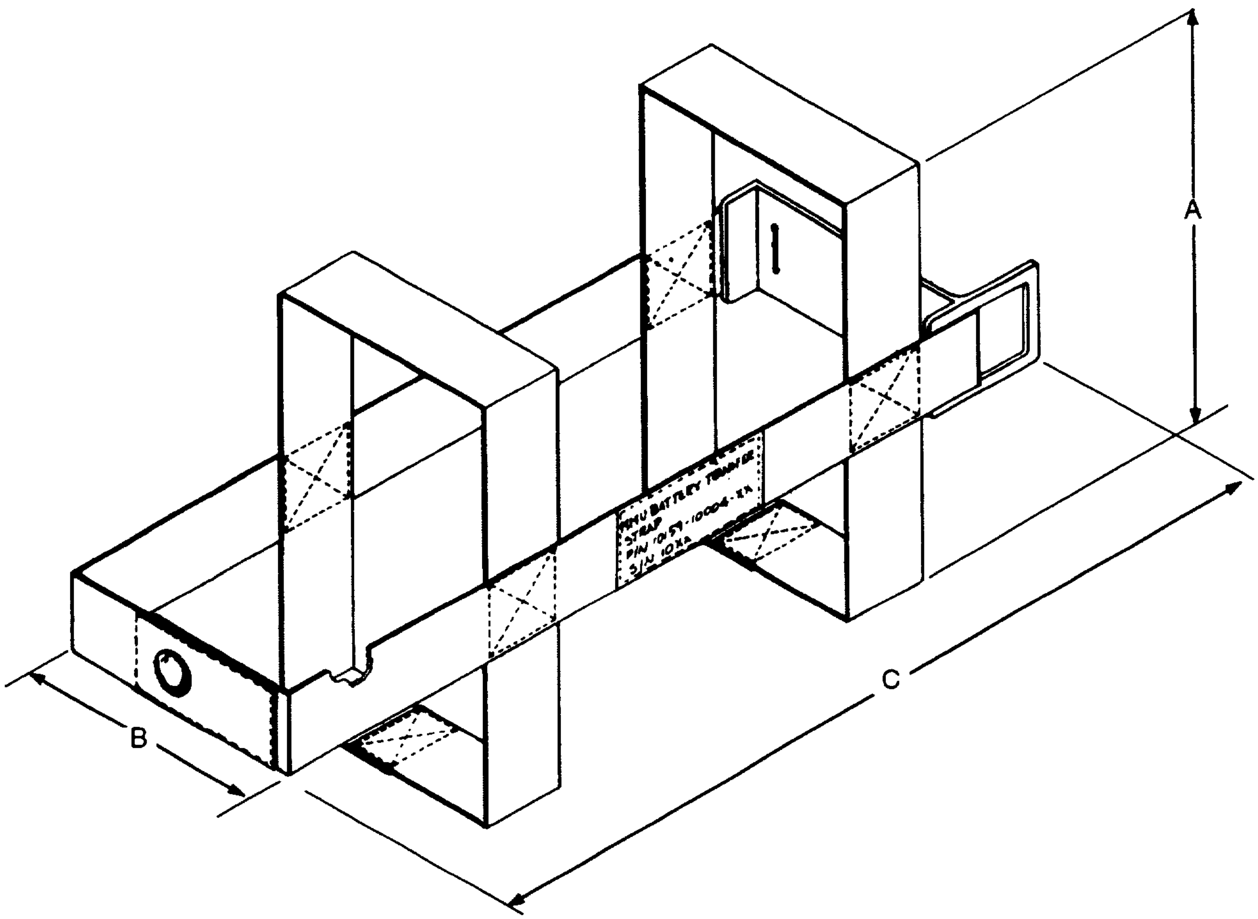
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: **C Hess, NASA/ER, (713) 483-9142**

BATTERY TRANSFER STRAP, MMU

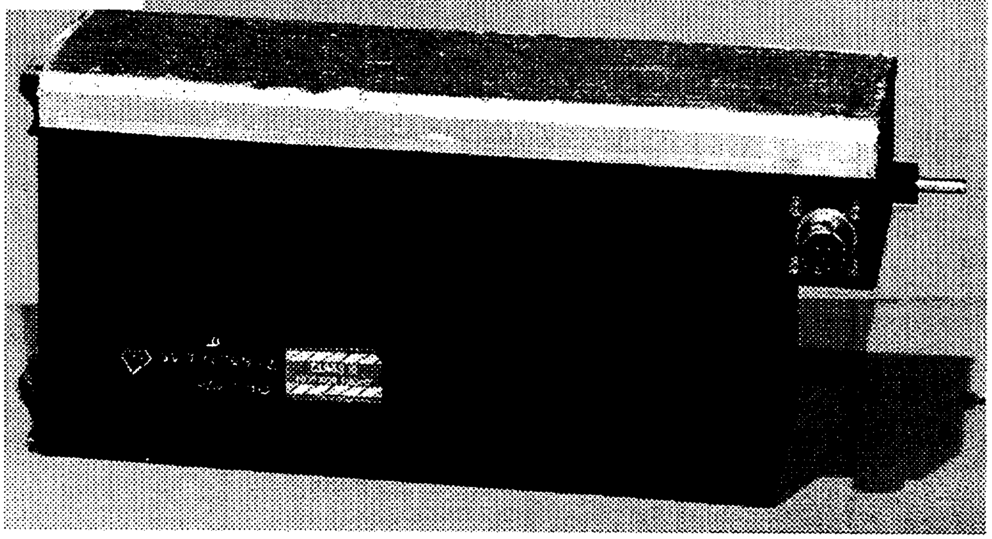
Technical Information	
Part number	10159-10004-01
Weight	0.16 lb
Material/ construction	Kevlar webbing 1 in. wide
Load rating	
Temperature range	
Quantity flown	
Stowage	**Middeck locker**
Availability	Flight specific

Dimensional Data		
	inches	cm
A	5.000	12.7
B	2.875	7.30
C	10.250	26.04



BATTERY, EMU

S82–40871



OVERVIEW

The extravehicular mobility unit (EMU) battery is the power supply for all the electrical and electronic components of the EMU.

The battery consists of 11 silver–zinc cells connected in series. Each cell has two relief valves in series. This arrangement forms a sealed system for safety in case of excess pressure. An absorbent material is placed in the cavity **above the** relief valves to keep the KOH electrolyte from leaking out of the battery **if** the relief valves open. Teflon and aluminum tape cover the battery cell cavity.

OPERATIONAL COMMENTS

The EMU battery is stored dry before launch and is activated on the ground by filling with premeasured electrolyte. In flight, prior to EVA, the battery can be replaced by a spare or recharged while in the primary life support subsystem. The battery is certified for 26.6 amp–hours after eight recharge cycles, **and has a 135–day shelf life after activation. It also has a six–recharge capacity with a 170–day shelf life.** Generic missions carry one battery installed in each EMU and one spare in a Teflon bag stowed in a middeck locker. Scheduled EVA missions carry additional EMU batteries.

The EMU battery is also used to power the EVA power package (EPP) and the module servicing tool (MST).

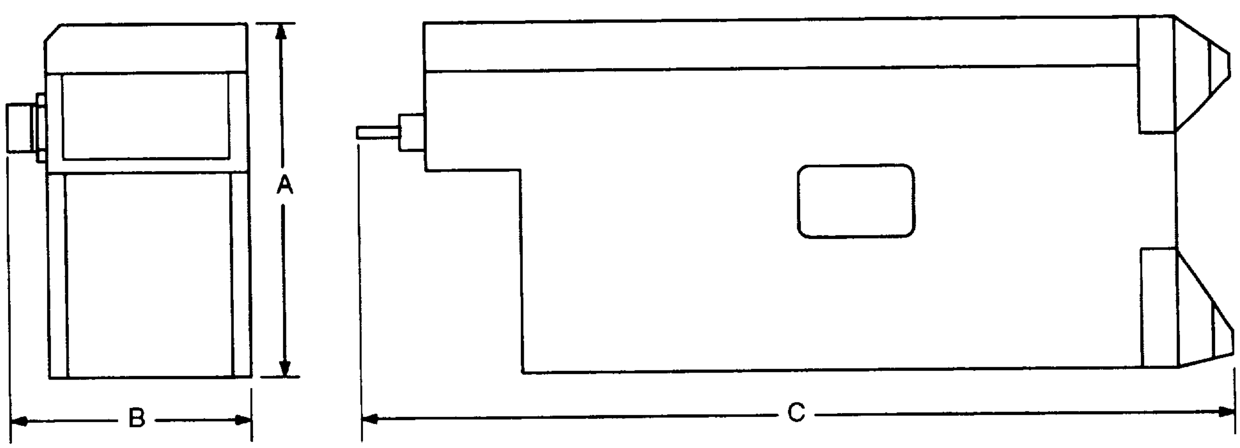
CONTACTS

Operational: **R. K. Fullerton**, NASA/DF42, (713) 483–2589
Technical: G. Lutz, NASA/EC6, (713) 483–9257

BATTERY, EMU

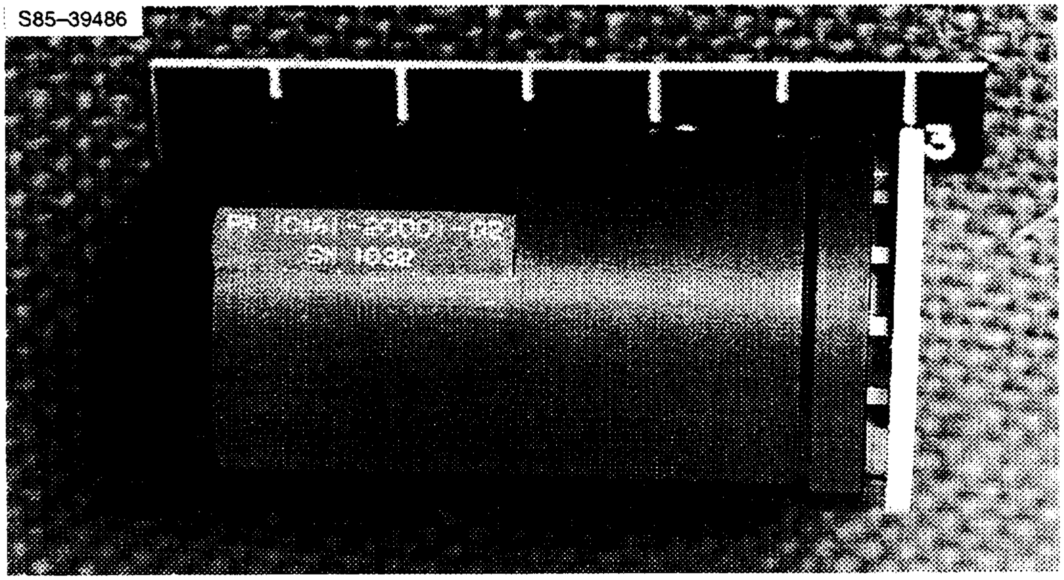
Technical Information	
Part number	SV767789–**08** (battery alone) SED13101547–305/308 (locker stowed in bag)
Weight	9.6 lb
Material/ construction	**Silver–zinc cells, K0H electrolyte, epoxy cell sealant** **Aluminum case**
Load rating	26.6 A–hr (minimum after **all** recharge cycles) 30.0 A–hr (new)
Voltage	16.2 to 17.0 V dc (loaded) 20.5 V dc (no load)
Current	3.5 A (nominal)
Full–recharge time	20 hr
Shelf life	**135 days activated (eight charge/discharge cycles)** **170 days activated (six charge/discharge cycles)**
Temperature range	
Quantity flown	Three (std)
Stowage	Two in EMU, one in locker (std)
Availability	Standard

Dimensional Data		
	inches	cm
A	5.00	12.7
B	3.35	8.51
C	12.25	31.12



BATTERY, EMU LIGHTS

S85–39486



OVERVIEW

The extravehicular mobility unit (EMU) lights batteries are required to supply the power for the EMU lights (one per side).

OPERATIONAL COMMENTS

Each EMU lights battery provides 2.5 watts to power one bulb on one side for 6 hours (0.7 amps at 3.6 +0.2/–0.5 load V dc). A built–in fuse protects against inadvertent shorting of the contacts. If the batteries are used in a hot environment, there is a danger of their venting because of overheating.

Twelve EMU lights batteries are stored in the orbiter volume H storage locker for each flight with up to three two–person EVA sorties. Each battery is replaced prior to each EVA.

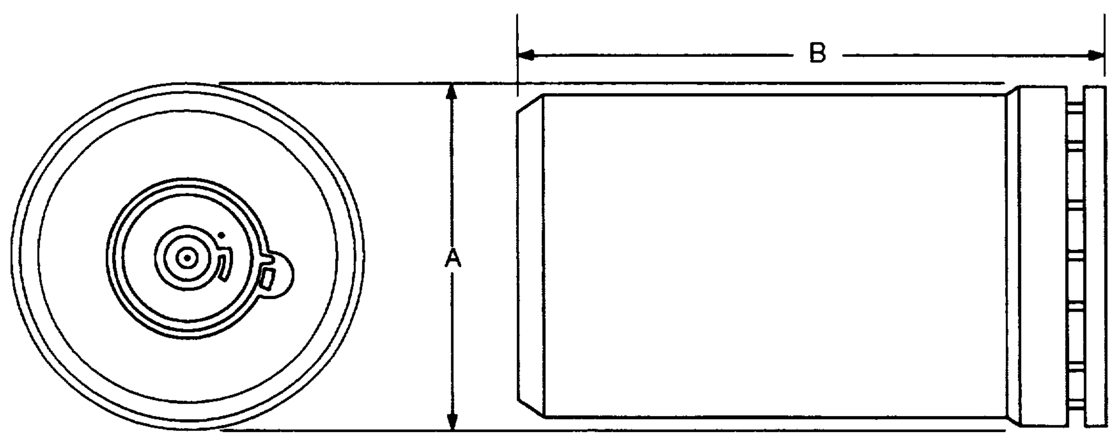
CONTACTS

Operational: **R. K. Fullerton**, NASA/DF42, (713) 483–2589
Technical: B. J. Bragg, NASA/EP5, (713) 483–9040

BATTERY, EMU LIGHTS

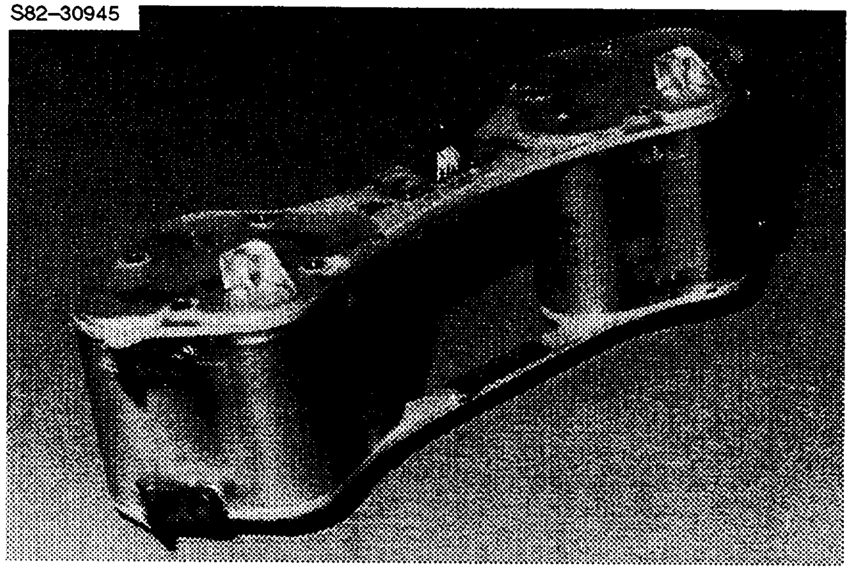
Technical Information	
Part number	10161–20001–03
Weight	0.34 lb
Material/ construction	Aluminum housing Lithium bromine complex cells
Load rating	8 A–hr
Temperature range	32° to 160° F (operational)
Volts	3.77 ± 2 V dc (open circuit) 3.25 V dc (loaded)
Shelf life	12 months
Watts	5.0 W with 2 bulbs for 3 hr (each side) 2.5 W with 1 bulb for 6 hr (each side)
Quantity flown	Twelve **(std)**
Stowage	**Volume H locker**
Availability	Standard

Dimensional Data		
	inches	cm
A	1.50	3.81
B	2.80	7.11



BATTERY, EMU TV

S82–30945



OVERVIEW

The extravehicular mobility unit (EMU) TV battery provides the power required to run the EMU TV assembly. The battery pack is made up of eight nonrechargeable lithium bromine complex battery cells grouped in two clusters of four. The entire battery pack assembly is easily separated from the TV assembly for replacement.

OPERATIONAL COMMENTS

The EMU TV battery generates a total of 28 V dc for the main TV circuit. There is also a separate in–line tap to direct 14 V dc to the logic circuit of the TV power control module. Each cell has a load voltage of approximately 3.5 V dc at a discharge rate of 0.9 amp for a minimum of 6 hours.

The EMU TV battery is designed to operate at 32° to 160° F, a range well beyond normal expected EVA temperatures inside the well–insulated TV enclosure. Each battery is protected by **fuses/diodes and** an internal thermostat that opens the circuit if 160° F is exceeded.

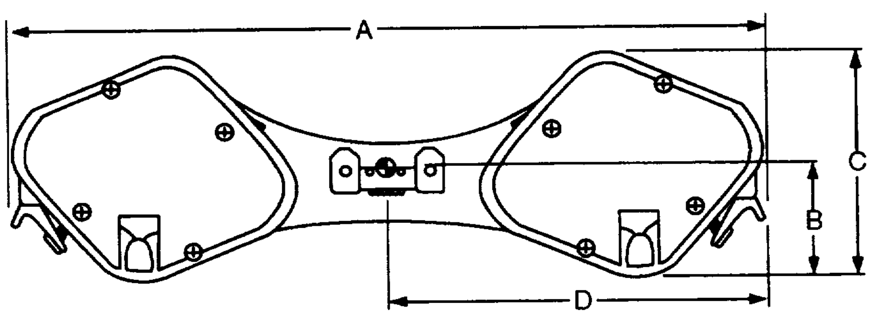
CONTACTS

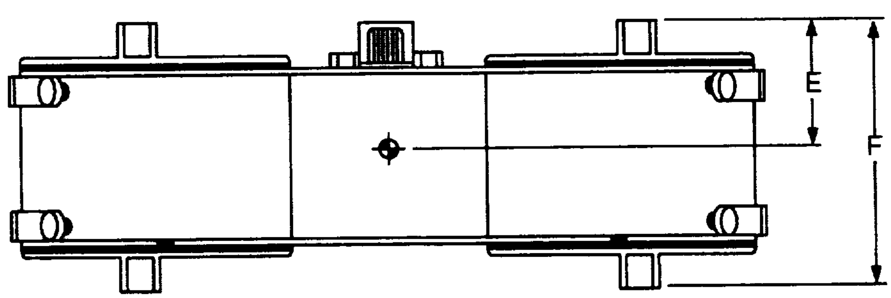
Operational: **R. K. Fullerton**, NASA/DF42, (713) 483–2589
Technical: B. J. Bragg, NASA/EP5, (713) 483–9040

BATTERY, EMU TV

Technical Information	
Part number	10160–20072–02
Weight	2.6 lb
Material/construction	Lithium bromine couplex cells
Load rating	8 A–h
Battery pack voltage	28 V dc
In–line tap voltage	14 V dc
Load voltage per cell	3.5 V dc
Battery pack life rating under continuous use	Minimum 6 hr at 0.9 A discharge rate
Temperature range	32° to 160° F **(operational)**
Quantity flown	**One per TV per EVA**
Stowage	**Middeck lockers**
Availability	Flight specific

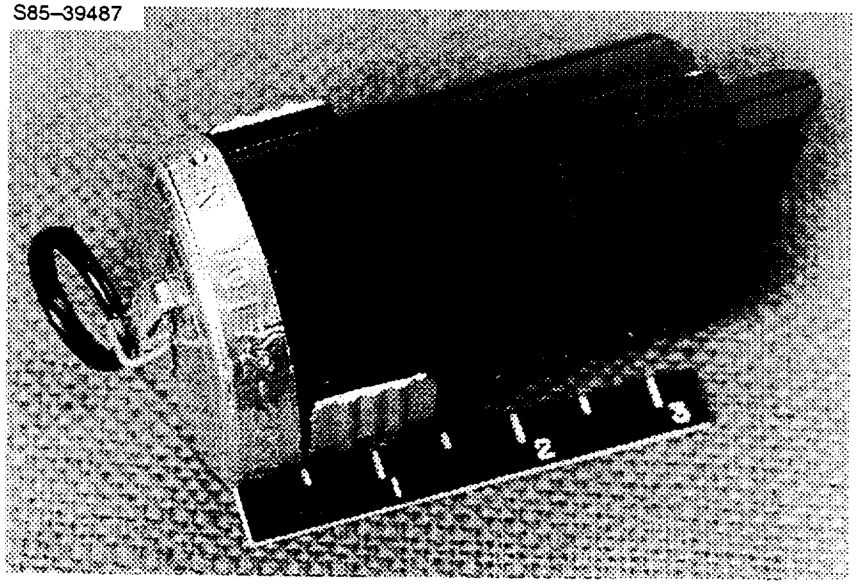
Dimensional Data		
	inches	cm
A	9.93	25.22
B	1.48	3.76
C	2.97	7.54
D	5.21	13.23
E	1.80	4.57
F	3.59	9.12





BATTERY, EVA POWER TOOL

S85–39487



OVERVIEW

The EVA power tool battery is a six–celled nickel–cadmium power pack for the EVA power hand tool.

OPERATIONAL COMMENTS

The EVA power tool battery inserts into the back end of the power hand tool and locks into place. The base of the battery has an attached tether ring. Internally, six sub "C" nickel–cadmium cells are arranged in two individual circuits, each of which consists of three cells connected in series. Each circuit has an in–line 3θ–A fuse which interrupts power in case of a fault. When installed in an EVA power tool, the battery provides 3.6 V dc in low speed mode and 7.2 V dc in high speed mode. **Multiple** battery packs are manifested **on a flight–specific basis** and **are** stowed in the middeck for launch. A thermal bag is provided for transfer of the battery to the EVA power tool worksite.

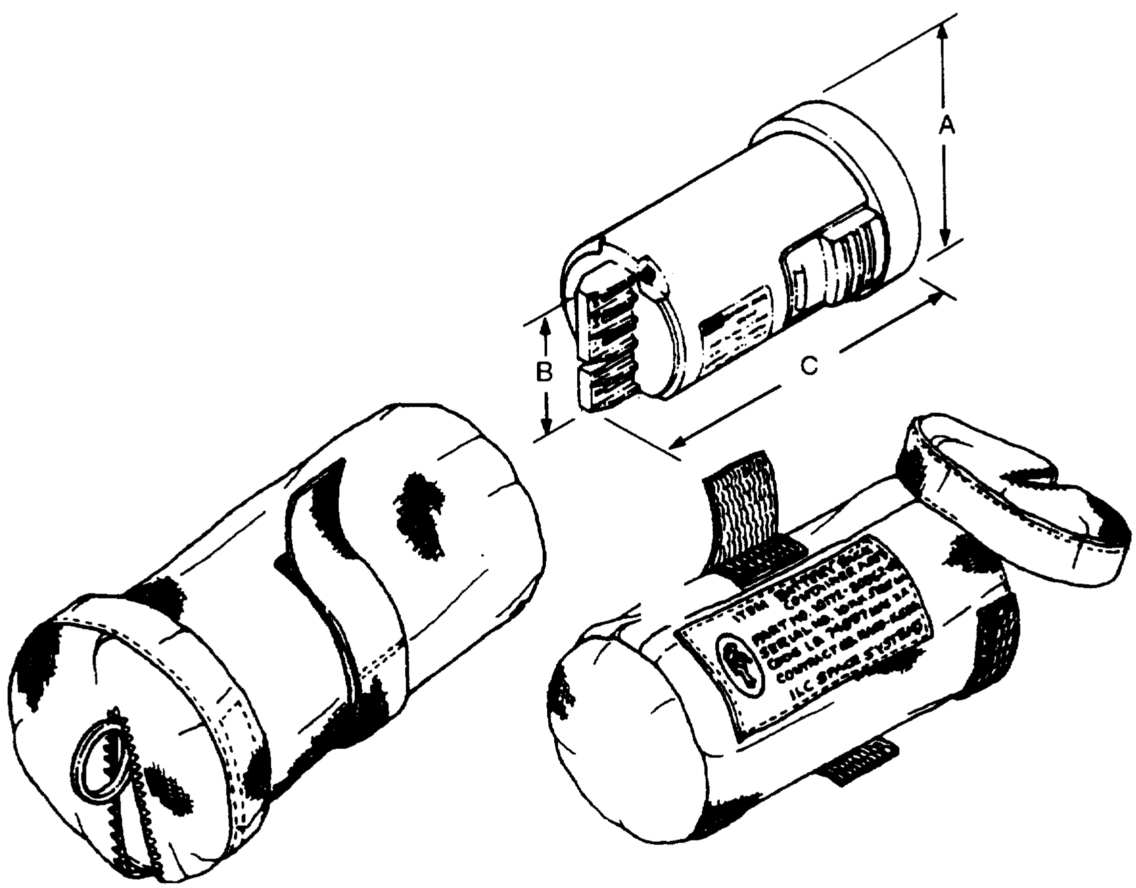
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

BATTERY, EVA POWER TOOL

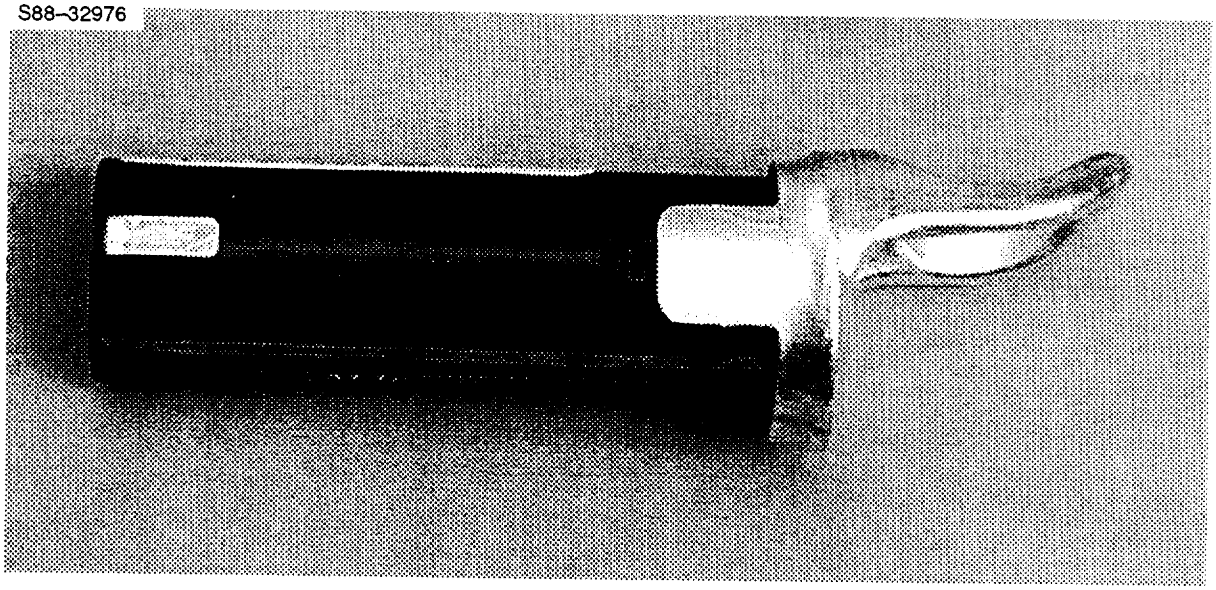
Technical Information	
Part number	10181–10002–01 **(battery without bag)** **10181–20025–02 (bag)** **10181–10037–02 (battery and bag)**
Weight	0.85 lb
Material/ construction	Plastic case, nickel–cadmium cells
Load rating	1.5 A–h
Fuse	30–A fuse
Voltage	3.6 V dc (low speed), 7.2 V dc (high speed)
Temperature range	
Quantity flown	As required (10 for STS–49)
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	2.31	5.87
B	1.680	4.27
C	4.87	12.37



BATTERY, MINI POWER TOOL

S88–32976



OVERVIEW

The mini power tool battery is a two–celled nickel–cadmium power pack for the mini power tool.

OPERATIONAL COMMENTS

The mini power tool battery inserts in the back end of the mini power tool and locks into place. The base of the battery has an attached tether ring. Internally, two sub "C" nickel–cadmium cells are connected in series with an inline 30–amp fuse for short circuit interruption. This battery is functionally interchangeable with the STS intravehicular activity (IVA) mini power tool. **An insulating bag protects the battery from thermal extremes and external electrical shorts. Its end flap has a Velcro closure that leaves the battery tether point accessible.**

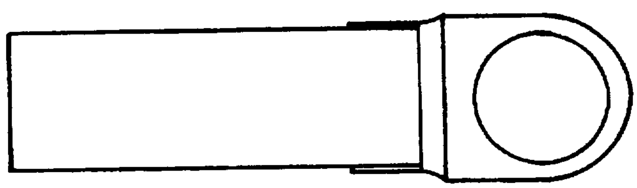
CONTACTS

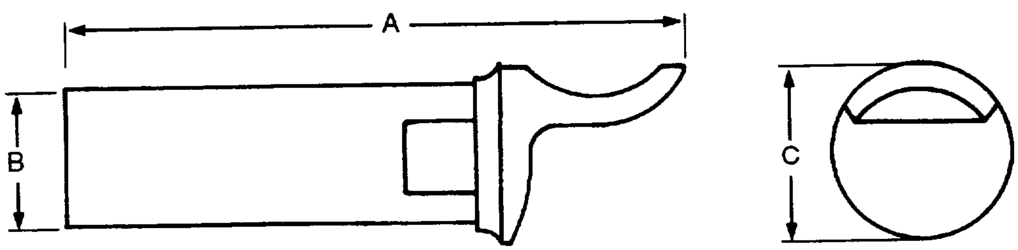
Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

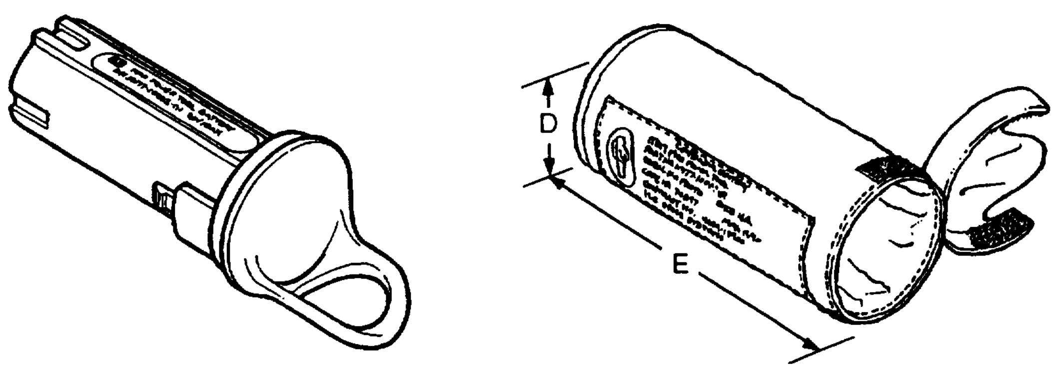
BATTERY, MINI POWER TOOL

Technical Information	
Part number	**10177-10002-01 (battery)** **10177-10003-01 (battery bag)** **10177-10004-01 (battery and bag)**
Weight	0.38 lb **(battery)** 0.10 lb (bag)
Material/ construction	Tapes – Kapton embossing aluminum Battery pack – Plastic case NiCd cells **Bag – Outer layer Orthofabric** **Inner layer Teflon fabric**
Load rating	2.4 V dc, 1.**5** A–hr (power output) 30 A (fuse)
Temperature range	–130° to +150° F (operational)
Quantity flown	**As required** (**four** for STS–48)
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	5.380	13.67
B	1.500	3.81
C	1.188	3.02
D	**1.88**	**4.78**
E	**4.50**	**11.43**

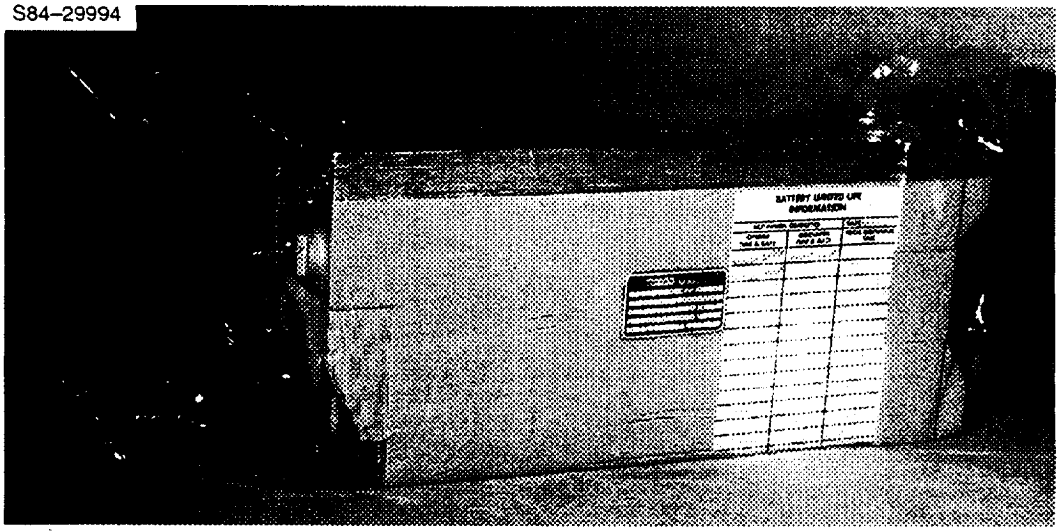






BATTERY, MMU

S84–29994



OVERVIEW

All manned maneuvering unit (MMU) power is provided by two MMU batteries installed on the front–facing vertical surface of the MMU center structure. Two spare batteries are carried inside the orbiter cabin. Each battery is a silver–zinc (Ag–Zn) oxide 16.8–V battery consisting of 11 series–connected cells. The MMU and extravehicular mobility unit (EMU) batteries are functionally interchangeable for use in the MMU. The MMU battery, however, has never been used as an EMU battery. The MMU battery has a tether ring and a heavier case and latch pin. The battery compartment of the MMU has a fabric thermal cover.

OPERATIONAL COMMENTS

Electrical servicing of the MMU includes replacement of the two batteries. The useful life of the battery is 15 yr when stored dry and 135 to 170 days when activated. During the wet life, the battery is capable of six to eight charge/discharge cycles where the charge cycle spans 16 hr and the depth of discharge is 365 W/hr.

For MMU flights, two spare MMU batteries are stowed in a middeck locker and are transferred to the worksite in an MMU battery transfer bag. The MMU batteries can be charged either in the EMU as EMU batteries or by using MMU battery recharge cables, which can be connected directly to the airlock service and cooling umbilicals (SCU's).

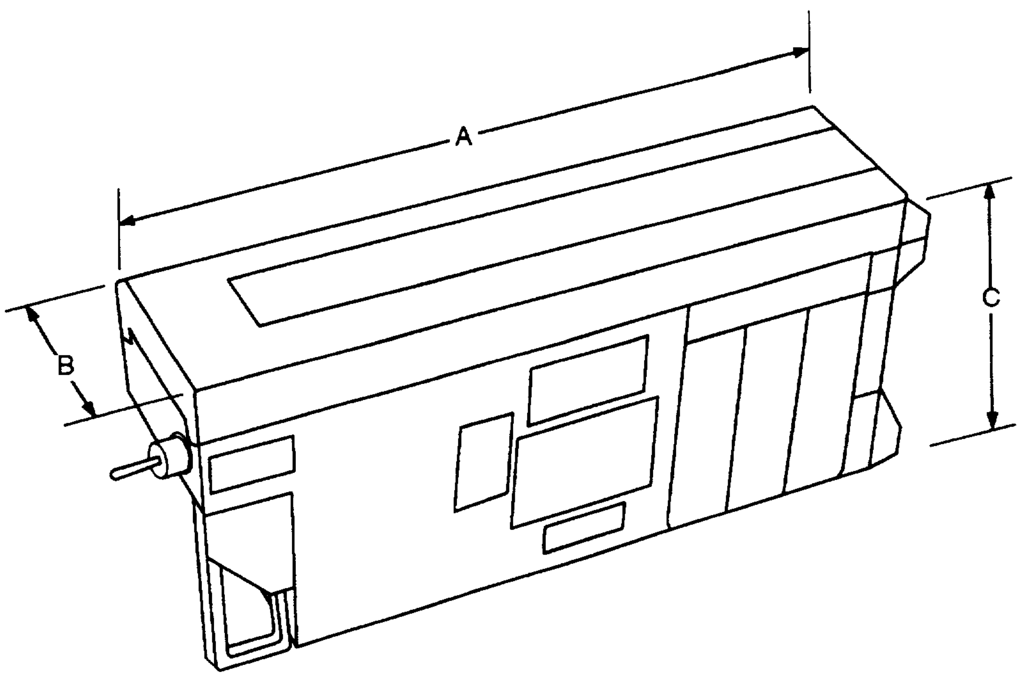
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: G. Lutz, NASA/EC6, (713) 483–9257

BATTERY, MMU

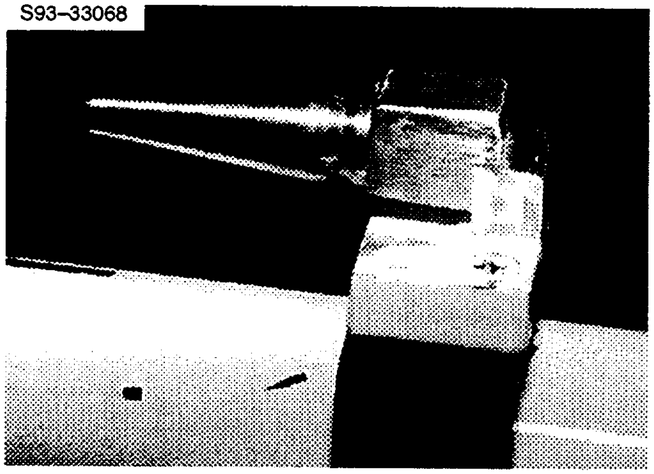
Technical Information	
Part number	SED13101573
Weight	9.1 lb activated
Material/ construction	Battery – Ag–Zn oxide, KOH electrolyte Case – Aluminum Pressure relief valve to prevent loss of electrolyte into space in case of disc rupture on individual cells
Load rating	**26.6 A–hr (minimum after all recharge cycles)**
Nominal voltage	16.8 ± 0.8 V with load; 20.5 V without load
Battery life	**15 yr dry** **135 days activated (eight charge/discharge cycles)** **170 days activated (six charge/discharge cycles)**
Temperature range	
Quantity flown	
Stowage	Spares in a middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	10.0	25.40
B	3.0	7.62
C	5.0	12.70



BAYONET FITTING

S93–33068



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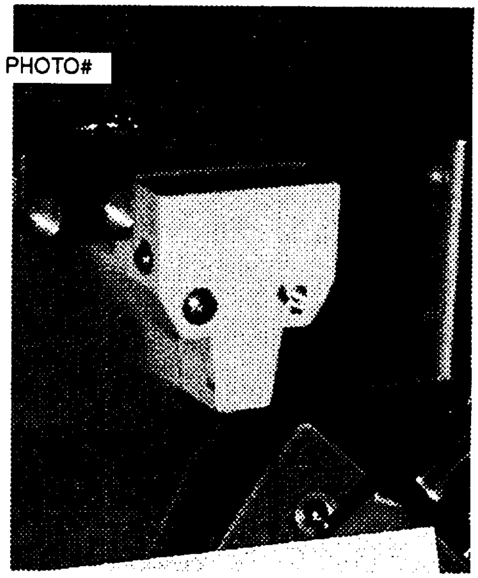


OVERVIEW

The bayonet fitting, also known as an interface adapter bracket, provides rigid restraint of objects during manual translation and at the worksite. This allows small items to be carried on the mini–workstation on the front of the extravehicular mobility unit (EMU) or attached to a workstation stanchion. This frees up the crewmember's hands for body positioning and the use of other tools without having to fight a loosely tethered object. The bayonet fitting has a male probe and a female receptacle.

OPERATIONAL COMMENTS

Based upon shuttle EVA flight experience, single crewmember capability to transport objects while free floating is not unlimited. Anytime an object is transported it degrades the crewmember's mobility and ability to maintain body control. Increases in object size lead to corresponding decreases in feasible translation rates and translation distances. Simple limp tethers off the crew's wrist or waist have been used in the past, but these tethers subject the object and the surrounding structure to impact damage. This is because the crewmember cannot maintain body control during translation without full use of both hands, and any tending of loosely tethered objects detracts from body control. If the assistance of an additional EV crewmember or a robot is unavailable, the bayonet fitting is a solution to this problem.

The bayonet fitting can be attached directly to each item or to a transport container like a tool caddy. The location of the bayonnet probe on each item must consider the preferred orientation of the item while carried on the mini–workstation to keep both hands free and avoid vision obscuration. The weight and size of each object must also be considered. Interferences with mini–workstation mechanisms like the clutch knob must be factored in. A recently proposed probe modification involves the machining of a recessed hex in the end of the probe for proper tightening to prevent loosening during use. The bayonnet receptacle typically has a slide lock mechanism and a ball detent to aid item restraint. Only small objects are candidates for mini–workstation transport. Refer to NSTS–07700, Vol. XIV, appendix 7, for object transport constraints.

Fit checks are mandatory between bayonet interfaces such as the mini–workstation receptacles and all probes.

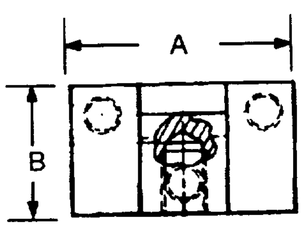
CONTACTS

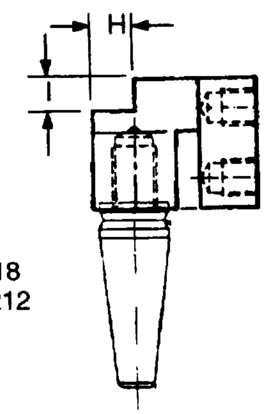
Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. Marak, NASA/EC5, (713) 483–9144
W. B. Wood, NASA/EC5, (713) 483–9247

BAYONET FITTING

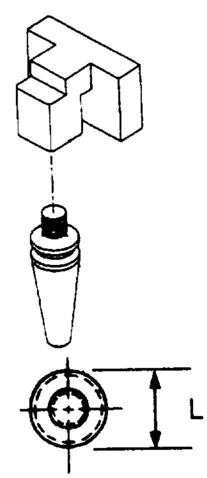
Technical Information	
Part number	10153–20018 (bayonet bracket) 10153–20019 (bayonet probe) 10150–20076 (locking receptacle) SED33104212–701 (bayonet bracket) SDD33104929–001 (bayonet probe w/ tightening hex) SDD33104211–001 (bayonet probe, standard) SED33102279–701/705 (receptacle) SED33102278–301 (receptacle slide lock)
Weight	
Material/ construction	Aluminum receptacle/bracket, CRES probe, Loctite
Load rating	
Temperature range	
Quantity flown	As required
Stowage	As required
Availability	Flight specific

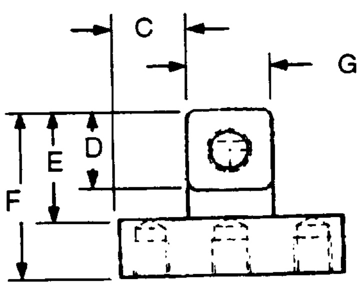
Dimensional Data		
	inches	cm
A	1.31	3.33
B	0.78	1.98
C	0.41	1.04
D	0.498	1.265
E	0.63	1.60
F	0.95	2.41
G	0.498	1.265
H	0.25	0.64
I	0.19	0.48
J	1.320	3.35
K	0.24	0.61
L	0.498	1.265
M	0.625	1.59
N	1.625	4.13
O	1.83	4.65
P	1.07	2.72
Q	0.30	0.76

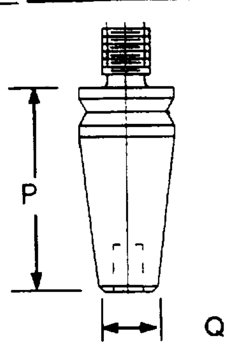




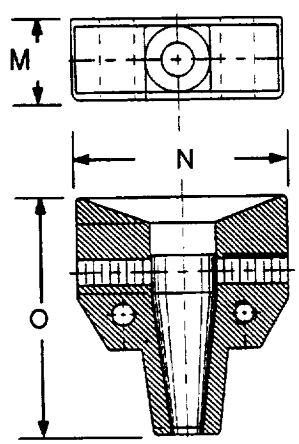
10153–20018
SED33104212



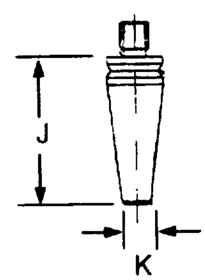




SDD33104929

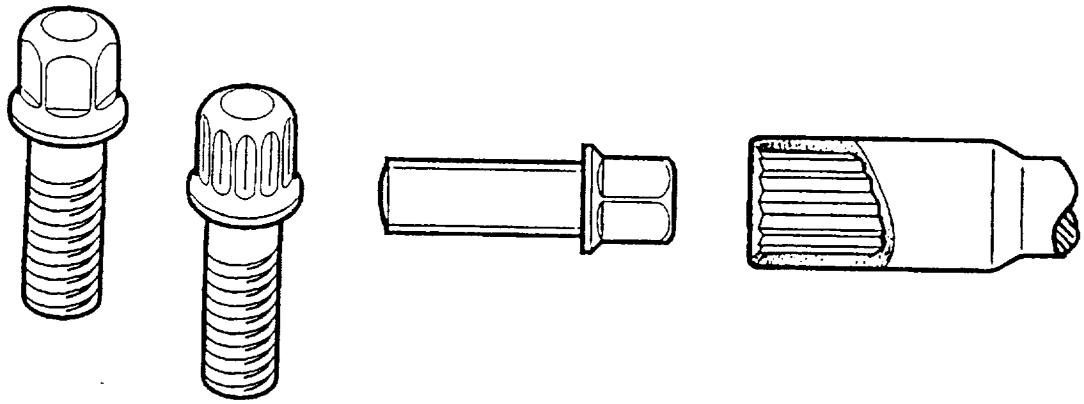


SED33103379
10150–20076



SDD33104211
10153–20019

BOLT AND SOCKET, EVA STANDARD



OVERVIEW

The standard for bolts and sockets is based on an extended height 7/16–in. hex–head bolt. There is a single–socket standard and separate standards for 12–point and hex–head bolts. The 12–point–headed bolts are used in high–torque applications. In the past, "double height" bolts were recommended, but they have since been replaced by these revised standards for all new applications.

OPERATIONAL COMMENTS

The head of the standardized EVA bolt satisfies dimensional tolerances for thermal exposure and ease of tool installation and driving under load. Screwdriver–type bolt heads such as Phillips, Torque–set, and slotted are prohibited from EVA use because their drive tools require an axial engagement force and inevitably slip off the fastener. An allen drive hex machined into the head of EVA bolts can serve as a backup interface for a stripped bolt head. All EVA fasteners should be captive. Exceptions may be allowed for one–time contingency interfaces. Bolts requiring a large number of turns should use a Zip nut to reduce EVA overhead. All EVA bolts should have a minimum running torque of 7 in.–oz to prevent slippage of manual ratchet mechanisms. The threaded bolt shaft should have a rounded end to assist in hole alignment.

The EVA socket standard calls for a 12–point socket and a minimum internal depth to match extended–height bolt heads. This socket also has an internal chamfer to aid in installation alignment. Refer to NSTS–07700, Vol. XIV, appendix 7 for EVA compatible mechanical fastener design requirements.

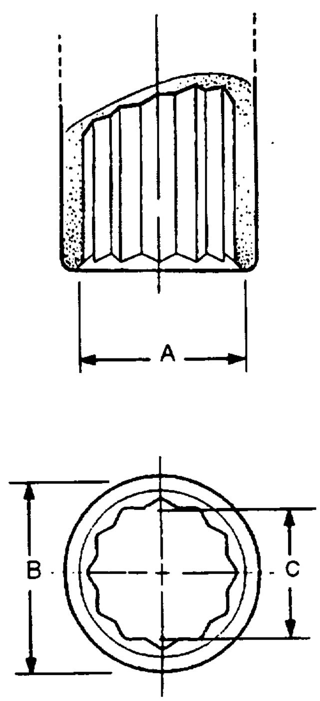
CONTACTS

Operational: R. Trevino, NASA/DF42, (713) 483–2597
Technical: R. Marak, NASA/EC5, (713) 483–9144

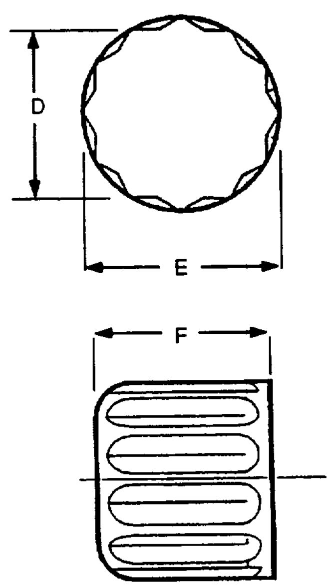
BOLT AND SOCKET, EVA STANDARD

Technical Information	
Part number	10107–70915
Weight	
Material/ construction	MP35N
Load rating	171 ft–lb (design torque for 7/16 hex bolt head) 240 ft–lb (yield torque for 7/16 hex bolt head) 301 ft–lb (ultimate torque for 7/16 hex bolt head) 226 ft–lb (design torque for 12 point bolt head) 316 ft–lb (yield torque for 12 point bolt head) 332 ft–lb (ultimate torque for 12 point bolt head)
Temperature range	
Quantity flown	
Stowage	
Availability	Flight specific

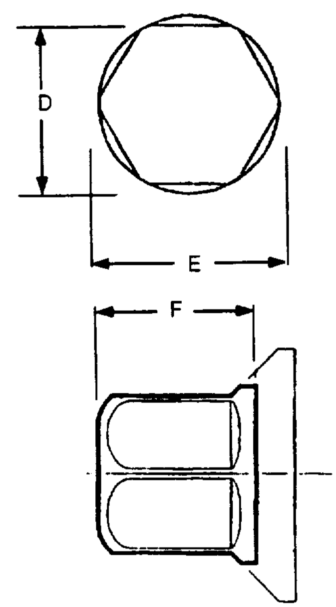
Dimensional Data		
	inches	cm
A	0.580	1.473
B	.660	1.676
C	.443 .446	1.125 1.132
D	.434 .439	1.102 1.115
E	.486 .491	1.234 1.247
F	.430 .450	1.092 1.143



7/16 12–point socket



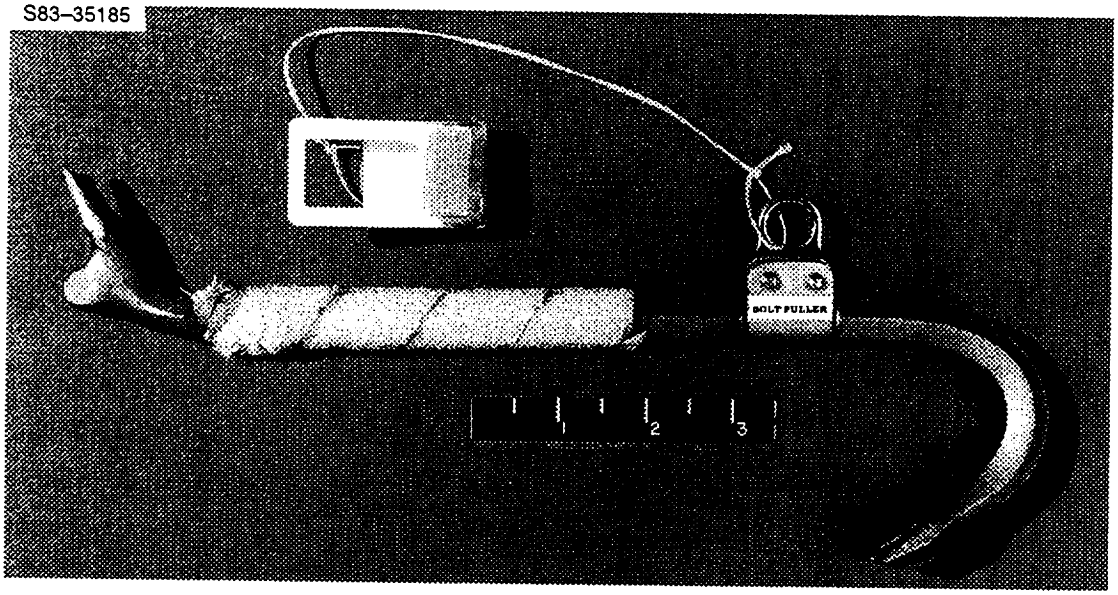
7/16 12–point bolt



7/16 hex bolt

BOLT PULLER

S83–35185



OVERVIEW

The bolt puller is a common crowbar modified for contingency extravehicular activity (EVA) use and intended for improved leverage in confined spaces. A tool ring for tethering has been added near the claw end, and the tool is partially wrapped in Velcro. Both ends of the tool are tapered and slotted. The end opposite the claw end has a 1/2–in. cylindrical piece attached near the end to provide a heel for leverage for prying with that end. That same end has a protective cover that is attached to the tether ring by a lanyard.

OPERATIONAL COMMENTS

The bolt puller is one of the jam removal tools. It is used primarily for prying or unjamming. It can be used to remove a bolt after the nut has already been removed. One end has been sized specifically to fit the bolts at the three disconnect points at each door drive bellcrank.

This tool is part of the normally manifested orbiter equipment. It is wrapped in a Velcro–lined tool caddy along with the Vise–grip pliers and stowed in the port provisions stowage assembly (PSA).

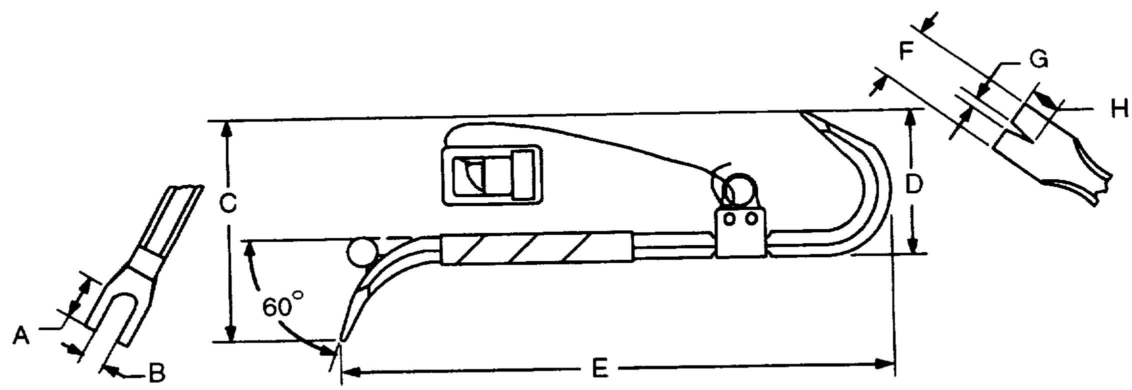
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

BOLT PULLER

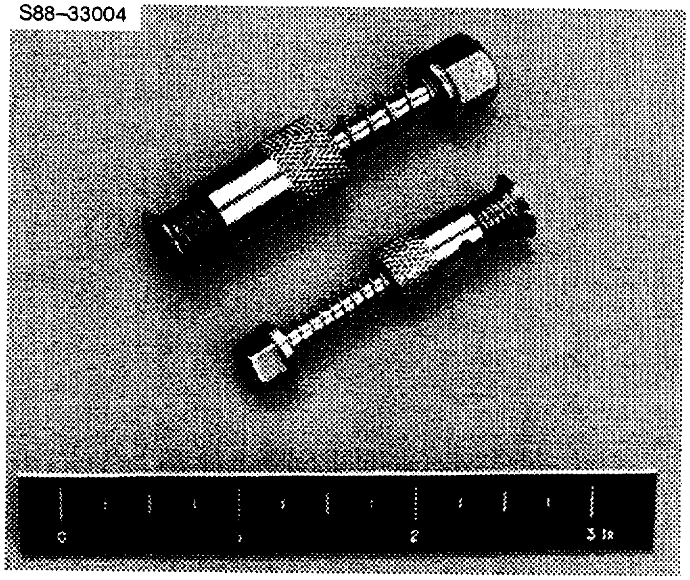
Technical Information	
Part number	V628–650880–009 or SDD33103435–301
Weight	0.8 lb
Material/ construction	Crowbar – Tool steel Heat treatment – To Rockwell C20 to C30 hardness Plating – Commercial electroless nickel plating
Load rating	**30–lb input**
Temperature range	–200° to 250° F (operational), +350° F (stowage)
Quantity flown	One
Stowage	Port PSA
Availability	Standard

Dimensional Data		
	inches	cm
A	0.640	1.63
B	0.375	0.95
C	4.100	10.41
D	2.900	7.37
E	10.000	25.40
F	1.060	2.69
G	0.250	0.64
H	0.560	1.42



BOLTS, EVA CAPTIVE

S88–33004



OVERVIEW

These captive bolts are designed in two different hex head sizes for Hubble Space Telescope (HST) hardware installation. The fastener was designed to remain attached to the flight hardware during changeout operations. The fastener consists of two parts: a retainer nut and a captive screw assembly. The fastener is assembled in a housing with a spring to extend the fastener when loosened. The captive screw assembly is mounted to the hardware mounting flange with the retainer nut.

OPERATIONAL COMMENTS

The captive screws used on HST hardware are 5/16– and 7/16–in. hex head fasteners. Each captive fastener has two mechanical interfaces. It can be accessed with a 5/16– or 7/16–in. hex socket or a number 10 torque–set tip tool. For HST applications, the 7/16–in. captive fastener requires torque of 90 to 110 in–lb. The 5/16–in. fasteners require torques of 35–45 in–lb. The retainer nut seating torque for the 7/16–in. fastener is 110–130 in–lb and 80–100 in–lb for the 5/16–in. fastener.

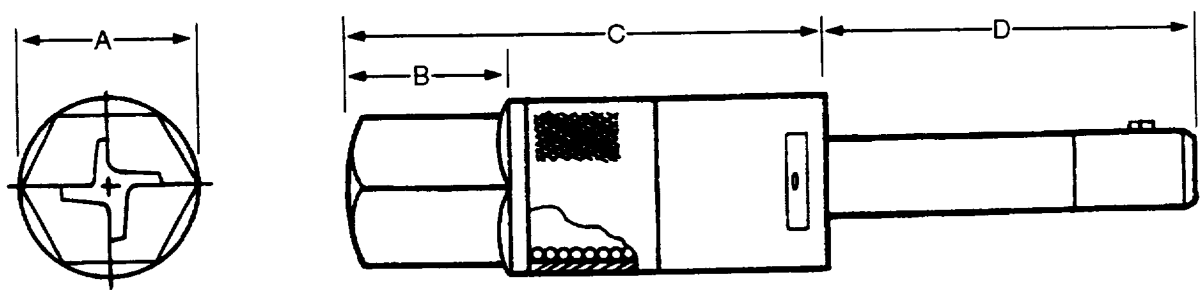
CONTACTS

Operational: S. P. Rainwater, NASA/DF42, (713) 483–1755
Technical: **R. Sheffield, LMSC/Dept 64–10, (408) 742–8464**

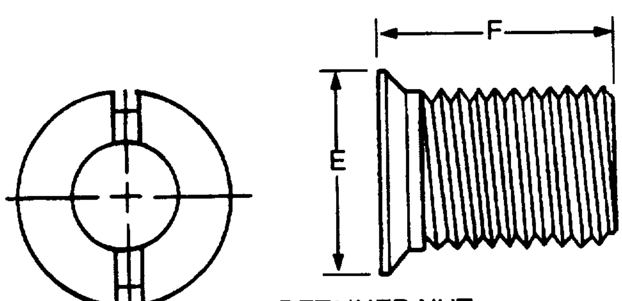
BOLTS, EVA CAPTIVE

Technical Information	
Part number	1622481–001–06 through 16 (5/16 hex) 1622481–002–07 through 16 (7/16 hex) 1622506–001 through 007 (retainer nut)
Weight	0.0309 lb max. (1622481–001–016) 0.0649 lb max. (1622481–002–16) 0.0083 lb max. (1622506–001)
Material/ construction	Corrosion resistant steel, Vespel (1622481–XXX–XX) 18–8 type 300 cres (1622506–XXX)
Load rating	**90–110 in–lb (7/16 in.)** **35–45 in–lb (5/16 in.)**
Temperature range	
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data				
	inches	cm	inches	cm
	5/16 hex		7/16 hex	
A	0.370	0.94	0.500	1.27
B	0.250	0.64	0.375	0.95
C	0.875	2.22	1.250	3.18
D	0.375 to1.000	0.95 to 2.54	0.437 to1.000	1.11 to 2.54
Retainer nut				
E	0.430 (001–003) 0.490 (004–007)	1.09 (001–003) 1.24 (004–007)	0.430 (001–003) 0.490 (004–007)	1.09 (001–003) 1.24 (004–007)
F	0.375 in. to 0.781 in. (0.125 in. increments)		0.95 cm to 1.98 cm (0.32 cm increments)	



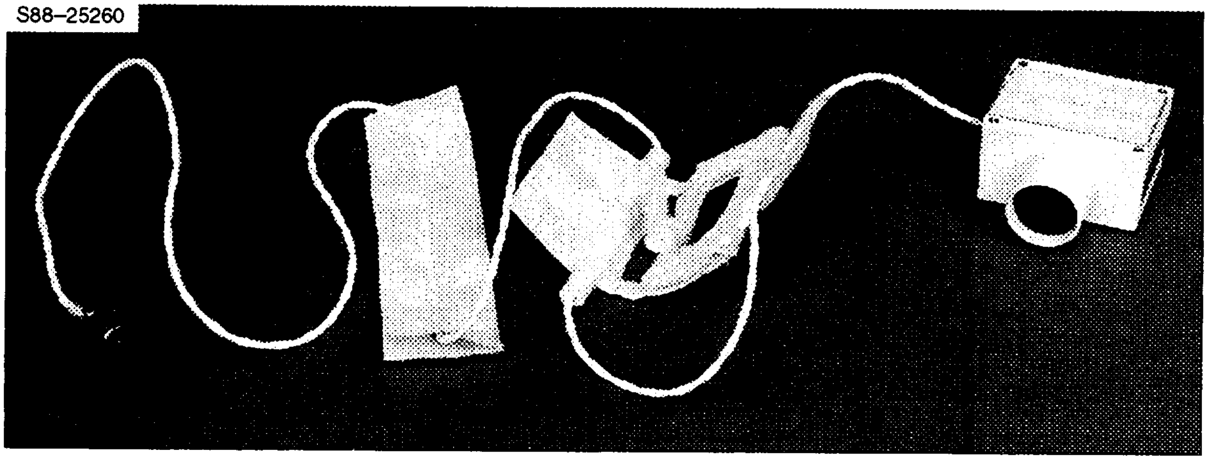
SCREW ASSEMBLY



RETAINER NUT

CAMERA ACTUATOR AND CABLE, MMU 35mm

S88–25260



OVERVIEW

The manned maneuvering unit (MMU) 35mm camera actuator, also known as the 35mm camera remote control assembly, provides a remote method for operating a camera shutter. The actuator is an electrical switch with connecting wires to the remote control fitting on the front of a 35mm camera.

OPERATIONAL COMMENTS

The actuator can be mounted on either side of the MMU using cable clamps and restraint straps. A 72–in. cable connects the camera with a switch attached to the MMU near the crewmember's hand.

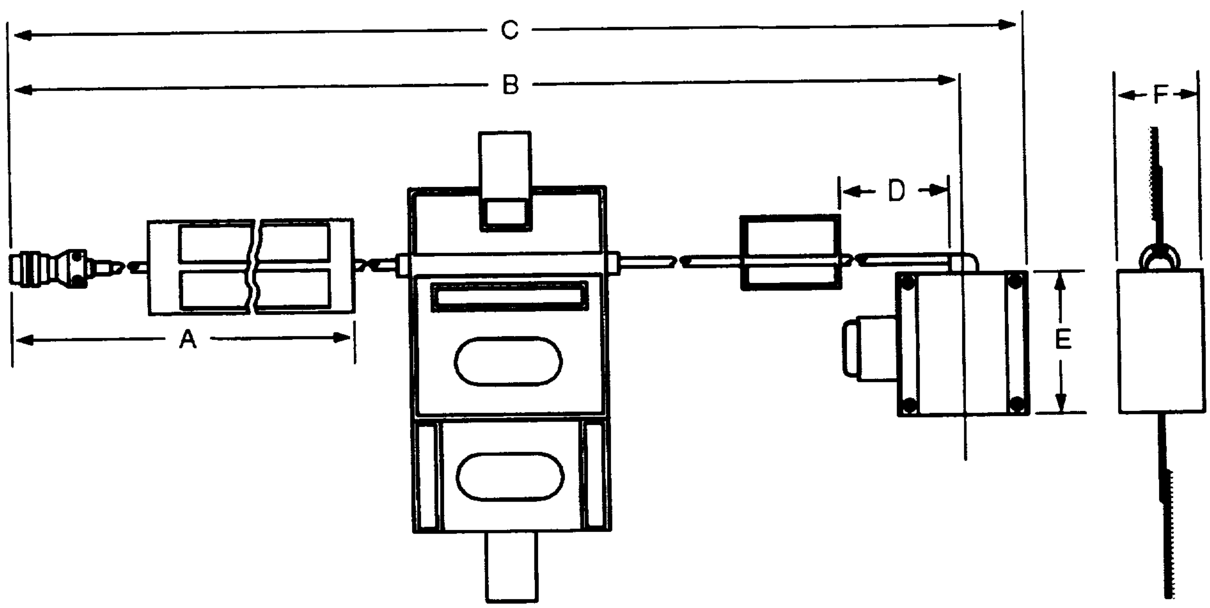
CONTACTS

Operational: R. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

CAMERA ACTUATOR AND CABLE, MMU 35mm

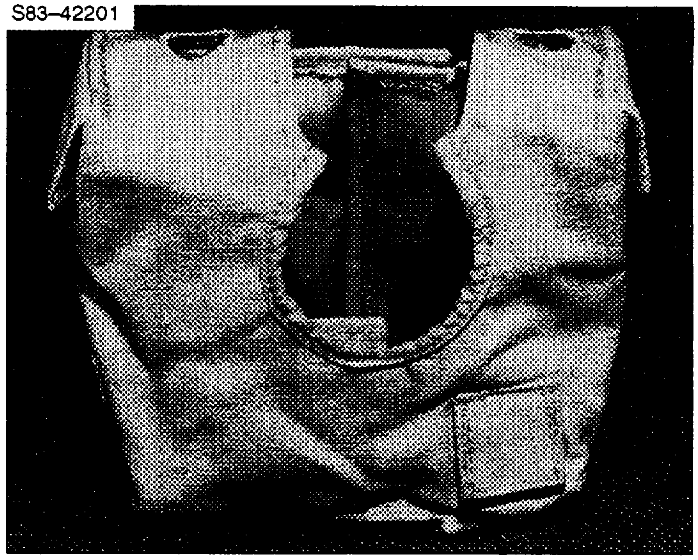
Technical Information	
Part number	SED331102479-301 SED331102479-302
Weight	11.0 oz
Material/ construction	Housing – Aluminum Ortho fabric Velcro Teflon
Load rating	
Temperature range	–130° to +150° F
Quantity flown	**One on STS 41-B**
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	34.38	87.33
B	70.00	177.80
C	71.31	181.13
D	4.25	10.80
E	3.00	7.62
F	1.65	4.19



CAMERA COVER, 35mm

S83-42201



OVERVIEW

The 35mm camera cover is one of two selectable thermal insulation garments that encase the 35mm camera when used for EVA.

OPERATIONAL COMMENTS

The multilayer insulation cover uses 12 layers of aluminized Mylar film as the prime insulation material. The shell is Teflon fabric on the inside and Ortho fabric on the outside. It conforms to the camera shape by means of many flaps which overlap and are secured by Velcro tape. **This cover lacks a tether point and relies upon the camera mount bracket for restraint. A pair of holes cut into the top of this cover allow free winder rotation and use of the shutter release EVA button.** The cover is stowed in a cabin camera bag for scheduled EVA missions.

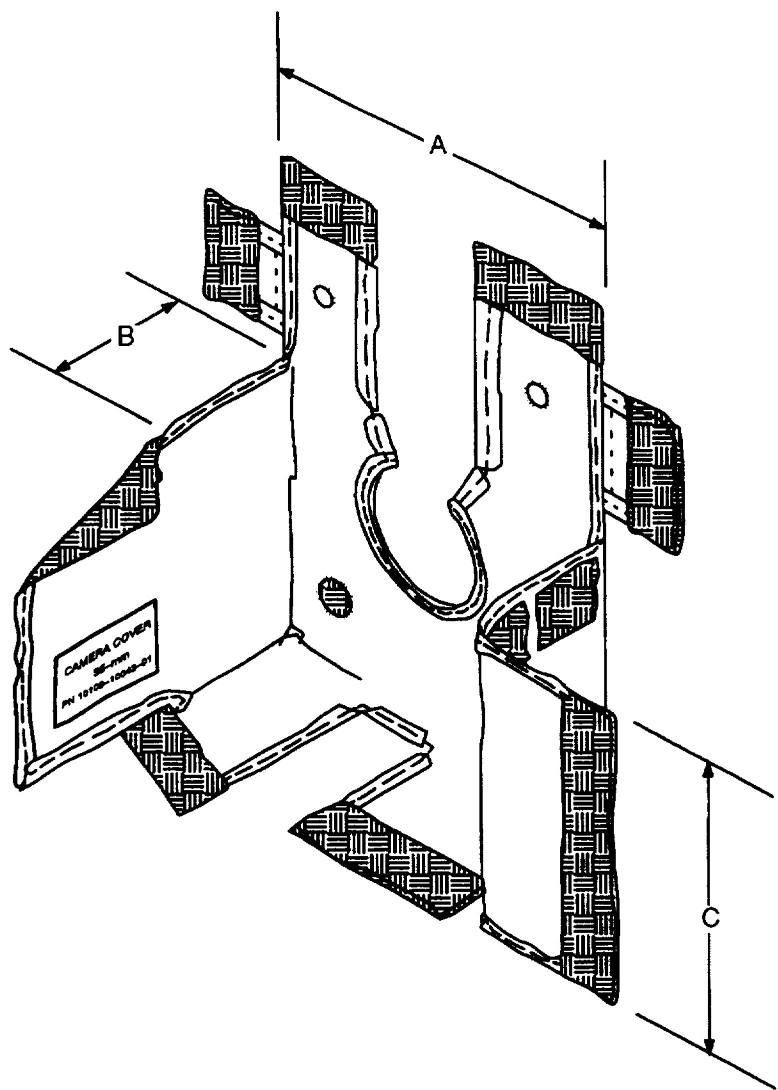
CONTACTS

Operational: J. Alexander, NASA/DF4, (713) 483-2596
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

CAMERA COVER, 35mm

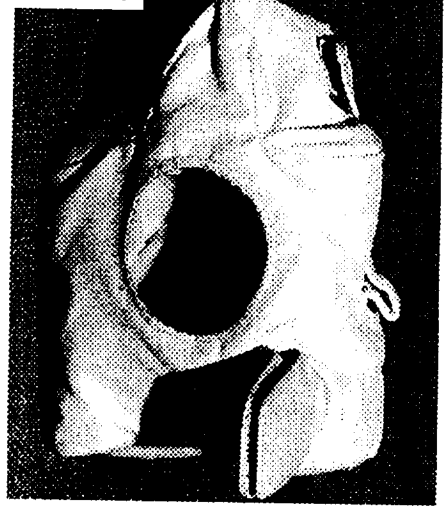
Technical Information	
Part number	10108–10043–01
Weight	0.35 lb.
Material/ construction	Ortho, Teflon, aluminized Mylar, polyester scrim
Load rating	N/A
Temperature range	
Quantity flown	One per EV camera
Stowage	Middeck or **aft flight deck** locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	6.50	16.51
B	2.25	5.62
C	6.00	15.24



CAMERA COVER, MMU 35mm

S83–42148



OVERVIEW

The manned maneuvering unit (MMU) camera cover is one of two thermal garments for the EVA 35mm camera. It was originally designed for use with an MMU mounted camera, but can be used on a loose camera.

OPERATIONAL COMMENTS

The MMU camera cover conforms to the shape of the camera with the aid of Velcro. The multilayer insulation cover uses 12 layers of aluminized Mylar as the prime insulator. The outermost fabric is Ortho; the innermost, Teflon. This is the only camera cover with a built–in tether point. The front flaps protect a remote actuator connector and cable. A pair of holes cut in the top of this cover allow both free winder rotation and visual verification of the camera shutter mode select. It lacks a hole for the shutter release button.

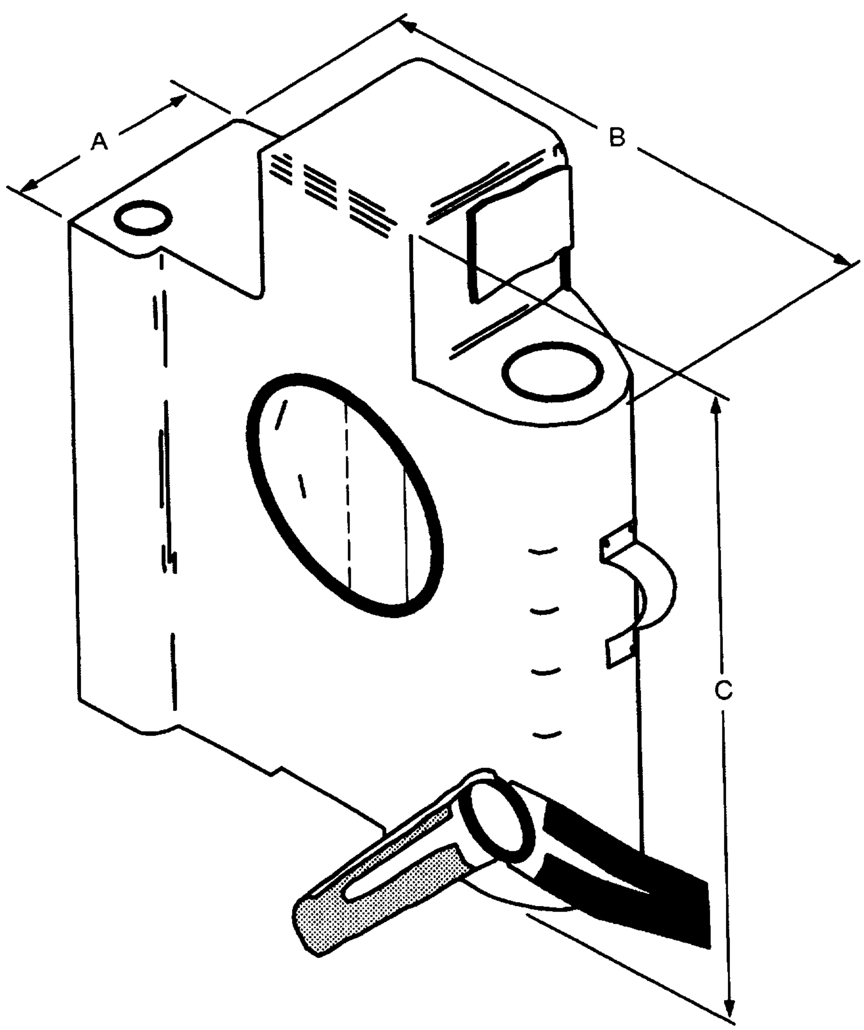
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

CAMERA COVER, MMU 35mm

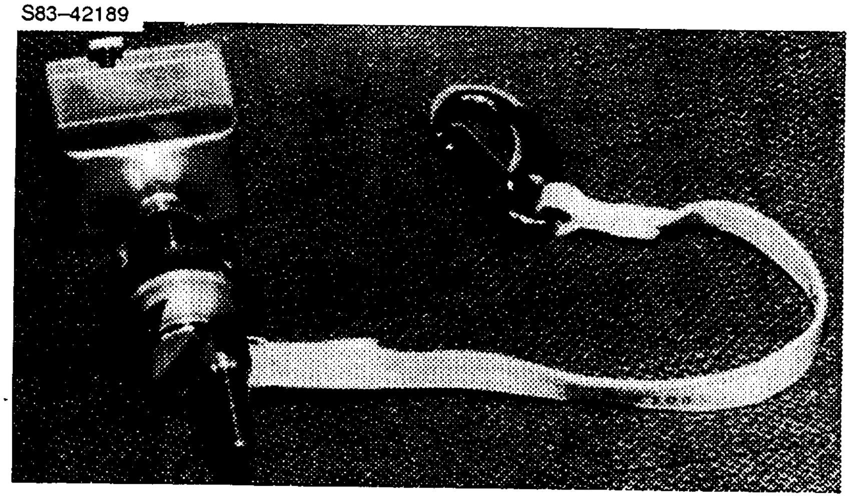
Technical Information	
Part number	10159–10012–02
Weight	6.807 oz
Material/ construction	**Ortho, Teflon, aluminized Mylar, polyester scrim**
Load rating	
Temperature range	
Quantity flown	One for STS 41–B **and 41–G**
Stowage	Middeck **or aft flight deck** locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	2.6	6.60
B	6.0	15.24
C	7.5	19.05



CAMERA MOUNT, 35mm

S83–42189



OVERVIEW

The **35mm** camera mount is used to attach a **35mm** camera to **a tool stanchion and to tether the camera at a worksite with no stanchion.**

OPERATIONAL COMMENTS

The **35mm** camera mount attaches to the MWS **or MFR tool stanchion** by means of **a bayonet fitting** pin **and stanchion mounted socket.** A strap assembly with snap hook extends from the mount to be secured to the work station crossbar.

The **35mm** camera has a male bottom fitting that slides into place on the camera mount and is secured by engaging a pushbutton lock. The mount pedestal supports the camera at a height that allows the crewmember to see through the viewfinder. The crewmember can position the camera at the desired orientation by manipulating the ball socket of the mount pedestal.

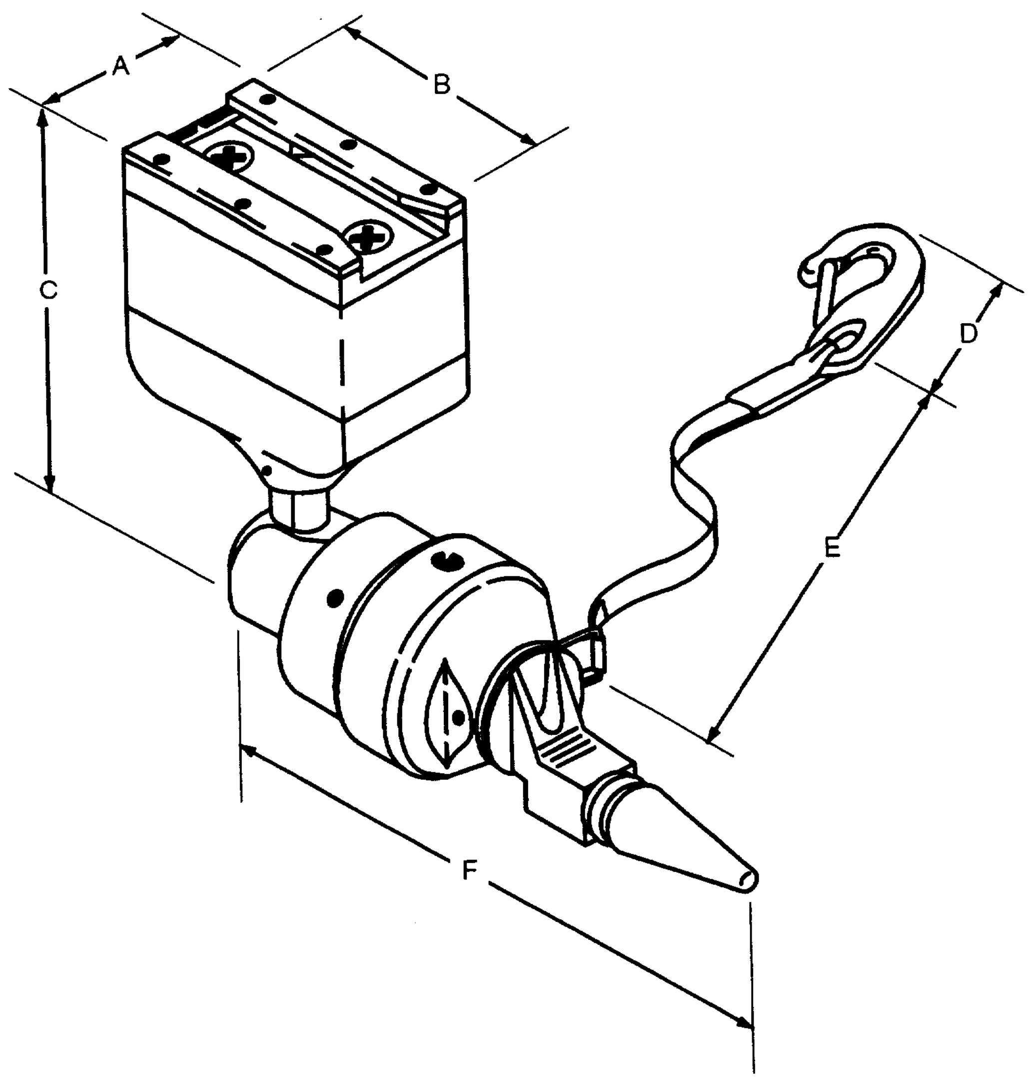
CONTACTS

Operational: J. **Alexander**, NASA/DF4, (713) 483–2596
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

CAMERA MOUNT, 35mm

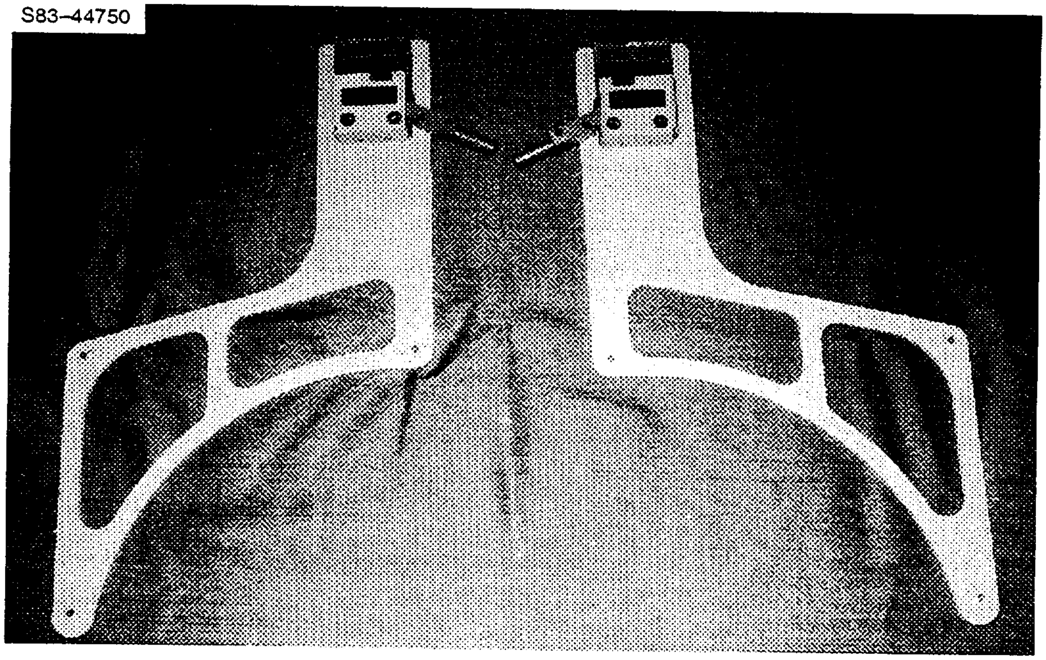
Technical Information	
Part number	10159–10009–02
Weight	1.04 lb
Material/ construction	Aluminum, stainless steel
Load rating	
Temperature range	
Quantity flown	One per EV camera
Stowage	Middeck or aft flight deck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.19	3.02
B	2.04	5.18
C	2.76	7.01
D	2.38	6.05
E	12.00 true length	30.48
F	4.50	11.43



CAMERA MOUNT, MMU 35mm

S83-44750



OVERVIEW

The manned maneuvering unit (MMU) 35mm camera mounts are attachment points for a 35mm camera. The mount can be attached prelaunch to either the right or left side of the MMU, depending upon the stowage position of the MMU in the payload bay.

OPERATIONAL COMMENTS

The mount is bolted to a bracket extending from the MMU, as shown in the picture. The 35mm camera adapter slides into the mount and is locked in place by engaging a spring mechanism in the mount assembly.

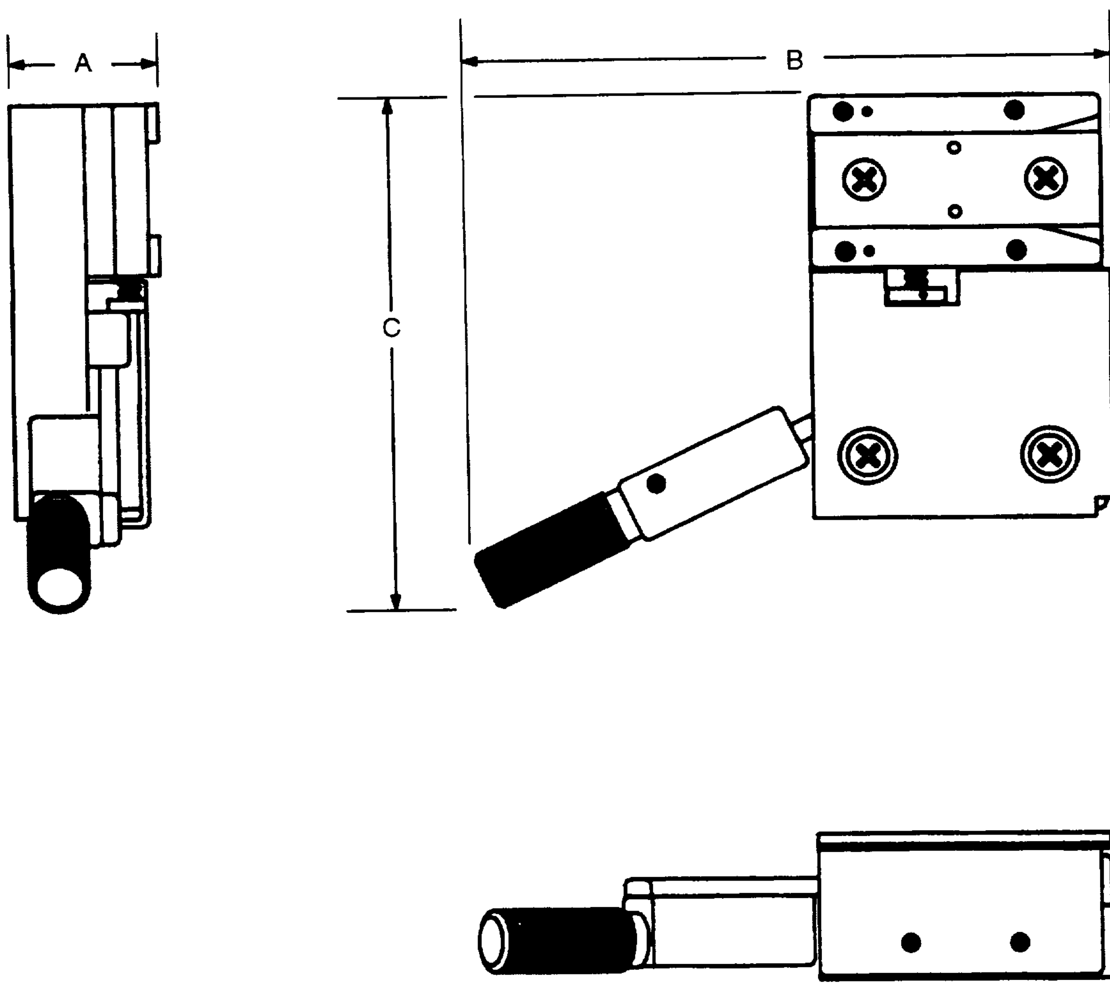
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: **E. Whitsett, NASA JSC/ER, (713) 483-9111**

CAMERA MOUNT, MMU 35mm

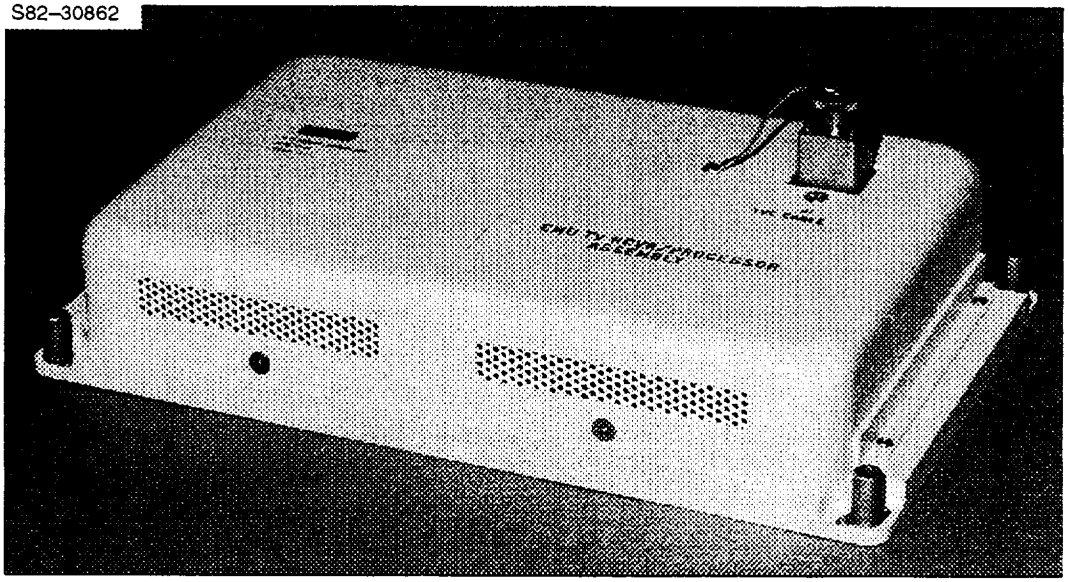
Technical Information	
Part number	SED33102490–301, –302
Weight	0.5 lb
Material/ construction	Aluminum
Load rating	
Temperature range	
Quantity flown	One per MMU
Stowage	MMU
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.02	2.59
B	4.35	11.05
C	3.73	9.47



CAMERA RECEIVER AND VIDEO PROCESSOR, EMU TV

S82–30862



OVERVIEW

The extravehicular mobility unit (EMU) TV receiver and video processor assembly, also called the radio frequency (RF) receiver/video processing unit (VPU), receives video signals from the EMU TV camera and transmitter and provides asynchronous signals for presentation to the closed–circuit television (CCTV) system.

OPERATIONAL COMMENTS

The EMU TV receiver and video processor assembly is mounted in the middeck of the orbiter and is connected preflight to the S–band antenna switch in the orbiter. Before use in flight, the crew must connect the EMU TV receiver and video processor assembly to the TV input station with a prestowed 20–ft long CCTV cable, which also carries the TV picture to the CCTV system. The video processor assembly provides dc/dc conversion and furnishes power to the RF receiver. It receives 28 V dc from the CCTV input station via the same 20–ft cable.

The video processor assembly provides dc restoration of the receiver output and converts the signal to 1 volt peak–to–peak. It also provides a balanced differential output for the CCTV system.

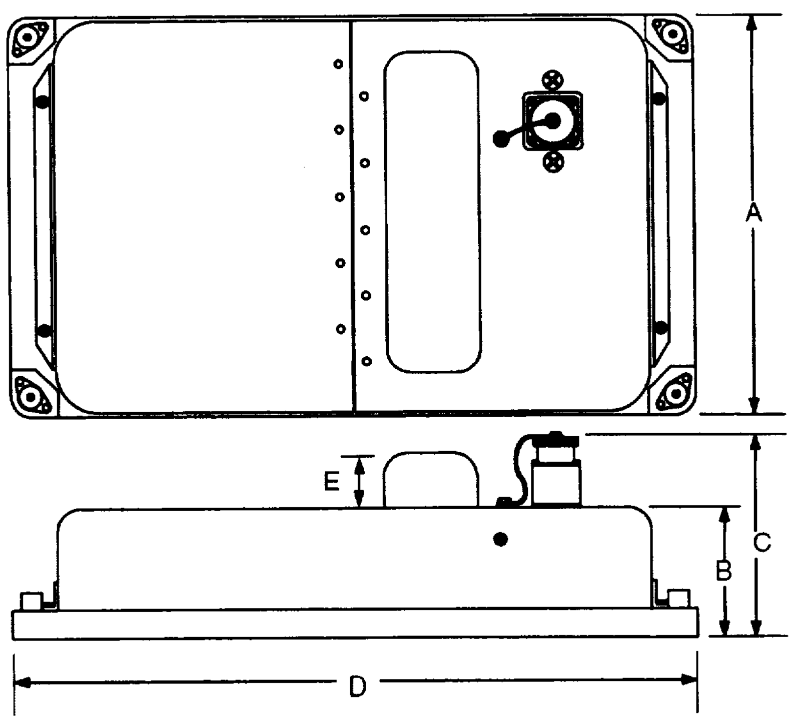
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: B. C. Embrey, Jr., NASA/EE2, (713) 483–0184

CAMERA RECEIVER AND VIDEO PROCESSOR, EMU TV

Technical Information	
Part number	SED18100025-303
Weight	19.4 lb
Material/ construction	Aluminum housing
Load rating	
Temperature range	
Power requirement	28 V dc
Rcvr bandwidth	20 MHz
Quantity flown	One
Stowage	Substitutes for middeck locker MA9N
Availability	Flight specific

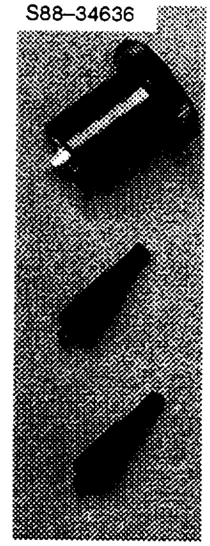
Dimensional Data		
	inches	cm
A	10.755	27.32
B	3.500	8.89
C	5.560	14.12
D	18.125	46.04
E	1.15	2.92



CAMERA, 35mm

S85–41346

S88–34636



OVERVIEW

The 35mm camera used in EVA's is a specially modified Nikon F3HP single–lens reflex with titanium housing. The EVA camera has a permanently attached motor drive, film capacity of up to 72 exposures, a fuse–protected power supply, hermetically sealed battery compartment, **vacuum–compatible lubrication,** and specially tested electronics.

OPERATIONAL COMMENTS

The 35mm camera requires a special long–eye viewfinder with large exit pupil for use in EVA. An EVA kit provides tab extenders to allow operation of the shutter release and focus and aperture rings with extravehicular mobility unit (EMU) gloves. **Since the focus and f–stop tabs are easily snagged or bumped, sometimes the settings are fixed with tape and the tabs are omitted. The preferred** databack imprints different combinations of time, date, and frame number **between frames** as photos are taken. An ultraviolet filter is used to reduce the film's excessive blue response to ultraviolet (UV) radiation. Special EVA film, Ektachrome 64 with 65 exposures, **was** used **formerly, but now Ektar with only 36 frames is typically selected.** The camera is protected for EVA use by **either of two** special thermal covers.

A bracket mounts to the camera base for tool–stanchion mounting and for tethering the camera locally. When the crewmember using the camera is not in foot restraints, it is difficult to get a steady shot because of the two–handed nature of this design.

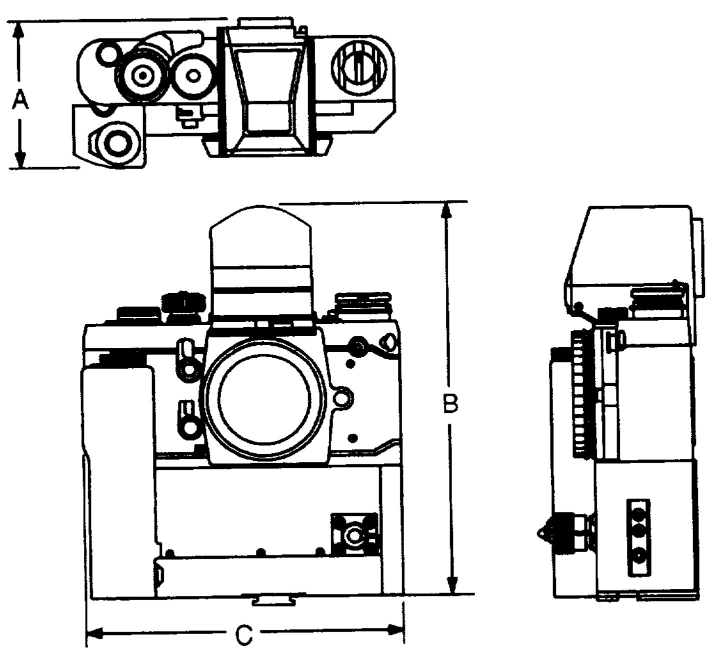
CONTACTS

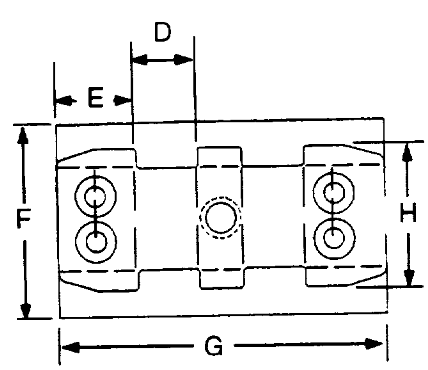
Operational: J. **Alexander,** NASA/DF4, (713) 483–2596
Technical: J. Ragan, NASA/SP4, (713) 483–3646

CAMERA, 35mm

Technical Information	
Part number	SED33101585–303, modified 35mm Nikon F3HP
Weight	3.2 lb, body only; **0.7 lb, battery pack**
Viewfinder	SED33101574–301, long–eye, large exit pupil
Battery pack	SED33101573–301
EVA kit	SED33102478–301, tab extenders for focus, aperture, and shutter release
Databack	SED33101588–304, year–month–day or hours–minutes–seconds or frame number (vertically between frames)
UV haze filter	**SED33102477–301**
Quick mount shoe	**SDD33103310–002**
Film	**SED33101564–301**
Film container	**SED33101586–302**
35mm lens	SED33101579–302, mild wide angle, little distortion
28mm lens	SED33101583–302, medium wide angle, moderate distortion
16mm lens	SED33103387–301, very wide angle
Material/ construction	
Load rating	
Temperature range	**–15° to +100° F (with thermal cover)**
Quantity flown	
Stowage	Middeck **or aft flight deck** locker
Availability	Camera – Standard, EVA **accessories** – Flight specific

Dimensional Data		
	inches	cm
A	2.89	7.34
B	7.5	19.05
C	5.97	15.16
D	0.375	0.953
E	0.490	1.245
F	1.184	3.007
G	2.000	5.08
H	0.86	2.18

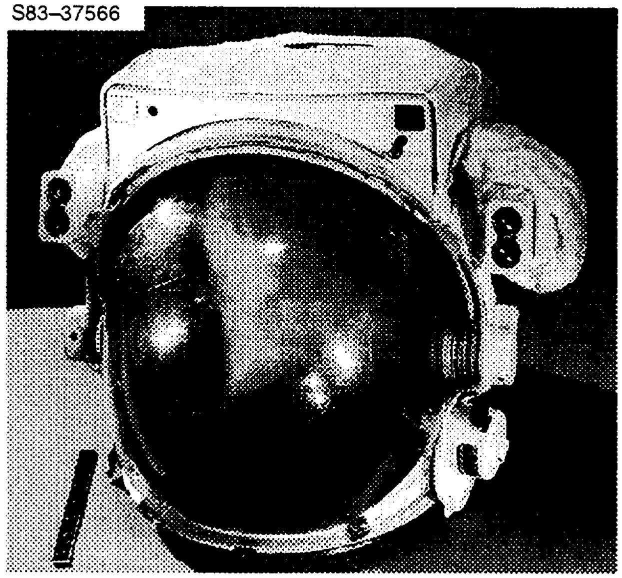




Quick mount shoe

CAMERA, EMU TV

S83–37566



OVERVIEW

The extravehicular mobility unit (EMU) TV is a helmet–mounted, solid–state color TV camera that provides real–time scenes from the approximate point of view of the crewmember. It was originally designed to support in–flight orbiter tile repair. The EMU TV comprises a small TV camera, closeup lens, battery pack, on–off switch, radio frequency (RF) antenna, an S–band transmitter, and a low–voltage cutoff circuit. The battery pack of eight cells is removable and can supply power for about 6 hr. The orbiter receives the RF TV transmission through its upper or lower S–band hemi antennas from one TV at a time and relays the signals to the closed circuit television system for display, recording, or transmission to the ground.

OPERATIONAL COMMENTS

The EMU TV power on/off pushbutton switch is located on the forward right–hand side of the housing. The flush mounting of this switch precludes tether snags but results in limited tactile feedback. A green light–emitting diode indicator is located to the left of the on/off pushbutton and can be difficult to see illuminated with varying on–orbit lighting. The normal EMU TV lens provides for viewing objects 36 in. to 25 ft away. The closeup lens allows for viewing objects 12 in. to 36 in. away. The lens is mounted on a movable bracket and can be moved into place using a hand–operated switch located on the forward left side, just below the TV lens opening (up for closeup, down for distant viewing). The camera field–of–view is 7° below the horizontal. The TV mounts to the EMU helmet by attachment receptacles on the EMU lights. If more than one TV is flown, only one can be active at a time or the combined signals will allow neither to provide useful images. In–cabin checkout is limited to rough signal reception, because clear images are precluded by vehicle structure between the TV and the external antennas. Future enhancements include an upgraded transmitter.

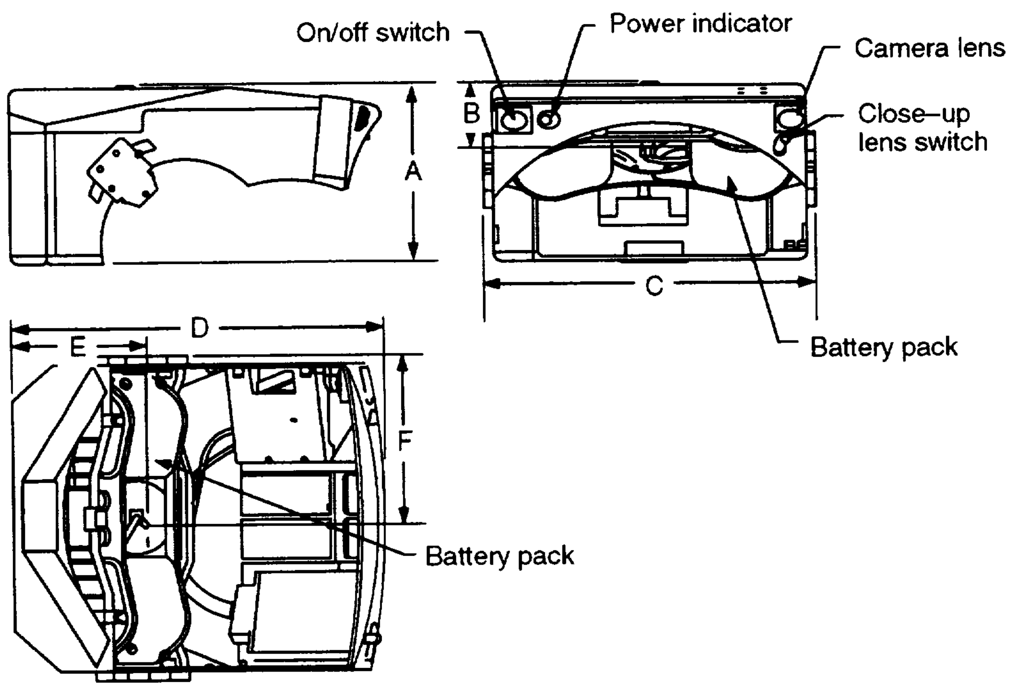
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: B. C. Embrey, Jr., NASA/EE2, (713) 483–0184

CAMERA, EMU TV

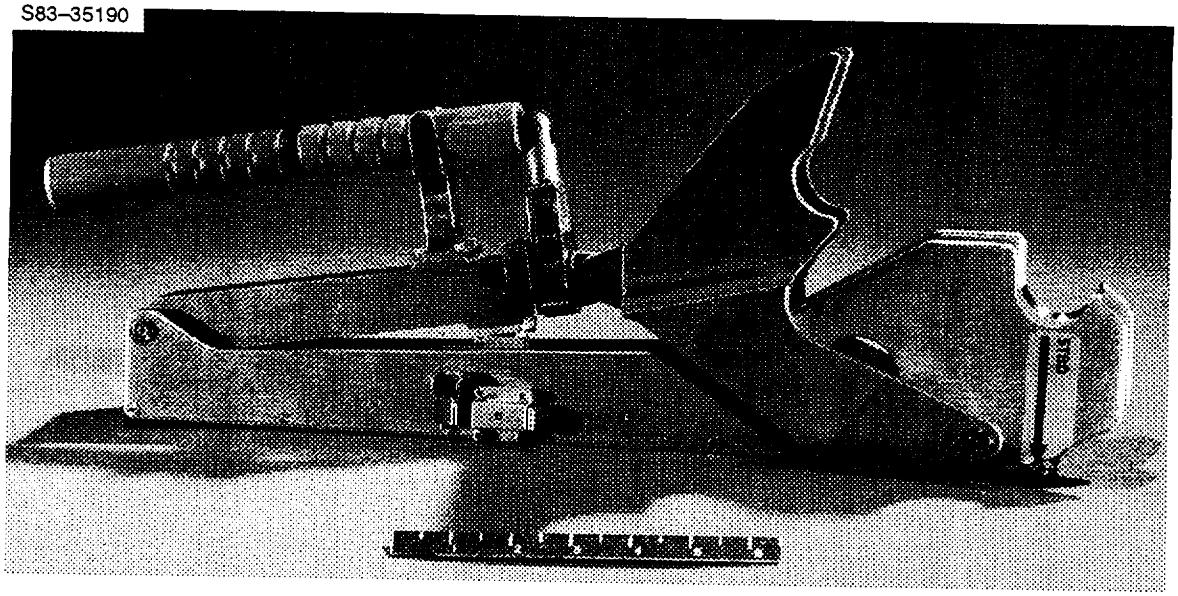
Technical Information	
Part number	SED18100247–306
Weight	11.0 lb (with battery)
Material/ construction	Aluminum housing
Field of view	32° horizontal scan, 25° vertical scan
Lens	19.7 mm
Normal viewing	36 in. to 25 ft
Closeup viewing	12 in. to 36 in.
TV transmission range	500 ft (minimum)
Transmission signal	2250 MHz at 1.0 watt
Auto light control	5–16K foot–candles
Battery duration	Up to 8 hr fully charged
Load rating	
Temperature range	
Quantity flown	1 or 2
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	6.02	15.29
B	2.38	6.05
C	10.77	27.36
D	12.09	30.71
E	4.20	10.67
F	5.60	14.22



CENTERLINE LATCH BYPASS TOOL

S83–35190



OVERVIEW

The centerline latch bypass tool consists of spring–loaded and fixed–load pickup points, a reversible ratchet with stowable handle, and release triggers that have a safety to prevent accidental release.

OPERATIONAL COMMENTS

The centerline latch tool is used to bypass a failed cargo bay door centerline latch. This tool is designed to exactly duplicate the nominal latch loads on the latch hook and roller. The frame of the tool fits over the latch hook pivot. With the frame held firmly in place, the tool latch is released, which in turn captures the latch roller. **The** tool handle is rotated to an upright position, and the drive is ratcheted to a hard stop, loading the tool and securing the latch. **Green on the ratchet selector indicates tool installation, red means tool removal.** Two of these tools are part of the normally manifested orbiter equipment. Four tools would be flown for the first two flights of a new orbiter **or on flights following a major payload bay door overhaul**. They are stowed in the centerline latch tool bag in the port provisions stowage assembly (PSA).

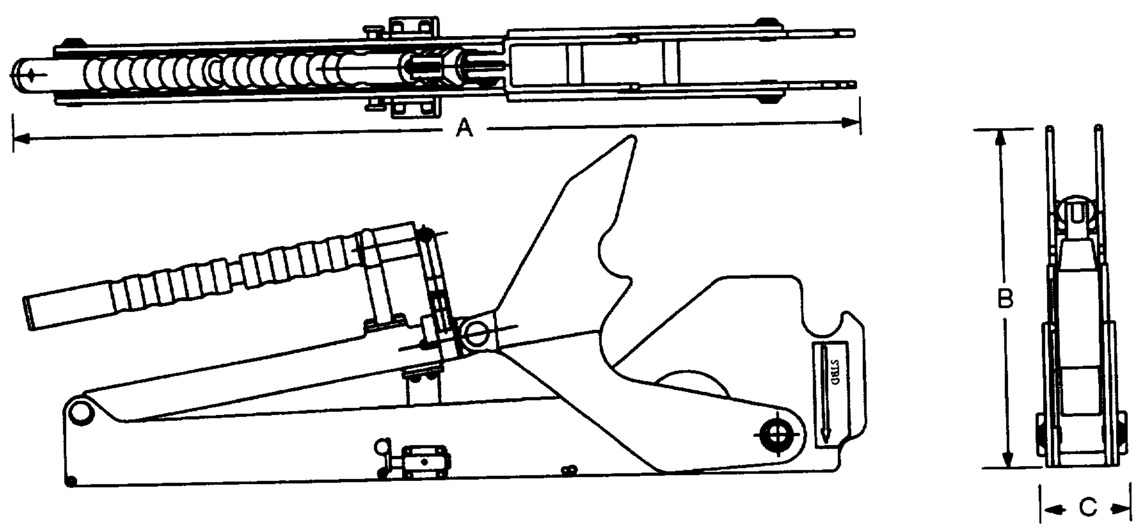
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: **N. Gonzalez**, NASA/ES6, (713) 483–8944

CENTERLINE LATCH BYPASS TOOL

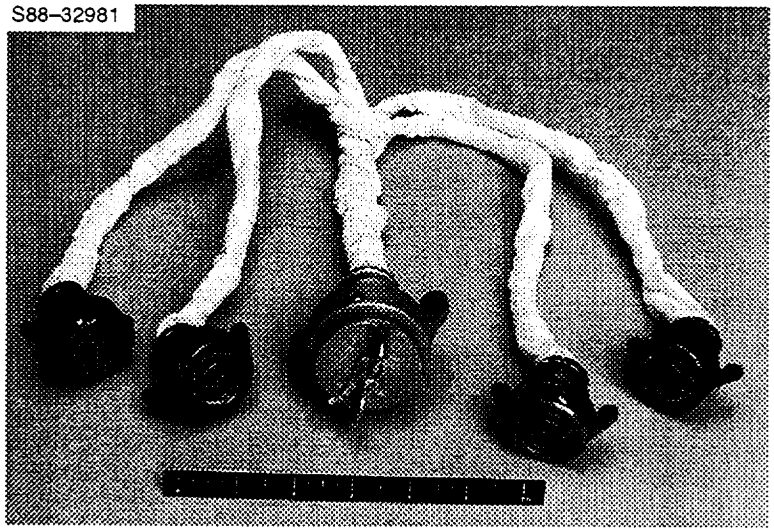
Technical Information	
Part number	SED3310621–305
Weight	11.45 lb
Material/ construction	4340 steel, nickel–plated
Load rating	**12691 lb (outboard)** **48 lb (downward)**
Temperature range	**–250° to 275° F**
Quantity flown	Two stowed in port PSA
Stowage	
Availability	Standard

Dimensional Data		
	inches	cm
A	19.60	49.78
B	7.45	18.92
C	2.49	6.32



CONNECTOR AND CAP, WING TAB

S88–32981



OVERVIEW

The wing tab connector and cap assembly is an electrical circular connector with added features for EVA protection and function. These features include a high profile adapter wing, integral strain relief, and winged dust cap.

OPERATIONAL COMMENTS

Existing connector configuration is fabricated to specific end–use needs for the EVA power package. However, the assembly piece parts can be designed for qualification to any desired system application.

The adapter wing provides grip ease for suited operation. The adapter enlarges the overall connector diameter to accommodate the limited dexterity of the gloved hand.

The strain relief is a coned piece that screws directly to the connector and protects the electrical connection from direct application of force. The cone provides a receptacle for encapsulation, which seals the cable/connector juncture and directs pull force to the strain relief and cable rather than the electrical connections.

A winged dust cap provides protection to the exposed pins in the connector. The wings allow easy installation and removal by a gloved hand.

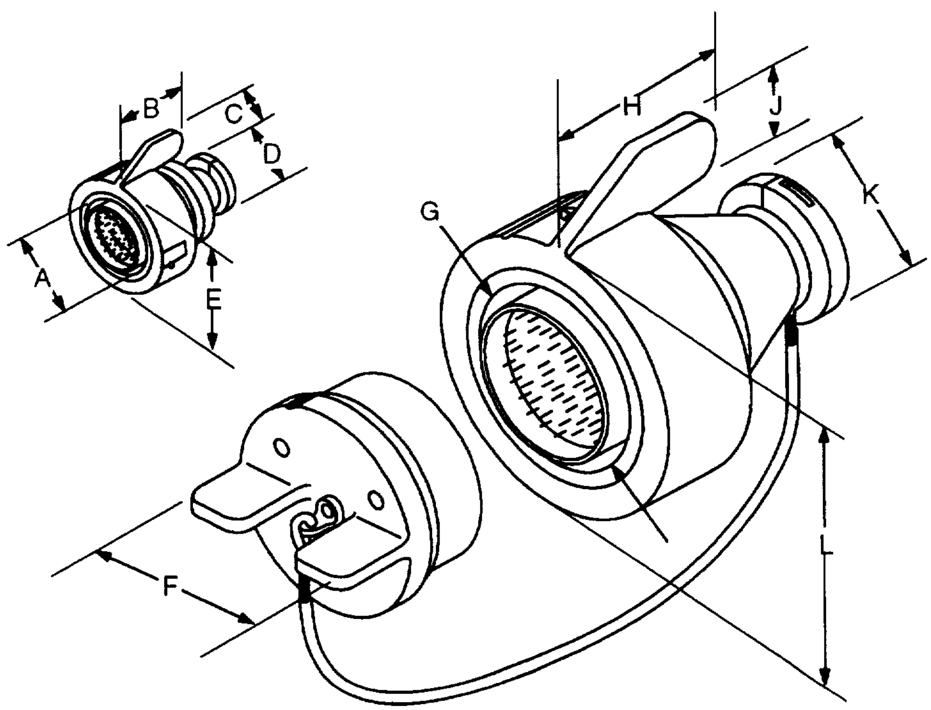
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

CONNECTOR AND CAP, WING TAB

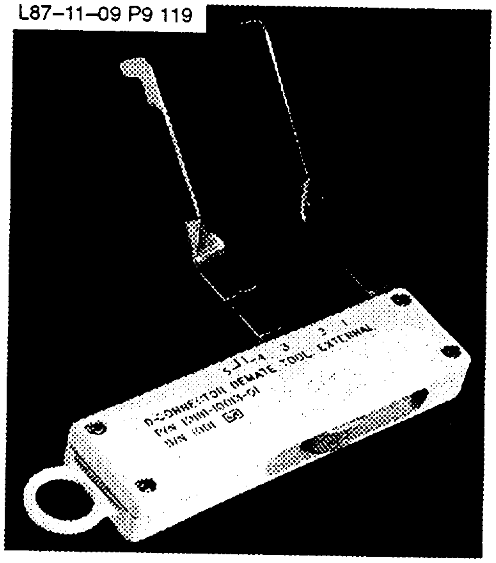
Technical Information	
Part number	10175-20024-01 (large and small connectors) 10175-20031-01 (large dust cap)
Weight	0.40 lb (large connector) 0.20 lb (small connector)
Material/ construction	Aluminum
Load rating	
Temperature range	-130° to +150° F
Dust cap lanyard length	8.0 in.
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.08	2.74
B	0.97	2.46
C	0.35	0.89
D	0.83	2.11
E	1.62	4.11
F	1.88	4.78
G	1.69	4.29
H	1.50	3.81
J	0.56	1.42
K	1.06	2.69
L	2.00	5.08

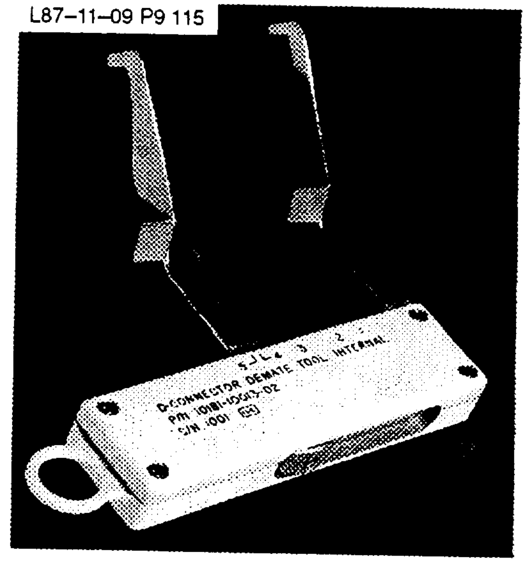


CONNECTOR DEMATE TOOL, D

L87–11–09 P9 119



L87–11–09 P9 115



OVERVIEW

The external D–connector demate tool (10181–10013–01) is used for removal of electrical connectors on the Hubble Space Telescope (HST) that are mounted with external flanges. The internal D–connector demate tool (10181–10013–02) is used for removal of electrical connectors on the HST that are mounted with internal flanges. The blades are adjustable for removal of 9–, 15–, 25–, 37–, and 50–pin D–connectors.

OPERATIONAL COMMENTS

These tools are suitable for one–handed removal of electrical connectors by a suited crewmember. The tools consist of a handle and two L–shaped hook blades that extend from the handle. The L–shaped blade design allows access to hard–to–reach areas. One of the blades can be moved along the handle length by simultaneously depressing and sliding the button on the handle face. The hooks on the ends of the blades are positioned under the connector flange in order to pry the connector loose. Each of the blades can be rotated 180° so the tool can be used in confined areas with obstructions on either the left or right sides of the connectors.

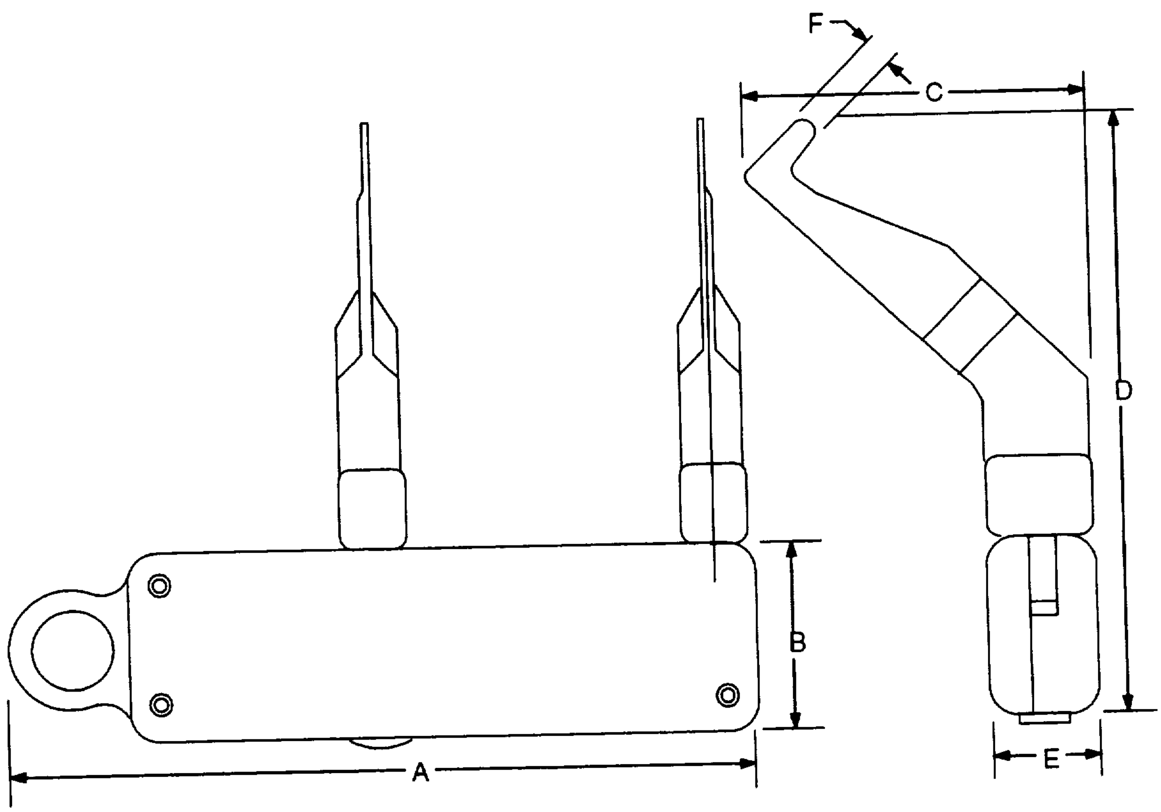
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

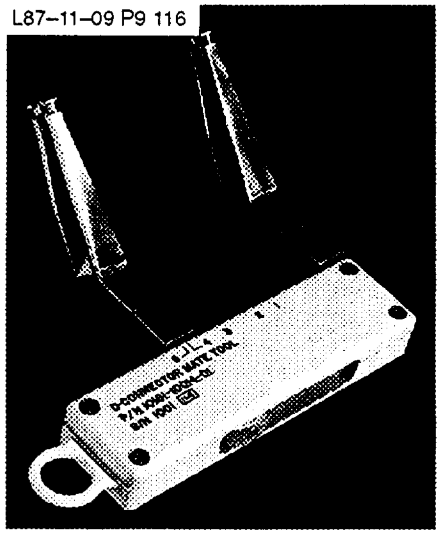
CONNECTOR DEMATE TOOL, D

Technical Information	
Part number	10181–10013–01 External 10181–10013–02 Internal
Weight	0.73 lb
Material/ construction	Stainless steel Aluminum
Distance between prong hooks	Position 1 0.800 in. 2 1.125 in. 3 1.671 in. 4 2.210 in. 5 2.315 in.
Load rating	**29.5/35.8 lb (use/proof)**
Temperature range	–150° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific, existing units reserved for HST

Dimensional Data		
	inches	cm
A	5.700	14.48
B	1.380	3.51
C	2.550	6.35
D	4.930	12.52
E	0.750	1.91
F	0.235 (–01) 0.172 (–02)	0.60 0.44



CONNECTOR MATE TOOL, D



L87–11–09 P9 116

OVERVIEW

The D–connector mate tool is used for installation of electrical connectors on the Hubble Space Telescope (HST). The tool is adjustable to fit 9–, 15–, 25–, 37–, and 50–pin D–connectors.

OPERATIONAL COMMENTS

The D–connector mate tool is suitable for one–handed operation. The tool consists of a handle and two I–shaped blades that extend from the handle. One of the blades can be moved along the handle length by simultaneously depressing and sliding the button on the handle face. The blade ends are shaped to grip the flanged ends of the connectors. Each blade can be rotated 180° so that the tool can be used in confined areas with obstructions on either the left or right sides of the connectors. The blade ends are positioned over the connector to secure it as it is put into place.

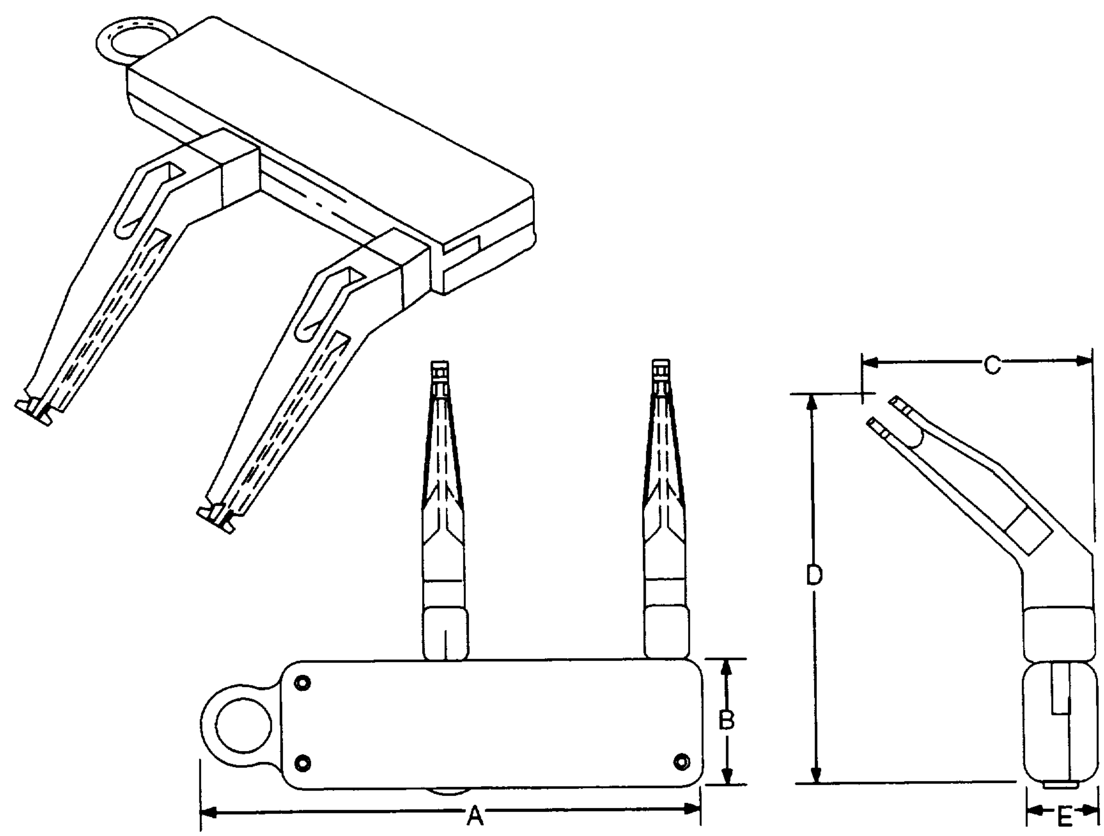
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

CONNECTOR MATE TOOL, D

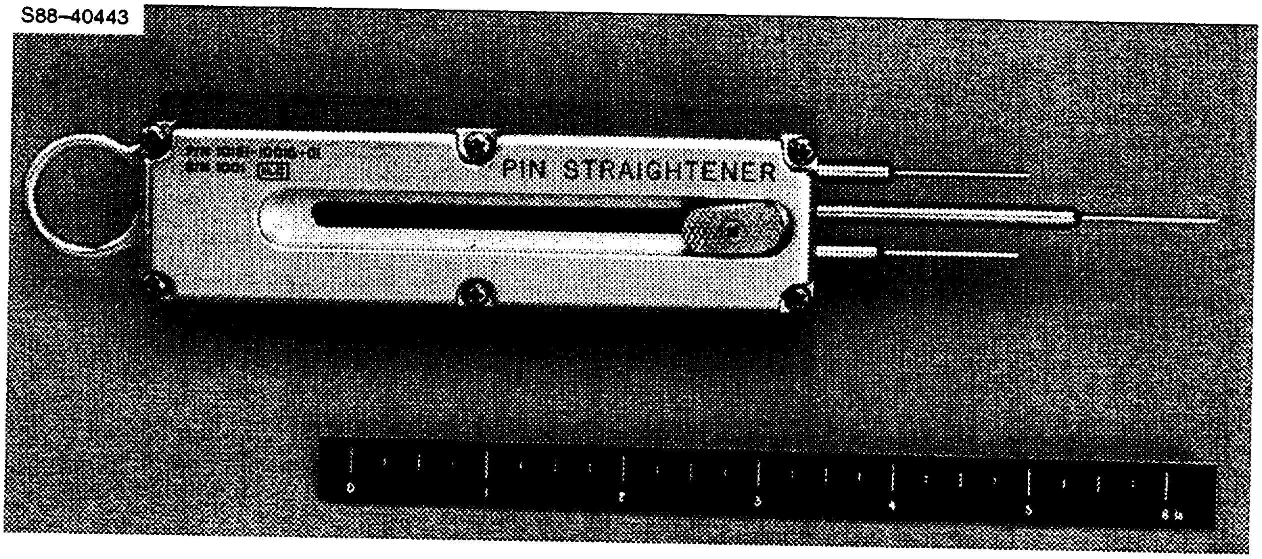
Technical Information	
Part number	10181–10014–01
Weight	**0.80** lb
Material/ construction	Aluminum Stainless steel
Distance between prong hooks	1 1.230 in. 2 1.550 in. 3 2.100 in. 4 2.650 in. 5 2.736 in.
Load rating	29.5/35.8 lb (use/proof)
Temperature range	–150° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific, existing units reserved for HST

Dimensional Data		
	inches	cm
A	5.70	14.48
B	1.38	3.51
C	2.49	6.32
D	**4.87**	12.14
E	0.75	1.91



CONNECTOR PIN STRAIGHTENER, MULTISIZE

S88–40443



OVERVIEW

The multisize electrical connector pin straightener is a tool for straightening bent pins in electrical connectors on the Hubble Space Telescope (HST). It consists of three metal shafts, two of one diameter and one of a smaller diameter, recessed within an aluminum box. The pins are extended as needed during EVA. There is a tether ring to secure the tool to the worksite or crewmember.

OPERATIONAL COMMENTS

The smaller shaft of the electrical connector pin straightener accommodates 22–gauge pins. The larger shaft accommodates 20–gauge pins. Each shaft works independently of the others. The crewmember can extend any of the shafts by simultaneously depressing and sliding its button forward. The bent connector pin is inserted into the extended shaft of the straightener to the apex of the bend. The crewmember then carefully works the bend out of the pin by applying pressure in the direction opposite from the bend. The shaft lengths may be adjusted as needed to accomplish the straightening process.

In the latest version (–02) to be flown on STS–61, the center shaft has been replaced with a probe that serves as a contingency tool to help free a troublesome drop proof tether mechanism.

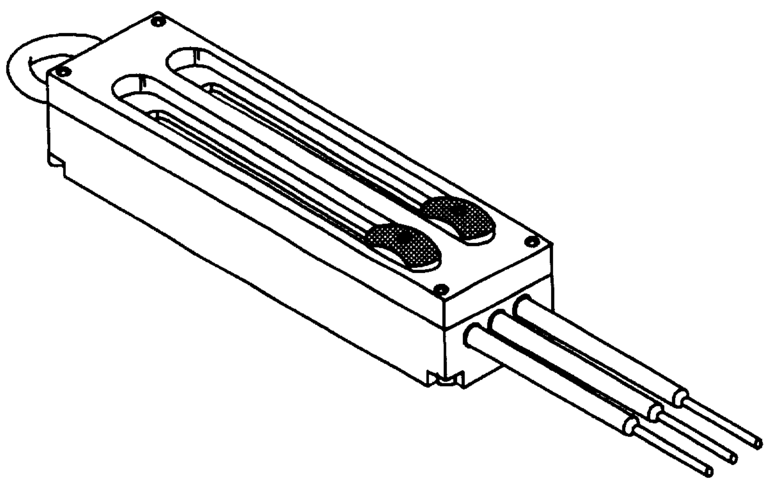
CONTACTS

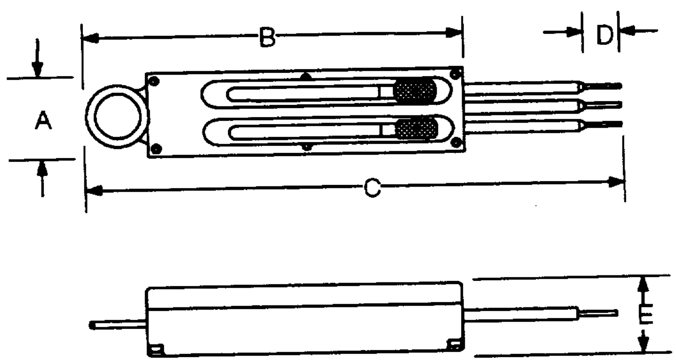
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

CONNECTOR PIN STRAIGHTENER, MULTISIZE

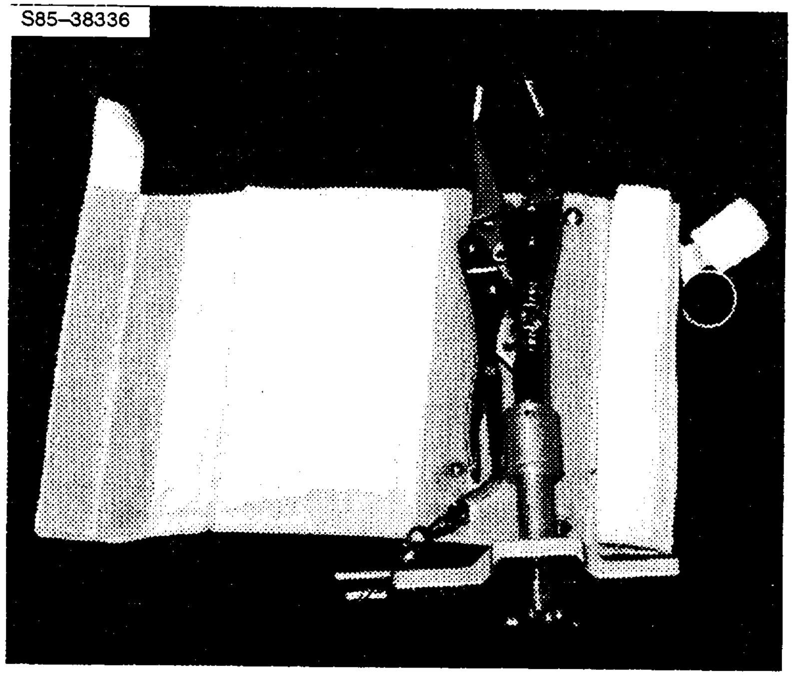
Technical Information	
Part number	10181–10015–01/02
Weight	0.60 lb
Material/ construction	Pin slides: Stainless steel Housing: Aluminum Knobs: Knurled aluminum
Load rating	
Temperature range	–150° to +250° F
Straightener characteristics	Depth 0.500 ID 0.042 (outer blades) 0.032 (center blade) OD 0.680
Quantity flown	
Stowage	
Availability	Flight specific, existing units reserved for HST

Dimensional Data		
	inches	cm
A	1.38	3.51
B	5.94	15.09
C	8.90	22.61
D	1.00	2.54
E	1.27	3.23





CONNECTOR TOOL, CIRCULAR



OVERVIEW

The electrical circular connector tool is a 7–in. Vise–grip tool modified for removal and installation of circular electrical connectors, flight dustcaps, and flight plugs on satellites.

OPERATIONAL COMMENTS

The electrical circular connector tool requires two hands for proper adjustment but one hand for actual clamping. The extended jaws allow the user to work in deep, close areas where connectors are found. Clamping force is limited to 10 lb to prevent damage to the electrical connectors. While the jaws are open, they are adjusted over the connector. Once contact is made, the handles are then clamped into the locked position.

This tool was used successfully on STS 51–I, the LEASAT Salvage Mission, to remove flight caps and shorting plugs from connectors on the Syncom F–3 spacecraft.

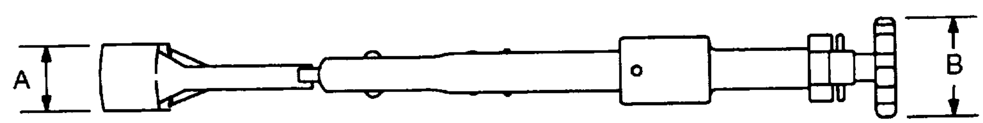
CONTACTS

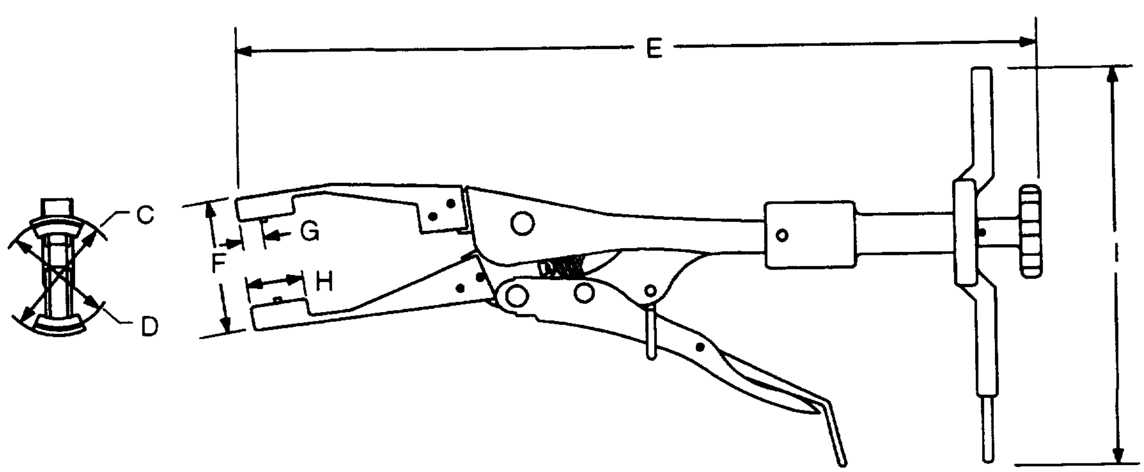
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. Marak, NASA/EC5,** (713) **483–9144**

CONNECTOR TOOL, CIRCULAR

Technical Information	
Part number	10176–20100–01
Weight	1.27 lb
Material/ construction	Aluminum, stainless steel
Load rating	40 in–lb clamp torque 10 lb maximum clamp force
Temperature range	**–60° to +180° F (operational)** **–95° to +180° F (stowage)**
Min. connector dia	0.5 in.
Max. connector dia	1.875 in.
Quantity flown	Two on STS 51–I
Stowage	Tool caddy no. 3 on STS 51–I
Availability	Flight specific

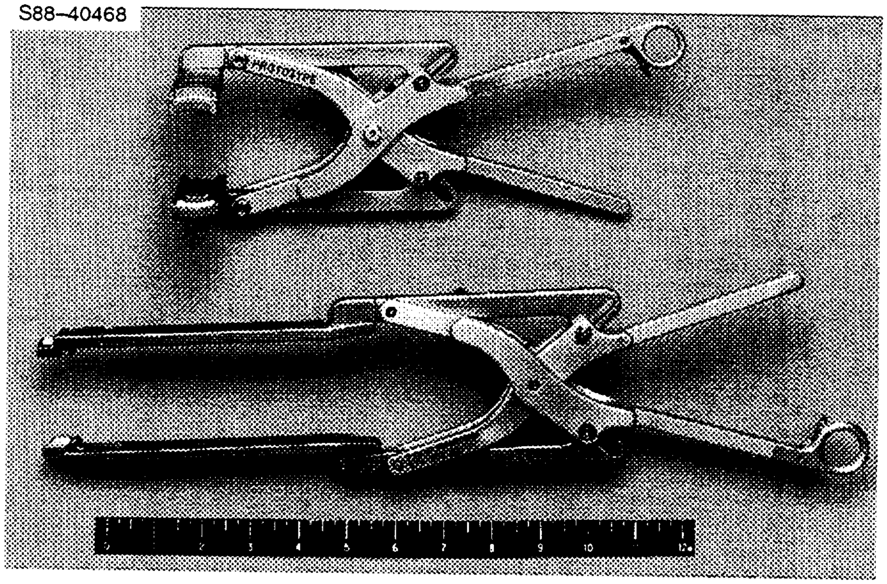
Dimensional Data		
	inches	cm
A	1.000	2.54
B	1.500	3.81
C	2.060	5.23
D	1.875	4.76
E	12.125	30.80
F	2.060	5.23
G	0.380	0.97
H	0.880	2.24
I	6.000	15.24





CONNECTOR TOOL, CIRCULAR (HST)

S88–40468



OVERVIEW

The 0° circular connector tool (10159–10036–01) and the 90° circular connector tool (10159–10036–02) were originally developed for Centaur satellite–type electrical connectors. They have been designed for use on Hubble Space Telescope (HST) circular type connectors. The tools are used to install or remove connectors ranging from 1/2 in. to 2 in. in diameter.

OPERATIONAL COMMENTS

The 0° and 90° circular connector tools design utilizes parallel jaw action to grip the connectors. The crewmember can secure either tool as desired using the integral tether ring on the handle. A locking feature to hold the tool closed is incorporated into the handle for stowage purposes. The jaw surfaces are lined with silicone rubber to minimize abrasion of the connectors. A spring–loaded retractable shoulder in each jaw aids connector installation.

The 90° circular connector tool is designed to simplify access to recessed connectors. The jaws extend at a 90° angle from the handle and are manipulated by parallel jaw action as the crewmember squeezes the handles together.

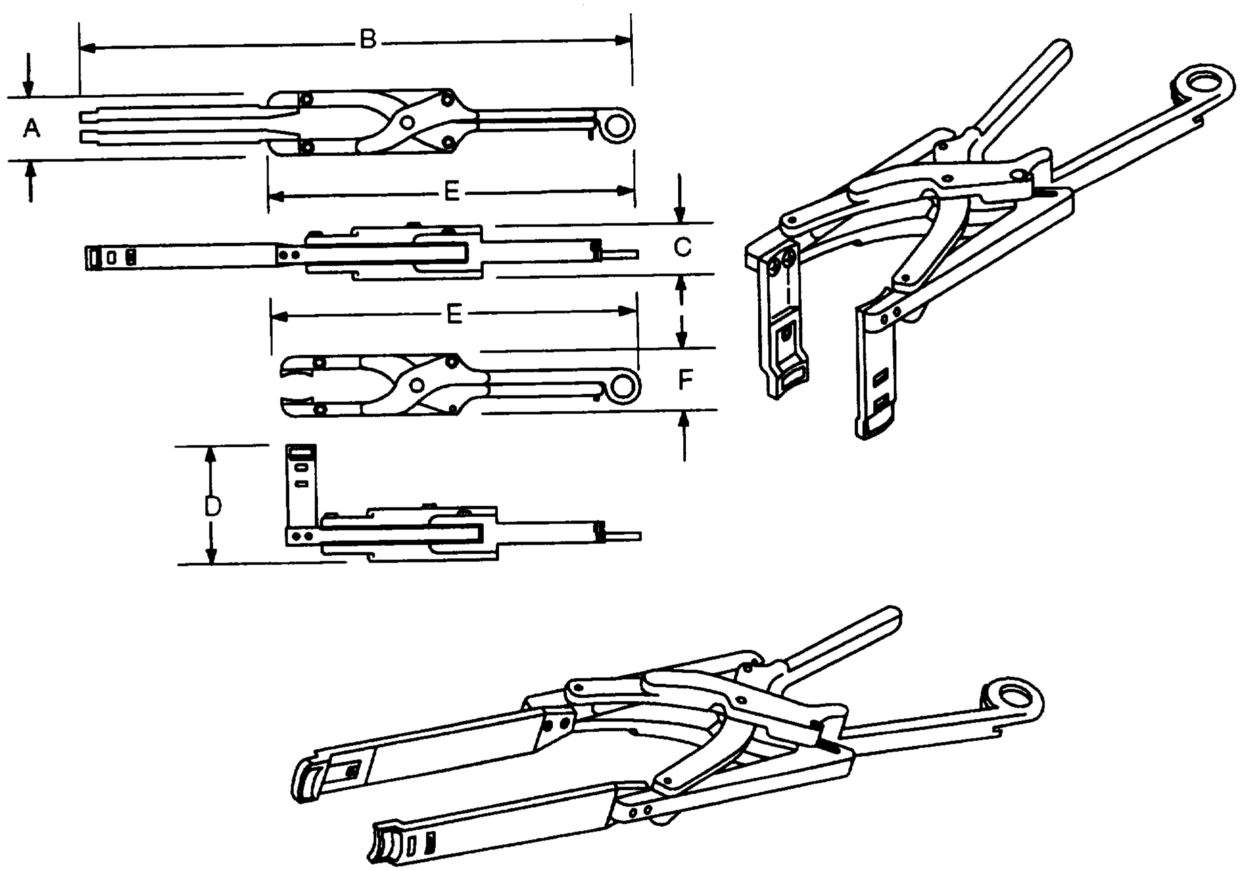
CONTACTS:

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

CONNECTOR TOOL, CIRCULAR (HST)

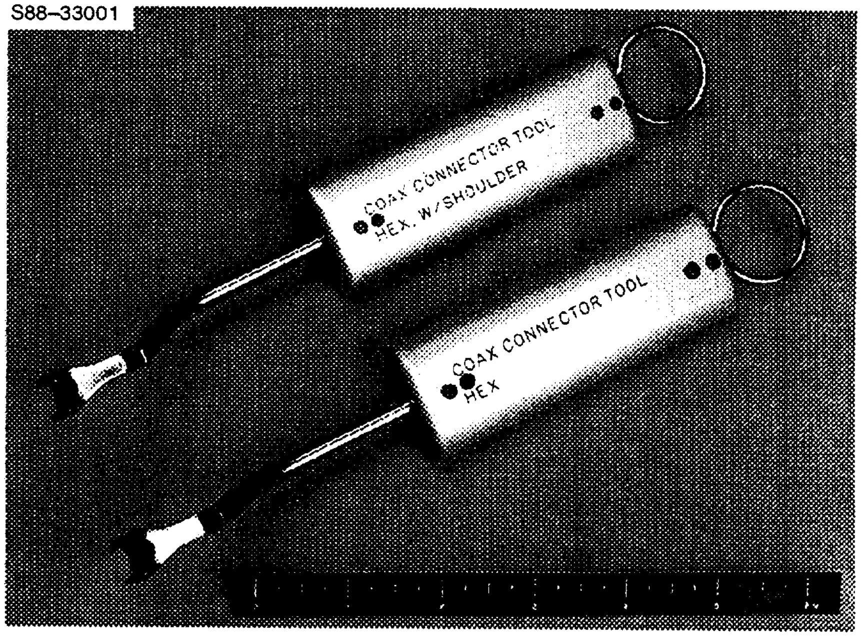
Technical Information	
Part number	10159–10036–01 (0°) 10159–10036–02 (90°)
Weight	10159–10036–01 2.19 lb 10159–10036–02 1.75 lb
Material/ construction	Jaw cushion – Silastic "E" rubber Jaw – Stainless steel Handle – Aluminum Washer – Vespel
Load rating (use/proof)	**23/28 in–lb**
Temperature range	–150° to +250° F (operational)
Jaw opening	10159–10036–01 0.5 to 1.85 in. 10159–10036–02 0.5 to 1.90 in.
Minimum grip	0.573 in.
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

Dimensional Data		
	inches	cm
A	2.00	5.08
B	17.65	44.83
C	1.74	4.42
D	4.00	10.16
E	11.65	29.59
F	2.00	5.08



CONNECTOR TOOL, COAX

S88–33001



OVERVIEW

The coax connector tools have been designed for use on the Hubble Space Telescope (HST). They are used to install and remove 5/16–in. hex coax connectors. The coax connector tool (10181–10011–01) is specially designed without a shoulder to enable mating with those connectors having shrink tubing relief. The coax connector tool with shoulder (10181–10011–02) has an integral shoulder that allows improved connector seating pressure when installing connectors that have adequate clearance.

OPERATIONAL COMMENTS

The coax connector tools have a special shaft shaped to provide greater accessibility to confined areas. The handle design is similar in cross section to that of the standard handrail tubing so that the crewmember can grasp the tool securely. **The handles lack Velcro for particulate contamination prevention**. Crewmembers can tether the tool to their workstations or to themselves using the tether ring on the handle.

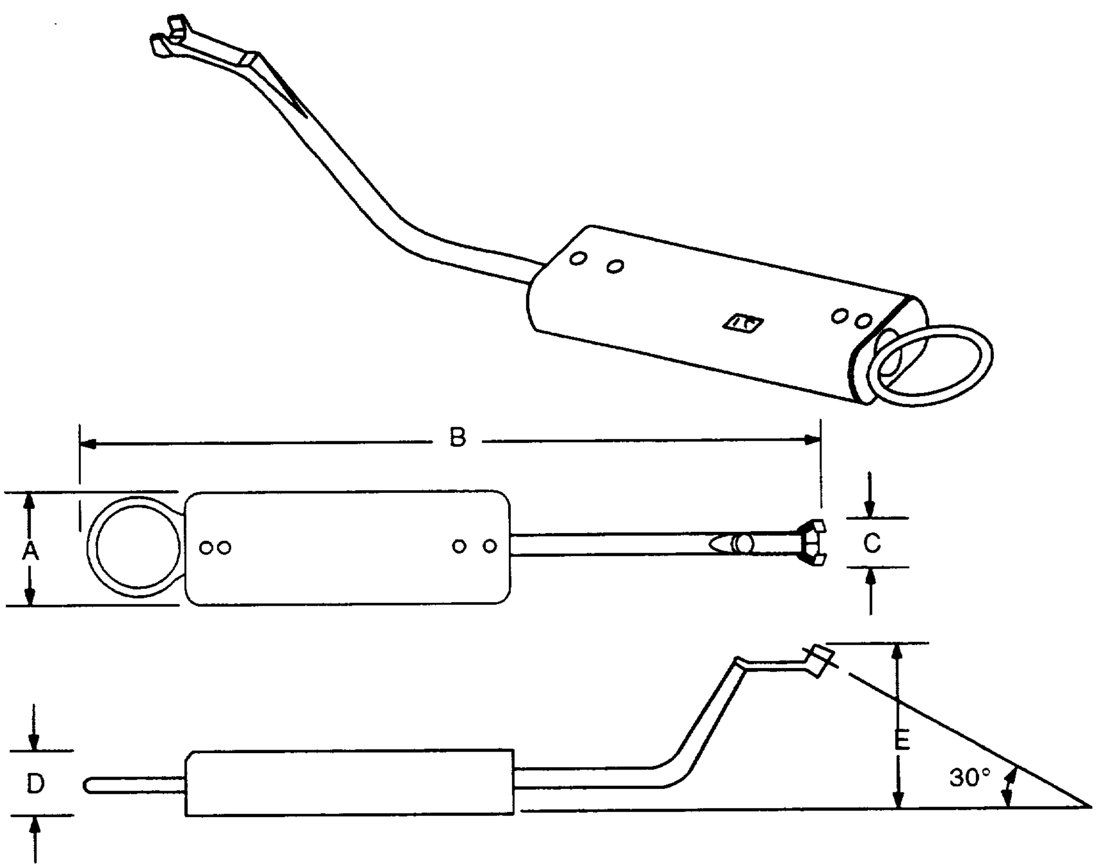
CONTACTS:

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

CONNECTOR TOOL, COAX

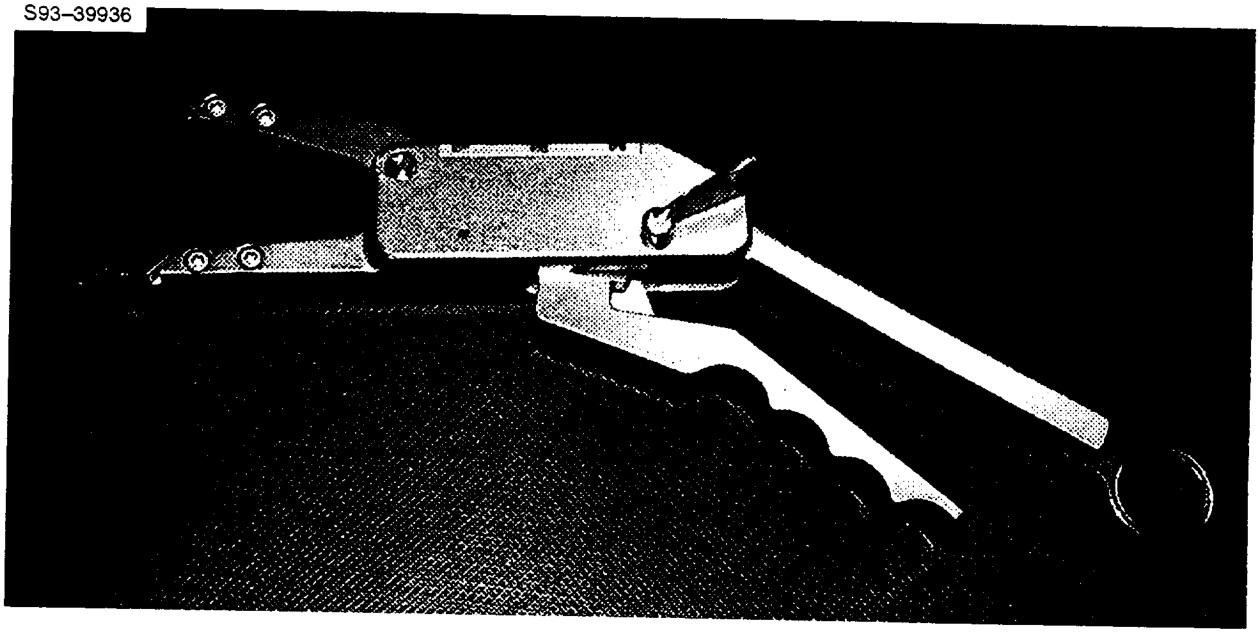
Technical Information	
Part number	10181–10011–01 without shoulder 10181–10011–02 with shoulder
Weight	0.41 lb
Material/ construction	Aluminum Stainless steel
Load rating	33/40 in–lb (use/proof)
Temperature range	–150° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

Dimensional Data		
	inches	cm
A	1.38	3.51
B	9.16	23.27
C	0.50	1.27
D	0.75	1.91
E	2.06	5.23



CONNECTOR TOOL, LOCKING ELECTRICAL

S93-39936



OVERVIEW

This electrical connector tool is designed to remove and install bayonet-style circular electrical connectors, dust caps, and plugs. The jaws will accommodate connectors ranging from 1.25 to 2.0-in. in diameter. The tool has a nonslip handle and tether point. It was originally created to support Hubble Space Telescope (HST) maintenance.

OPERATIONAL COMMENTS

Swivel detented jaws that rotated 180° were incorporated into a prototype design to provide greater articulation in tight quarters. The jaws of the flight configuration do not swivel. The jaws are locked by squeezing the handles to engage a ratchet mechanism. This lock function allows handle compression to be relinquished to reduce hand fatigue and allow tool repositioning. The ratchet is released by depressing a thumb lever. The jaws have a nonslip lining to ensure positive connector engagement.

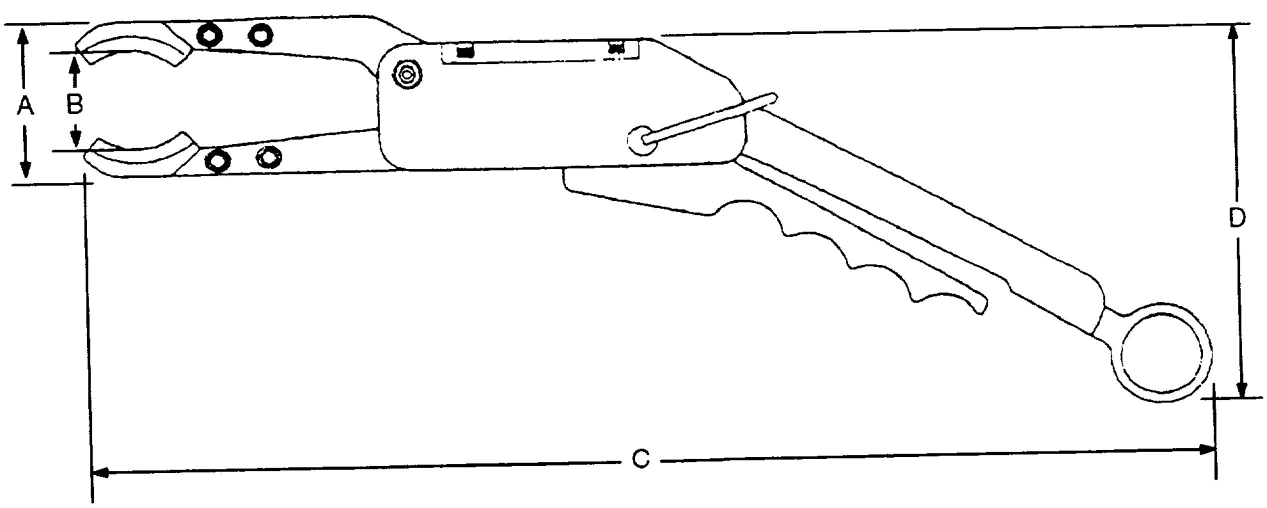
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483-2597
Technical: Russ Werneth, NASA/GSFC, (301) 286-4338

CONNECTOR TOOL, LOCKING ELECTRICAL

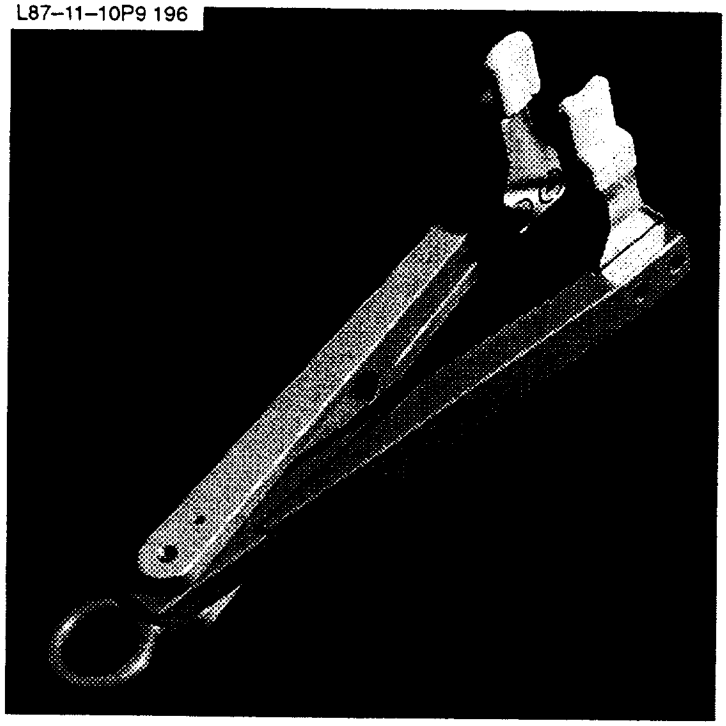
Technical Information	
Part number	97M22879
Weight	1.4 lb
Material/ construction	Limited life items – TBD Lubricants – TBD Metallics – Aluminum alloy, CRES Nonmetallics – TBD
Load rating	42 in–lb torque (max.) 10 lb clamping force (max.)
Temperature range	
Quantity flown	One (STS–61)
Stowage	Stbd PSA (STS–61)
Availability	Flight specific

Dimensional Data		
	inches	cm
A	**2.00**	**5.08**
B	**1.25**	**3.18**
C	**13.75**	**34.93**
D	**5.25**	**13.34**



CONNECTOR TOOL, ROUND COAX

L87–11–10P9 196



OVERVIEW

The round coax connector tool is designed for use on the Hubble Space Telescope (HST). The tool is used to remove and install coax connectors.

OPERATIONAL COMMENTS

The round coax connector tool closes the grip surfaces around the coax connector by manipulating the tool handles like tongs. The grip surfaces themselves are lined to minimize abrasion and maximize grip. The tool is designed to grip objects from 0.25 in. to 0.9 in. in diameter.

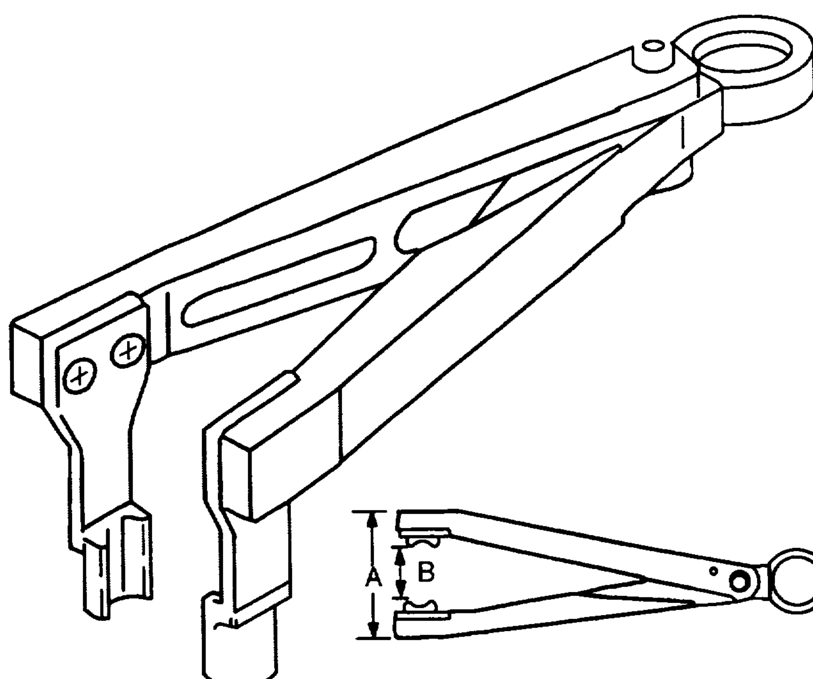
CONTACTS:

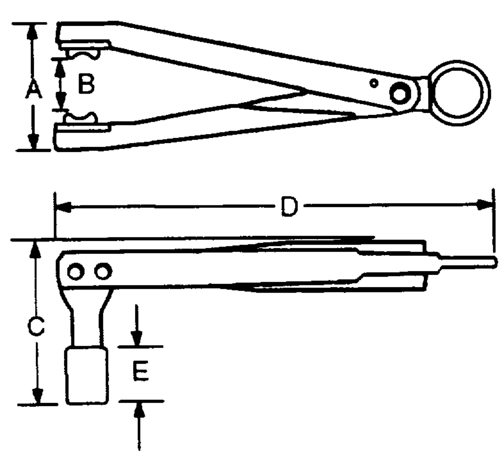
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

CONNECTOR TOOL, ROUND COAX

Technical Information	
Part number	10181–10012–01
Weight	0.49 lb
Material/ construction	Jaw cushion – Silastic "E" rubber Jaw – Stainless steel Handle – Aluminum
Load rating (use/proof)	**3.5/6.0 in–lb**
Temperature range	–150° to +250° F (operational)
Jaw opening	Minimum – 0.25 in. Maximum – 0.90 in.
Jaw grip length	0.80 in.
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

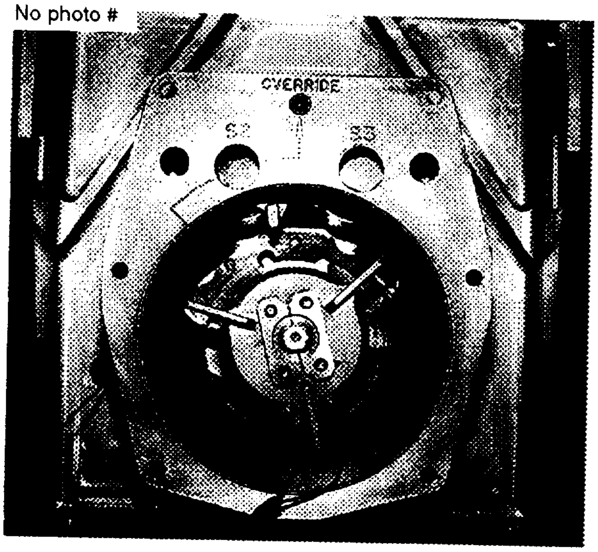
Dimensional Data		
	inches	cm
A	2.25	5.71
B	0.25 min 0.90 max.	0.64 2.29
C	2.88	7.32
D	7.75	19.68
E	1.00	2.54





CONNECTOR, EVA FLUID

No photo #



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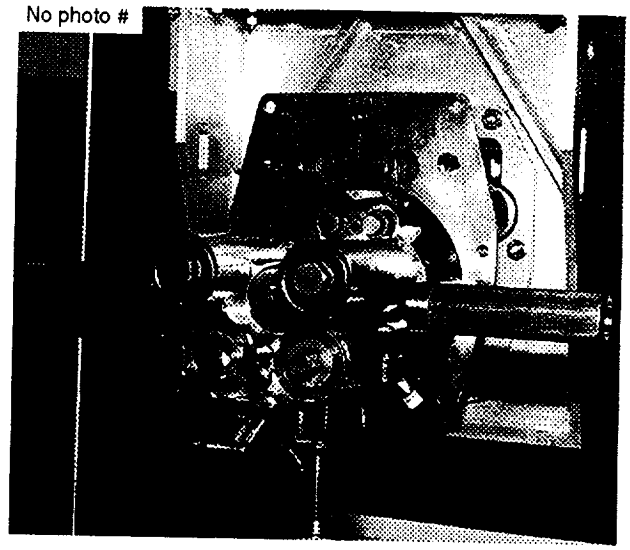


OVERVIEW

The EVA fluid connector is a coupling device designed for transferring fluids and low pressure gases. Each half of the fluid connector has three manual valves and pressure transducers to check valve integrity. Triply redundant interface seals between coupling halves have pressure ports to check seal integrity. Interlocks prevent valve opening while a coupling is disengaged and they prevent coupling disengagement with a valve open.

OPERATIONAL COMMENTS

The fluid connector is connected by first aligning the tanker coupling (male) and the spacecraft coupling (female) halves and then engaging. By means of the handle grips, the tanker coupling is rotated clockwise approximately 40° until the handles are horizontal. The locking pin is then rotated clockwise. The seal integrity is checked, and the safety lever is pulled forward and down exposing the flow control valves. The valves are opened in the following order: T–3, T–2, T–1/S–1, S–2, S–3, allowing fluid transfer. The operations, from rotating the locking pin through opening the valves, are clearly labeled 1 through 7 on the face of the coupling. These steps are reversed (7 to 1) to close the valve and remove the tool. A spacecraft coupling has been installed on the Gamma Ray Observatory (GRO). The tank coupling will eventually be installed on a hydrazine tanker for a GRO servicing mission.

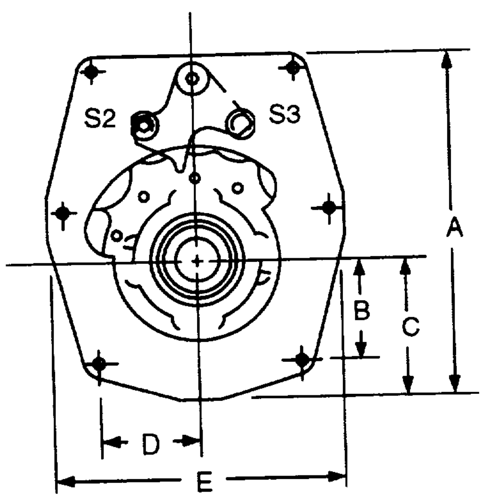
CONTACTS

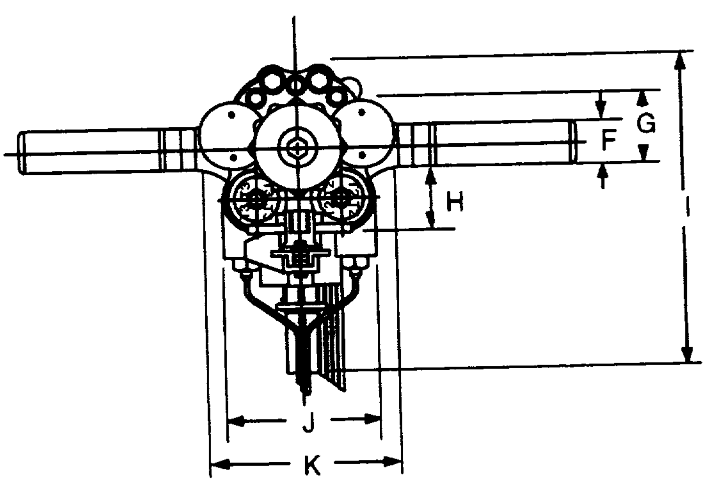
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: J. B. Henderson, NASA/EP4, (713) 483–9008

CONNECTOR, EVA FLUID

Technical Information	
Part number	84315000–513
Weight	16.0 lb max.
Material/ construction	Stainless steel
Load rating	
Pressure rating	500 psig nominal, 600 psig maximum **(operational)**
Flow rate	10 gpm nominal, 20 gpm maximum
Temperature range	40° F minimum, 70° F nominal, 120° F maximum **(operational)**
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	7.820	19.86
B	2.330	5.92
C	3.160	8.03
D	2.340	5.94
E	6.820	17.32
F	1.000	2.54
G	1.600	4.06
H	1.500	3.81
I	7.500	19.05
J	3.700	9.40
K	4.800	12.19

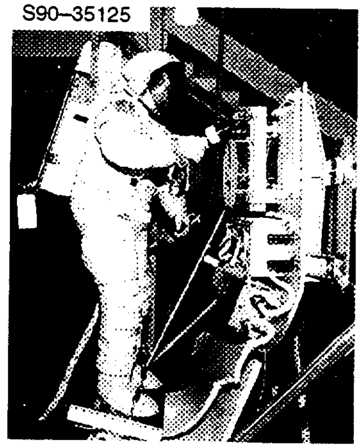




C-2

CREW LOADS INSTRUMENTED PALLET

S90–35125



OVERVIEW

The crew loads instrumented pallet (CLIP) was flown on STS–37 as a detailed test objective (DTO) device to collect static and dynamic extravehicular activity (EVA) crew loads for use as a design resource. The CLIP consists of a platform with three force/torque sensor plates, a soft tool stowage assembly, and restraints for a data recording device. For STS–37, the CLIP was installed on the starboard side of the orbiter payload bay in bay 1.

The uppermost section of the CLIP assembly consists of the instrumented horizontal handhold (IHH), the instrumented worksite (IWS), the soft stowage assembly (SSA), and a latching attachment plate for the portable data acquisition package (PDAP). The instrumented foot restraint (IFR) was mounted on the base of the CLIP for on–orbit operations, but was stowed on the upper platform for launch and landing.

OPERATIONAL COMMENTS

The IHH, IWS, and IFR were all instrumented with force measurement plates that fed data for recording to the PDAP. The IHH is a simple handhold, oriented vertically. The IWS has one horizontal handhold, a handhold in the shape of a steering wheel, seven 7/16–in. bolt interfaces, and a fixed knob. The IFR was also mounted to a sensor plate and measured crew loads during tasks with the other devices as well as during foot restraint ingress/egress. It could be rotated to alternate yaw positions of 90° and 135°.

The EVA crew performed specific tasks as called out on a decal. These tasks were representative of generic EVA operations and were selected to provide missing data or verify existing one–g data. Several accessories were used with the CLIP to generate this data. A force measurement tool was used to input a known force to the various handholds for calibration verification. A torque recorder and a small EVA knob with a pushbutton drop–proof tether served as input devices for the 7/16–in. bolt interfaces. A pair of special waist tethers were used to measure crew pushoff loads with fixed tethers between the suit waist bearing and handholds. These tethers were shorter than the standard waist tether and had a higher load–alleviation limit of 350 lb. A single truss joint was also used to represent SSF–unique hardware and for general cylindrical object grasping. The passive end of the joint attached to the 7/16–in. bolt interfaces with a pushbutton drop–proof tether. The foot restraint collected data during all the above tasks as well as during various body reach and maneuver efforts, including one task where the second crewmember was handled as a mass handling exercise. During the flight, analog data was stored in the PDAP for postflight retrieval and conversion into forces and torques.

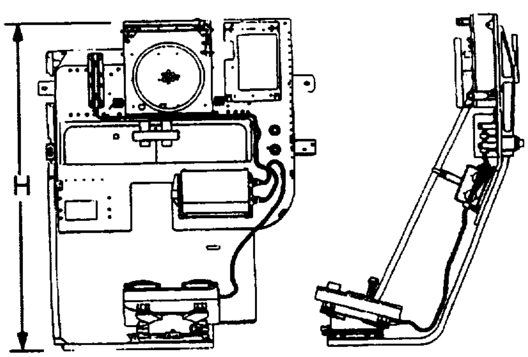
CONTACTS

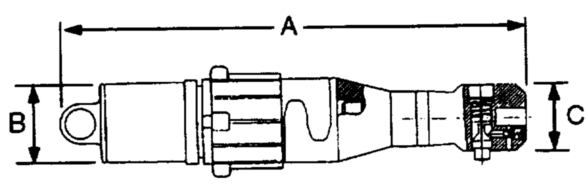
Operational: B. Adams, JSC/DF42, (713) 483–2567
Technical: J. O'Kane, NASA/EC5, (713) 483–9229

CREW LOADS INSTRUMENTED PALLET

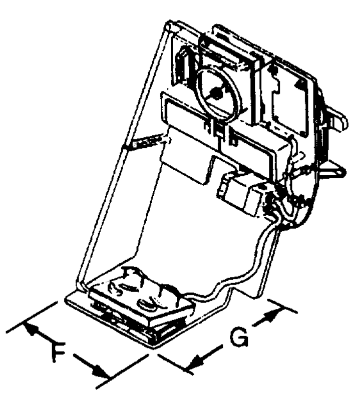
Technical Information	
Part number	**SED39121400–301 (foot restraint stowed)** **SED39121400–303 (foot restraint setup)** **10191–20002–01 (drop–proof tether knob)**
Weight	**264** lb
Material/ construction	Aluminum
Load rating	**IWS/IFR** **Fz 1000 lb** **Mz 5000 ft–lb** **Fx/Fy 500 lb** **Mx/My 10000 ft–lb** **IHH** **Fz 500 lb** **Mz 250 ft–lb** **Fx/Fy250 lb** **Mx/My 500 ft–lb**
Temperature range	–**120°** to +165° F
Quantity flown	One on STS–37
Stowage	Payload bay **starboard bay 1**
Availability	**Flight specific**

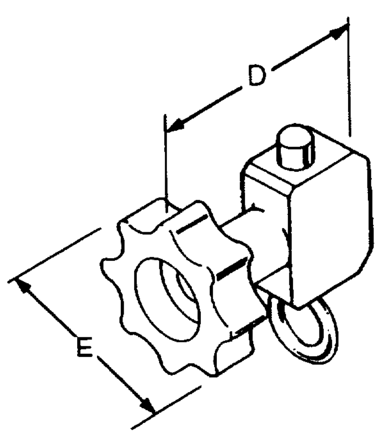
Dimensional Data		
	inches	cm
A	11.75	29.85
B	2.0	5.08
C	1.68	4.27
D	3.21	8.15
E	2.0	5.08
F	57.78	146.76
G	45.2	114.81
H	69.91	177.71
I	**8.0**	**20.32**
J	4.75	12.07
K	14.50	36.83

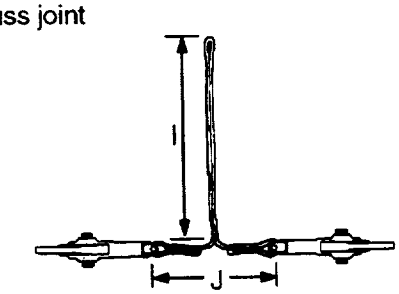


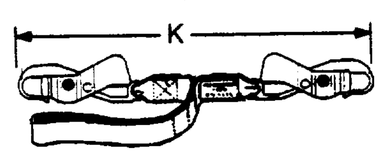


Truss joint







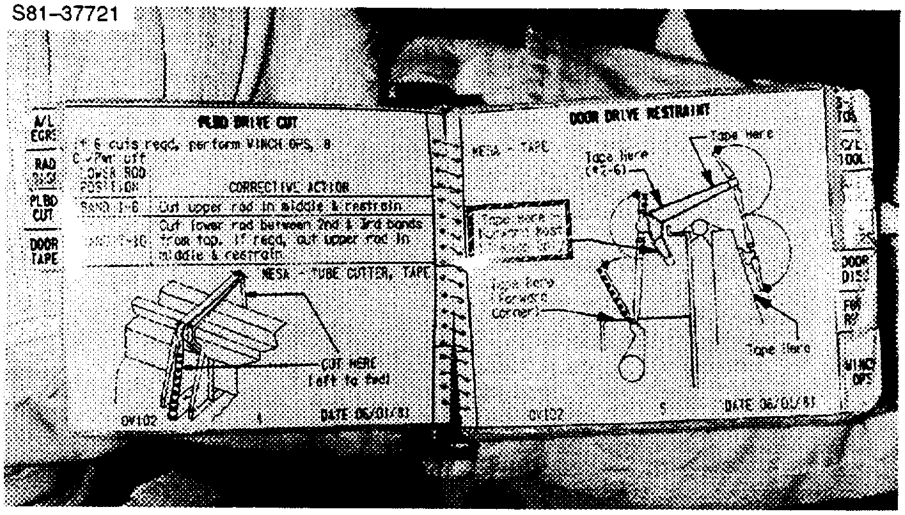


Drop–proof tether knob

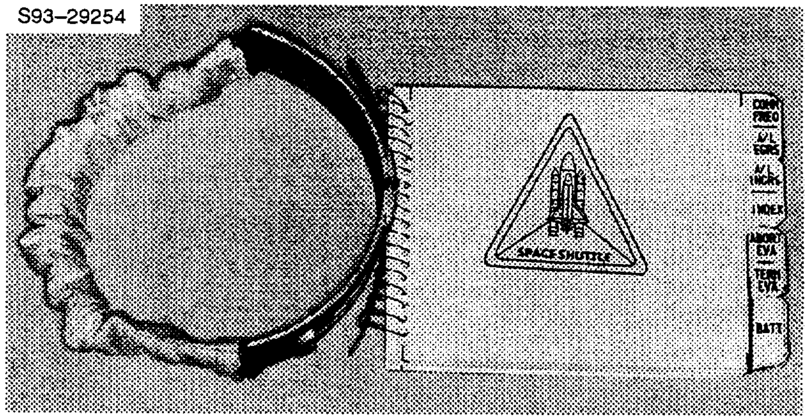
Special waist tether

CUFF CHECKLIST

S81–37721



S93–29254



OVERVIEW

The cuff checklist is a set of reference cards which are bound and attached to a wristband. The reference cards are approximately 4 in. by 5 in. in size and contain procedures and reference data for performing EVA tasks. The cuff checklist also contains procedures that aid in the diagnosis and resolution of an extravehicular mobility unit (EMU) failure. Each card has an indexing tab for easy card location.

OPERATIONAL COMMENTS

The checklist is worn below the left elbow of the EMU and is approximately 0.5 in. thick when closed. **Roughly 25 double–sided data sheets can be accommodated by the wire and spring binder. A few** pages can be added for flight–specific EVA tasks. **Blank front and back pages have been added to protect the internal printed information from abuse.**

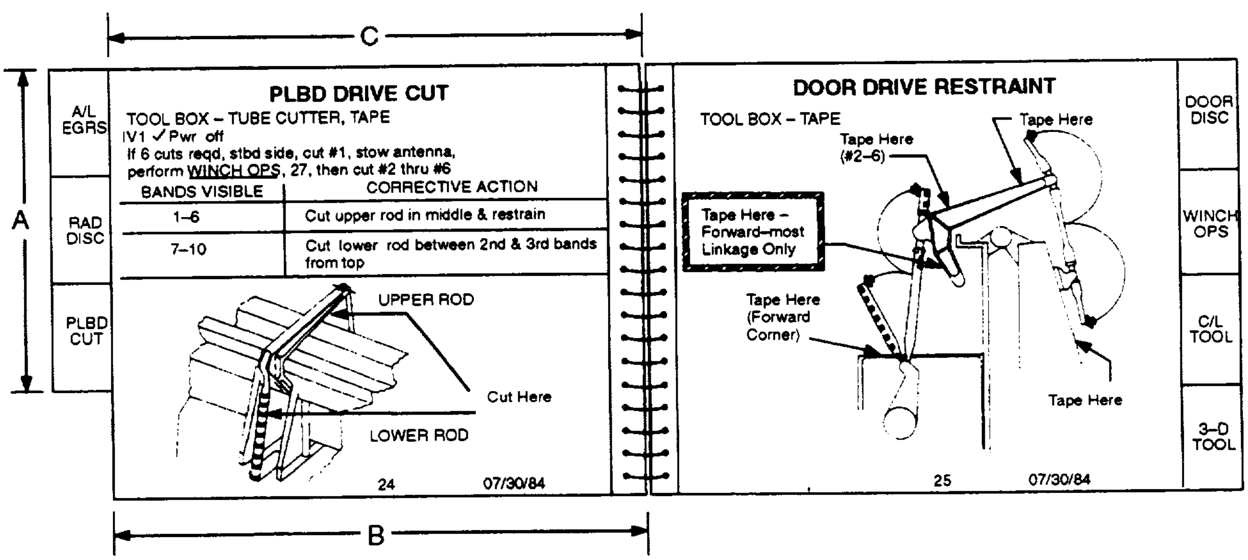
CONTACTS

Operational: **R. K. Fullerton**, NASA/DF42, (713) 483–2589
Technical: **J. Bearly**, NASA/DH, (713) 483–**4376**

CUFF CHECKLIST

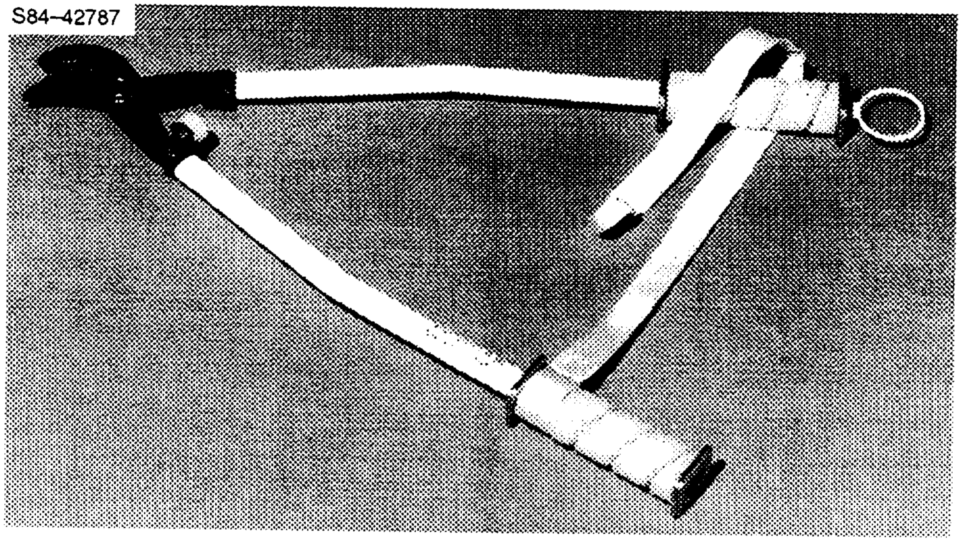
Technical Information	
Part number	SEB33100302-307 (arm band) SEB33100302-330 (leaf spring)
Weight	0.6 lb
Material/ construction	Pages – Chronopaque Bracket – Aluminum Wristband – **Aluminum,** steel Twistoflex with Ortho fabric cover Leaf spring – Copper beryllium Coil spring – **CRES**
Load rating	
Temperature range	
Quantity flown	One each for **each primary** EMU
Stowage	**Middeck locker**
Availability	Standard

Dimensional Data		
	inches	cm
A	3.875	9.84
B	4.5000	11.43
C	5.0000	12.7



CUTTER, ANTENNA

S84–42787



OVERVIEW

The antenna cutter is a large cutter modified for extravehicular activity use. The cutter jaws are designed to cut objects up to 1–1/2 in. in diameter. A bumper keeps the handles 3 in. apart when the tool is closed; a Velcro strap keeps the handles closed. The cutter has black stainless steel jaws and aluminum handles, one handle equipped with a tether ring.

OPERATIONAL COMMENTS

The antenna cutter was used to cut carbon graphite tubing used as the mast of the omnidirectional antennas on the Hughes satellite 376 retrieval mission (Westar VI and Palapa B–2). The antenna cutter proved to be very effective in cutting the carbon graphite antenna mast because it generated no debris or carbon dust and made a clean cut. The Velcro strap must be loosened before the cutting jaws can be opened. The antenna cutter is not normally manifested.

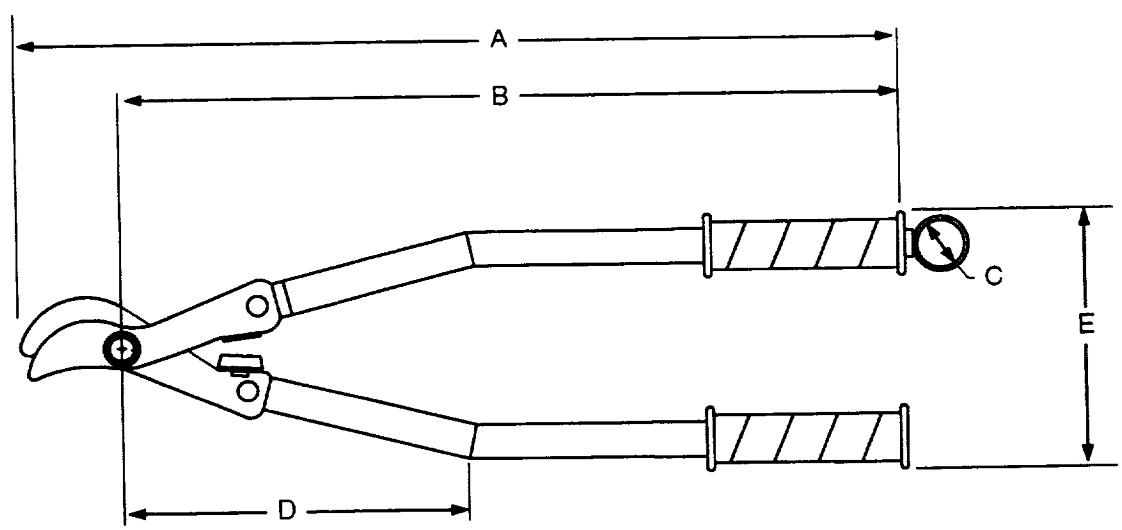
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. J. Marak**, NASA/EC5, (713) 483–9144

CUTTER, ANTENNA

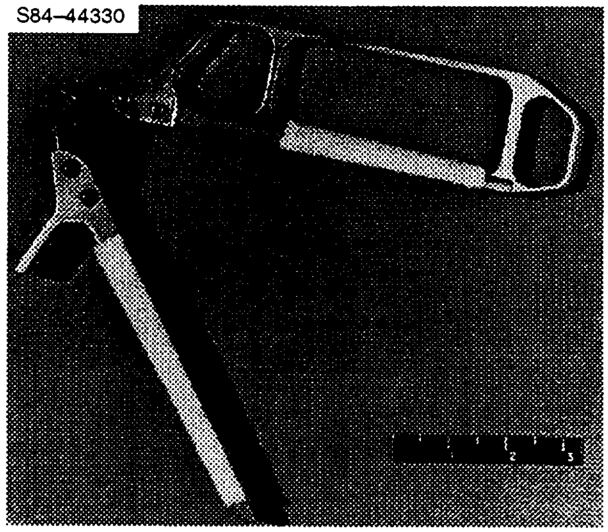
Technical Information	
Part number	SED39117580–301
Weight	2.5 lb
Material/ construction	Aluminum Velcro–wrapped handles, stainless steel jaws
Load rating	
Temperature range	–130° to 150° F **(operational)** **–130° to +250° F (stowage)**
Quantity flown	**One**
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	22.00	55.88
B	19.50	49.53
C	1.20	3.05
D	9.00	22.86
E	6.12 (closed)	15.54



CUTTER, CABLE

S84–44330



OVERVIEW

The cable cutter is a standard cutter modified for EVA use. It is equipped with large handles to fit the EVA glove. The tool handles are covered with Velcro with a tether point provided. The cutter jaw opening measures 5/16 in. wide and 5/16 in. deep when fully open.

OPERATIONAL COMMENTS

The cable cutter is operated with two hands and closed to capture the cable in the cutting jaws. At the capture position, the handles may then be operated with one hand to cut the cable. The cable cutters are part of the normally manifested orbiter equipment. They are wrapped in a Velcro–lined tool caddy along with the 1/2–in. ratcheting box end wrench.

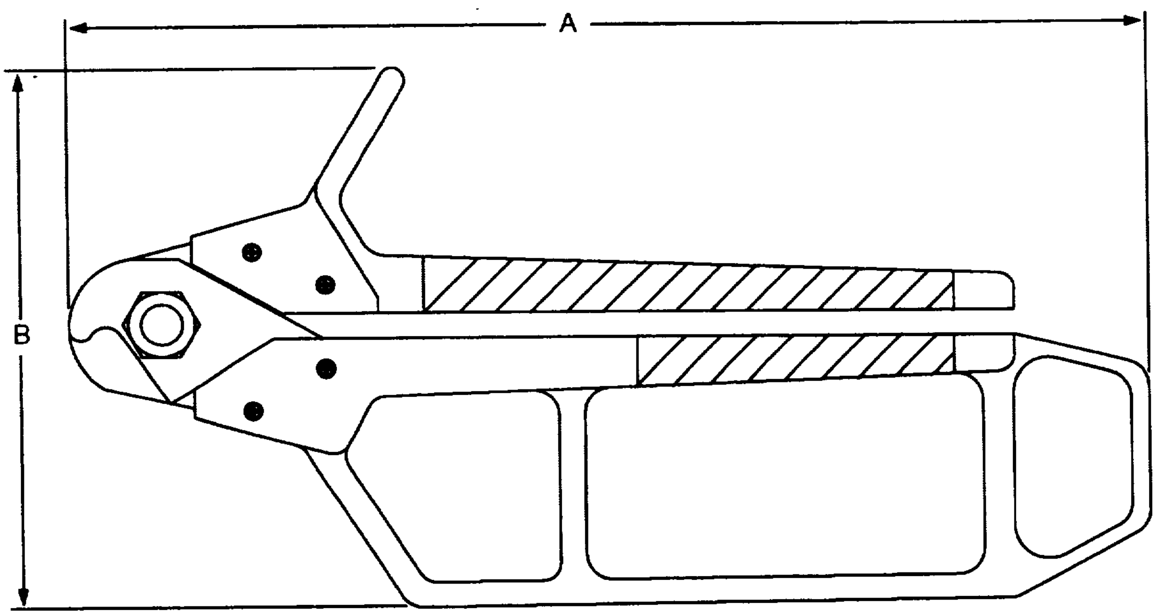
CONTACTS

Operational: R. C. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

CUTTER, CABLE

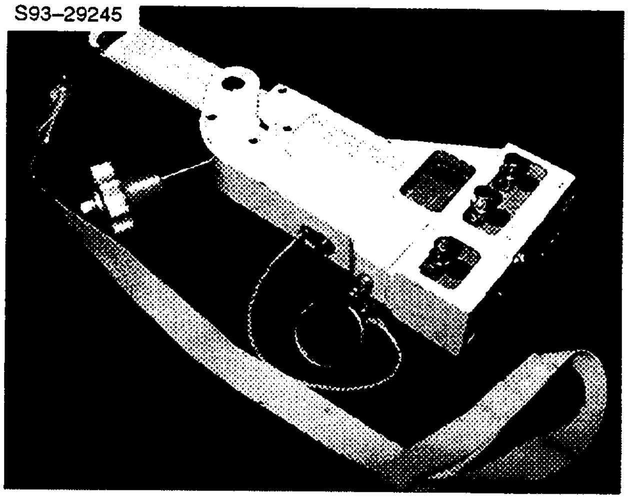
Technical Information	
Part number	SED39117075–301
Weight	0.4 lb
Material/ construction	7075 aluminum handles, stainless steel jaws, Velcro–wrapped handles, tether attachment
Load rating	
Temperature range	–200° to 250° F (operational), +350° F (stowage)
Quantity flown	One
Stowage	Port PSA
Availability	Standard

Dimensional Data		
	inches	cm
A	8.25	20.96
B	4.25	10.80

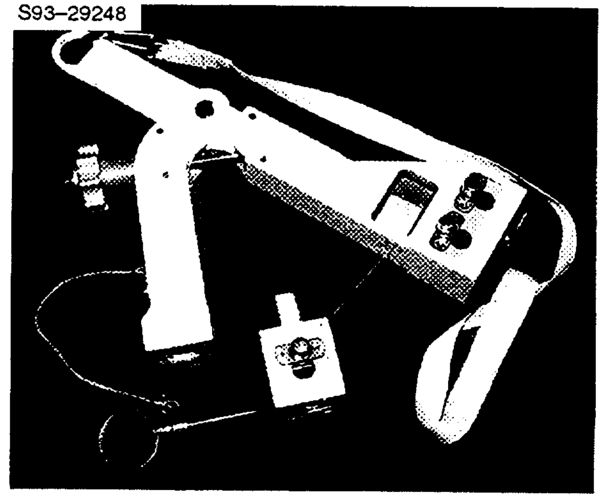


CUTTER, HIGH TENSION CABLE

S93–29245



S93–29248



OVERVIEW

This tool is a contingency device used after a failure in which one of the EURECA solar arrays has failed to nominally retract. Working in parallel from foot restraints, two EVA crewmembers each cut a high tension cable and secure the loose ends. Because the cables are under high tension, this tool is used to firmly grip either side of the cable to be cut and then to slowly release tension after the cut is complete.

OPERATIONAL COMMENTS

After setting up foot restraints, the crew locates each deployment cable (2.8–mm diameter) within the pulley systems on both sides of the failed array. These cables are larger than the retraction and synchronization cables, which have a 2.0–mm diameter and are located on the second pulley from the outside edge of the solar array. The cutter is installed on the deployment cables 6–in. inboard from the second pulley (6–in. from the outboard edge of the first panel). Trailing latches act as a soft–dock feature.

After tightening the wire restraint bolts by rotating clockwise and securing the handle of the cutter with a special strap/hook assembly, the cable is cut by rotating the cutting bolt clockwise to a hard stop. Energy in the 247–lb (1099 N) cable tension is released by rotating the drive extension bolt counterclockwise via its large knob to a hard stop. All bolt heads use the EVA standard 7/16–in. hex head. The housing for the cable restraint on the arm **that** relieves cable tension is released by removing a pip pin. A retractable tether in the cutter body limits cut cable separation to 50–in. and maintains a 0.5–lb tension in the cut cable. Slack is **removed periodically** during manual stow of the arrays by pulling the retraction cables toward the root hinge.

When the arrays are fully folded in the stowed position by the EV crew, the IV crew reactivates power and the ground commands latches to secure the arrays. The cutter is then released from the cable by loosening the two restraint bolts on the tool. Care is required when securing the sharp loose cable ends for landing. Velcro straps, tape strips, or tie wraps serve as cable restraints.

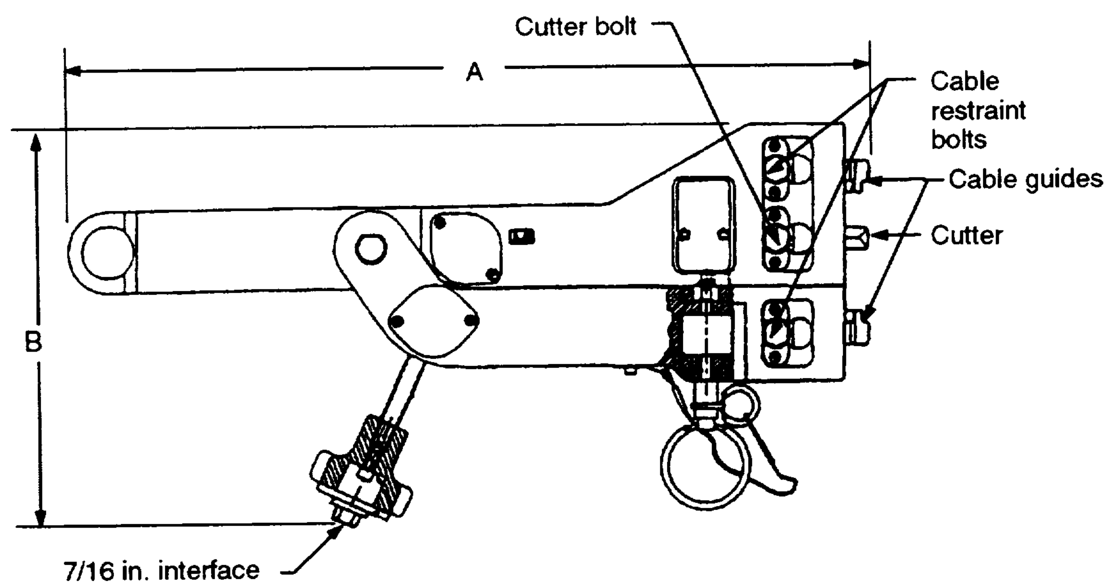
CONTACTS

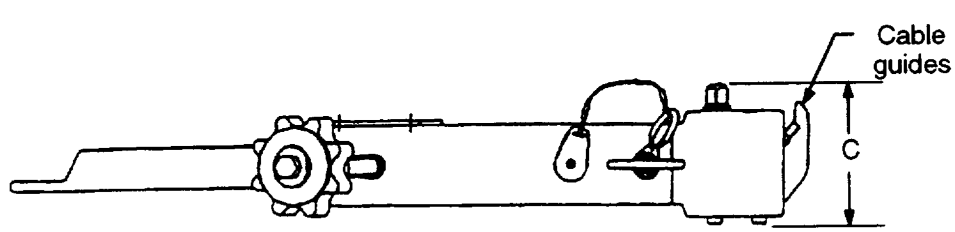
Operational: O. Koehler, Rockwell/DF42, (713) 483–4363
Technical: R. Marak, NASA/EC5, (713) 483–9144

CUTTER, HIGH TENSION CABLE

Technical Information	
Part number	10159–10088–01
Weight	7.4 lb
Material/ construction	Aluminum, stainless steel, Teflon–coated Kevlar cord
Load rating	247–lb Teflon coated cable tension (nominal) 350–lb uncoated cable tension (maximum) 12–ft–lb cable clamping torque (minimum) 22–25 ft–lb cable clamping torque (nominal) 150–lb self–tending tether cord
Temperature range	–30° to +150° F
Quantity flown	One
Stowage	Middeck locker
Availability	Flight specific

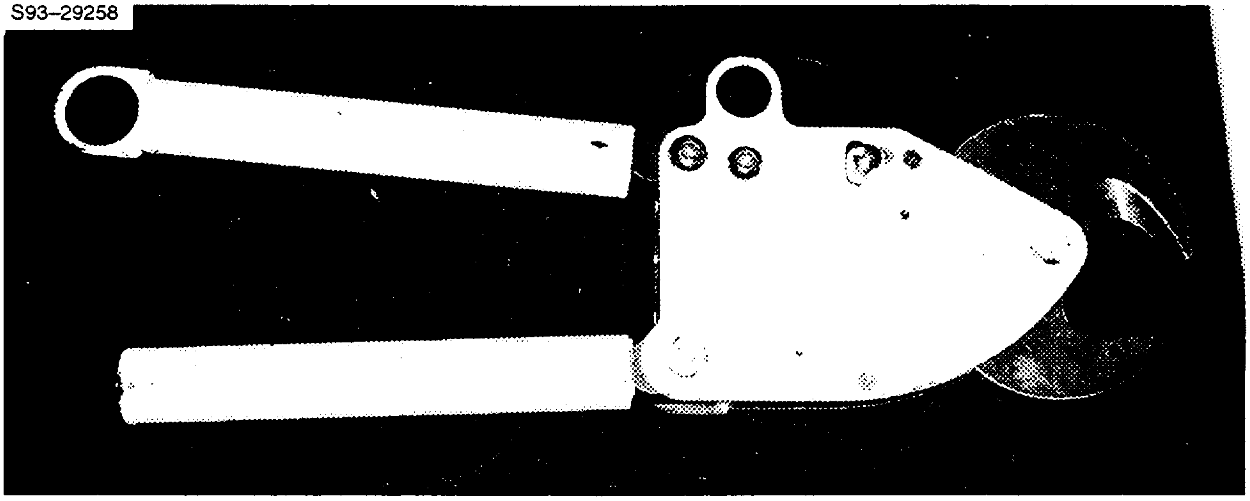
Dimensional Data		
	inches	cm
A	15.28	38.81
B	7.64	19.41
C	2.83	7.19





CUTTER, LARGE CABLE

S93-29258



OVERVIEW

The large cable cutter, also known as the EVA cable cutter, is a contingency tool designed to cut the interface wiring bundles of a payload **that** requires jettisoning. The cutter is designed to cut unpowered copper electrical cable **bundles** up to 1 **in.** in diameter, including the insulation. The maximum cross section of **solid** copper that can be cut is **0.6 in. diameter** (0.275 **in.**^{2}). The cutter is not designed to cut steel cables **or fabrics. It has been successful in cutting thin aluminum tubing and bistem material.** Shrouds cover the moving parts within the cutter housing to avoid pinching gloved fingers. Low profile shoulder screws are employed to avoid snagging tethers. **Two** tether rings **are** supplied to transfer the tool to and from the worksite. **The pair of tether points allow either horizontal or vertical tool stowage in a container.** The cutter is stowed in the port provisions stowage assembly (PSA).

OPERATIONAL COMMENTS

The blades are indexed by a ratcheting mechanism inside the cutter to assist in creating the force required to cut the wiring bundles. A spring-loaded, quick-return feature returns the blades for the next cutting task. **The ratcheting handle must be fully extended for blade release following push button actuation.**

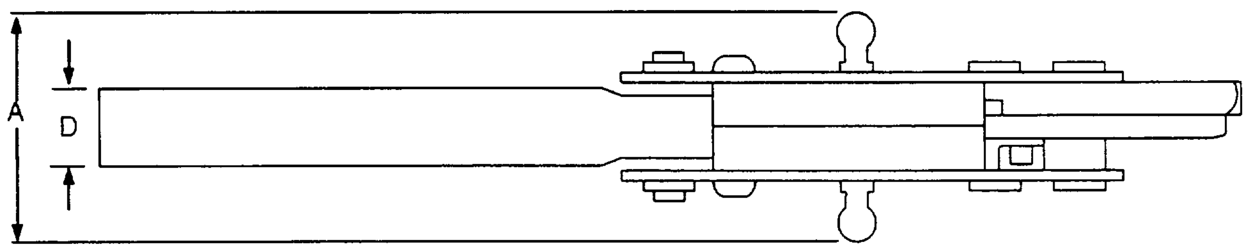
CONTACTS

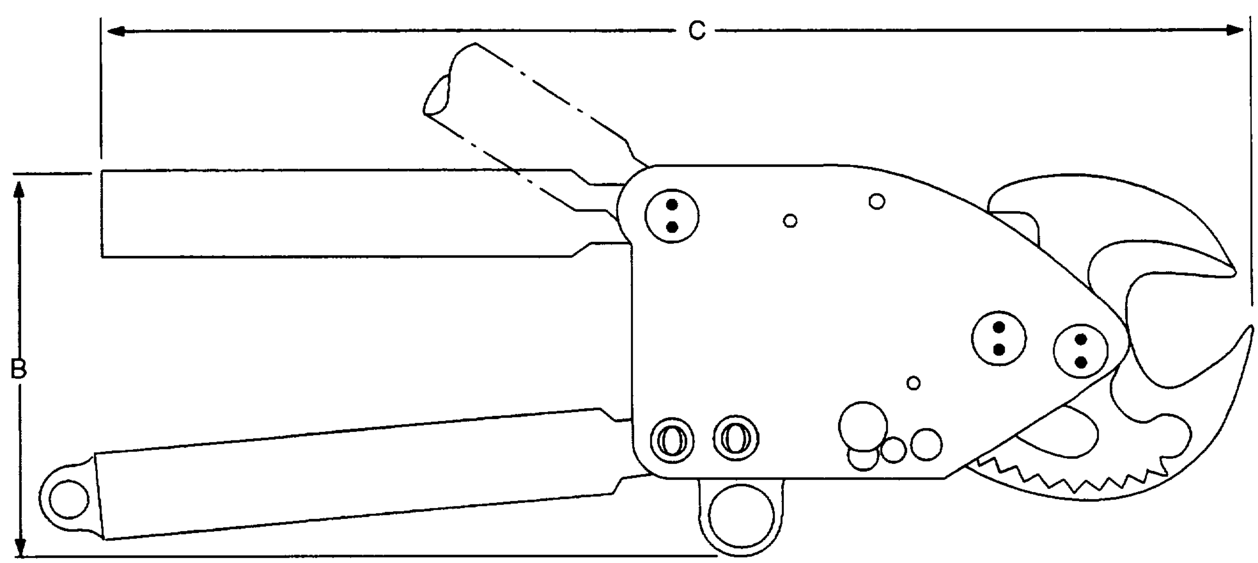
Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: **W.B. Wood,** NASA/EC5, (713) 483-**9247**

CUTTER, LARGE CABLE

Technical Information	
Part number	SED33104214–301
Weight	3.47 lb
Material/ construction	Blades – Stainless steel Housing and internal parts – Stainless steel Handles and shroud – Aluminum
Load rating	1–in. **diameter insulated** copper cable
Temperature range	–200° to 250° F (operational)
Quantity flown	One
Stowage	Port PSA
Availability	Standard

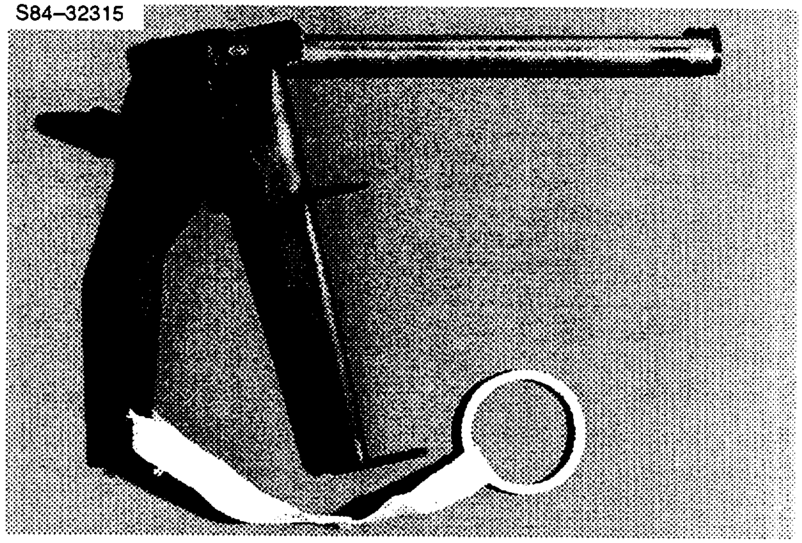
Dimensional Data		
	inches	cm
A	2.56	6.50
B	4.69	11.91
C	13.93	35.38
D	1.00	2.54





CUTTER, RIGHT ANGLE

S84–32315



OVERVIEW

The right angle cutter is part of the hydrazine servicing tool set of the orbital refueling system (ORS). **It was used on STS 41–G to demonstrate on–orbit satellite refueling from the orbiter**. The cutter is a pistol–grip type of tool with a knife opening movement on the top end of the barrel and a squeeze trigger handle. A tether ring is attached to the handle.

OPERATIONAL COMMENTS

The cutter is used to cut the satellite valve dust cap lockwire away from the satellite valve. It was specifically designed to cut wire in hard to access areas. **For generic lockwire removal, the needle nose pliers have proven to be superior in breaking the wire and retaining it for trash bag stowage.**

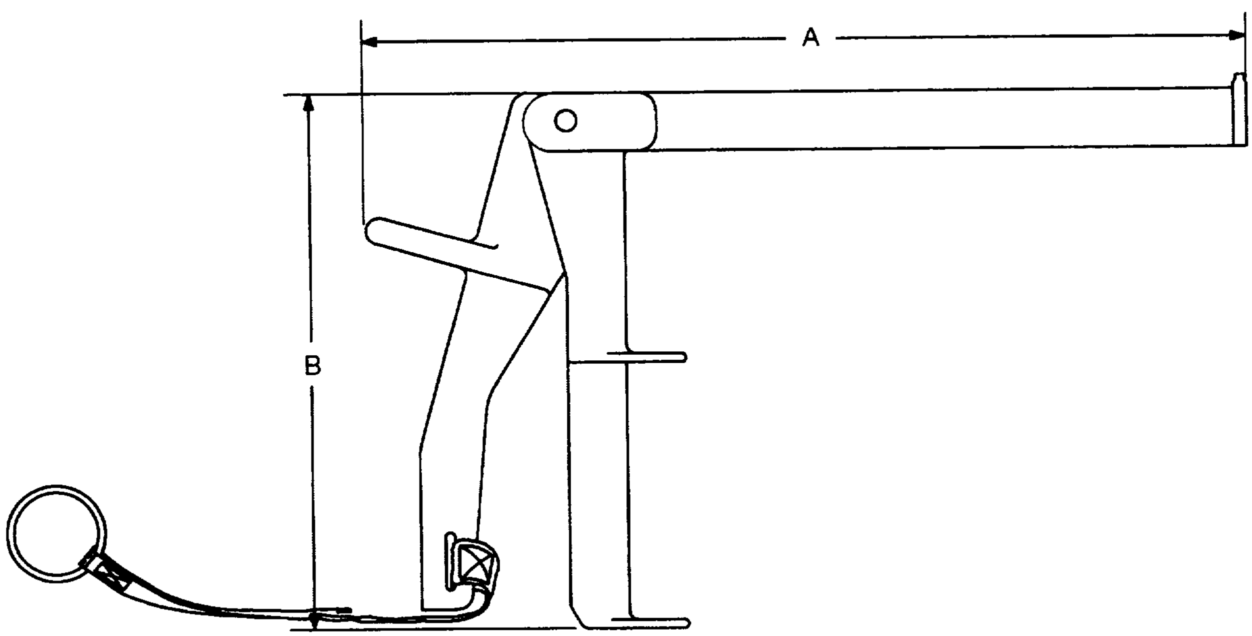
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. Marak**, NASA/EC5, (713) 483–9144

CUTTER, RIGHT ANGLE

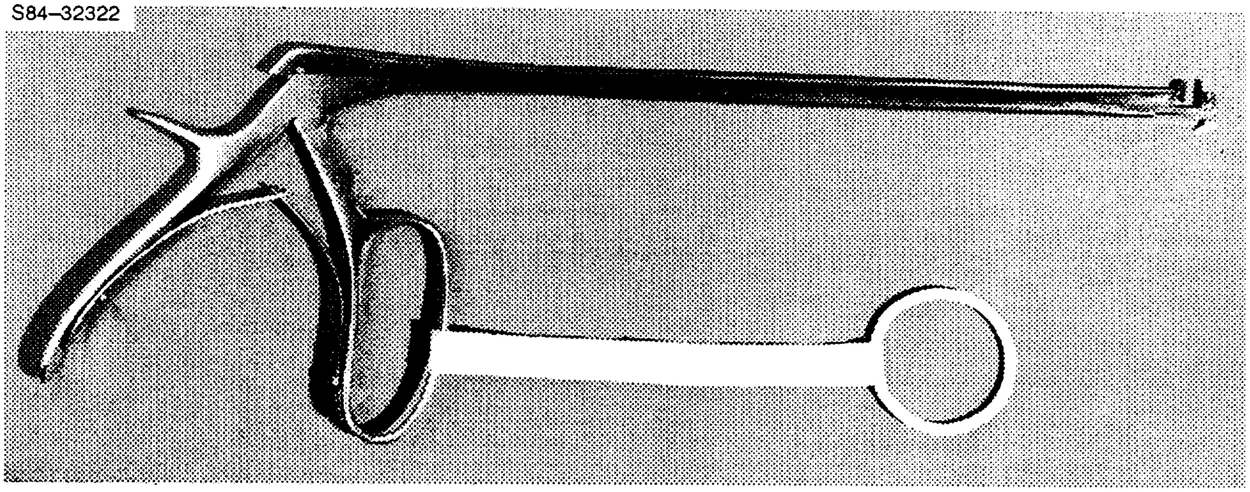
Technical Information	
Part number	SDD 39116430–001
Weight	0.44 lb
Material/ construction	Handle and barrel – Anodized aluminum Knife blades – Hardened steel
Load rating	Close trigger handle – 66.5 lb maximum
Temperature range	35° to 150° F
Cutting jaw opening	15°, 1/16 by 1/8 in.
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	7.81	19.84
B	4.75	12.07



CUTTER, SAFETY WIRE

S84–32322



OVERVIEW

The safety wire cutter is part of the hydrazine servicing tool set of the orbital refueling system (ORS). **It was used on STS 41–G to demonstrate on–orbit satellite refueling from the orbiter**. The cutter is a pistol–grip type of tool with a squeeze trigger handle and a knife opening movement on the top end of the barrel. A tether ring is attached to the trigger.

OPERATIONAL COMMENTS

The cutter is used to cut the top left satellite valve dust cap lockwire away from the satellite valve. It was specifically designed to cut wire in hard to access areas. **For generic safety wire removal, the needle nose pliers have proven to be superior in breaking the wire and retaining it for trash bag stowage.**

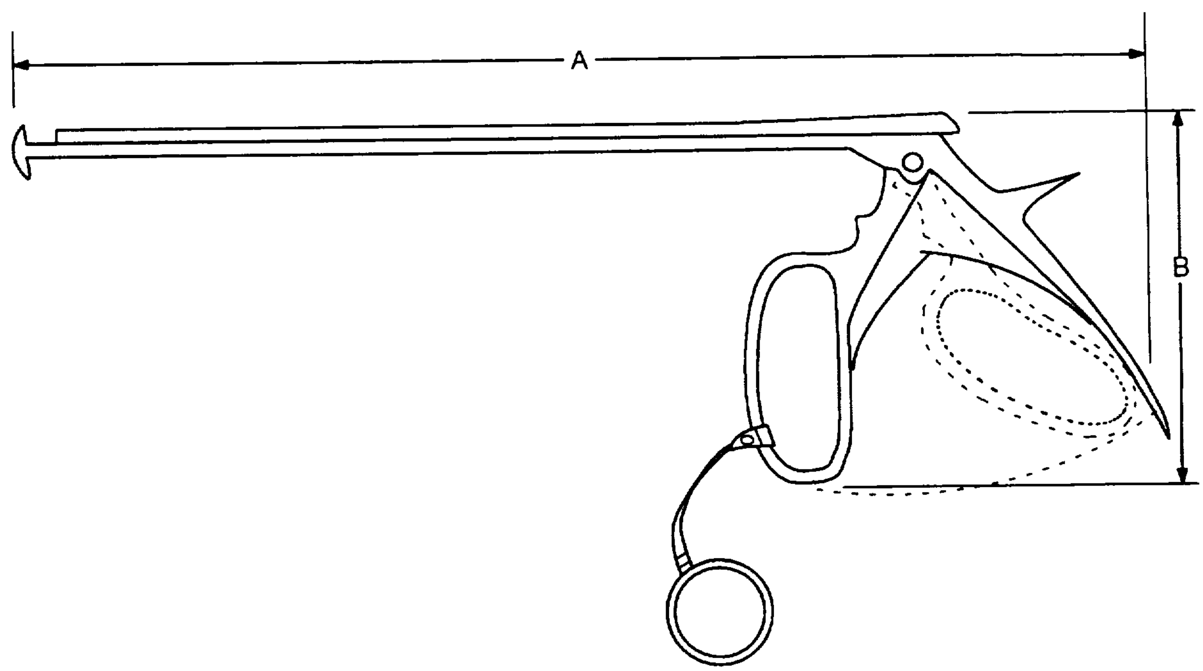
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. Marak**, NASA/EC5, (713) 483–9144

CUTTER, SAFETY WIRE

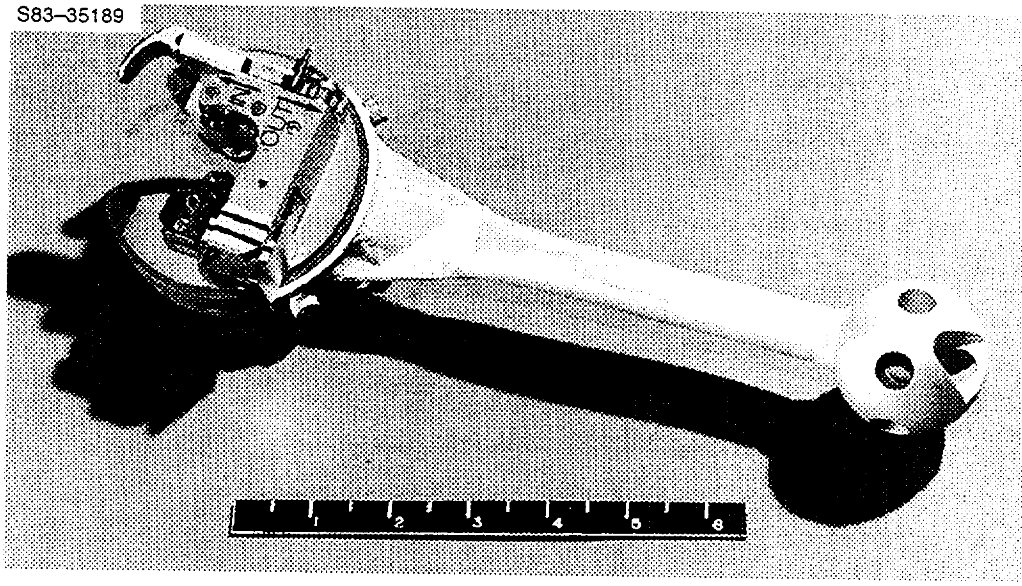
Technical Information	
Part number	SED 39115859
Weight	0.42 lb
Material/ construction	Handle and barrel – Stainless steel
Load rating	Squeeze clipper handle – 66.5 lb maximum
Temperature range	35° to 150° F
Cutting edge opening	5/16 in. high 3/16 in. opening
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	13.4	34.04
B	4.5	11.43



CUTTER, TUBE

S83–35189



OVERVIEW

The tube cutter consists of spring–loaded retention rollers, a cutter blade mounted on a slide, a blade ratchet handle, and a cutter ratchet handle. The cutter wheel is made of tool steel with hardness of 60 RC. The **payload bay door** drive links are made of heat–treated Inconel 718 **tubes of 0.049– and 0.055–in. wall thickness** and with a hardness of **59** to **61** RC. The tool is preset to cut tubes with 1/2– to 3/4–in. diameters but can be readjusted to cut 3/4– to 1–in. diameter tubes by flipping the slide 180° and moving the cutter blade to the second screw hole.

OPERATIONAL COMMENTS

The tube cutter is a disconnect tool necessary for the contingency door closing operation. For operation, the tool is pushed onto the tube and held in place by the retention rollers while the cutter blade is ratcheted down onto the tube. The large ratcheted handle is then used to rotate the cutter on the tube, and the blade is tightened down as required. Only a nominal force is required by the operator when cutting a drive tube.

This tool is part of the normally manifested orbiter equipment and is stowed in the **port** provisions stowage assembly (PSA).

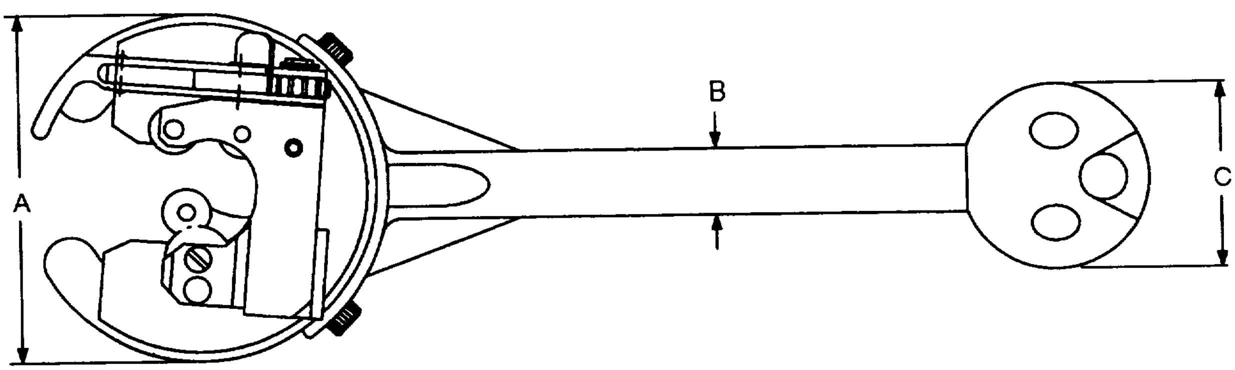
CONTACTS

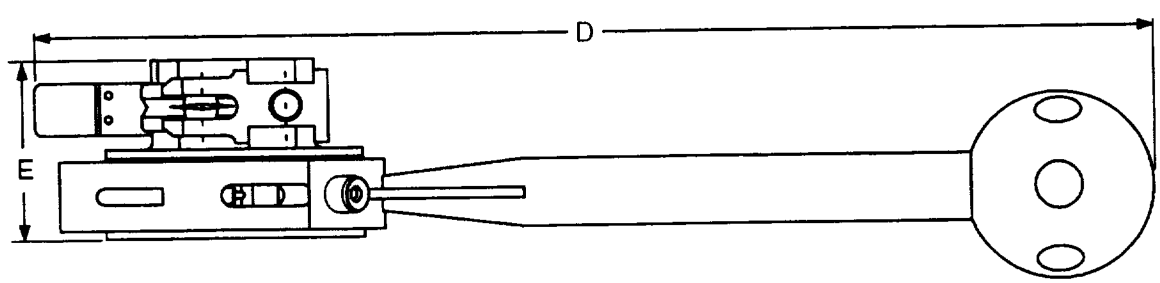
Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: **N. Gonzalez**, NASA/ES6, (713) 483–89**44**

CUTTER, TUBE

Technical Information	
Part number	SED33101368–301
Weight	1.7 lb
Material/ construction	Cutter wheel – AISI type 01 tool steel, 60 RC
Cutting range	1/2–in. to 1–in. diameter
Load rating	Heat–treated Inconel 718, **59** to **61** RC **Lower rods – 0.055 wall thickness, 0.75 dia.** **Upper rods – 0.049 wall thickness, 0.552 dia.**
Temperature range	–200° to 250° F **(operational), +350° F (stowage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

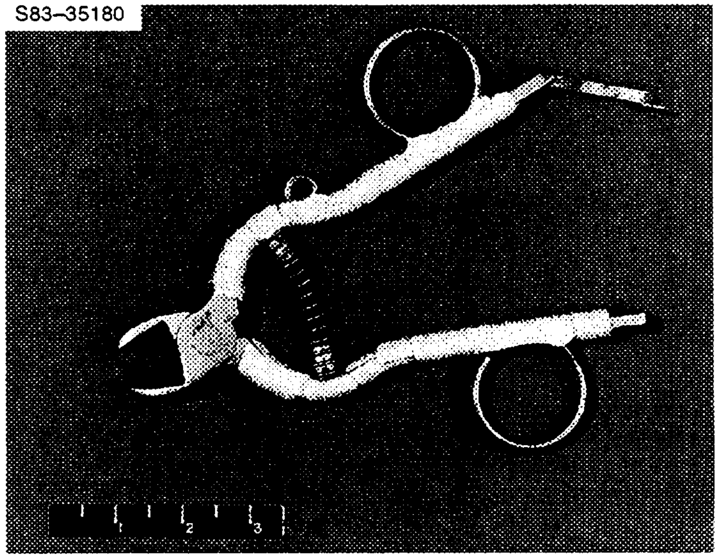
Dimensional Data		
	inches	cm
A	3.60	9.14
B	0.75	1.91
C	2.00	5.08
D	12.00	30.48
E	1.90	4.83





CUTTERS, DIAGONAL

S83-35180



OVERVIEW

The diagonal cutters have 1-in. blades with a maximum opening of 7/8 in. They have finger rings designed to fit the crewmember's gloved hand, a latch to hold the handle in the closed position, a spring to force the handles apart, and a ring for tether attachment. A silicone rubber insert has been added to the cutting blades to help in gripping items to be cut.

OPERATIONAL COMMENTS

The diagonal cutters can be used as a disconnect and jam removal tool. They are a general usage tool with no specific, designated tasks. This tool is part of the normally manifested orbiter equipment. It is wrapped in a Velcro-lined tool caddy along with the needlenose pliers and stowed in the **port** provisions stowage assembly (PSA).

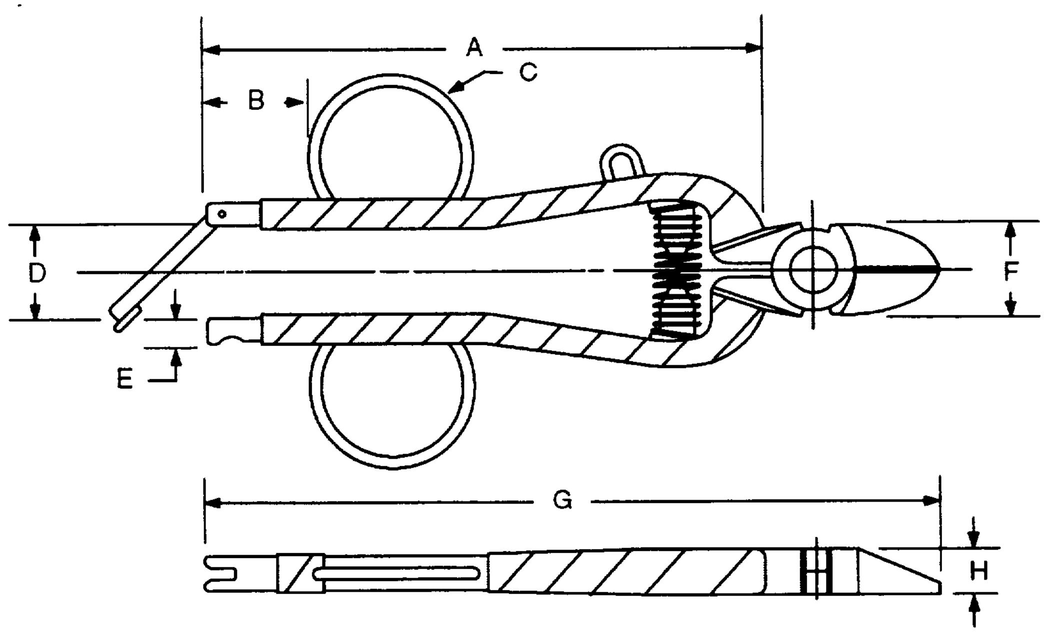
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC5, (713) 483-9247

CUTTERS, DIAGONAL

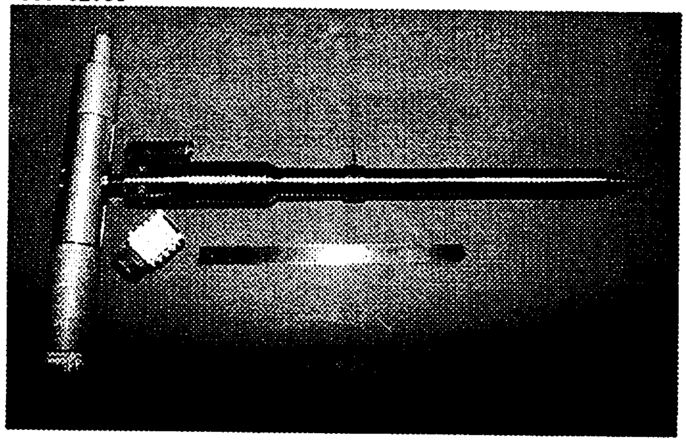
Technical Information	
Part number	V628–650866–018 or SDD33103437–301
Weight	0.6 lb
Material/ construction	AISI 4063 steel, RC 40 to 45 Cutting edge – RC 61 ± 2 Handles – Velcro–wrapped, tether ring on one
Maximum opening	7/8 in.
Load rating	**Cuts 1/16 in. diameter solid steel wire**
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	6.000	15.24
B	1.125	2.86
C	0.750	1.91
D	1.000	2.54
E	0.250	0.635
F	1.000	2.54
G	7.880	20.02
H	0.500	1.27



DOOR LATCH TOOL, EXTERNAL TANK

S88–32085



OVERVIEW

The external tank door latch tool **was derived from a KSC ground test tool and** is used for emergency latch release of the two latches that hold the ET umbilical doors open during launch. The doors must be closed for entry. The ET door latches are normally driven by a motor/clutch system; however, should a failure occur that renders the system inoperable, this manual override is available for releasing the latches.

OPERATIONAL COMMENTS

The external tank door latch tool has a folding tee handle with a spanner wrench on one end. A 1/8–in. hex head drive housed in a threaded barrel assembly interfaces with the orbiter override clutch mechanism. The barrel assembly also has a **lock** assembly that is used to control the working depth of the hex head drive shaft.

One thermal tile plug for each latch mechanism is removed using the spanner wrench assembly of the tool handle, exposing the latch drive and clutch mechanism of the door latch override mechanism. The threaded section of the barrel assembly is screwed into the clutch release and an outward force is applied to the barrel section while simultaneously **holding** in the drive shaft **lock** and **pushing in** the tee handle/**drive** shaft to **disengage the latch drive clutch and** engage the latch mechanism drive unit. When the **drive** shaft is engaged, the drive shaft **lock** may be released, locking the latch override drive and clutch mechanism in operating position. The tee handle is then rotated counterclockwise to release and stow the door latch. Approximately 14 revolutions of the tool are required to release and stow the latch into the orbiter recess. The tee handle may also be rotated clockwise to drive the mechanism to unstow, extend, and lock the latch open. **An adjustable tether should be installed to restrain the loaded doors before the latches are stowed**.

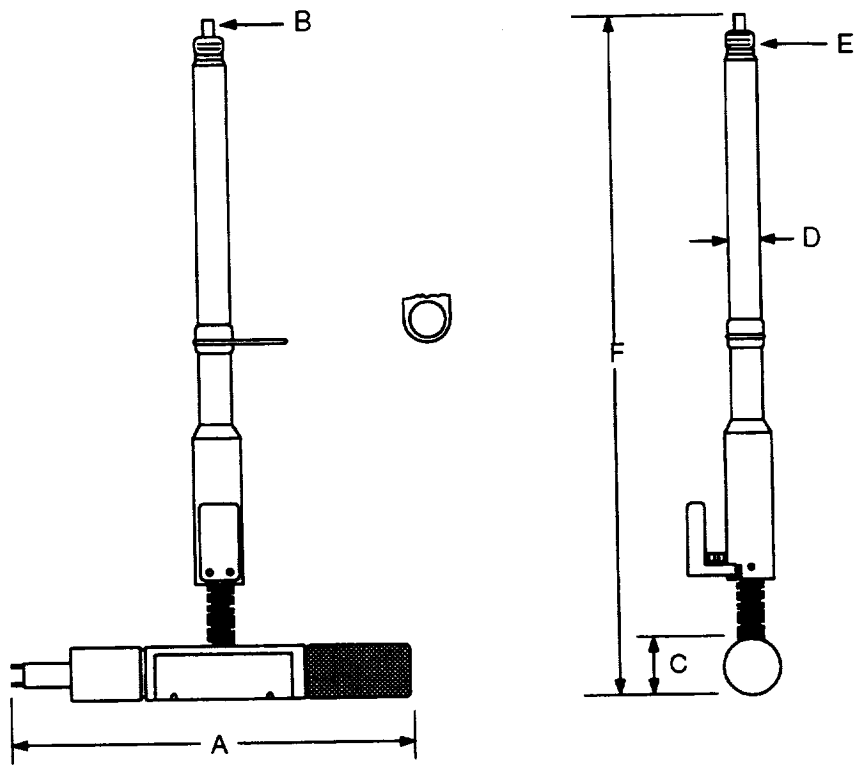
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

DOOR LATCH TOOL, EXTERNAL TANK

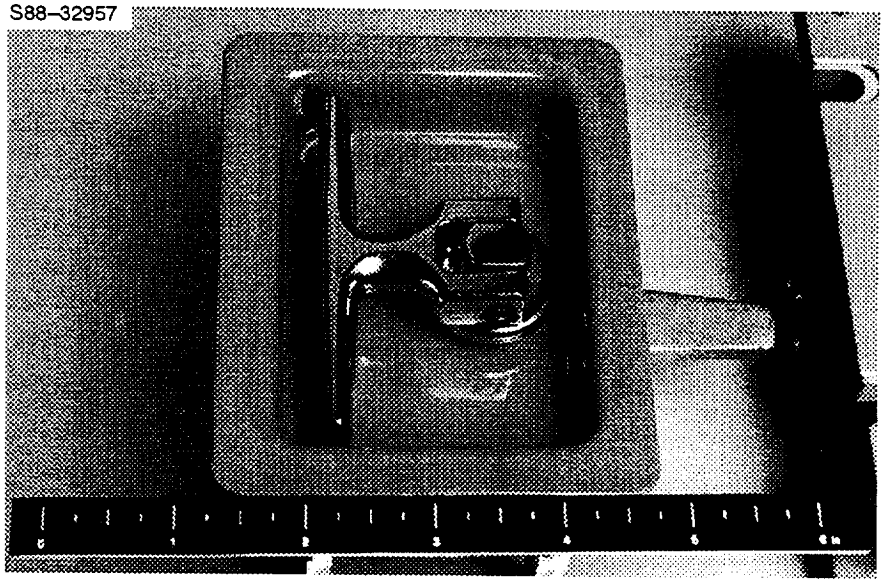
Technical Information	
Part number	SED39118691–301
Weight	1.40 lb
Material/ construction	Aluminum Stainless steel Nickel alloy
Load rating	**40 in–lb (design)**
Temperature range	–130° to +150° F (operational)
Quantity flown	One
Stowage	Port PSA
Availability	Standard

Dimensional Data		
	inches	cm
A	8.200	20.83
B	**0.125 hex**	**0.32**
C	1.120 dia.	2.84
D	0.670 dia.	1.70
E	0.500–, 200NF–2A	1.27
F	**14.150**	**35.94**



DOOR LATCH, 1/4–TURN

S88–32957



OVERVIEW

The 1/4–turn door latch was developed for use on the flight support system (FSS) locker (10172–20001–01) that was flown on STS 41–C. This door latching system incorporates a yellow housing for easy identification in the cargo bay and a large turning handle for gloved–hand use. The handle has a large tether ring that makes it easy to grasp, and it folds into the housing for stowage. This door latch style can be incorporated into a variety of stowage containers.

OPERATIONAL COMMENTS

The crewmember lifts the tether ring to take the handle from the housing and rotates it 90° to unlatch the locker door. There are two latches on each door of the FSS locker, requiring that the procedure be repeated four times to open both doors of the locker. This latch last saw flight use on equipment stowage boxes of the UARS deployment mission, STS–48.

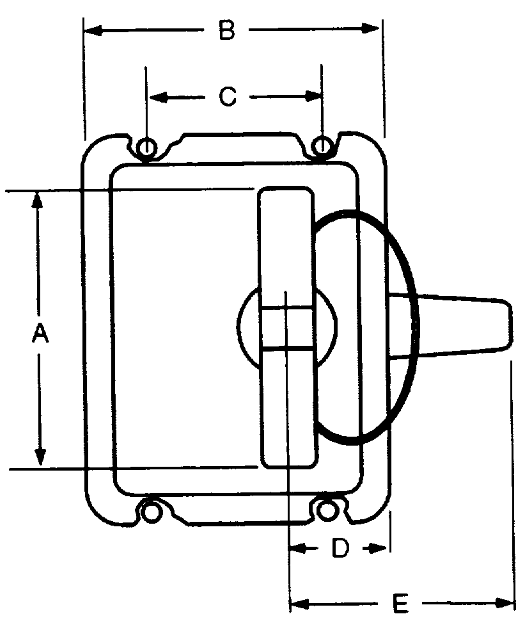
CONTACTS

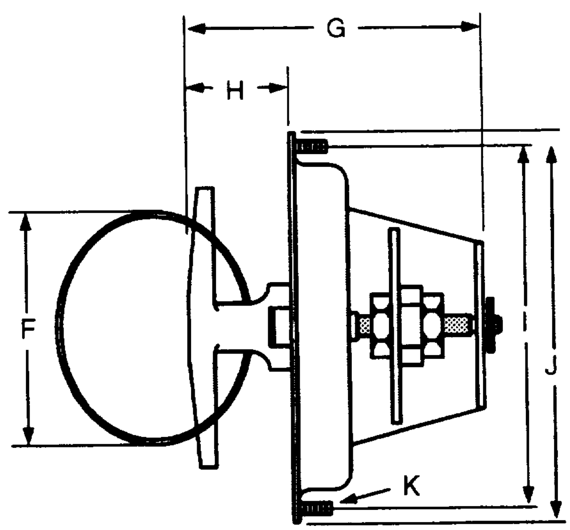
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

DOOR LATCH, 1/4–TURN

Technical Information	
Part number	10172–20016–01
Weight	1.05 lb
Material/ construction	Aluminum Stainless steel
Load rating	
Temperature range	–130° to +150° F (operational)
Quantity flown	
Stowage	
Availability	Flight specific

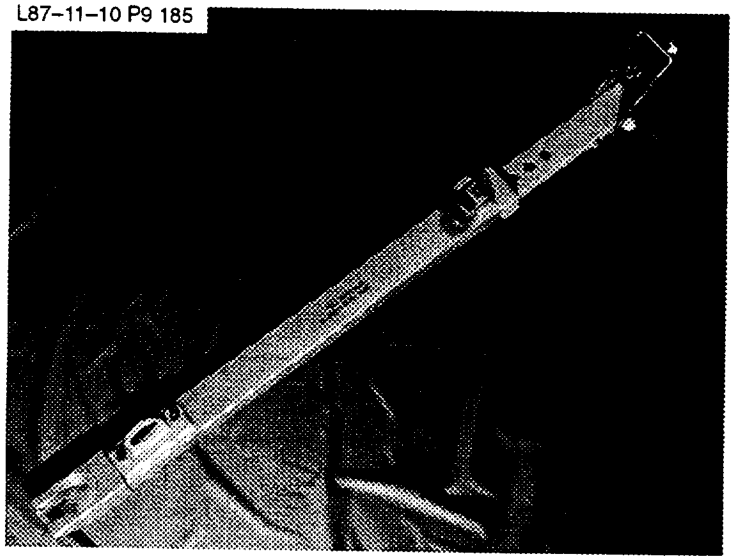
Dimensional Data		
	inches	cm
A	3.25	8.26
B	3.50	8.89
C	2.00	5.08
D	1.19	3.02
E	2.56	6.50
F	2.75	6.99
G	3.75	9.53
H	1.19	3.02
I	4.19	10.64
J	4.50	11.43
K	.190–24 UNC	





DOOR STAY, ADJUSTABLE, SSM

L87–11–10 P9 185



OVERVIEW

The systems support module (SSM) adjustable door stay is designed to secure the bay doors on the Hubble Space Telescope (HST) in an opened position. The stay will adjust to fit any SSM bay door that does not have an integral door stay. The stay can also be used in addition to the integral door stay at the opposite end of the door hinge line in cases where greater door stability is desired.

OPERATIONAL COMMENTS

The SSM adjustable door stay interfaces on one end with screws that extend out from the door frame. The other end latches over the J–hook screws. There are 15 possible length adjustments at 1/2–in. increments. The stay can range from 16–3/4 in. to 24–1/4 in. An integral tether ring provides a restraint attachment point.

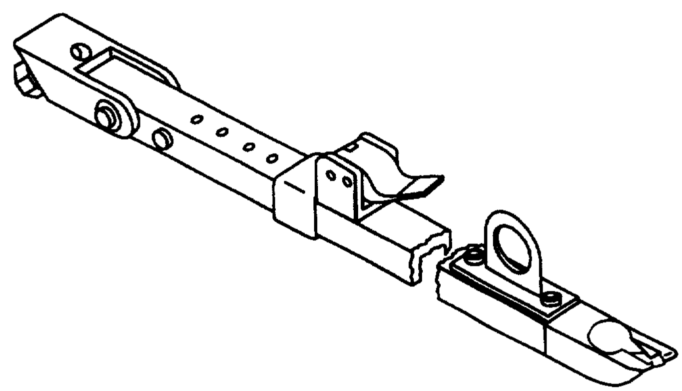
CONTACTS

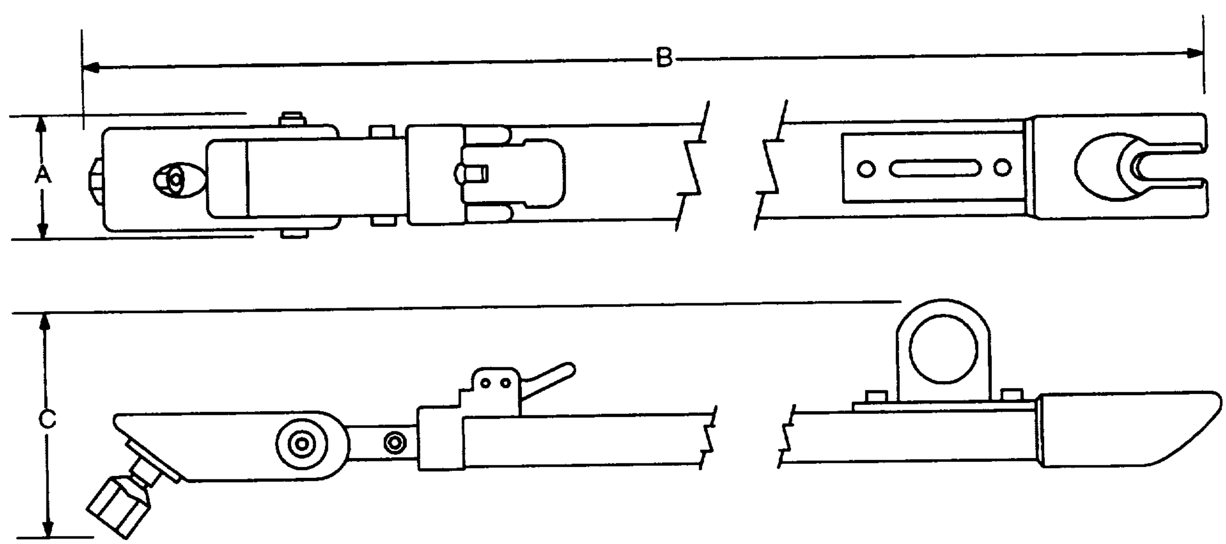
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

DOOR STAY, ADJUSTABLE, SSM

Technical Information	
Part number	10181–10010–01
Weight	0.80 lb
Material/ construction	Aluminum Stainless steel
Load rating	25 lb
Temperature range	–150° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific, existing units reserved for HST

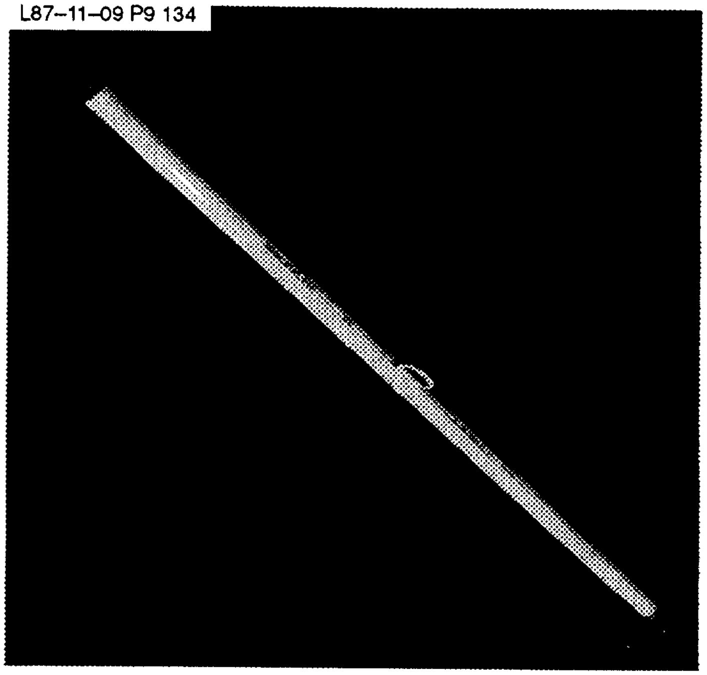
Dimensional Data		
	inches	cm
A	1.40	3.56
B	16.80 retracted 24.30 extended	42.67 61.72
C	2.60	6.60





DOOR STAY, OTA

L87–11–09 P9 134



OVERVIEW

The optical telescope assembly (OTA) door stay is designed specifically to secure the bay C door in the OTA section of the Hubble Space Telescope (HST) in an opened position.

OPERATIONAL COMMENTS

The door stay is made to secure the bay C door open at 118°. It is used by inserting one end through one of the door holes and securing the forked end under a J–bolt head. An integral tether ring provides a restraint attachment point.

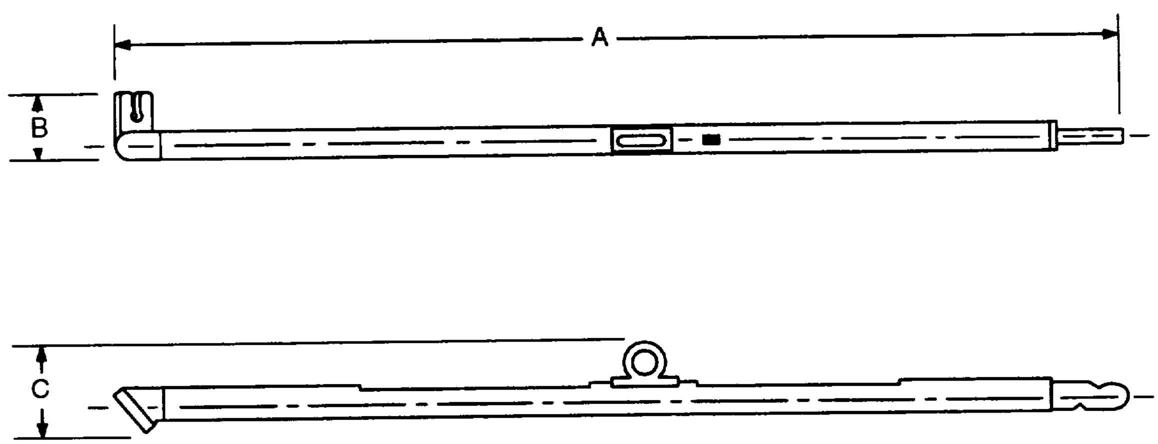
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

DOOR STAY, OTA

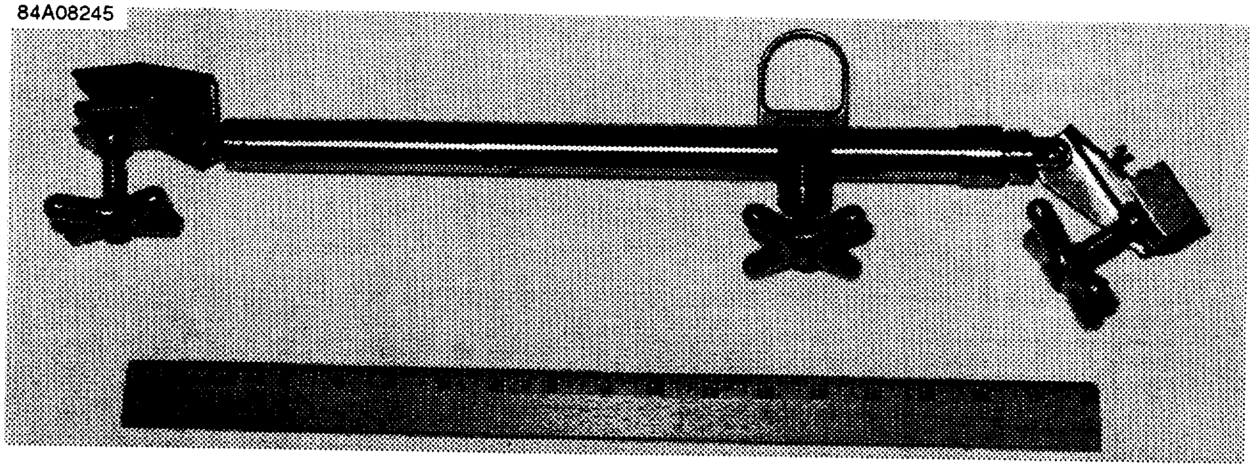
Technical Information	
Part number	10181–10009–01
Weight	0.53 lb
Material/ construction	Aluminum
Load rating	25 lb
Temperature range	–150° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific, existing units reserved for HST

Dimensional Data		
	inches	cm
A	25.70	65.28
B	1.76	4.47
C	2.25	5.71



DOOR SUPPORT BRACKET

84A08245



OVERVIEW

The door support bracket is a 20–in. telescoping tube with a swivel–motion bracket mounted at each end. Each end has an adjustable knob for tightening the bracket to the structure. The bar extends an additional 9 in. if needed. A tether ring is attached to the bar for easy transportation to a worksite.

OPERATIONAL COMMENTS

The door support bracket was used on the Solar Maximum Satellite (Solar Max) Repair Mission to hold open the main electronics box (MEB) panel. The support bracket was installed between the bottom of the MEB panel and the Solar Max frame. The MEB panel opened at approximately 90°, and the support bracket adjustment knob was tightened to maintain the MEB panel in the open position. This tool is not normally flown.

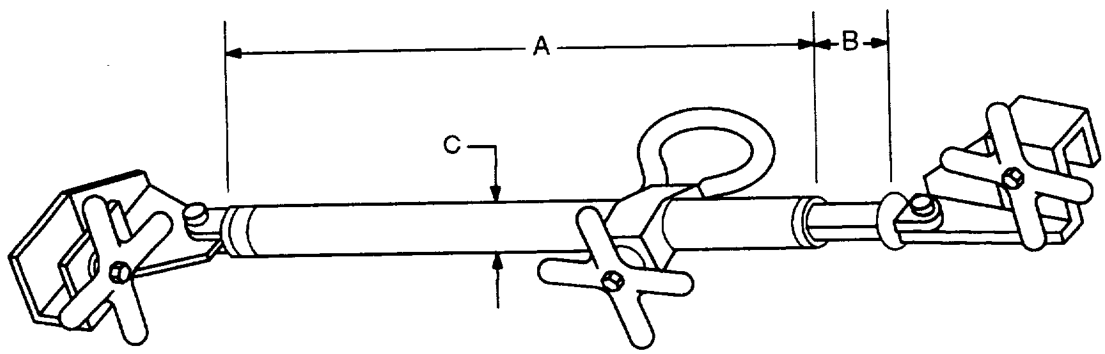
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: K. Olson, NASA/GSFC/442, (205) 772–7660

DOOR SUPPORT BRACKET

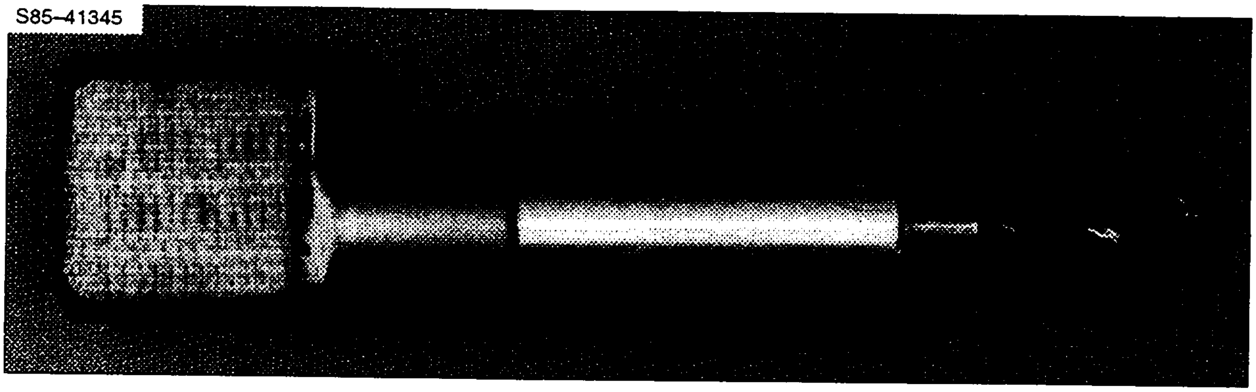
Technical Information	
Part number	1418231
Weight	5.0 lb
Material/ construction	Stainless steel
Load rating	
Temperature range	
Quantity flown	One on STS 41C
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	14.625	37.15
B	9.000 max.	22.86
C	1.000	2.54



DRILL, 1/4–INCH

S85–41345



OVERVIEW

The 1/4–in. drill extension for the 3/8–in. drive is a contingency tool that can be used **as a last resort to** remove the head of a socket head cap screw if traditional removal methods fail. **The original verison** consists of a 1/4–in. right–hand cobalt ball end mill with an aluminum sleeve and a stainless steel drop–proof tether. One side of the drop–proof tether is Velcro–covered to allow attachment to a tool caddy.

OPERATIONAL COMMENTS

The 1/4–in. drill extension was designed for use during the Solar Maximum Satellite (Solar Max) Repair Mission. A quick–release pin is used to connect or disconnect the drop–proof tether from a 3/8–in. driver such as the EVA power tool. Besides generating considerable debris/contamination, a large amount of force and time are required when drilling with this tool, and it is not recommended for **future** EVA **applications.** The drill extension was stowed in the flight support system (FSS) locker inside a tool caddy for the Solar Max mission but was not used.

A longer modified version is being flown on STS–61 as a contingency fastener release tool to support Hubble Space Telescope maintenance. **It uses a 1/2–in. left hand cobalt ball end mill mounted on a stainless steel 10.3–in. extension.**

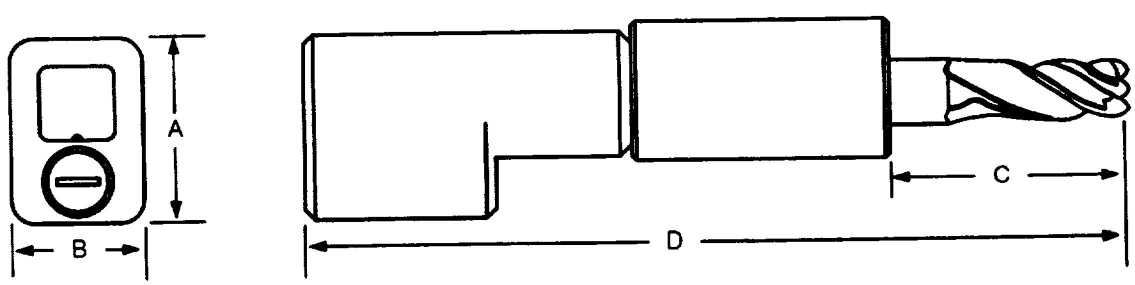
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

DRILL, 1/4–INCH

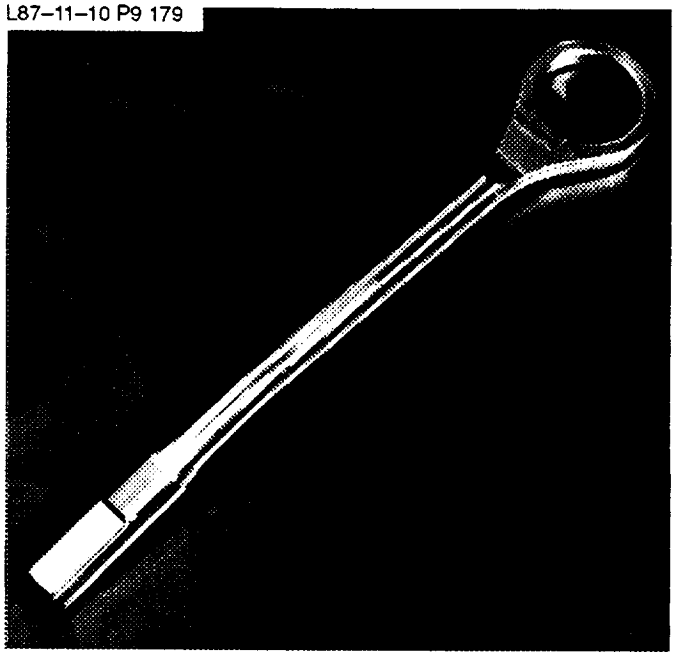
Technical Information	
Part number	10172–20551–01 10181–10070–301
Weight	0.3 lb (10172)
Material/ construction	Drill bit – cobalt Drill bit sleeve – aluminum Drop–proof tether – stainless steel Velcro – astro hook
Load rating	20 in–lb (10181)
Temperature range	–150° to +280° F (operational)
Quantity flown	One 10172 on STS 41–C One 10181 on STS–61
Stowage	Payload bay tool box
Availability	Flight specific

Dimensional Data	inches	cm
A	1.00	2.54
B	0.70	1.78
C	1.25	3.17
D	4.35	11.05



(10172–20551)

DRIVE UNIT PRELOAD TOOL



OVERVIEW

The drive unit preload tool is used for operation of the high gain antenna and aperture door manual deployment hinge of the Hubble Space Telescope (HST). It has a tether ring on one end and a hinge drive interface on the other end. The cross section of the hinge drive interface is D shaped.

OPERATIONAL COMMENTS

The drive unit preload tool is used to drive the output shaft of the rotary drive actuator to a mechanical stop. This will provide a preload on the aperture door and high gain antenna after manual deployment. Extravehicular activity (EVA) interface marking is provided on each hinge drive.

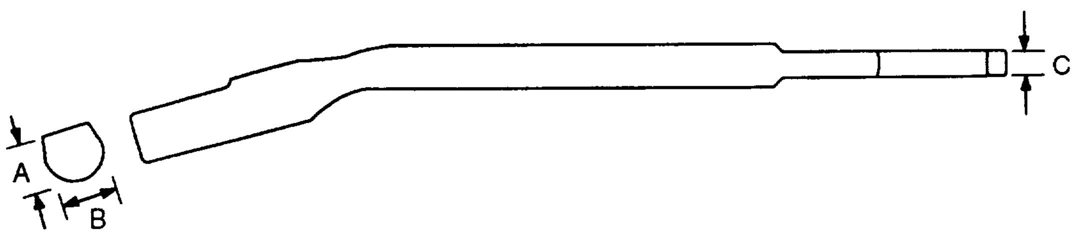
CONTACTS

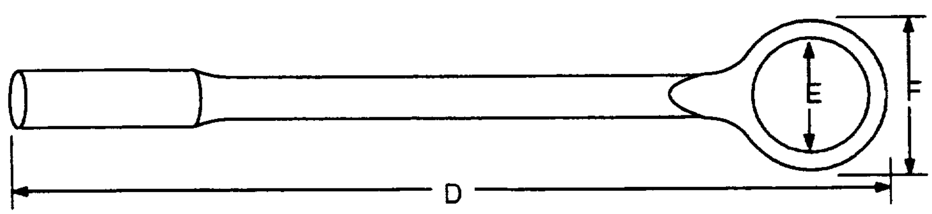
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: **R. Sheffield,** LMSC/Dept 64–10, (408) 742–**8464**

DRIVE UNIT PRELOAD TOOL

Technical Information	
Part number	4177312–001
Weight	0.74 lb
Material/ construction	Stainless steel, 15–5 PH CRES
Load rating	15 lb
Temperature range	
Quantity flown	
Stowage	
Availability	Flight specific, existing units reserved for HST

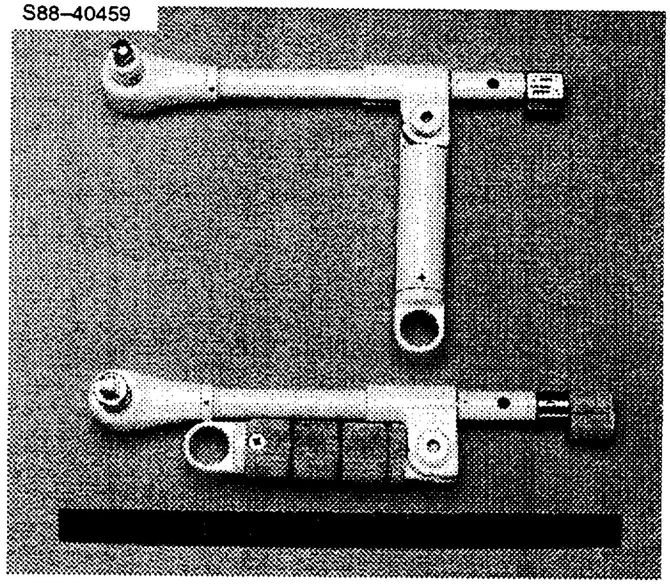
Dimensional Data		
	inches	cm
A	0.620	1.57
B	0.700	1.78
C	0.300	0.76
D	10.085	25.62
E	1.310	3.33
F	1.750	4.45





DRIVE, RIGHT ANGLE

S88–40459



OVERVIEW

The right angle drive transmits torque 90° to various driver tips. It is normally used with the extravehicular activity power tool.

OPERATIONAL COMMENTS

The right angle drive tool has a 3/8–in. square drive and accepts driver or drill tips fitted with drop–proof tether interfaces. Each version of the tool has a folding handle on the right side and drop–proof tether interfaces: male at the output end and female at the input end. 10176–20150–01 has a Velcro–wrapped handle and drop–proof tether. It was flown and successfully used on STS 51–I to aid in access to a cover plate under the Syncom IV UHF receiver antenna. 10181–10048 uses no Velcro **to eliminate particulate contamination** and has a lightweight mini drop–proof tether. It has been designed for use during maintenance of the Hubble Space Telescope (HST). **It was first used on STS–49 for Intelsat rocket motor installation. The torque reaction handle can be custom positioned about the drive shaft as a preflight option (e.g., left– or right–hand).**

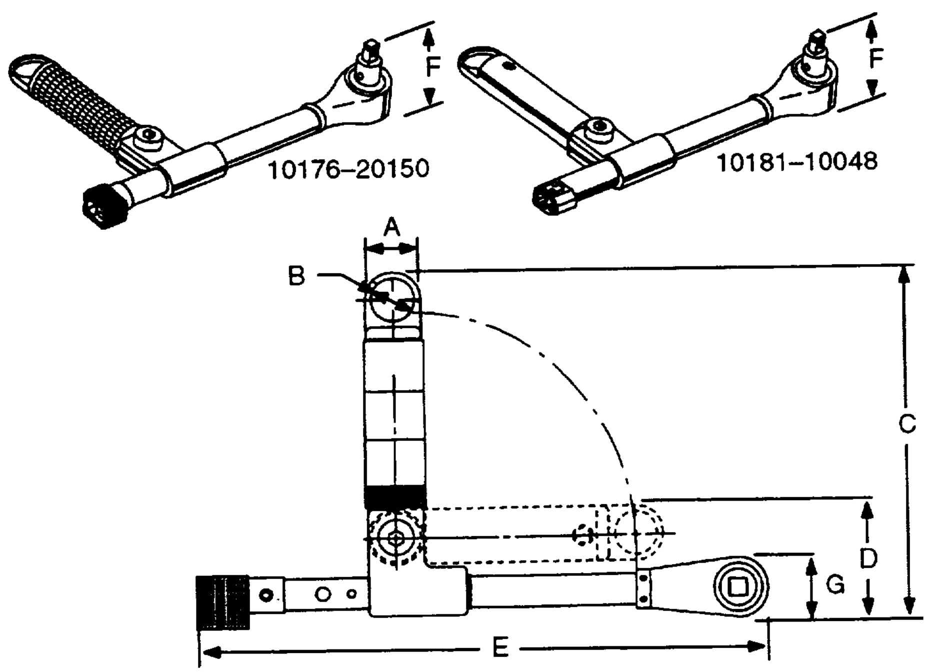
CONTACTS

Operational: R. C. Trevino, NASA/DF4, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

DRIVE, RIGHT ANGLE

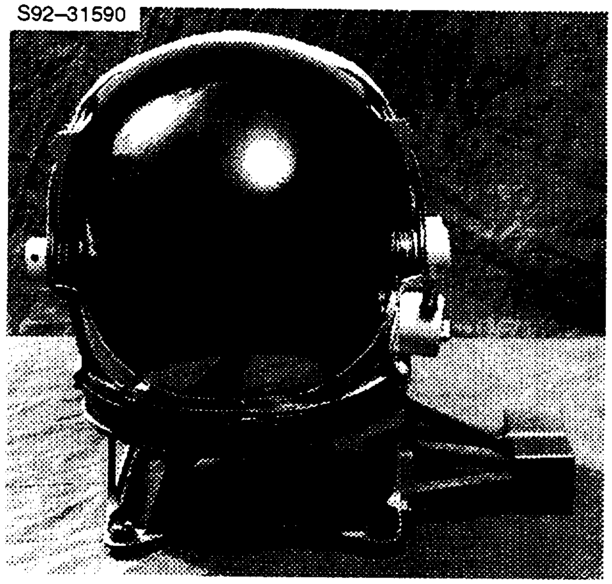
Technical Information	
Part number	10176–20150–01 **10181–10048–01 (right side handle)** **10181–10048–02 (left side handle)**
Weight	2.0 lb
Material/ construction	Stainless steel, aluminum
Load rating	Force of 20 lb Torque of **336** in–lb 10 lb maximum **release force** **1.8 to 1 gear reduction**
Temperature range	**–60° to +180° F (operational)** **–130° to +180° F (stowage)**
Quantity flown	One on STS 51–I (10176) **Two on STS–49 (10181–10048–02)**
Stowage	Shuttle cabin for STS 51–I **Stbd PSA for STS–49**
Articulation	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.18	**3.0**
B	0.90	**2.29**
C	7.22	**18.34**
D	2.34	**5.94**
E	11.62 (10176) 10.83 (10181)	**29.51** **27.51**
F	2.44	**6.20**
G	1.25	**3.18**



EMU HELMET HOLDING FIXTURE

S92–31590



OVERVIEW

Normally, a pair of crewmembers will conduct extravehicular activity (EVA) sorties with a day of rest in between. Given the limited on–orbit stay time of the orbiter at present, in order to perform a high number of EVA sorties, it is necessary to conduct them on consecutive days using two teams of two EVA crewmembers. To support the four EVA crewmembers with minimal **extravehicular mobility unit (EMU)** reconfiguration between each sortie, four EMU's are stowed in the orbiter. When all are stowed in the airlock, the ceiling–mounted suit precludes having helmets attached to each wall–mounted suit. This situation has forced the use of a special helmet holding fixture that mounts on the airlock floor on either side of the floor–mounted EMU. These helmet fixtures utilize surplus Apollo EMU neck rings.

OPERATIONAL COMMENTS

The floor–mounted helmet fixtures can be left in the airlock at all times because they do not interfere with the opening or closing of the outer airlock hatch. Special standoffs project off the side of each helmet fixture so that the hatch support legs have a surface to reset against before the hatch latches and helmet fixture come into contact. In case the fixtures must be removed for more room in the airlock, four captive bolts with 5/32–in. allen heads can be released. This removal is discouraged to avoid the impact to in–cabin crew time. The fixtures rest on vibration–isolating rubber cushions to absorb launch and landing loads. There are four threaded pads bonded to the airlock floor for each fixture. The neck ring latch functions similarly to the current shuttle EMU neck ring for helmet removal and installation. To protect the helmet visor from scratches, a protective bag is installed over each helmet when not in use. Two fixtures were first flown on STS–49.

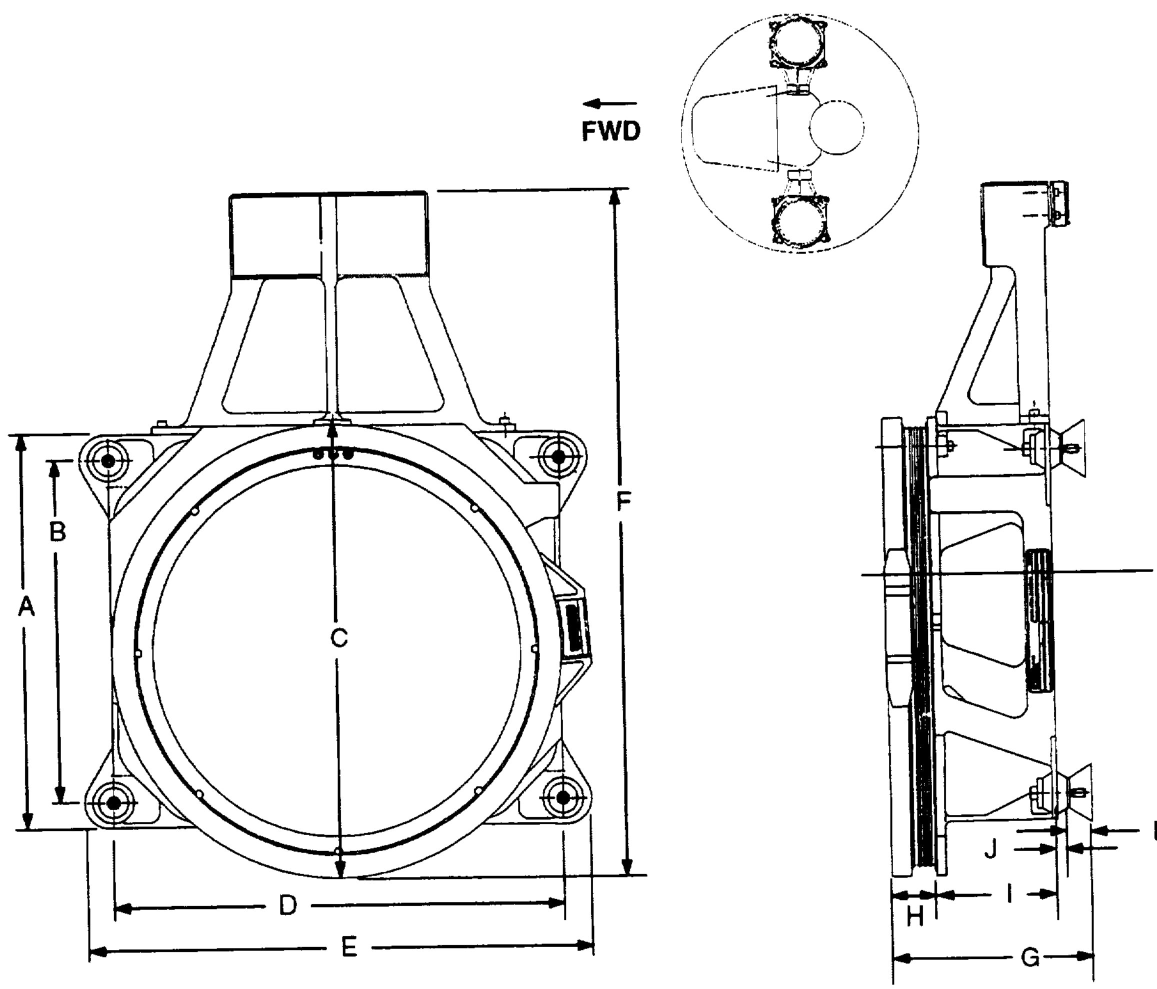
CONTACTS

Operational: S. Bleisath, NASA JSC/DF42, (713) 483–1756
Technical: G. Lutz, NASA JSC/EC6, (713) 483–9257

EMU HELMET HOLDING FIXTURE

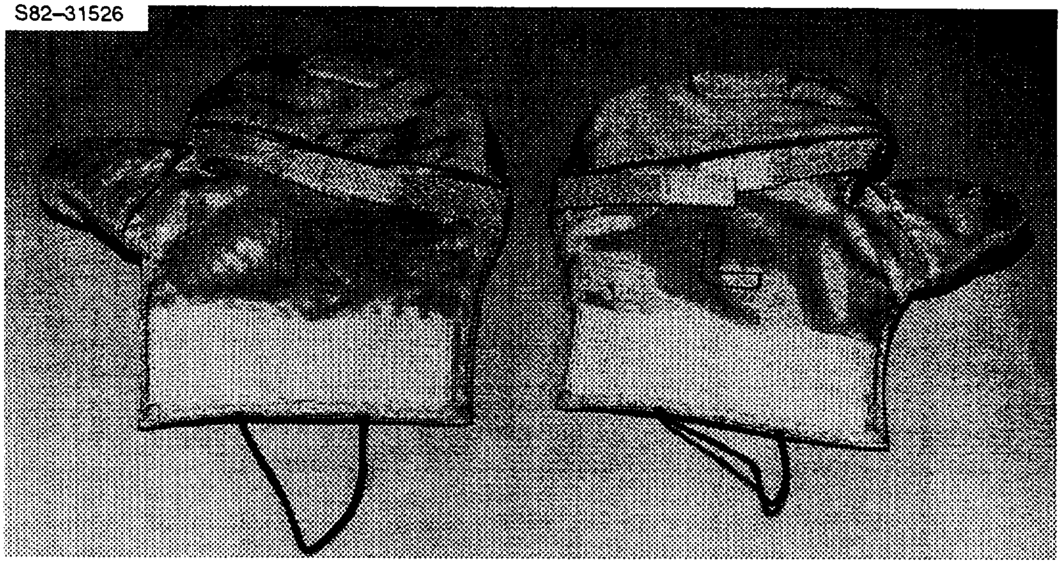
Technical Information	
Part number	SV809335 (helmet fixture) ICD–3–0027–01 (airlock EMU stowage)
Weight	
Material/ construction	Aluminum frame and neck ring, silicone cushions, dry film bolt thread lubricant
Load rating	**8.5** in–lb attachment bolt torque
Temperature range	
Quantity flown	Two on missions with consecutive EVA sorties
Stowage	Airlock floor
Availability	Flight specific

Dimensional Data		
	inches	cm
A	9.65	24.51
B	8.31	21.11
C	10.70	27.18
D	11.00	27.94
E	12.48	31.70
F	**16.50**	41.40
G	4.875	12.383
H	1.125	2.858
I	3.0	7.62
J	0.25	0.64
K	0.5	1.27



EMU THERMAL MITTENS

S82–31526



OVERVIEW

The thermal mittens are accessories to the space shuttle extravehicular mobility unit (EMU) glove assemblies to allow for the handling of extremely cold or hot objects. They can be used in a contingency for added protection against sharp objects. The mittens have a main pocket for the EMU glove fingers and a side pocket for the EMU glove thumb. The thermal mittens reduce the dexterity of the EMU–gloved astronaut.

OPERATIONAL COMMENTS

A pair of thermal mittens is provided **as standard GFE for each flight. They are available for** extravehicular crewmembers who may be required to handle an object with a surface temperature lower than –180° F or higher than 235° F for longer than 30 seconds. If an object begins to feel warm when wearing the standard EMU glove, the crewmember will don the mittens. The maximum allowable surface grip temperature is 350° F. The thermal mittens are part of the normally manifested orbiter equipment. Two pair are stowed in the **airlock** EVA bag **throughout each EVA and in** the middeck Volume H locker **for launch/landing. There are at least three standard sizes to fit most gloves. Custom sized mittens are provided when necessary**.

An improved design is being developed to support the HST maintenance mission. It is actually an insulated glove with fingers that slip on over the EMU gloves and have elastic for a conformal fit.

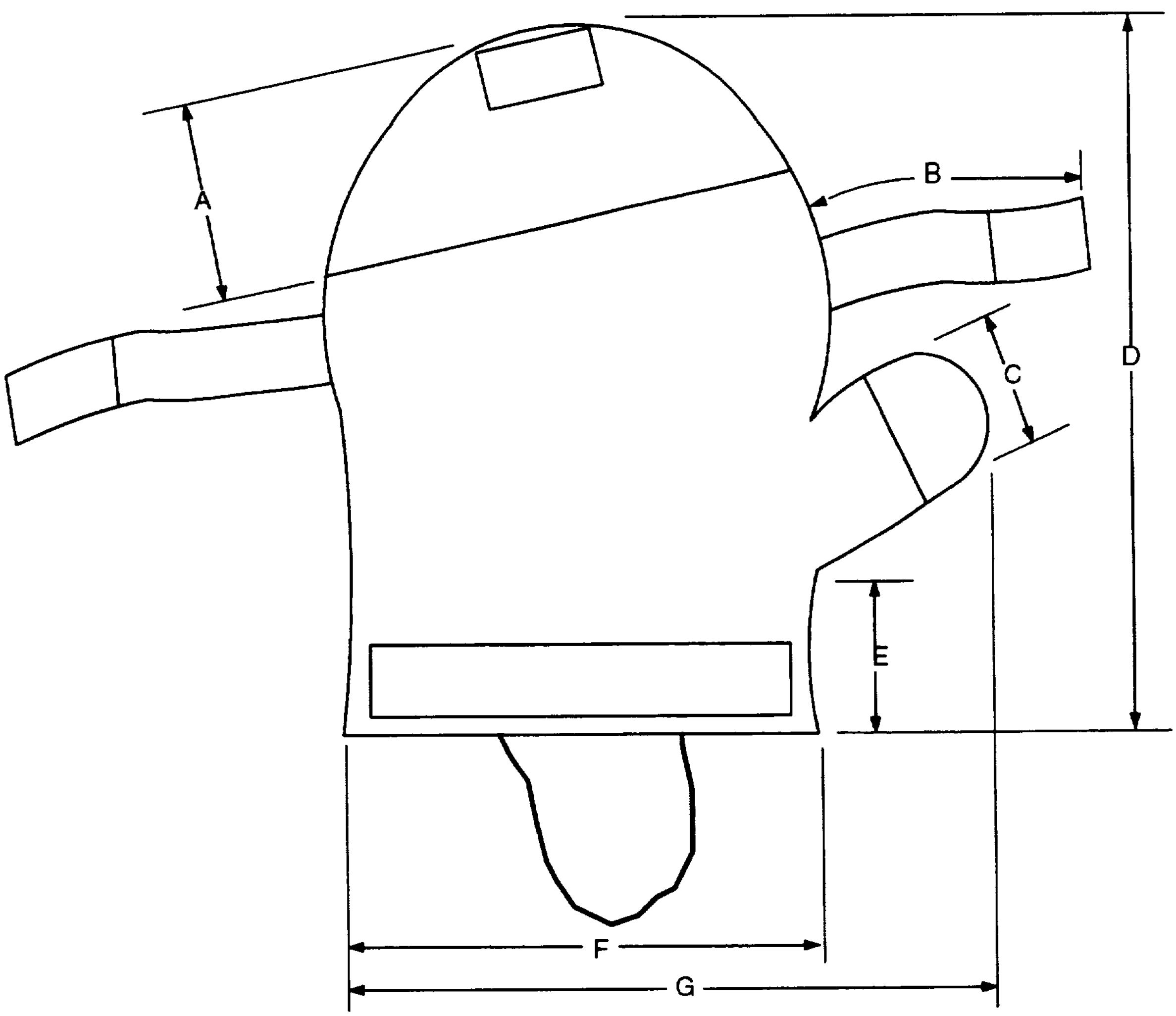
CONTACTS

Operational: **R. K. Fullerton**, NASA/DF42, (713) 483–2589
Technical: **G. Lutz**, NASA/EC6, (713) 483–9257

EMU THERMAL MITTENS

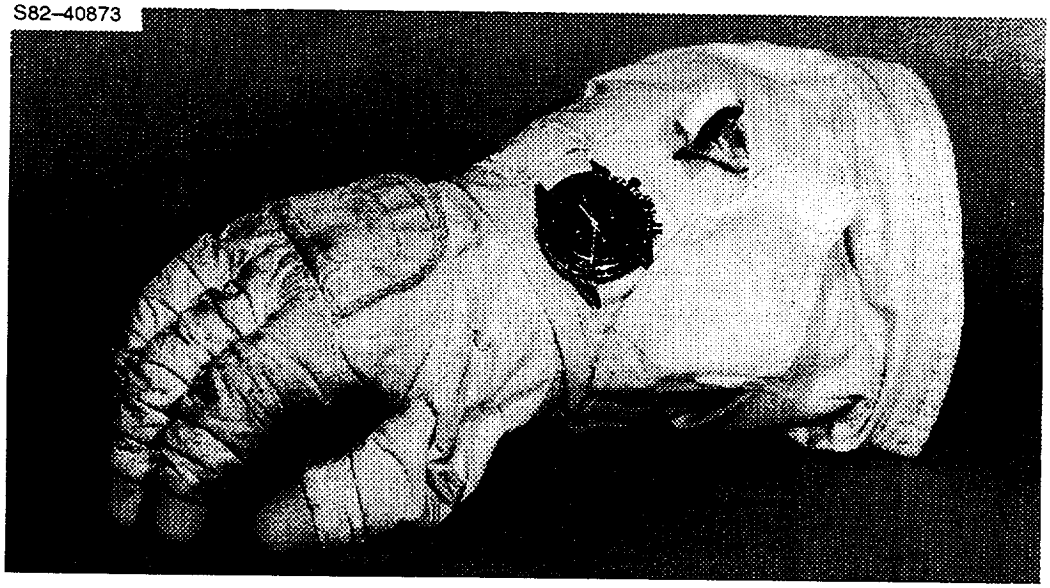
Technical Information	
Part number	0106–84268–05/–06/–07 left hand 0106–84268–08 right hand
Weight	0.2 lb each
Material/ construction	
Load rating	
Temperature range	350° F
Quantity flown	Two pair
Stowage	
Availability	Standard

Dimensional Data		
	inches	cm
A	3.5	8.89
B	3.0	7.62
C	2.0	5.08
D	9.0	22.86
E	2.5	6.35
F	5.0	12.7
G	7.0	17.78



EMU WATCH

S82–40873



OVERVIEW

The extravehicular mobility unit (EMU) watch, also called the astronaut chronograph, is an analog, manual–wind watch with a 12–hour movement. It attaches to an integral watchband on the right EMU glove and is covered by a thermal multilayer garment.

OPERATIONAL COMMENTS

The EMU watch attaches to the right EMU glove. This item has been used very sparingly on actual flights and was acquired during the Apollo–era flights. **It is provided as standard GFE with each set of primary EMU gloves.**

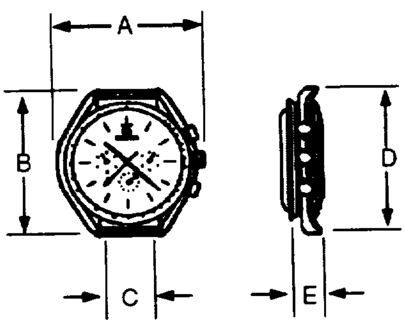
CONTACTS

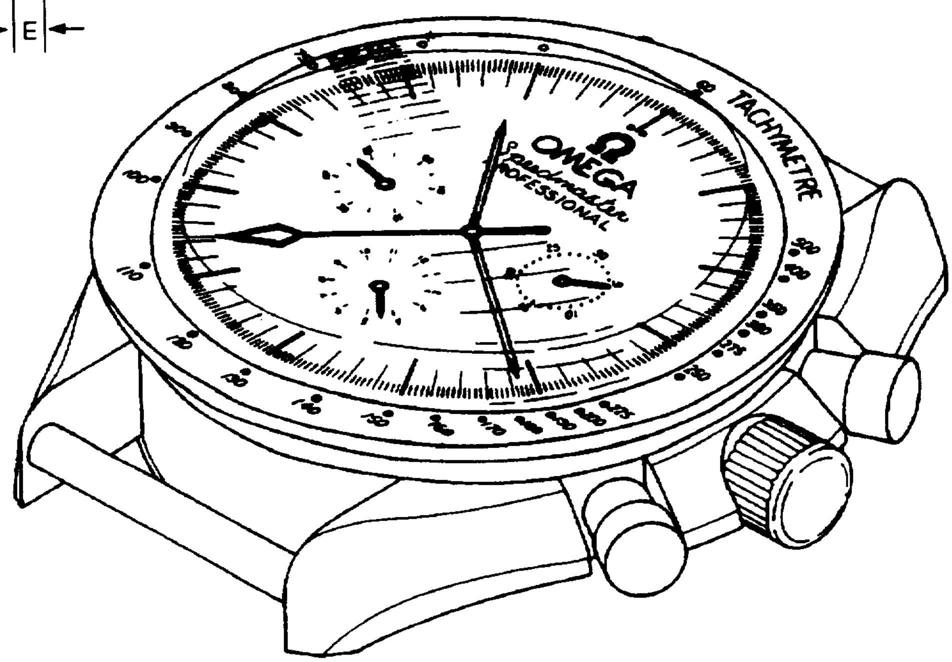
Operational: **R. K. Fullerton,** NASA/DF42, (713) 483–2589
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

EMU WATCH

Technical Information	
Part number	SED12100312–301
Weight	0.137 lb
Material/ construction	**Stainless steel casing**
Load rating	
Temperature range	
Dial indicator	Hours, minutes, seconds, elapsed time
Quantity flown	One for each prime EMU
Stowage	**Right EMU glove**
Availability	Standard

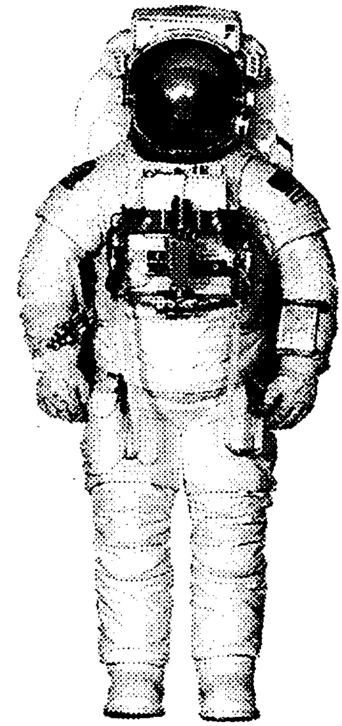
Dimensional Data		
	inches	cm
A	1.69	4.29
B	1.71	4.34
C	0.75	1.91
D	1.90	4.83
E	0.53	1.35





EXTRAVEHICULAR MOBILITY UNIT

S82–40857



OVERVIEW

The extravehicular mobility unit (EMU) is an independent anthropomorphic system that provides crewmembers with environmental protection, life support, mobility, UHF communications, and visibility while performing various EVA's. The EMU has an on–orbit recharge capability and can provide multiple EVA periods during a single flight.

OPERATIONAL COMMENTS

Two EMU's are included in each orbiter mission without a scheduled EVA. Three **or four** EMU's are flown for a scheduled EVA mission. Consumables **are normally** provided for up to three two–man, 6–hour EVA's, two of which are available for payload use (mission success) and the other reserved for an orbiter safety–critical EVA. The EMU primary life support system is designed for 7 hours of independent life support, of which only 6 hours are available for **customer use**. The EMU also has a backup oxygen system that can provide 30 minutes of open loop purge flow for contingency life support. Instrumentation and a microprocessor provide the capability **for the EV crew and ground controllers** to monitor the status of the EMU and expendables and to alert the crewmember of any abnormal system function.

Interface attachments accomodate the manned maneuvering unit, the mini–workstation, tool caddies, EMU television system, EMU lights, and the wrist and waist tethers.

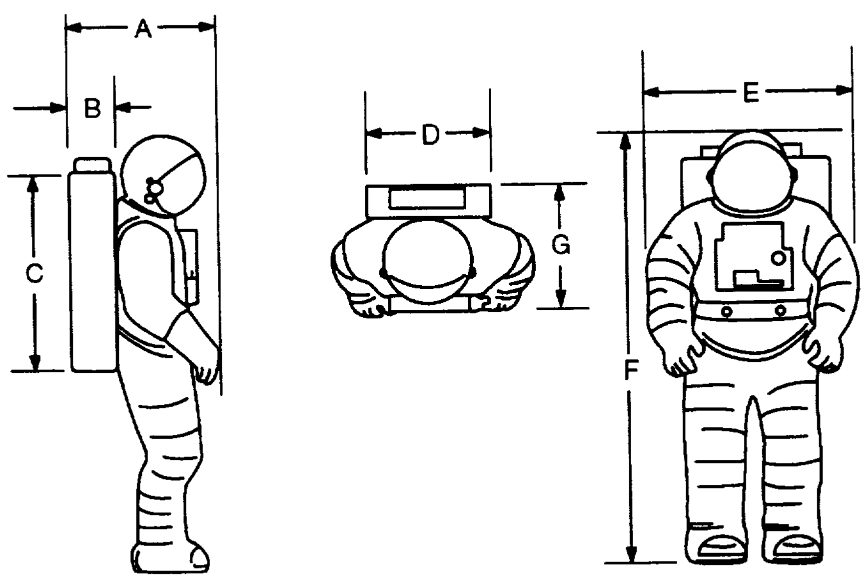
CONTACTS

Operational: **R. K. Fullerton**, NASA/DF42, (713) 483–2589
Technical: G. Lutz, NASA/EC6, (713) 483–9257

EXTRAVEHICULAR MOBILITY UNIT

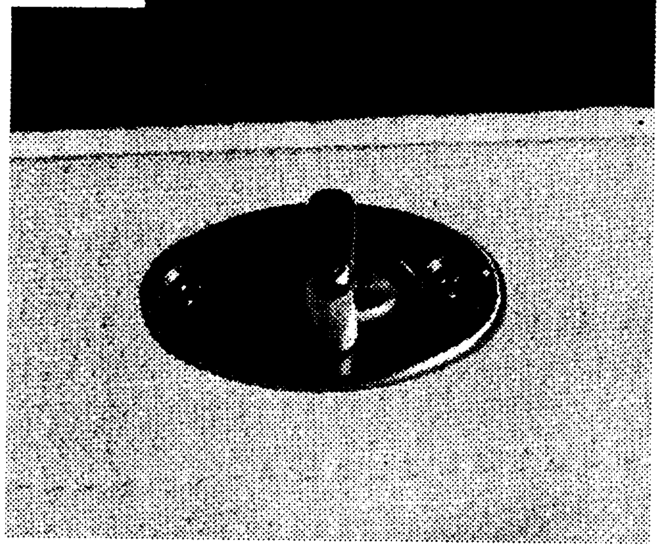
Technical Information	
Part number	SED 13101492-307
Weight	257 lb (min.) **295** lb (max.)
Material/ construction	**Fiberglass upper torso, neoprene bladder, aluminized Mylar insulation, orthofabric outer layer, Velcro, aluminum/ stainless steel life support and bearings, Lexan polycarbonate helmet bubble**
Load rating	**80 lb (mini-workstation fitting strength)** **30 lb (wrist tether loop breaking force)** **585 lb (static proof load for waist tether D-ring)** **2 ft/sec with 0.02-inch radius sphere (impact rating)**
Rf EMI limits	**3.2 V/m (UHF), 20 V/m (Ku-band), 120 V/m (S-band)**
Venting	1 lb/hr water vapor
Temperature range (glove contact)	**+40° to +113° F (continuous)** -180° to +235° F (1.0 psi pressure for 30 sec)
Quantity flown	**Up to four**
Stowage	**Airlock**
Availability	**Two standard**

Dimensional Data				
	inches	cm	inches	cm
	95% Male		5% Female	
A	28.4	72.14	26.0	66.04
B	7.0	17.78	7.0	17.78
C	32.0	81.28	32.0	81.28
D	23.0	58.42	23.0	58.42
E	29.4	74.68	–	–
F	75.5	191.77	67.5	171.45
G	**19.75**	**50.17**	–	–



FASTENER, 1/4 TURN

S89–25581



S93–39931

OVERVIEW

The 1/4–turn fastener, **also known as a common sense fastener**, serves to replace Velcro as a means of securing or closing a variety of items used in the EVA environment.

OPERATIONAL COMMENTS

1/4–turn fasteners are used to meet the strict cleanliness requirements of the Hubble Space Telescope (HST) program. **When used on a rigidly restrained device**, they allow for one–handed operation by the gloved hand of the crewmember without adding significant bulk or weight to an assembly. The 1/4–turn fasteners are used on the fuse transfer containers, the tool caddy with french hooks, and the cushioned tool board no. 1 from the HST program. **They may also be found on the shuttle slidewire cushions, tether reel box, and PSA door restraint strap. In practice, the small size of these fasteners and nonrigid restraint of items like the slidewire cushion make this design incompatible for gloved hand re–engagement. A larger version (shown at right above) shows promise for applications where Velcro is not allowed because of contamination concerns and because the larger version is more EVA friendly than the smaller version. Use of the older, smaller design is not recommended for any purpose.**

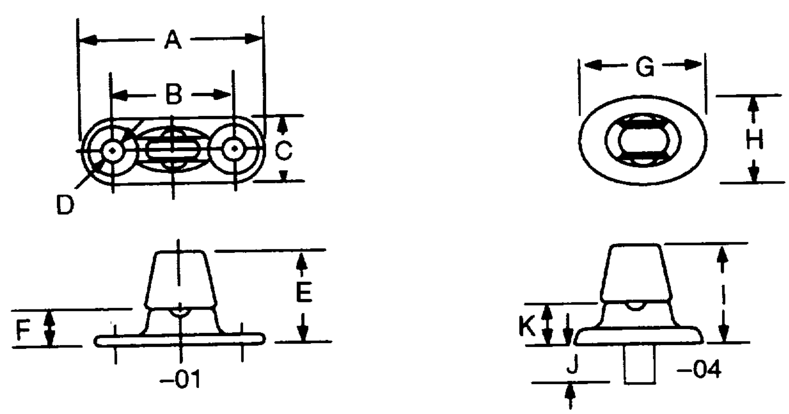
CONTENTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

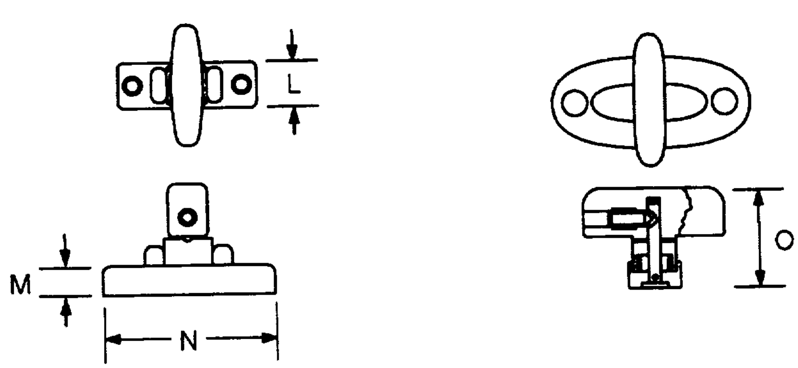
FASTENER, 1/4–TURN

Technical Information	
Part number	SO22MF2209–01 SO22MF2209–04 **10181–10052 (large)**
Weight	SO22MF2209–01 0.014 lb SO22MF2209–04 0.023 lb
Material/ construction	Male fastener – nickel plated brass Female eyelet – stainless steel
Load rating	
Temperature range	–150° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.250	3.18
B	0.875	2.22
C	0.480	1.22
D	0.165 dia	0.42 dia.
E	0.680	1.73
F	0.280	0.71
G	0.780	1.98
H	0.540	1.37
I	0.900	2.29
J	0.210	0.53
K	0.510	1.30
L	**0.372**	**0.94**
M	**0.19**	**0.48**
N	**0.872**	**2.21**
O	**0.73–0.98**	**1.85–2.49**



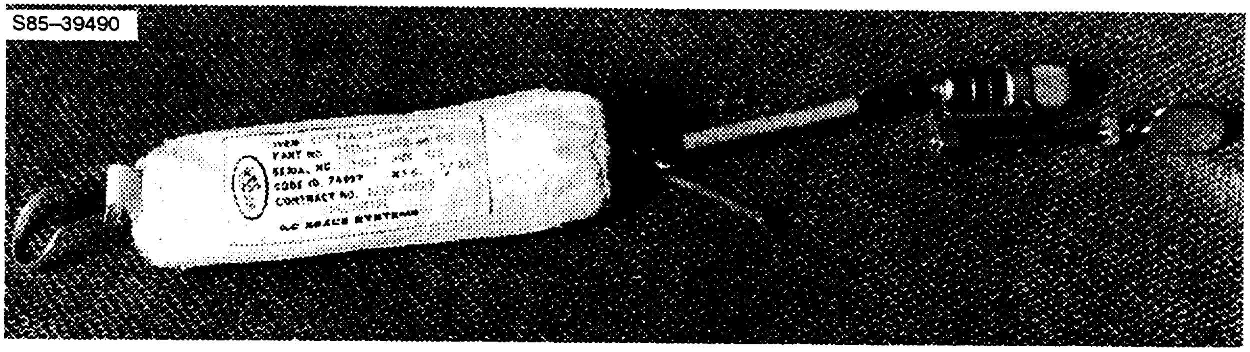
S022MF2209



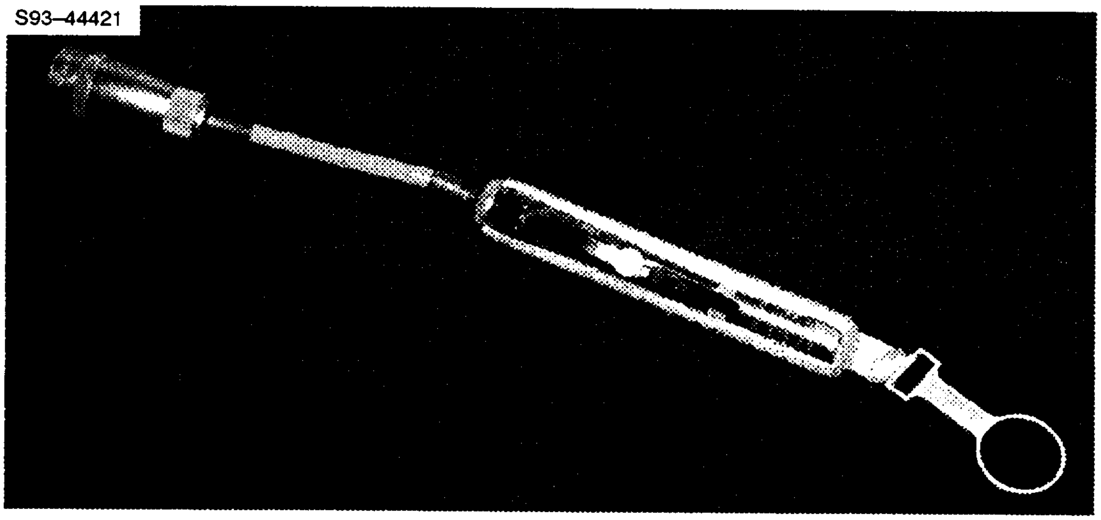
10181–10052

FLASHLIGHT

S85–39490



S93–44421



OVERVIEW

The EVA flashlight is a handheld, portable light source used by crewmembers to illuminate hard–to–reach areas.

OPERATIONAL COMMENTS

The EVA flashlight bulb casing and base are connected by a flexible neck, which can be bent at the desired angle by the crewmember. On the original version, mirror extends outward from the bulb end to aid the crewmember in seeing the item being illuminated. The flashlight is turned on by rotating the bulb assembly manually. It is stowed in the middeck during launch and entry and on a tool board or in the EVA bag during EVA.

The flashlight thermal garment is covered with hook Velcro and has a guide pull to provide a means of attachment. The thermal garment covers the base of the flashlight to protect the batteries from temperature extremes during EVA. The batteries are only designed for IVA replacement.

An IVA version of this flashlight was created to support orbiter ascent and entry as a crew worn/carry on item. The original unit was modified to have a brighter halogen lamp. The thermal garment was deleted and the mirror was removed. With an appropriate thermal garment, this IVA unit can be used for EVA and will first be manifested for STS–61 Hubble Space Telescope maintenance support.

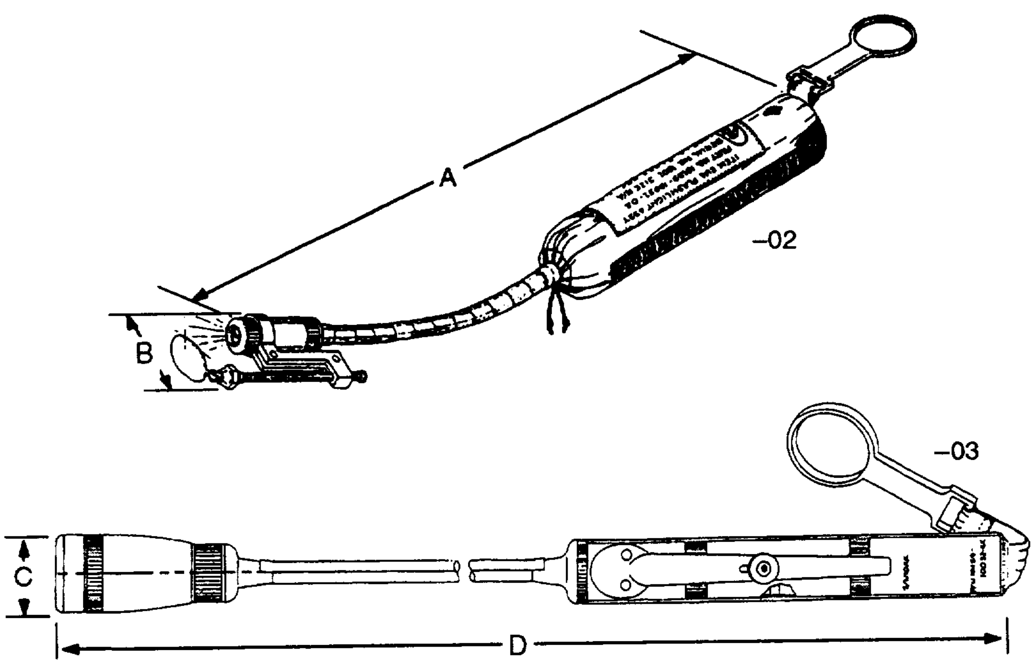
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

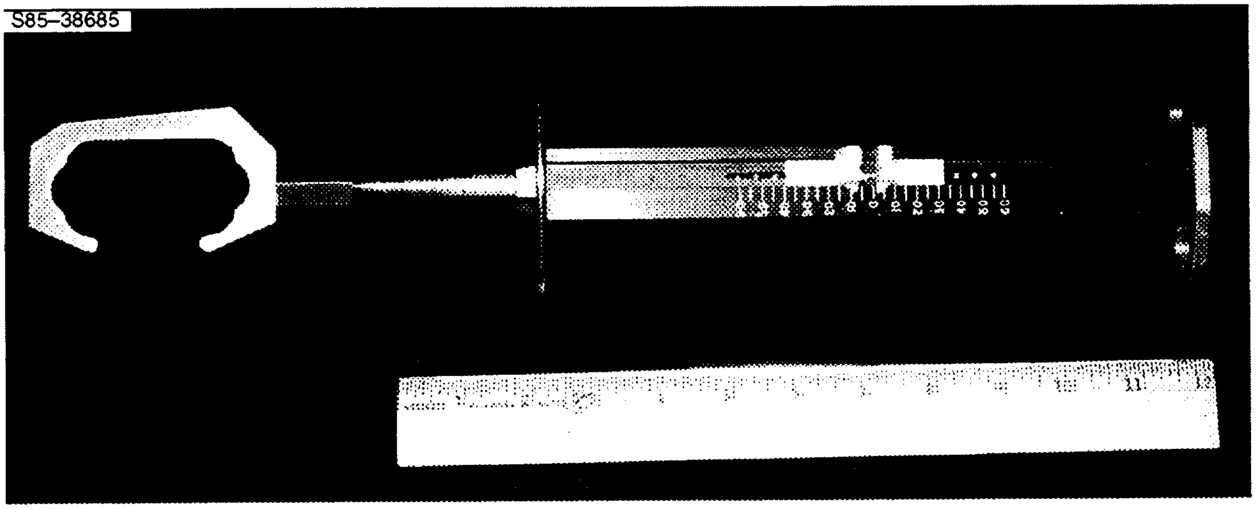
FLASHLIGHT

Technical Information	
Part number	10159–10032–**03 (IVA use)** 10159–10032–02/**04 (EVA use)** **10159–20144 (Batteries)** **ST20B927–01 (Bulbs for –02 unit)** **10159–20431–02 (Bulbs for 03/04)**
Weight	0.26 lb
Material/ construction	Two AA alkaline batteries wrapped with Teflon and Kapton
Load rating	2 yr battery life, 1.5 V each
Temperature range	
Quantity flown	One for STS 41–G, 51–A, 51–I (–02) One for STS 33, 36 (–03) One for STS–61 (–04)
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	12.00	30.48
B	1.40	3.56
C	1.00	2.54
D	11.50	29.21



FORCE MEASUREMENT TOOL



OVERVIEW

The force measurement tool **can be** used to measure crew push–pull strength capability. The tool is basically a spring scale that measures up to 60 lb in either direction (push or pull). At one end is a hook with a **1.45**–in. opening; at the other end is a plate with two tether points. Two sliding stops record the force applied.

OPERATIONAL COMMENTS

The force measurement tool was developed for use with the extravehicular activity (EVA) crewmember positioned in the manipulator foot restraint. Its purpose was for the EVA crewmember to apply a force at the tip of the remote manipulator system (RMS) by pulling or pushing on the arm with the tool. The force read by the crewmember (**11–12 lb to deflect RMS**) was then compared against the readings from the RMS joint actuators to verify proper readings from the RMS.

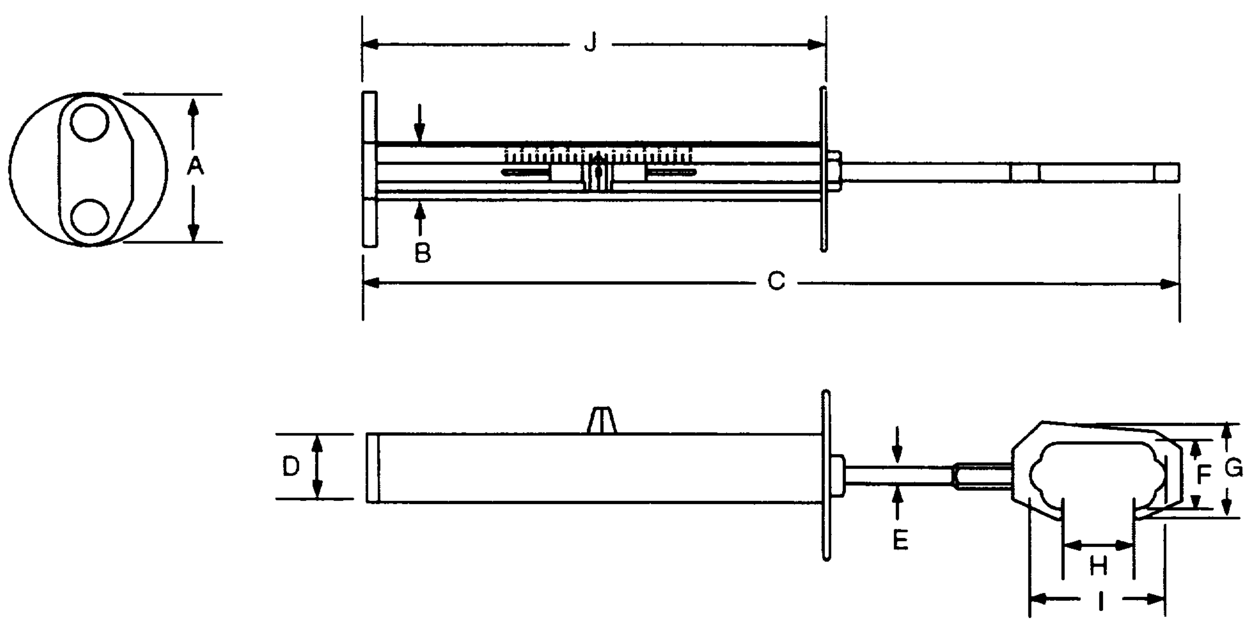
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. Marak**, NASA/**EC5**, (713) 483–**9144**

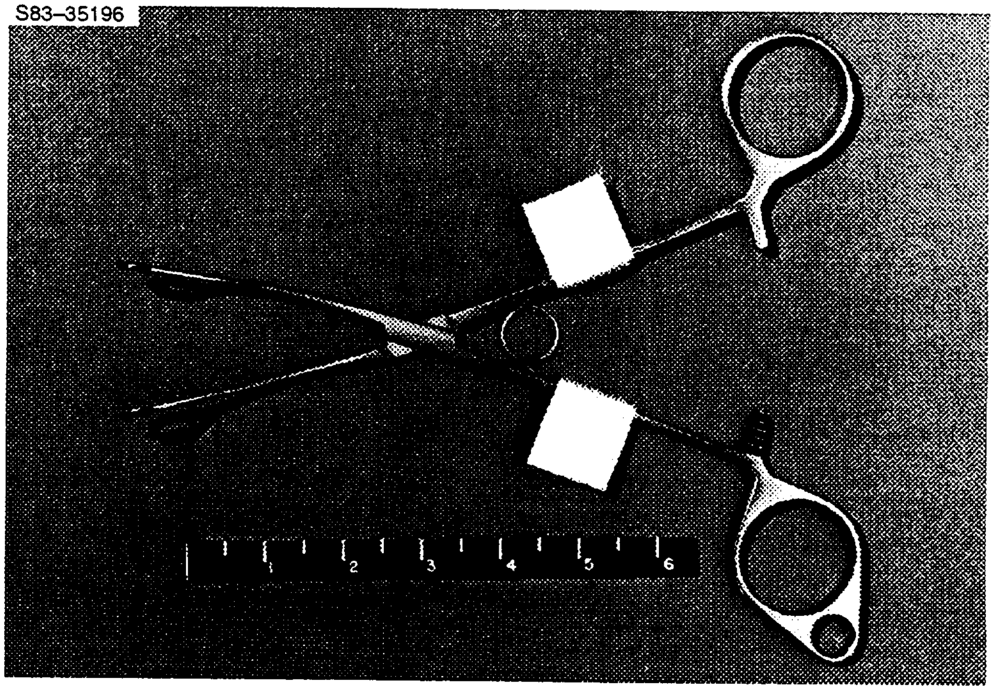
FORCE MEASUREMENT TOOL

Technical Information	
Part number	SED 33103285-301
Weight	2.0 lb
Material/ construction	Aluminum housing, steel shaft
Load rating	60 lb **(tension/compression)**
Temperature range	
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	3.25	8.26
B	1.20	3.05
C	16.88	42.88
D	1.50	3.81
E	0.35	0.89
F	1.40	3.56
G	2.10	5.33
H	1.45	3.68
I	2.85	7.24
J	9.50	24.13



FORCEPS



OVERVIEW

The forceps are a common medical instrument modified for extravehicular activity use. They have 1/2– by 1–in. elliptical tips that are serrated for gripping, a sawtooth locking mechanism that allows adjustable clamping positions, and a spring to force the handles apart. They are equipped with Velcro tabs and have a ring for tether attachment.

OPERATIONAL COMMENTS

The forceps are a general usage tool for disconnect and jam removal. They have an approximate 2–3/4–in. opening for convenient one–handed operation, but it is possible to open them wider. This tool is part of the normally manifested orbiter equipment. They are wrapped in a Velcro–lined tool caddy along with the pry bar and stowed in the **port** provisions stowage assembly (PSA).

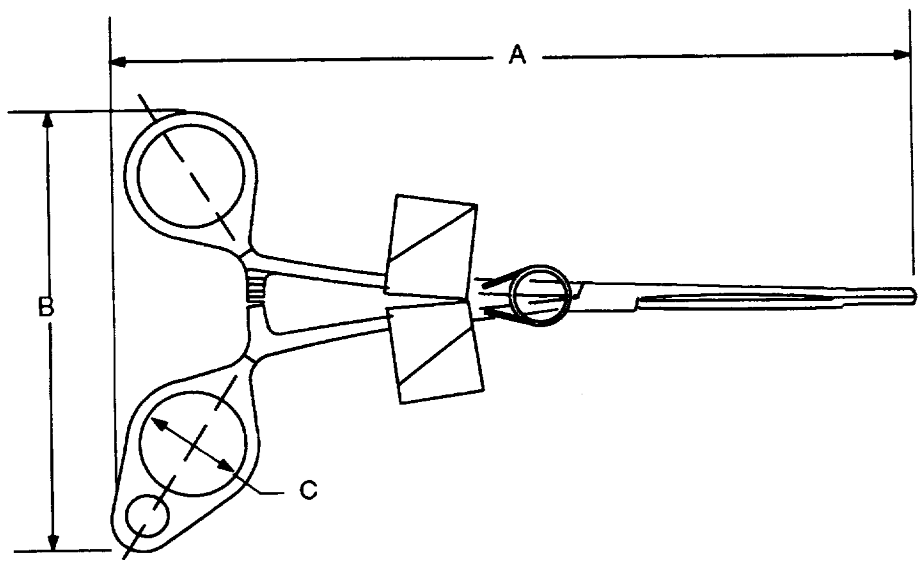
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

FORCEPS

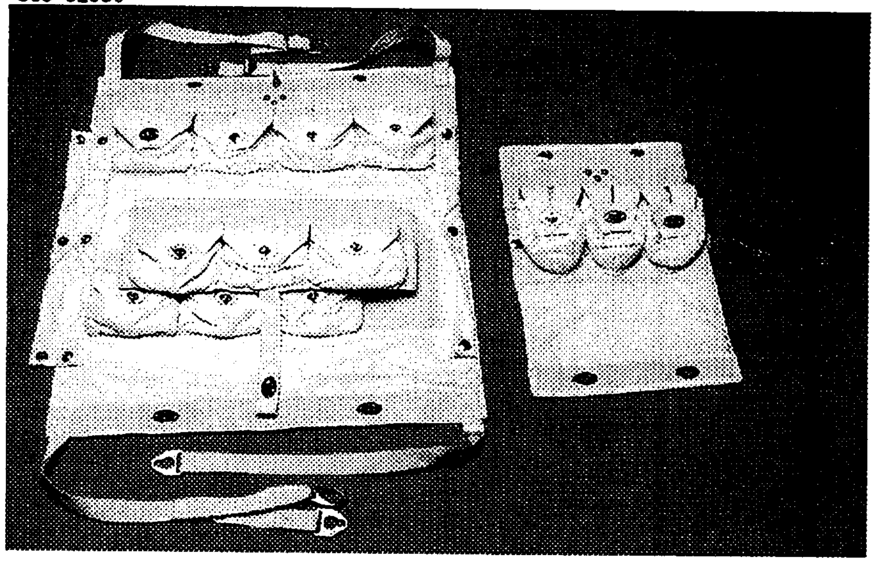
Technical Information	
Part number	V628–650877–001 or SDD33103445–301
Weight	0.2 lb
Material/ construction	Tool steel with Velcro tabs
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	9.90	25.15
B	5.60	14.22
C	1.44	3.66



FUSE TRANSFER CONTAINER

S88–32959



OVERVIEW

The electrical power/thermal canister experiment (EP/TCE) fuse transfer container (10181–10027–01) provides containment and transport of spare fuses to and from the EP/TCE box at bay 4 of the Hubble Space Telescope (HST). The fabric bag provides thermal protection from –40° to 160° F. The container consists of three insulated pockets: two for the replacement fuses and one for the initial changeout fuse.

The power distribution unit (PDU) fuse transfer container (10181–10028–01) is a thermally protective bag in which replacement fuses for the power distribution unit of the HST are stowed and transported. Twelve fuses in the PDU are replaced during a maintenance and repair mission. The container consists of 13 insulated pockets: 12 for the replacement fuses and 1 for the initial changeout fuse. The fuses are protected from –40° to 160° F.

OPERATIONAL COMMENTS

The fuse transfer containers are fabricated from a multiple layer insulation layup using eight layers of aluminized Mylar. Each container folds up for stowage. The container is tethered to the EVA crewmember until replacement operations are underway. At this point the crewmember can unfold the container and attach it to the work area as desired. One fuse is removed from the telescope and stowed in the one empty pocket. Then the exchange of new fuses and old fuses continues. The pockets are numbered to keep track of which fuses have been changed out.

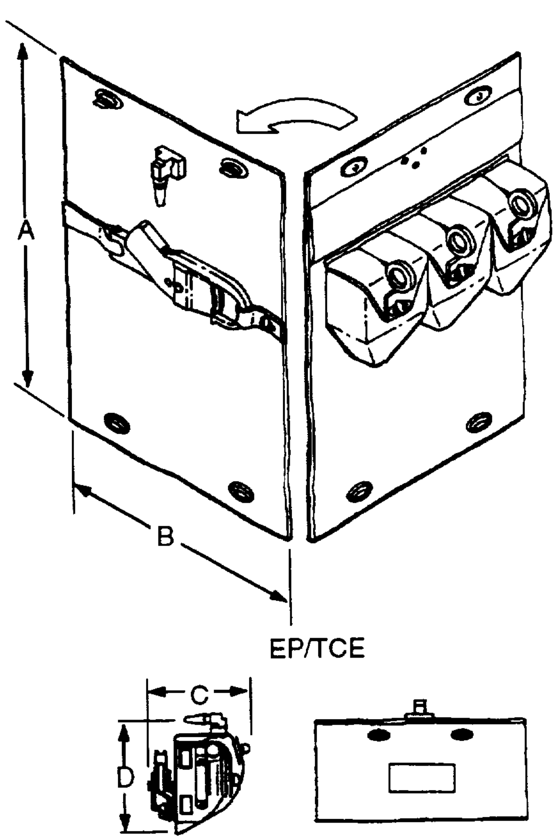
CONTACTS

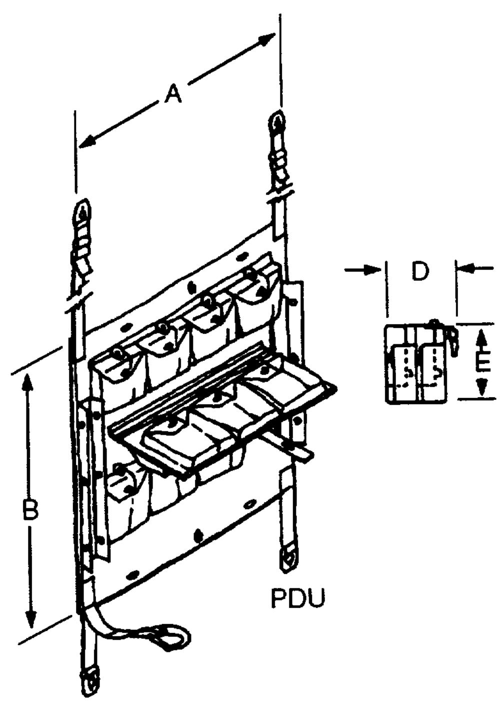
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

FUSE TRANSFER CONTAINER

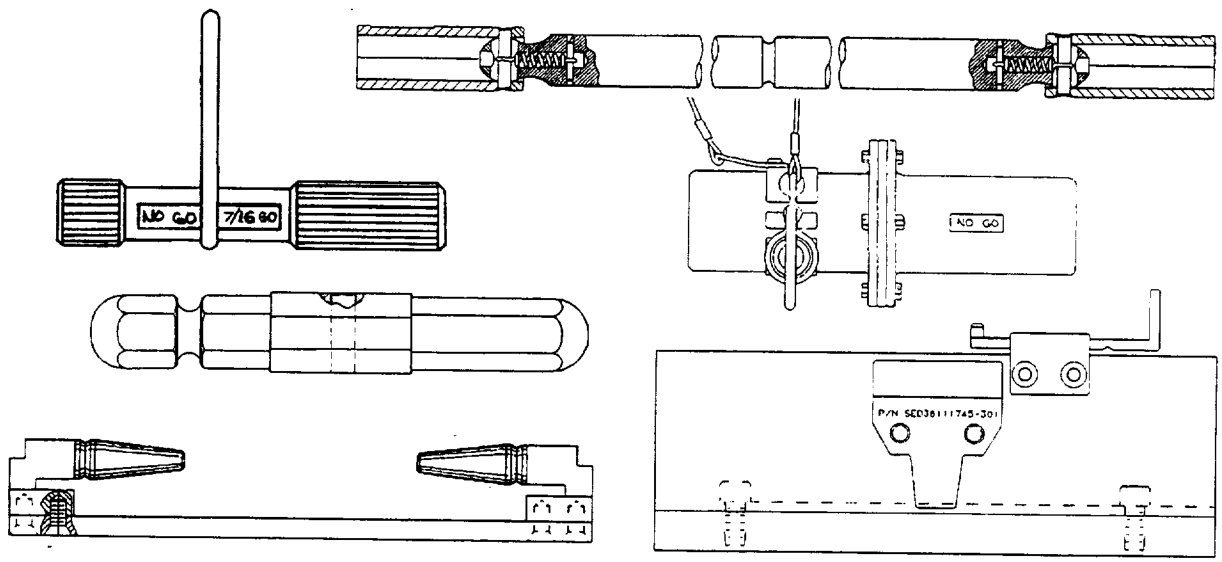
Technical Information		
Part number	10181–10027–01 10181–10028–01	(EP/TCE) (PDU)
Weight	10181–10027–01 10181–10028–01	**1.80** lb **5.00** lb
Material/ construction	Teflon cloth Nomex tape and cloth Ortho fabric Teflon–coated fiberglass Aluminum stiffener plates	
Load rating		
Temperature range	–150° to +250° F **(pocket fasteners)** –40° to +160° F **(fuse protection range)**	
Quantity flown		
Stowage		
Availability	Flight specific, **existing units reserved for HST**	

Dimensional Data				
	10181–10027		10181–10028	
	inches	cm	inches	cm
A	15.00	38.1	21.00	53.34
B	10.50	26.67	22.75	57.79
C	5.20	13.21	6.50	16.51
D	6.00	15.24	5.88	14.94





GO/NO-GO GAUGES



OVERVIEW

Go/no-go gauges act as a certified substitute for flight tools during the execution of interface fit checks. While flight tools are preferred for fit checks, they are often unavailable because of scheduling conflicts during preflight processing or because the interface or tool is already in orbit. Because tools and interfaces tend to be manufactured by numerous different suppliers and because experience has repeatedly shown that the stackup of tolerances can lead to a negative or sloppy fit, the fit check of extravehicular activity tools is critical to safe and successful task performance. Only approved go/no-go gauges can be substituted for the flight tools.

OPERATIONAL COMMENTS

There are currently go/no-go gauges for 5/16-inch and 7/16-inch bolt heads and 12-point sockets. Gauges also exist for the foot restraint probe and socket. Other gauges have been created to test the fit between bayonet probes and receptacles.

These go/no-go gauges test the fit between the male and female sides of each interface. They also verify full engagement of any lock mechanism that holds on-orbit assembled components together. For sockets and bolt heads, the gauges verify full and easy engagement including flat-to-flat and corner-to-corner dimensions as well as full insertion depth. Corner radius tolerances are important for bayonet fittings and all bolt heads. On-orbit thermal expansion and contraction conditions are verified. Locking connections between the portable foot restraint (PFR) socket/probe (pip pin) and the bayonet receptacle/probe (sliding lock) are tested to ensure proper full engagement.

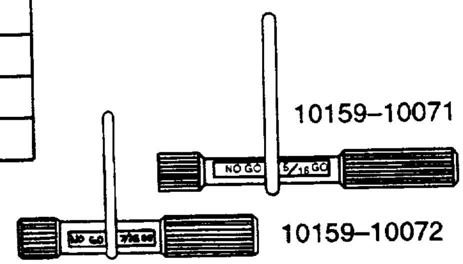
CONTACTS

Operational: B. Adams, JSC/DF42, (713) 483-2567
Technical: R. Marak, NASA/EC5, (713) 483-9144
W.B. Wood, NASA/EC5, (713) 483-9247

GO/NO–GO GAUGES

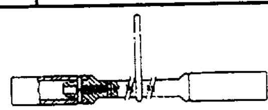
Technical Information	
Part number	10159–10071–01 (5/16–in. 12 pt bolt head) 10159–10073–01 (5/16–in. hex bolt head) 10159–10072–01 (7/16–in. 12 pt bolt head) 10181–60060–01 (7/16–in. 12 pt socket) 10181–60060–02 (5/16–in. 12 pt socket) 10159–10074–01 (7/16–in. hex bolt head) 10155–60008–02 (PFR hex probe) SED39123272–301 (PFR hex probe) SED39123273 (PFR hex socket) SED38111607 (tool caddy/bayonet receptacle) SED38111606 (tool caddy/bayonet probe)
Weight	
Material/ construction	CRES, stainless steel
Load rating	N/A
Temperature range	N/A
Quantity flown	N/A
Stowage	N/A
Availability	Flight specific

Dimensional Data		
	inches	cm
A	4.63	11.76
B	7.00	17.78
C	2.5	6.35
D	4.00	10.16
E	7.00	17.78
F	5.63	14.30
G	1.26	1.09
H	7.75	19.69



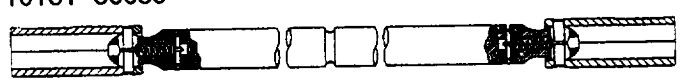
10159–10071

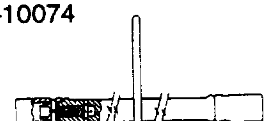
10159–10072



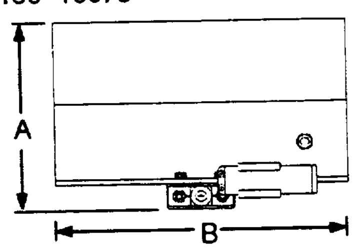
10159–10074

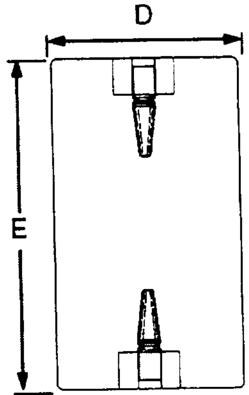
10181–60060

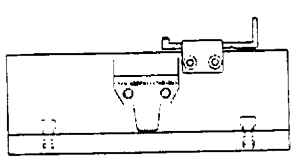


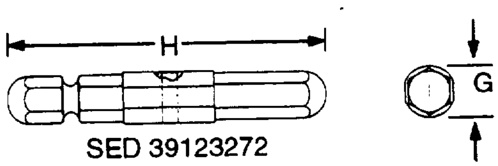


10159–10073

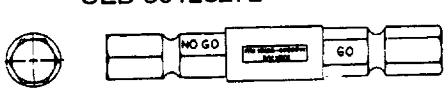




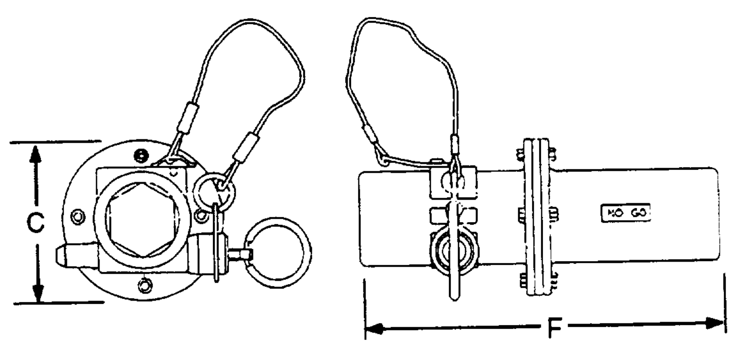




SED 39123272



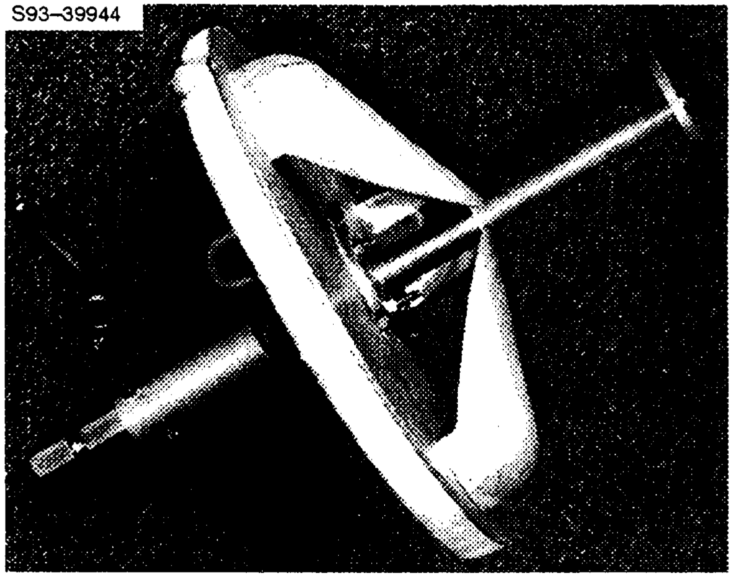
10155–60008



SED 39123273

GRAPPLE FIXTURE, PORTABLE FLIGHT RELEASABLE

S93–39944



OVERVIEW

This extravehicular activity (EVA)–installable grapple fixture was developed to support maintenance of the Hubble Space Telescope (HST). It attaches to a receptacle on the HST solar array and allows the orbiter remote manipulator to hold or transfer the array between the spacecraft and the array stowage site during changeout operations. This is a temporary fixture provided only for array changeout. It is removed by the EVA crewmembers after array replacement. It plugs into a hex receptacle on the array and pip pins in place. With this grapple fixture installed, robotic transport is feasible and the EVA crew is free to perform other tasks.

OPERATIONAL COMMENTS

The design of this device integrates a standard flight–releasable grapple fixture with the hex probe of an EVA portable foot restraint. The probe is inserted into a socket and pinned in place. A tether ring is provided for crewmembers' transport of the unit.

The nominal plan for transporting a large object like these solar arrays uses the orbiter remote manipulator system to move an EVA crewmember held in foot restraints, but this fixture can be used if robotic support is available and the EVA crew is busy elsewhere. In one anticipated application, a partially stowed array could be held by the robot arm while a new array is installed by the EVA crew. In this contingency mode, both EVA crewmembers would manually maneuver the new array during replacement operations.

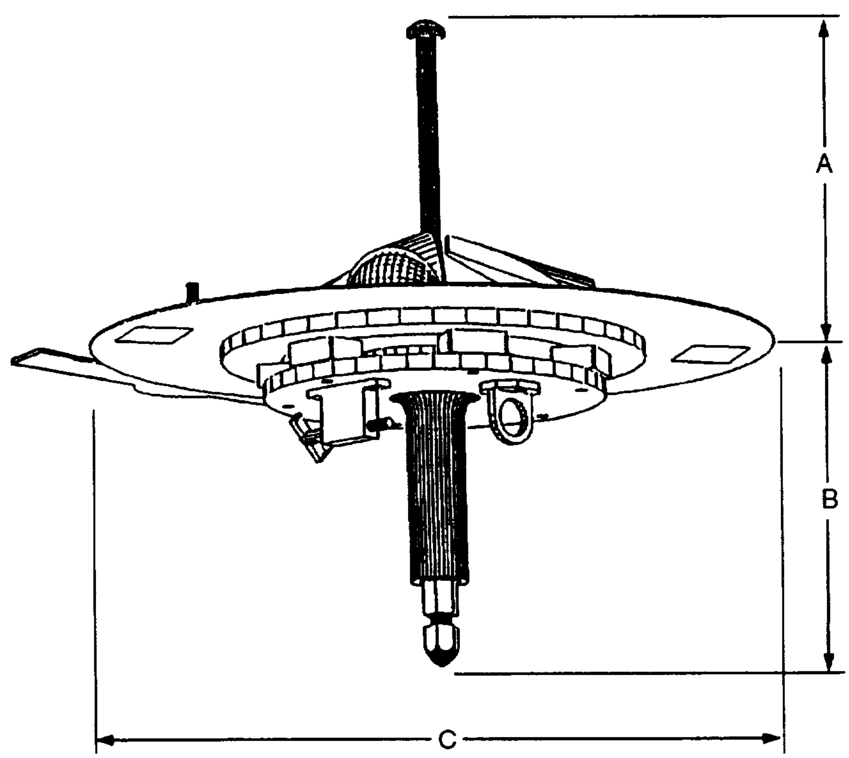
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. Werneth, NASA/GSFC, (301) 286–4338

GRAPPLE FIXTURE, PORTABLE FLIGHT RELEASABLE

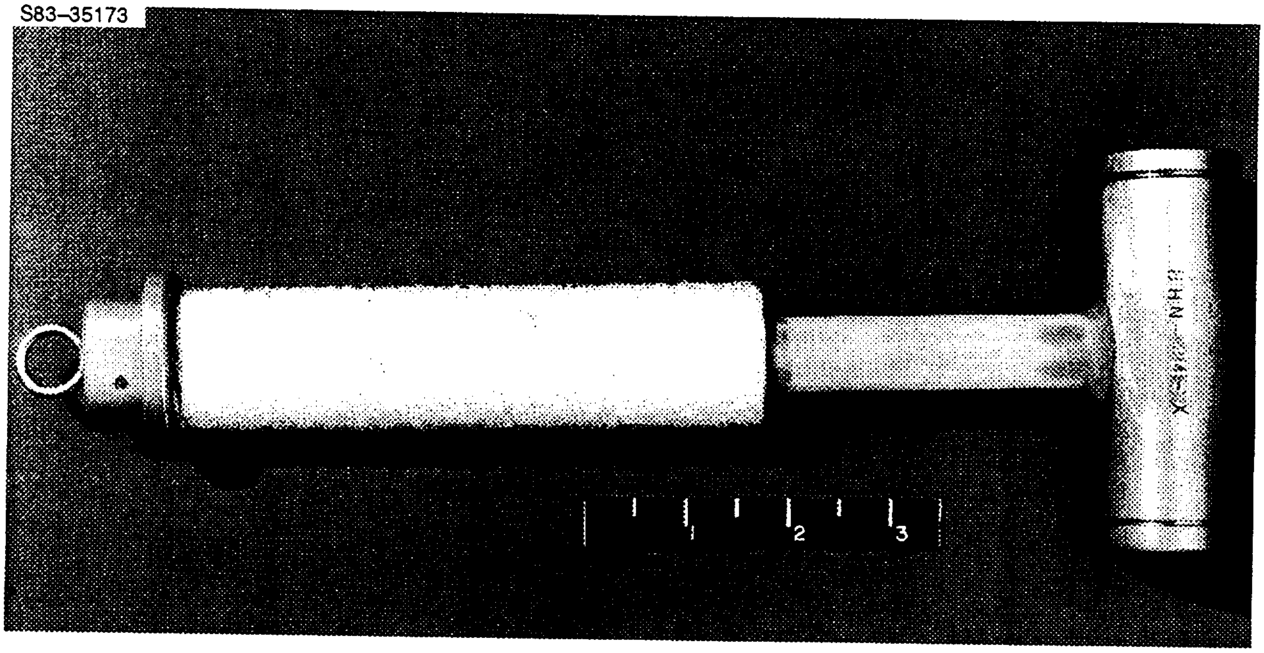
Technical Information	
Part number	1525430
Weight	40 lb
Material/ construction	**Aluminum, stainless**
Load rating **(from robot end effector)**	**Fx, Fy = 10 lb, Fz= 5 lb** **Mx = 50 ft–lb, My = 75 ft–lb, Mz = 100 ft–lb**
Temperature range	
Quantity flown	Two (STS–61)
Stowage	Payload bay
Availability	Flight specific (existing units reserved for HST)

Dimensional Data		
	inches	cm
A	**7.0**	**17.8**
B	**8.2**	**20.8**
C	**14.0**	**35.6**



HAMMER

S83–35173



OVERVIEW

The hammer is a common tool modified for extravehicular activity use. The handle is built up and wrapped with Velcro to provide a positive grip for the gloved hand. A tether ring is mounted on the end of the handle for tethering.

OPERATIONAL COMMENTS

The hammer is a general purpose tool used for disconnect and jam removal. **The fiberglass shaft and brass head damps the shock of hammer blows.** This tool is part of the normally manifested orbiter equipment. It is wrapped in a Velcro–lined tool caddy along with the probe and is stowed in the port provisions stowage assembly (PSA).

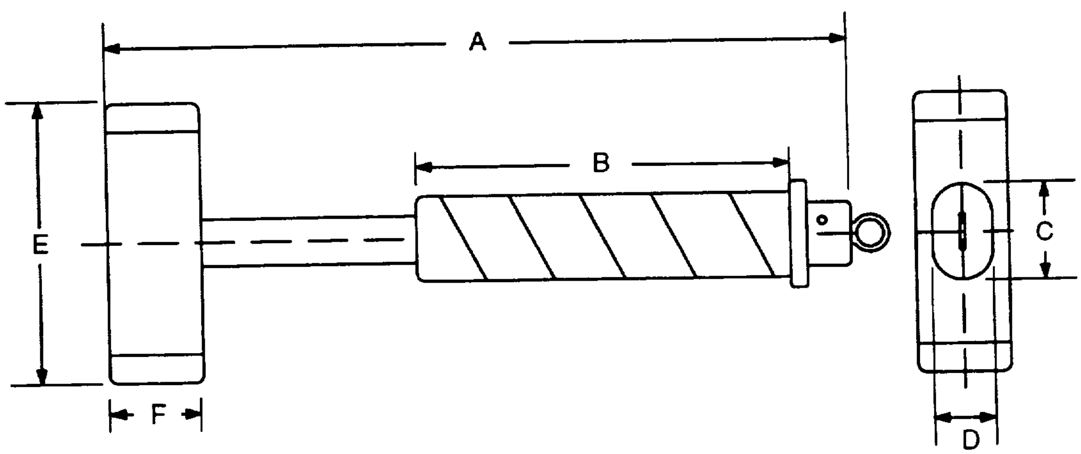
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

HAMMER

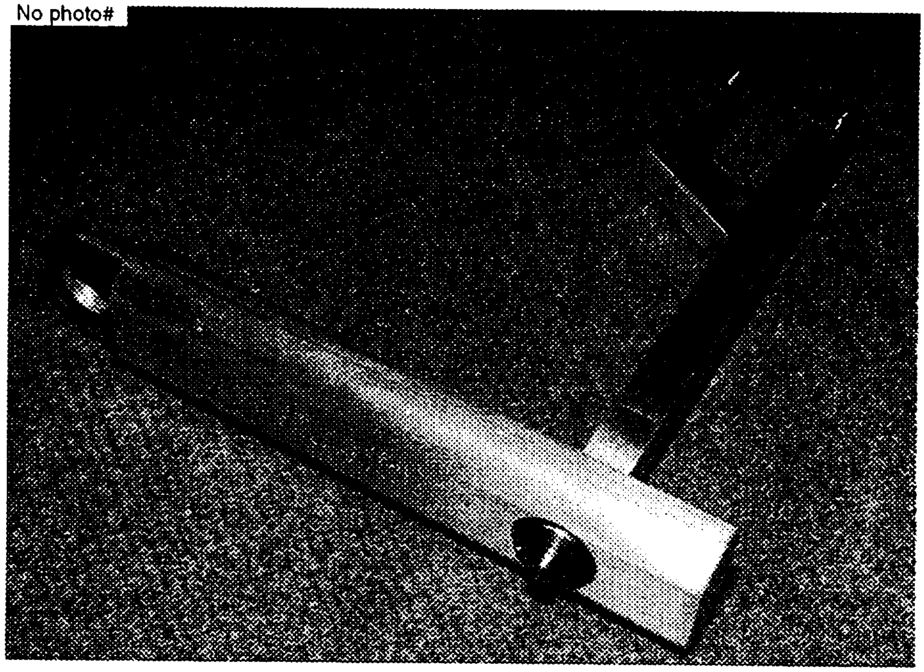
Technical Information	
Part number	V628–650875–004 or SDD33103433–301
Weight	2 lb
Material/ construction	Handle – Aluminum and fiberglass wrapped with Velcro Head – 1–1/4–in. diameter brass
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	11.000	27.94
B	5.600	14.22
C	1.750	4.45
D	1.250	3.18
E	3.875	9.84
F	1.250	3.18



HANDLE, ELECTRICAL CONNECTOR CAP T

No photo#



OVERVIEW

The electrical connector cap T–handle was designed for use on the Leasat Salvage Mission. Two T–handles, a prime and a spare, were flown on STS 51–I. They were stowed on tool boards no. 2 and no. 9 in the Leasat equipment stowage assembly (LESA).

OPERATIONAL COMMENTS

The T–handle was designed to install specially designed shorting plugs on exposed electrical connectors. A button on the top of the handle must be depressed to allow release of the handle from the shorting plug after it is installed on the connector. This tool is essentially a long pip pin built into an extravehicular activity–compatible handle.

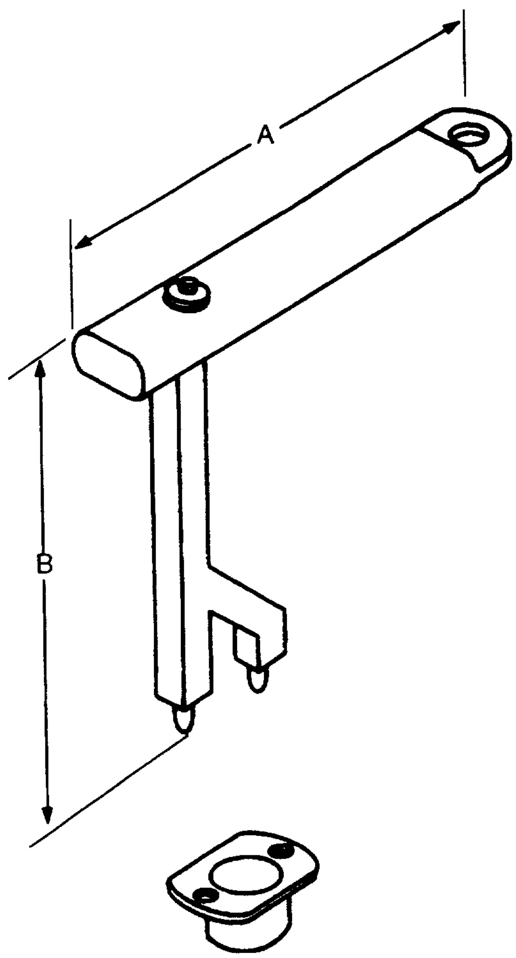
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

HANDLE, ELECTRICAL CONNECTOR CAP T

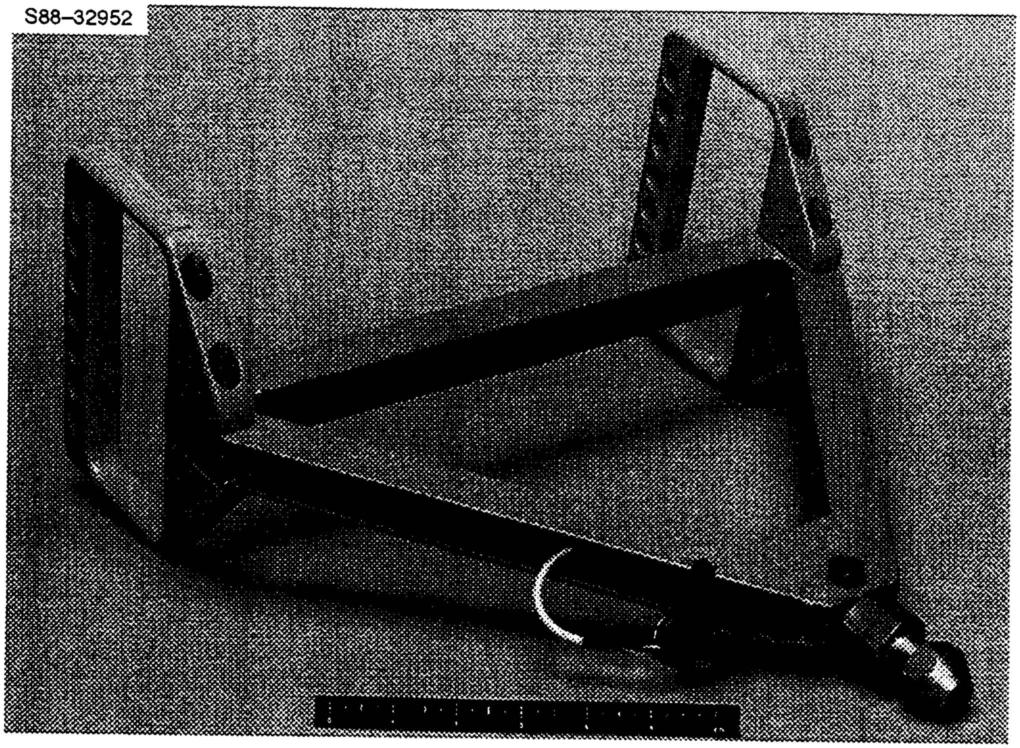
Technical Information	
Part number	6044440 (Hughes Aircraft Co.)
Weight	0.852 lb
Material/ construction	Aluminum
Load rating	
Temperature range	–150° to +250° F (operational)
Quantity flown	**Two on STS 51–I**
Stowage	**Tool boards in PLB tool box**
Availability	Flight specific

Dimensional Data		
	inches	cm
A	7.00	17.78
B	6.75	17.15



HANDLE, TRANSFER/JETTISON

S88–32952



OVERVIEW

The transfer and jettison handles have been devised to support the Hubble Space Telescope (HST). They are installed by the extravehicular activity (EVA) crew and used to maneuver large structures for component changeout or jettison. The original STS–31 jettison handle has been supplemented with the new transfer handle. The clocking of the hex probe interface can be customized based on specific applications.

OPERATIONAL COMMENTS

Each handle connects into a socket located on the **component** near **its** center of gravity and provides a means of **manipulating** the structure for easy movement away from the HST. The socket fitting is similar to a portable foot restraint probe. **The solar arrays and aperture door have a mounted socket that mates with each handle. For solar array transport, the transfer handle is mounted in–line or perpendicular to the stowed array long axis.**

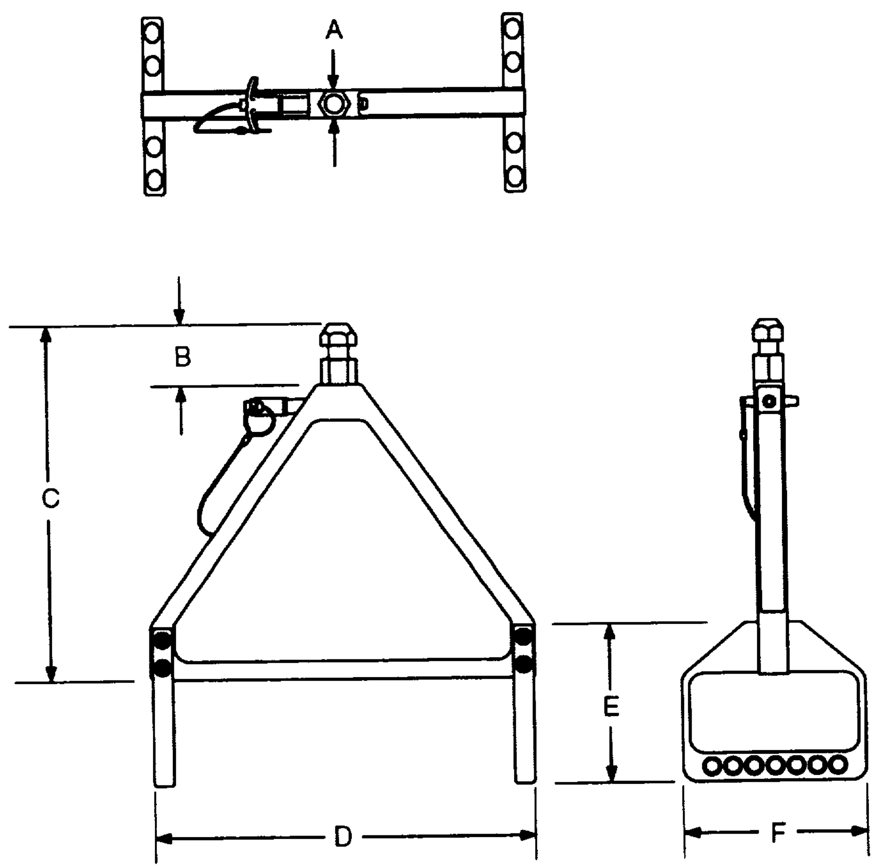
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. Sheffield, LMSC/ (408) 742–8464

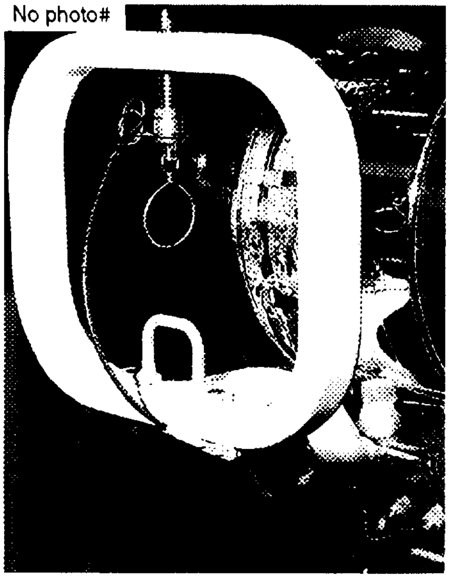
HANDLE, TRANSFER/JETTISON

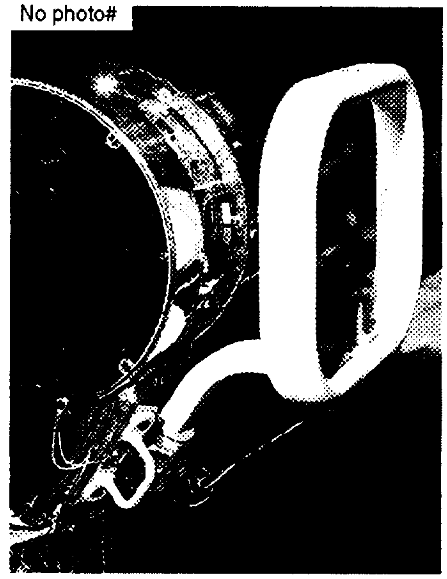
Technical Information	
Part number	**4175850–503 (Jettison)** 4175850–505 (Transfer)
Weight	**4.7 lb**
Material/ construction	Aluminum alloy
Load rating	
Temperature range	
Quantity flown	
Stowage	**Payload bay**
Availability	Flight specific, **existing units reserved for HST**

Dimensional Data		
	inches	cm
A	0.980	2.49
B	2.250	5.72
C	12.720	32.31
D	13.540	34.39
E	5.650	14.35
F	6.500	16.51



HANDLE, PRIMARY DEPLOYMENT MECHANISM





OVERVIEW

This handle was developed to support maintenance of the Hubble Space Telescope (HST). It is an extravehicular activity (EVA)–installable aid used for manual transport and handling of the HST solar arrays. When in the stowed configuration for replacement, the newer HST solar arrays lack a good handhold on the end near the deployment mechanisms. This handle plugs into a hex receptacle on the primary deployment mechanism and is held in place with pip pins. With the handle installed, manual transport between the solar array launch carrier and the spacecraft is enhanced.

OPERATIONAL COMMENTS

Since the nominal plan for transporting a large object like these solar arrays uses the orbiter remote manipulator system to move an EVA crewmember held in foot restraints, this handle is useful if robotic support is unavailable. In this contingency mode, both EVA crewmembers would manually maneuver the array during replacement operations. This handle and another fixed handle on the other end of the array allow manual transport. For nominal operations, the handle is used for fine positioning of the array deployment mechanisms by an assisting crewmember.

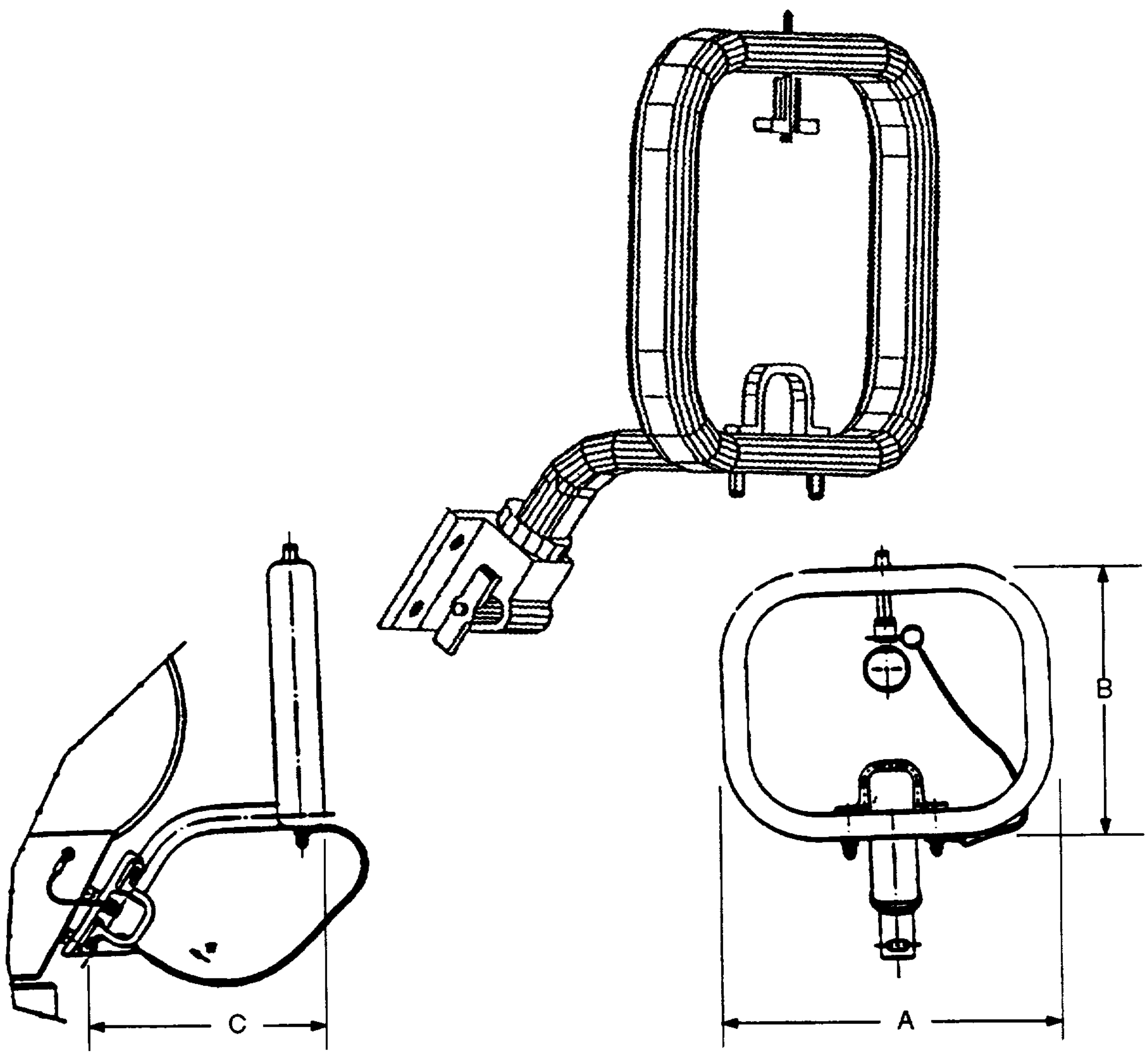
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. **Werneth, NASA/GSFC, (301) 286–4338**

HANDLE, PRIMARY DEPLOYMENT MECHANISM

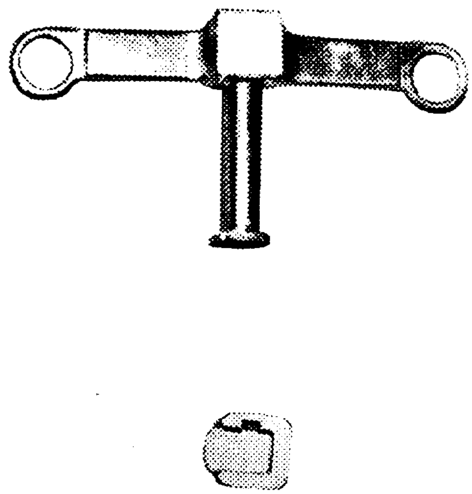
Technical Information	
Part number	CPK802
Weight	1.1 lb
Material/ construction	Aluminum
Load rating	**40 lb (single point), 20 lb (each of two points)**
Temperature range	
Quantity flown	Two (STS–61)
Stowage	Payload bay
Availability	Flight specific, existing units reserved for HST

Dimensional Data		
	inches	cm
A	**10.25**	**26.04**
B	**8.25**	**20.96**
C	**8.50**	**21.59**



HANDLE, T

No photo#



OVERVIEW

The T–handle is a detachable handle for use with small extravehicular activity (EVA) tools **and is designed for light crew applied loads.**

OPERATIONAL COMMENTS

The T–handle makes a secure connection with tools and can be attached or detached with one hand by a suited EVA crewmember. A patch of hook Velcro on the handle provides secure attachment to a tool caddy.

The handle shank, which has a lip around the bottom, slides into a slot on the tool, where it is held by the lip. A spring–loaded section of the lip rises into a hidden notch in the slot to lock the handle in place. Pushing a button at the top center of the handle releases the spring–loaded section and allows the handle to slide back out of the slot. This T–handle has been used successfully on STS 51–I as a removable handle for the Syncom separation lever tool and for the electrical shorting plugs.

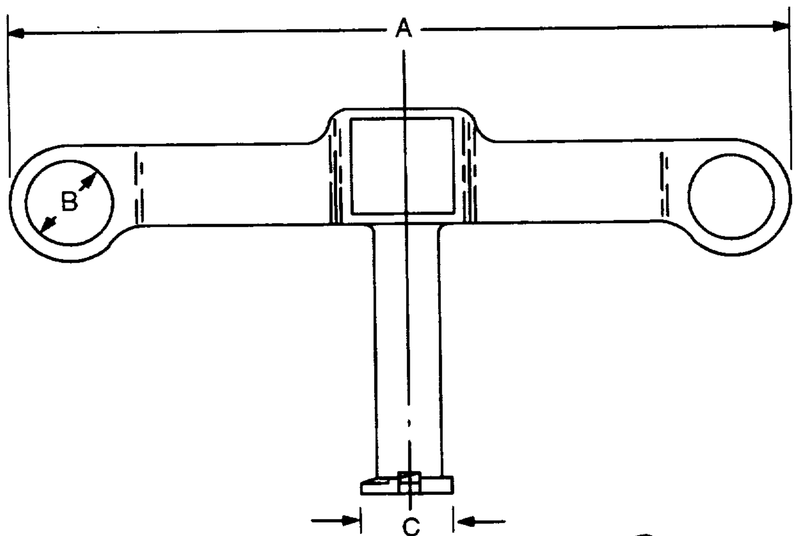
CONTACTS

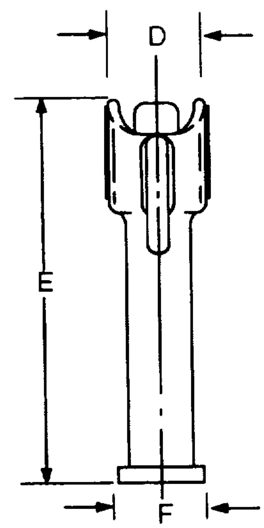
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

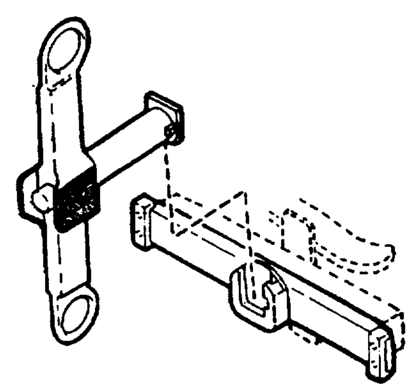
HANDLE, T

Technical Information	
Part number	10176-200113-01
Weight	0.17 lb
Material/ construction	Aluminum
Load rating	
Temperature range	
Quantity flown	Three on STS 51-I
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	5.88	14.94
B	0.63	1.60
C	0.69	1.75
D	0.75	1.91
E	2.88	7.32
F	0.69	1.75

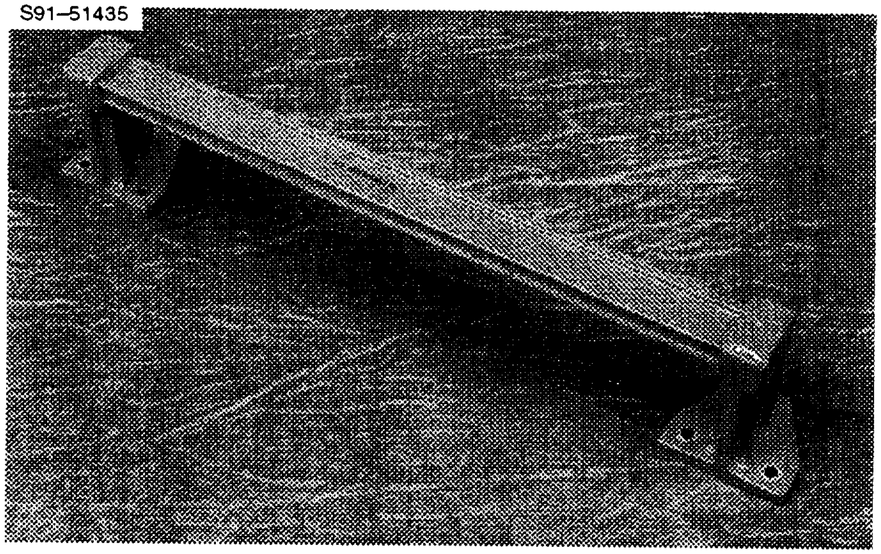






HANDRAIL, GFE

S91-51435



OVERVIEW

Handrails are designed for crewmember translation, body reorientation, and restraint at or between worksites. The Government-furnished equipment (GFE) handrail, like all handrails, is an assembly of left and right standoff brackets with connecting tubing. A middle bracket is incorporated when the unsupported span between the end brackets is excessive. All extravehicular activity (EVA) handrails are color-coded yellow (usually paint, sometimes anodized) for easy visual identification. The standoffs have large tether points that accommodate all current EVA tether hooks.

The standoffs pictured above can also be supplied in shorter and lighter units.

OPERATIONAL COMMENTS

The minimum grip length of a handrail tube is 6 in. The maximum standard length that can be supplied is 10 ft. Spacing between handrails is 24 in. maximum, except along frequently used translation paths where continuous handrails are preferred. These GFE standoffs meet or exceed the 2.25-in. minimum gap between the underside of the handrail tube and supporting structure.

Besides easy visual recognition, yellow standoffs with tether points indicate that they are crew safety tether rated. Whenever they are only equipment rated, they must be colored white as a crew reminder. The small tether point of this particular design is designed only for equipment restraint using the small wrist tether hook, but it is too small for easy hookup and does not preclude hook jamming when twisted. It should not be used for any hooks.

Based on STS-37 flight experience, the preferred handrail tube now has a "dog-bone" cross section instead of an oval cross section. The oval tube did not provide a positive grip to prevent gloved hand slippage around the tube. The dog-bone shape gives the crew more body control.

For more detailed information on handrail design criteria, refer to NSTS 07700, Description and Design Criteria - EVA, vol. XIV, appendix 7.

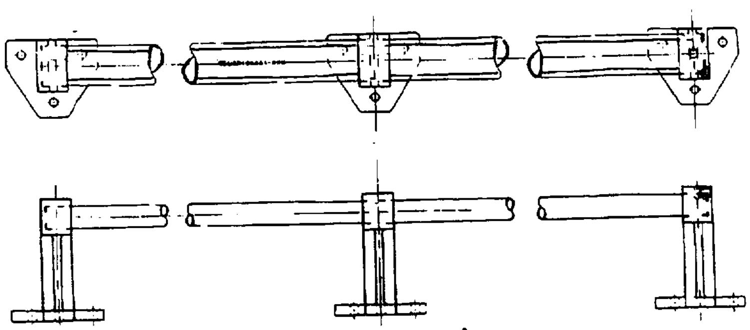
CONTACTS

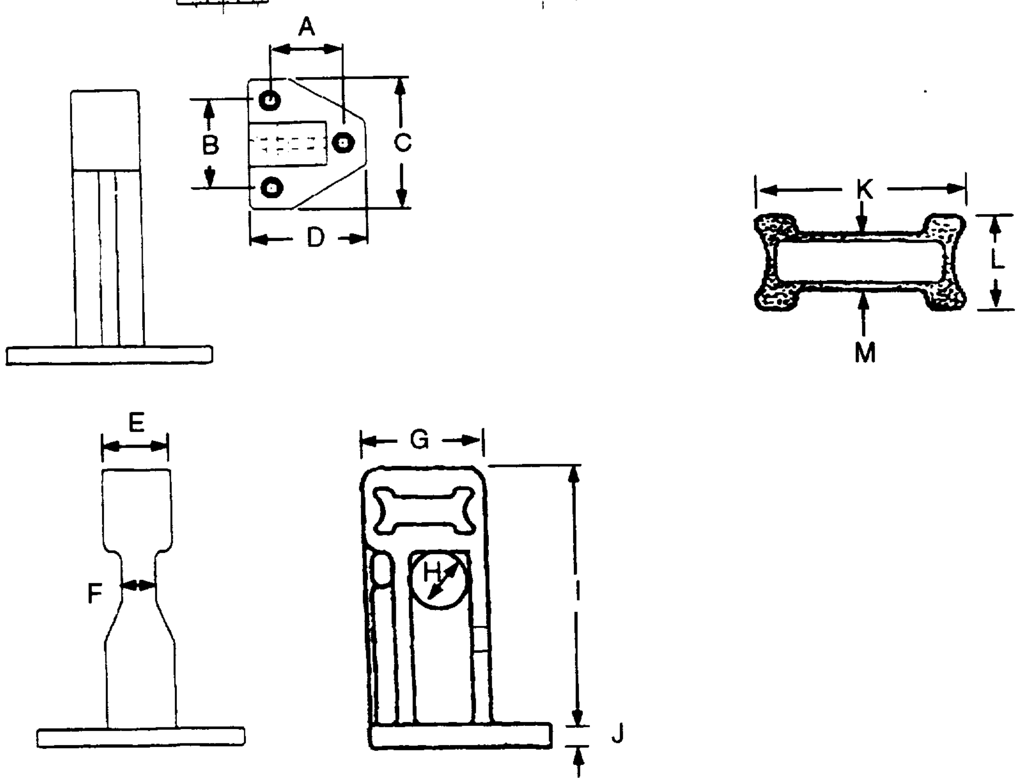
Operational: R. McDaniel, NASA/DF42, (713) 483-2570
Technical: W. B. Wood, NASA/EC5, (713) 483-9247

HANDRAIL, GFE

Technical Information	
Part number	SED33104502–XXX (tube and standoffs)
Weight	0.34 lb/foot (“dog–bone” tubing)
Material/ construction	Extruded aluminum tubing Cast/machined aluminum standoffs
Load rating	187–lb handrail tube 574–lb standoff tether points
Temperature range	–200° to 250° F
Quantity flown	
Stowage	
Availability	Flight specific

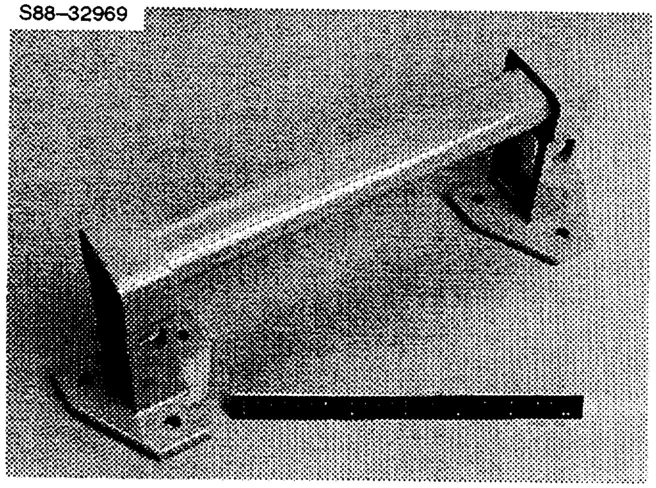
Dimensional Data		
	inches	cm
A	1.625	4.128
B	2.0	5.080
C	3.0	7.620
D	2.63	6.680
E	1.0	2.540
F	0.5	1.270
G	1.75	4.445
H	0.82	2.083
I	4.1	10.414
J	0.35	.889
K	1.376	3.495
L	0.625	1.588
M	0.375	.953





HANDRAIL, OVAL

S88–32969



OVERVIEW

This extravehicular activity (EVA) handrail is an assembly of a left– and right–hand standoff bracket and tubing, designed to allow crewmember translation and restraint along a variety of structures. A middle bracket is incorporated into the design when additional structural support is required. **It was used on an early version of the Hubble Space Telescope (HST) tool box. This** handrail **has integral tether points and** is painted yellow for easy visual identification.

OPERATIONAL COMMENTS

Many different EVA handrails have been used in the Space Shuttle EVA program. This particular handrail represents one of the better examples of oval handrail design. It is included in this document **for reference only since the "dog–bone" design is the new preferred design and is available as GFE.**

For more detailed information on handrail design criteria, refer to NSTS 07700, vol. XIV, appendix 7, Description and Design Requirements - EVA.

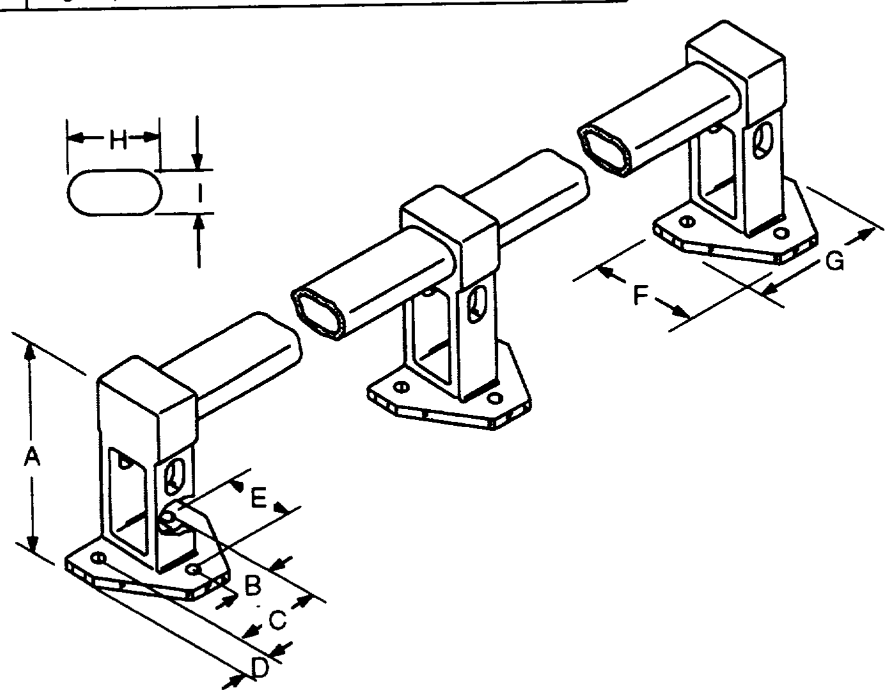
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

HANDRAIL, OVAL

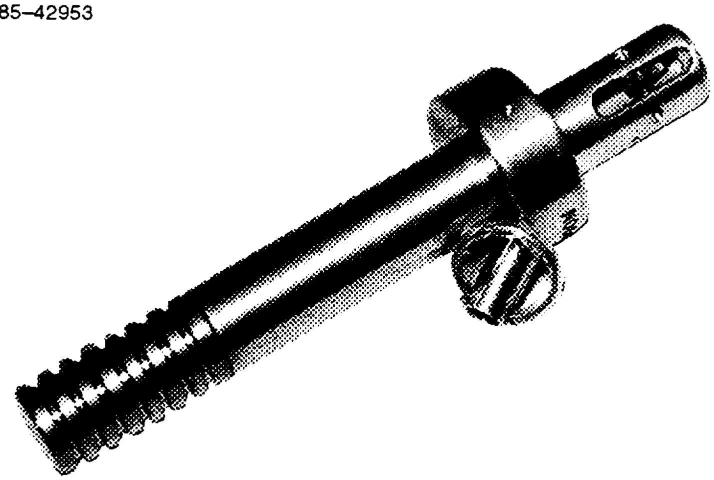
Technical Information		
Part number	Tube 10174–20036–01 10174–20036–02 10174–20036–03 10174–20036–04 10174–20036–05 10174–20036–06 10174–20036–07 Bracket 10174–20023–01 10174–20023–02 10174–20023–03	9.72 in. 14.98 in. 19.72 in. 25.97 in. 32.77 in. 51.22 in. 61.01 in. Right hand Left hand Middle
Weight	Tube 10174–20036–01 10174–20036–02 10174–20036–03 10174–20036–04 10174–20036–05 10174–20036–06 10174–20036–07 Bracket 10174–20023–01 10174–20023–02 10174–20023–03	0.19 lb 0.29 lb 0.38 lb 0.50 lb 0.63 lb 0.98 lb 1.16 lb 0.54 lb 0.54 lb 0.48 lb
Material/ construction	Aluminum	
Load rating	**187 lb handrail tube** **574 lb standoff tether point**	
Temperature range	–150° to +250° F (operational)	
Quantity flown		
Stowage		
Availability	Flight specific	

Dimensional Data		
	inches	cm
A	4.100	10.41
B	1.000	2.54
C	2.000	5.08
D	0.500	1.27
E	1.625	4.13
F	2.630	6.68
G	3.000	7.62
H	1.380	3.51
I	0.750	1.91



HARPOON, EASE TRUSS NODE

S85–42953



OVERVIEW

The Experimental Assembly of Structures with EVA (EASE) truss node harpoon was developed for use during the EASE flight experiment. The harpoon is similar in design to a large pip pin. A tether ring is attached to the shaft near the midpoint. There is a cylindrical handle for releasing the harpoon from the structure.

OPERATIONAL COMMENTS

The harpoon is inserted by pressing the shaft into the beam hole. The end of the handle must be pulled to release the shaft from the hole.

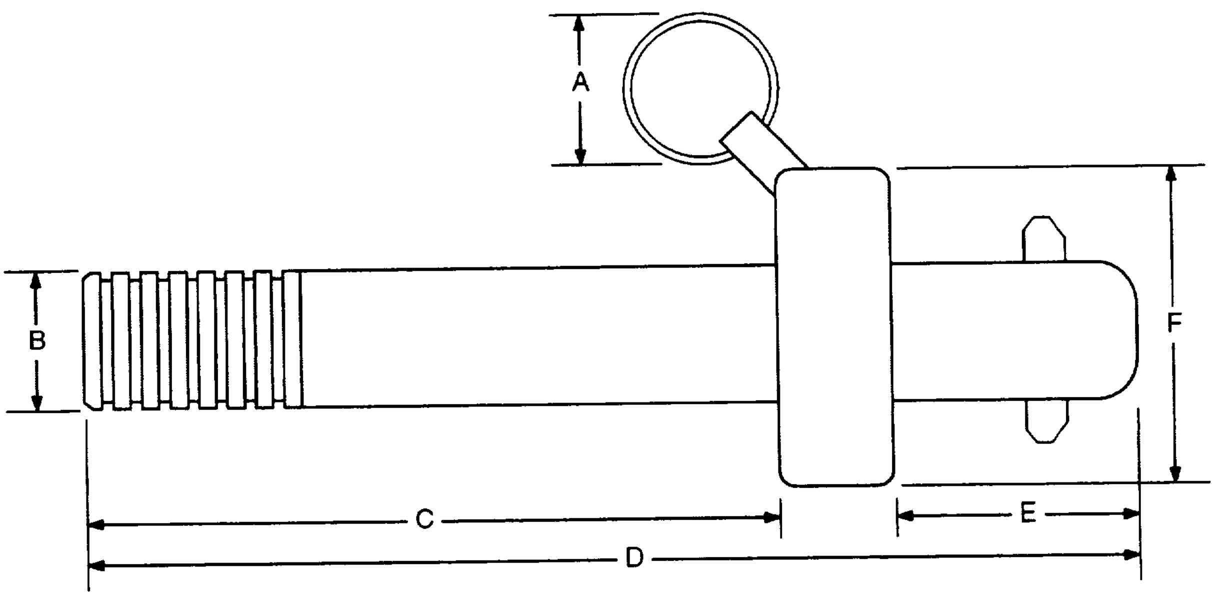
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **Dr. D. Akin, Massachusetts Institute of Technology, MS 33–309 Cambridge, MA 32139, (617) 253–2263**

HARPOON, EASE TRUSS NODE

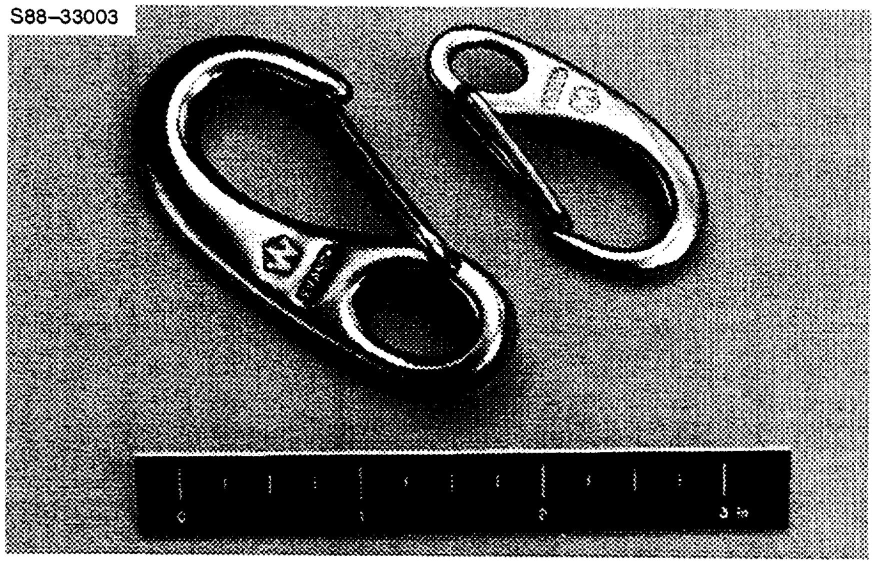
Technical Information	
Part number	Not available
Weight	0.15 lb
Material/ construction	Stainless steel/aluminum alloy
Load rating	Insertion < 1 lb Removal < 2 lb
Temperature range	–250° to +220° F
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.125	2.86
B	1.000	2.54
C	5.125	13.02
D	8.000	20.32
E	2.000	5.08
F	2.000	5.08



HOOK, FRENCH

S88–33003



OVERVIEW

French hooks, also known as snap hooks, are used in a variety of extravehicular activity (EVA) applications. They serve to tether tools that incorporate a tether ring. Small french hooks (shown above) are typically used with retracting tethers on the wide range of tool caddies. Larger 4–in. french hooks are used on the payload retention device and snatch block. These hooks are not to be used as safety tether hooks or for applications where a lock–lock feature is required. They should be used only in applications where a tool or equipment is to be restrained temporarily.

OPERATIONAL COMMENTS

Each hook is designed for ease of operation. The hook opens when pressure is applied to the bail. After the hook passes over the item it is to tether, the bail snaps closed. **Care must be exercised to avoid twisting the hook against nearby structure since the bailer bar can be inadvertantly released resulting in unwanted hook release**. Hooks commonly used for EVA purposes are functionally rated from 880 to 2000 lb, depending on the size of the hook. An example of its use is the restraint of the EVA power tool **with a built–in retractable tether in the tool handle. The hook and retractable tether combination are also useful on tool caddies, tool boards, and inside tool boxes as a means for pretethering items to minimize EVA overhead**.

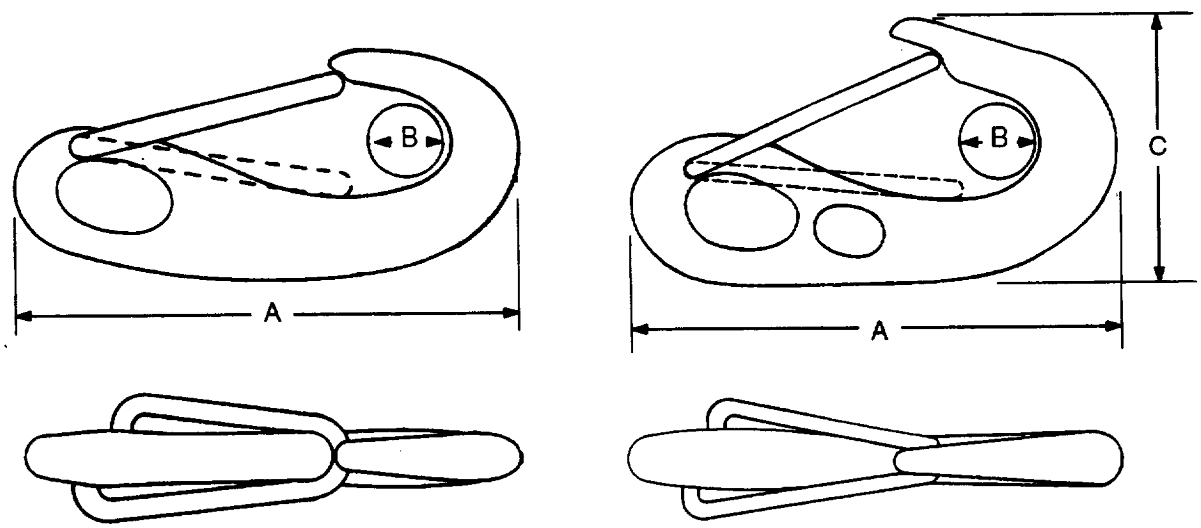
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

HOOK, FRENCH

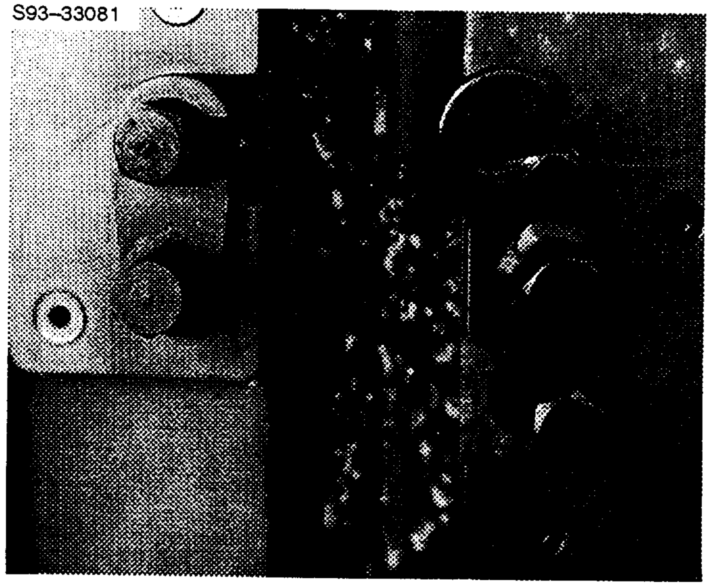
Technical Information	
Part number	ST20H1387–05/06 (2 in. long) ST20H1387–01 (3 in. long) 10163–20057–01 (4 in. long)
Weight	ST20H1387–05/06 0.041 lb ST20H1387–01 0.135 lb 10163–20057–01 0.375 lb
Material/ construction	Drop forged stainless steel
Load rating	ST20H1387–05/06 880 lb ST20H1387–01 1760 lb 10163–20057–01 2000 lb
Temperature range	–150° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data						
	ST20H1387–05/06		ST20H1387–01		10163–20057–01	
	inches	cm	inches	cm	inches	cm
A	**2.0**	5.08	**3.0**	7.62	**4.0**	10.16
B	0.25	0.64	0.41	1.04	0.56	1.42
C	–	–	–	–	2.18	5.54



HOOK, J

S93–33081



OVERVIEW

The J–hook is used extensively on the Hubble Space Telescope (HST) as a latching device for protective doors and as a structural restraint for orbital replaceable units (ORU's). It provides a simple positive lock, but at the expense of high EVA crew overhead, since a tool is required for its operation.

OPERATIONAL COMMENTS

To open the J–hook, the retaining bolt is backed off five to six turns with a tool. The J–hook is then manually rotated 1/4 turn to clear the retaining bolt. A hex stud at the pivot point can be used with a tool for additional mechanical advantage to aid hook rotation. The hook features a countersink to accommodate the retaining bolt.

As a door latch and ORU restraint, this device is not optimal since use of a tool adds to extravehicular activity overhead. However, as an ORU restraint, this hook concept has the advantage of requiring only that the crew rotate and align the hook with preinstalled bolts. This avoids the fine alignment and initial threading of each bolt, which is a task prone to error even with good visibility and physical access.

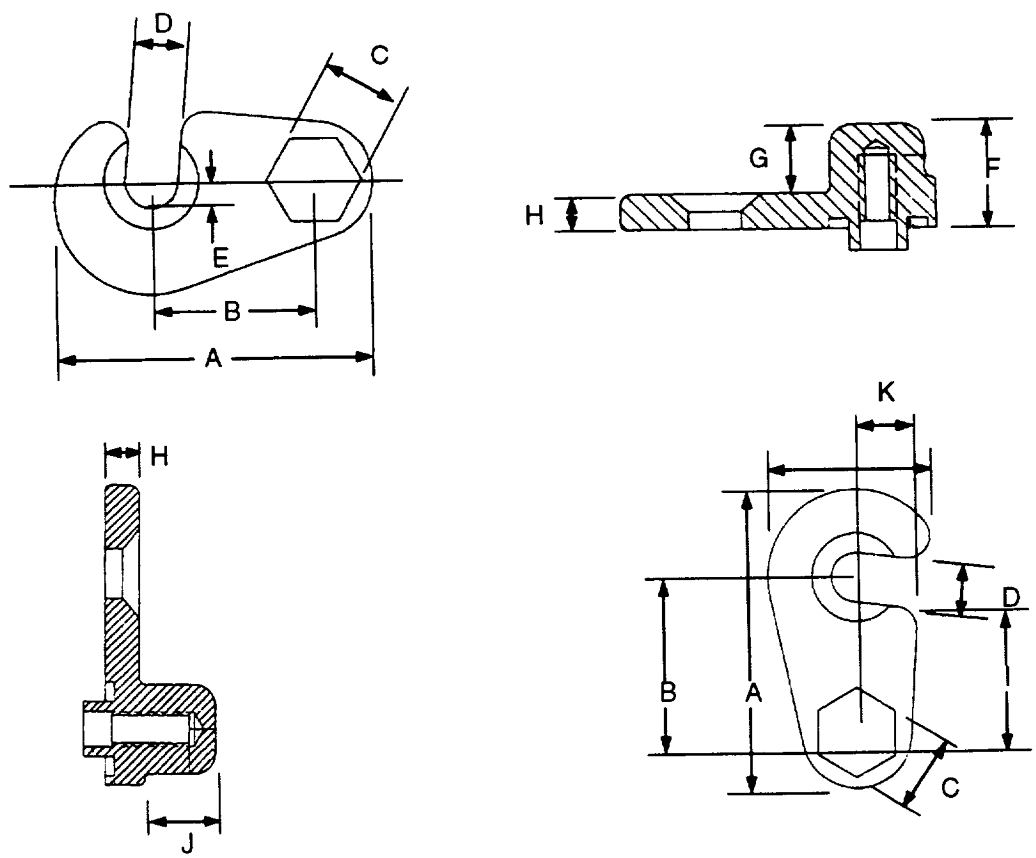
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. Sheffield, LMSC/DGN–22, (408) 742–6278

HOOK, J

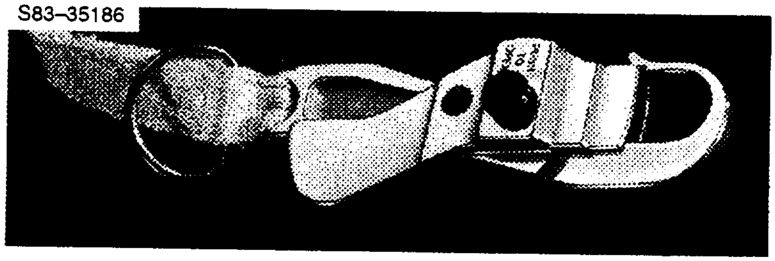
Technical Information	
Part number	4174314–001, –003 4173092 4175697
Weight	0.04 lb
Material/ construction	Titanium
Load rating	890 lb (ultimate)
Temperature range	–121° to +66° F
Quantity flown	Many
Stowage	N/A
Availability	Reference only (HST unique)

Dimensional Data		
	inches	cm
A	1.687	4.285
B	.875	2.223
C	.430 –.439	1.092 – 1.115
D	.280	.711
E	.100	.254
F	.675	1.715
G	.367	.932
H	.188	.478
I	.697	1.770
J	.429	1.090
K	.188	.478

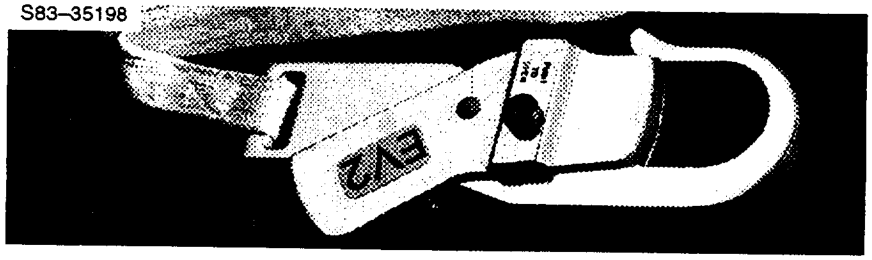


HOOK, UNIVERSAL TETHER

S83–35186



S83–35198



OVERVIEW

The large and small universal tether hooks are designed for use in a variety of extravehicular activity (EVA) applications. The hooks are designed with safety and reliability in mind, because they are primary restraints for crewmembers and equipment. 10181–10046–**02** and 10181–10047–**02** are used in the adjustable equipment tether for the Hubble Space Telescope (HST). The EVA **standard** waist and wrist tethers **use the other listed part numbers**. All configurations are functionally equivalent. The wrist and waist tether hooks are shown above.

OPERATIONAL COMMENTS

The large and small universal hooks incorporate a lock–lock feature that requires the crewmember to **simultaneously** press two actuation buttons located on opposite sides of the bail. The buttons compress the male and female plungers and releases the hook from its locked position. The hook can then be **squeezed between the fingers and palm for** attachment to or release from a tether point. **The hooks cannot be operated by a single, gloved hand without positioning aid from the second hand. These hooks are also fatiguing when used frequently.**

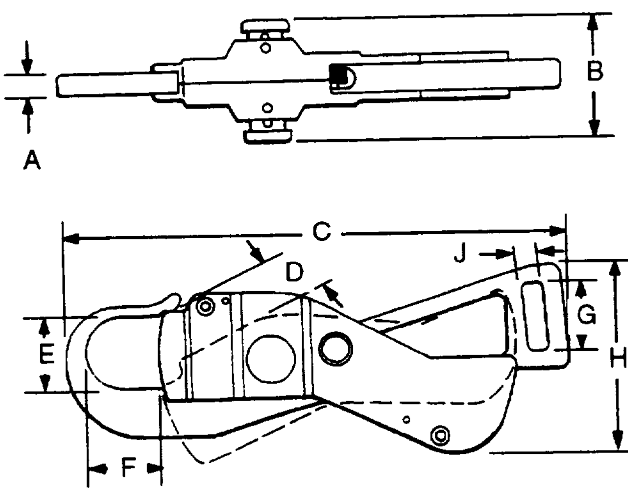
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

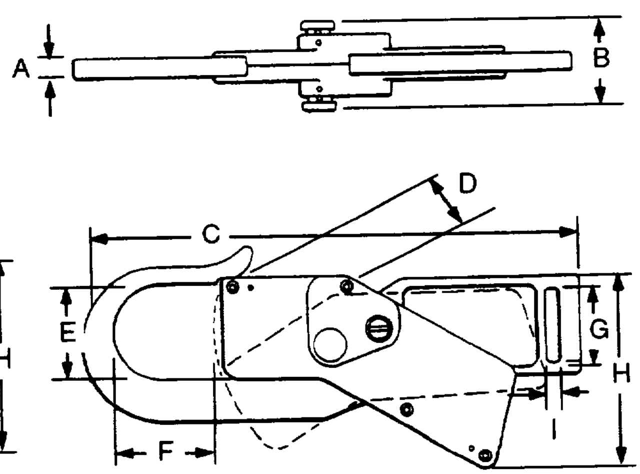
HOOK, UNIVERSAL TETHER

Technical Information	
Part number	**SED39121780–301 (large)** **10181–10047–01 (large)** **10151–20083–01 (large)** **9815–04 (large)** **SED39119074–303 (small)** **10181–10046–01 (small)** **9792–03 (small)**
Weight	Small 0.22 lb Large 0.50 lb
Material/ construction	Aluminum alloy Vespel plunger lock
Load rating	**585** lb
Temperature range	–150° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data				
	10181–10046–01		10181–10047–01	
	inches	cm	inches	cm
A	0.20	0.51	0.30	0.76
B	1.31	3.33	1.40	3.56
C	0.60	13.34	1.00	19.05
D	0.60	1.52	1.00	2.54
E	0.80	2.03	1.50	3.81
F	0.80	2.03	1.50	3.81
G	0.75	1.91	1.10	2.79
H	2.00	5.08	4.20	10.67
I	0.20	0.51	0.25	0.64

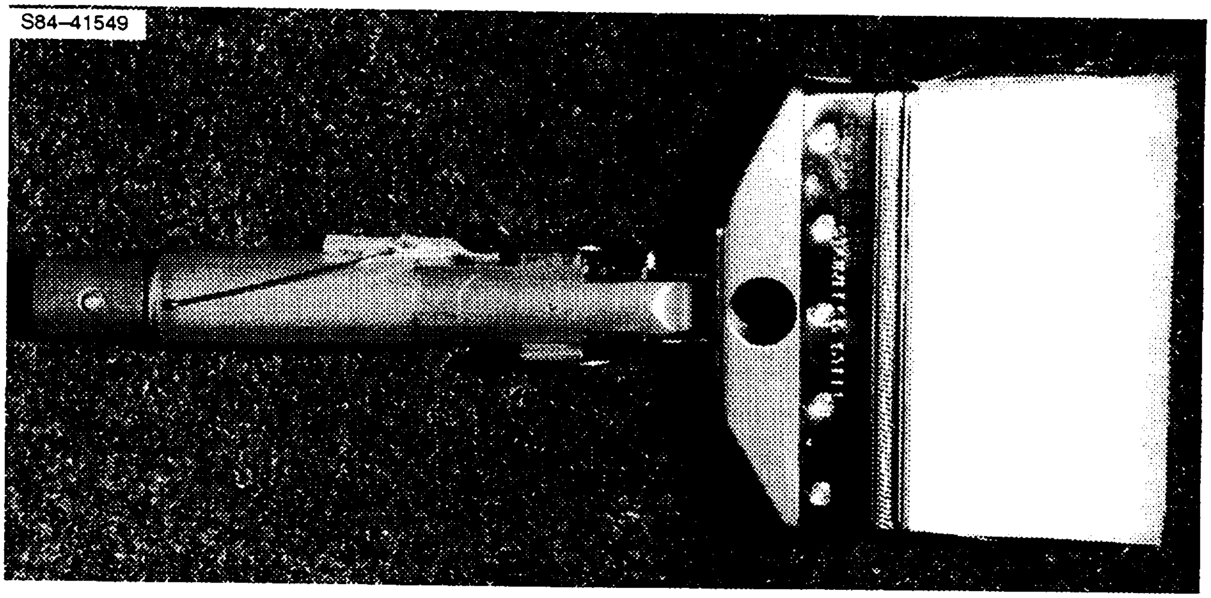


10181–10046–01



10181–10047–01

HYDRAZINE BRUSH



OVERVIEW

The hydrazine brush is manifested when there is a possibility of **direct** extravehicular mobility unit (EMU) **exposure to** contamination by **orbiter** or payload–related hydrazine. The brush is used in the cargo bay to remove visible hydrazine contamination from the EMU. The brush is a modified Apollo lunar dust brush. A tether ring is attached to the handle.

OPERATIONAL COMMENTS

Hydrazine can be detected on the EMU as flakes (white snow color), as ice (white patches), or as stains (light brown). The crewmembers will inspect each other when clear of a potential contamination source and use the hydrazine brush to remove any flakes prior to entering the airlock. Stowage for the brush is provided in the provisions stowage assembly (PSA) on a flight specific basis. **Squeezing two knobs on the base of the handle allows the handle to be rotated, which changes the brush orientation. The handle locks at rotation angles of 0°, ± 45°, and ± 90°.**

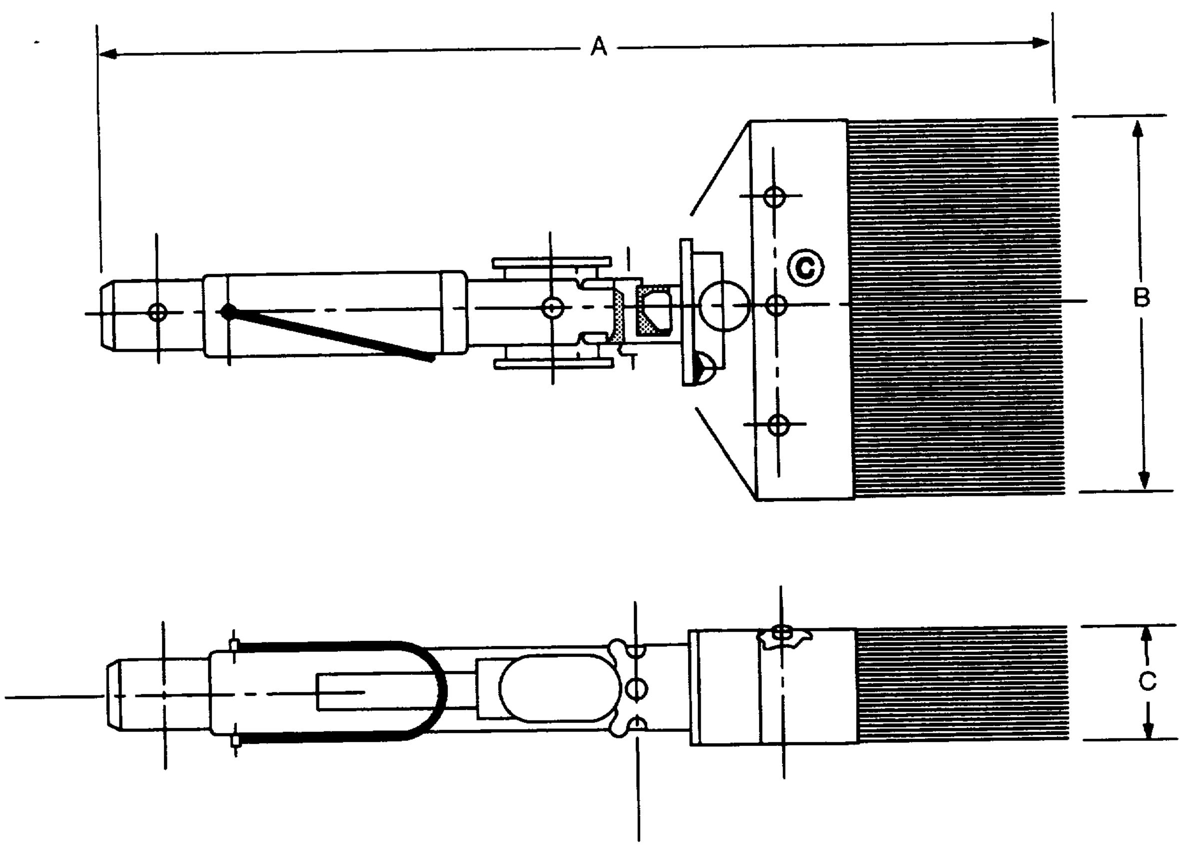
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

HYDRAZINE BRUSH

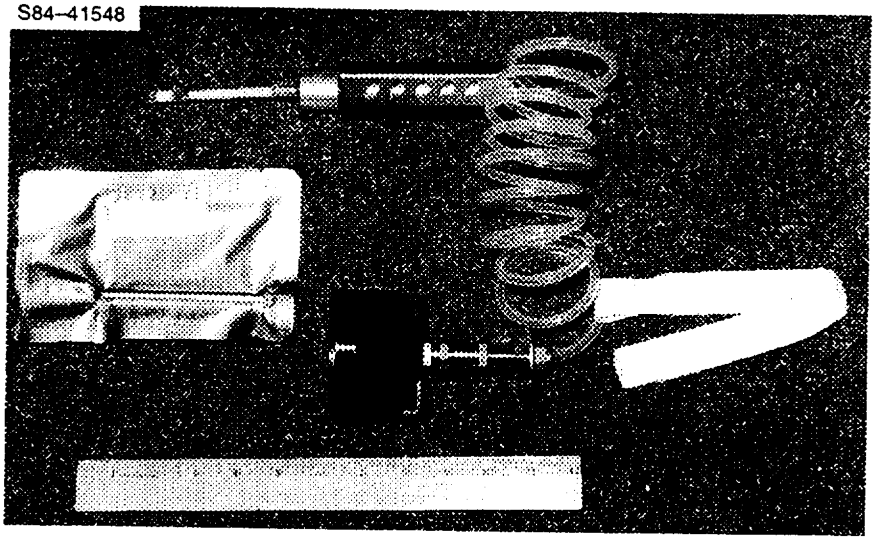
Technical Information	
Part number	**SEB 39105185–302**
Weight	1.4 lb
Material/ construction	Stainless steel and anodized aluminum handle
Load rating	150 ± 50 in–lb maximum
Temperature range	–200° to 250° F (operational)
Quantity flown	**One**
Stowage	**PSA**
Availability	Flight specific

Dimensional Data		
	inches	cm
A	12.5	31.75
B	5.0	**12.7**
C	1.5	3.81



HYDRAZINE DETECTOR

S84–41548



OVERVIEW

The hydrazine detector, also known as the Draeger tube assembly, is intended to be only a qualitative sampler of **chemical** contamination. The detector kit consists of two parts, the air sampler and the detector tube. The air sampler consists of a **modified** airlock depress valve cap, a tube holder, and coiled Teflon tubing. The detector tubes are covered with Teflon shrink tubing and are packaged in standard foil–Mylar vacuum packaging.

Hydrazine detection is based upon chemical reaction with a crystalline mixture of yellow acetic acid and bromophenol blue. Reaction occurs as the airlock atmosphere is drawn through the reactants. The crystals change color from yellow to royal blue upon contact with hydrazine. **There is a separate detector tube for sampling the N_2O_4 fuel oxidizer of the orbiter or other spacecraft. Its crystals change from light grey to blue–grey upon exposure to NO_2 (a byproduct of N_2O_4).**

OPERATIONAL COMMENTS

The system is stowed in the airlock EVA bag prior to depress and is assembled by the EVA crew for use after airlock repress. **Operation and contamination detection involves** a depress of the airlock with visual observation of a color change in the detector. **With the airlock at 5 psi, a 1.5 to 2.0 minute depress is required. If the airlock is at cabin pressure, only 30 seconds to 1 minute is required. If a reaction** is detected, the EVA crew will return to vacuum to sublimate any contamination. **This system is manifested for scheduled and unscheduled EVA missions with a credible risk of contamination exposure.**

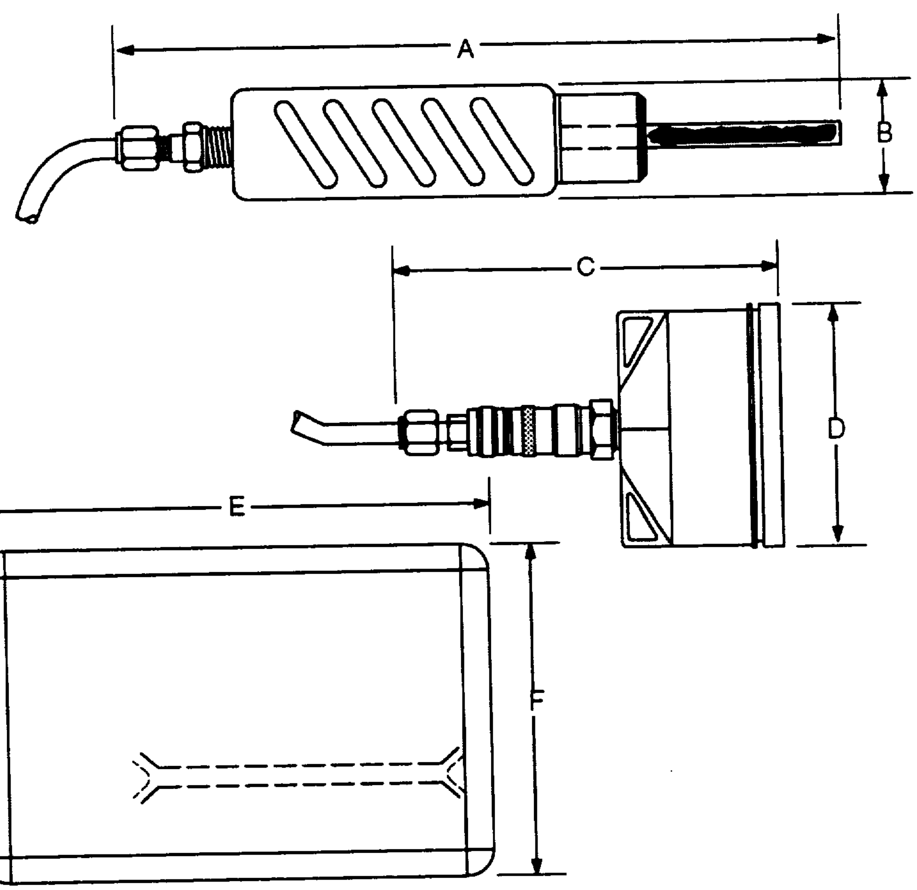
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

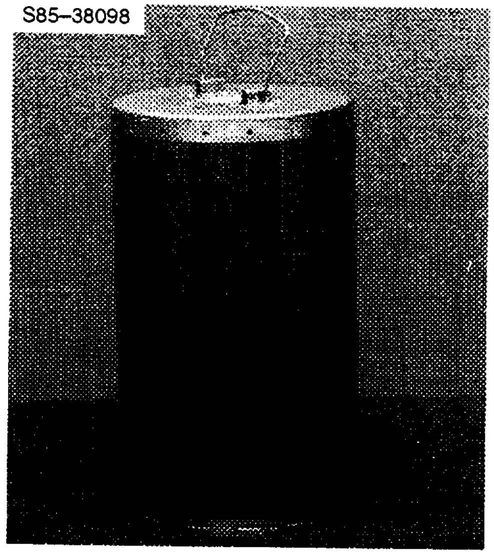
HYDRAZINE DETECTOR

Technical Information	
Part number	SED39116311–301 (air sampler) SED39117159–301 (Draeger tube for hydrazine) SED39117159–302 (Draeger tube for N_2O_2)
Weight	1.3 lb
Material/ construction	Package – Foil–Mylar Tubing – Teflon Tube holder – Anodized aluminum Valve cap – Anodized aluminum Draeger tube – Glass covered by Teflon shrink tubing
Load rating	Attach cap to depress valve – Hand–tight
Temperature range	50° to 300° F
Accuracy	Qualitative only
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	9.750	24.77
B	1.500	3.81
C	5.250	13.34
D	3.125	7.94
E	6.875	17.46
F	4.250	10.80



HYDRAZINE REMOVAL CANISTER



OVERVIEW

The orbiter atmosphere revitalization system nominally scrubs CO_2 out of the cabin air through two LiOH canisters installed in the middeck floor. On missions in which extravehicular activity (EVA) contamination is a possibility, two **of these** canisters are also manifested. **One canister is onboard each vehicle generically to cover non–EVA in–cabin contingencies.** While the LiOH canisters will eventually remove hydrazine from the cabin, the hydrazine canisters are two to three times faster because they contain an ambient temperature catalytic oxidizer (ATCO). Both canisters are externally identical except that the LiOH canister top is gold and the ATCO canister top is white.

OPERATIONAL COMMENTS

These canisters are used in conjunction with the **various** hydrazine **sampling devices** during post–EVA procedures for **chemical** contamination. If contamination is detected in the cabin, both LiOH canisters should be replaced with the two hydrazine canisters. These special canisters may remain in place for 2 hr or until cabin $PPCO_2$ reaches 7 to 10 mm Hg. At that time, one new LiOH canister will be reinstalled. This configuration will be maintained until the cabin is clean. Any remaining hydrazine will eventually oxidize after several hours.

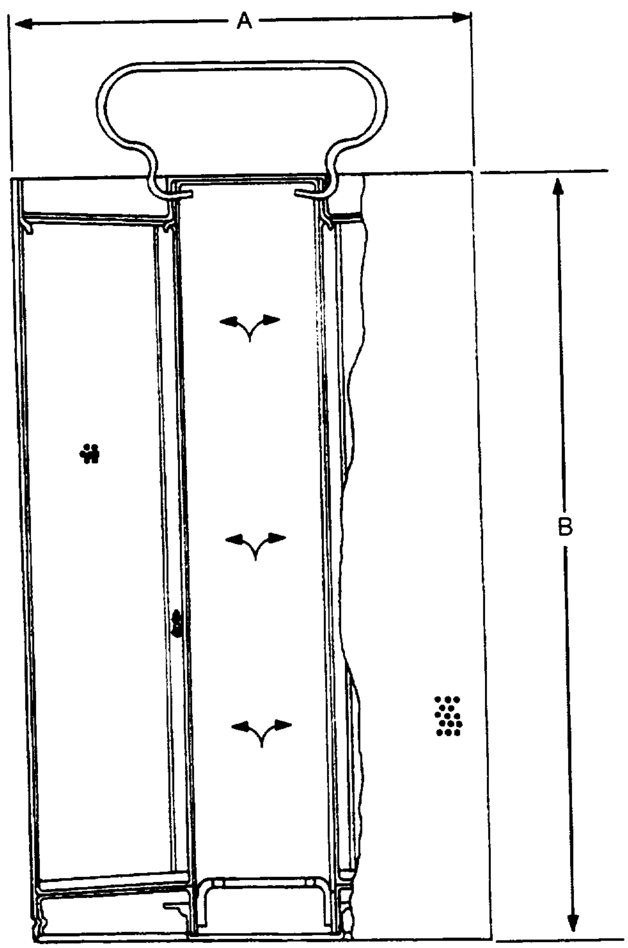
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: G. Winkler, NASA/EC6, (713) 483–9244

HYDRAZINE REMOVAL CANISTER

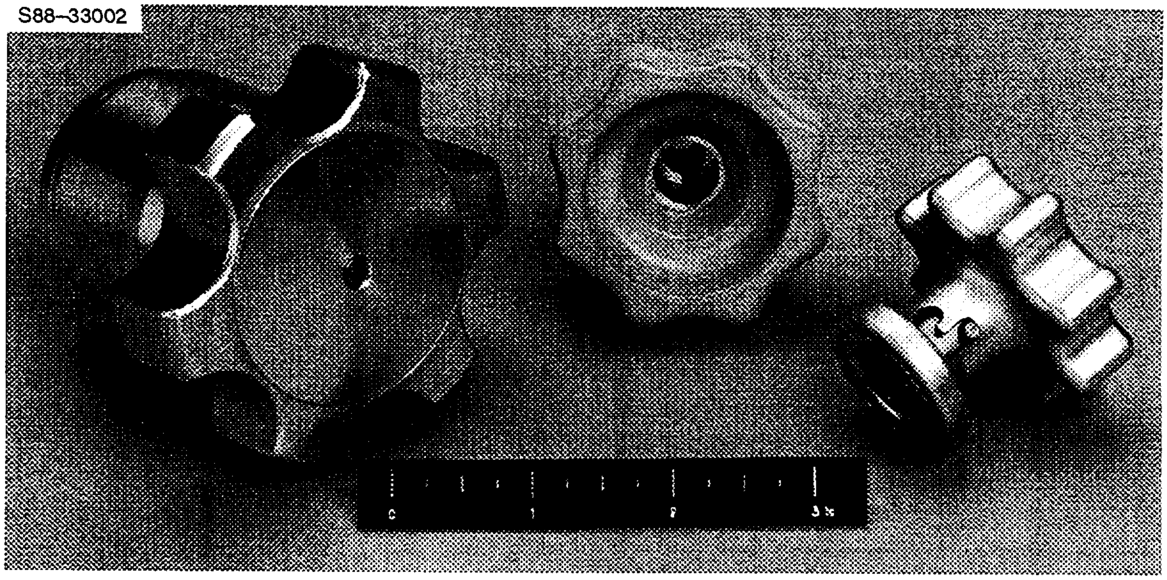
Technical Information	
Part number	MC 621–0008–0060
Weight	6.72 lb
Material/ construction	
Load rating	
Temperature range	
Quantity flown	**One (std)** Two for STS 41–G, STS 51–A, STS 51–I, **and STS–49**
Stowage	**Middeck**
Availability	Flight specific

Dimensional Data		
	inches	cm
A	6.68	16.97
B	11.30	28.70



KNOB, EVA

S88–33002



OVERVIEW

EVA knobs come in a variety of styles. The requirements of the item **using the** knob determine the knob style used. Each knob is designed for ease of use by the gloved hand. With that in mind, EVA knobs are **large in size and are scalloped** to facilitate the grasp of the gloved hand while minimizing slipping when the knob is turned.

OPERATIONAL COMMENTS

The photograph shows three types of knobs. The knob on the left is used to adjust the position of the mini–workstation (10150–10054–01) that mounts on the front of the extravehicular mobility unit (EMU). The middle knob is part of the manned maneuvering unit (MMU) donning station. The knob style shown on the right is used on the portable foot restraint (PFR) and a variety of PFR–related items, including the articulating socket, telescoping boom, workstation stanchion, sill longeron, and bridge attachment clamp. This particular style incorporates a locking feature **and a 7/16–in. hex stud for contingency release of an overtorqued or jammed knob. The shuttle umbilical retraction system (SURS) wrench that is part of the standard orbiter manifest can also be used on this knob. The number of turns to tighten or loosen any knob must be kept to a minimum to minimize gloved hand fatigue.**

CONTACTS

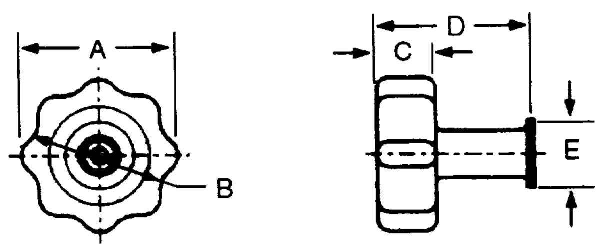
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

KNOB, EVA

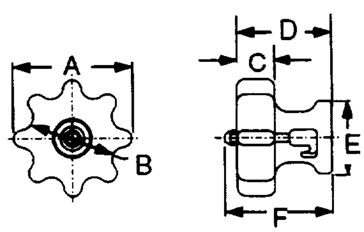
Technical Information		
Part number	SK118–030–01 10150–20054–01 10176–20666–01	(MMU FSS) (MWS) (PFR)
Weight	SK118–030–01 10150–20054–01 10176–20666–01	0.198 lb 0.174 lb 0.150 lb
Material/ construction	Aluminum	
Load rating		
Temperature range	–150° to +250° F (operational)	
Quantity flown		
Stowage		
Availability	Flight specific	

Dimensional Data						
	SK118–030–01		10176–20666–01		10150–20054–01	
	inches	cm	inches	cm	inches	cm
A	2.25	5.72	2.00	5.08	3.00	7.62
B	2.00	5.08	1.50	3.81	2.12	5.38
C	0.80	2.03	0.62	1.57	1.02	2.59
D	2.25	5.72	1.60	4.06	–	–
E	1.00	2.54	1.25	3.18	–	–
F	–	–	2.69	6.83	–	–

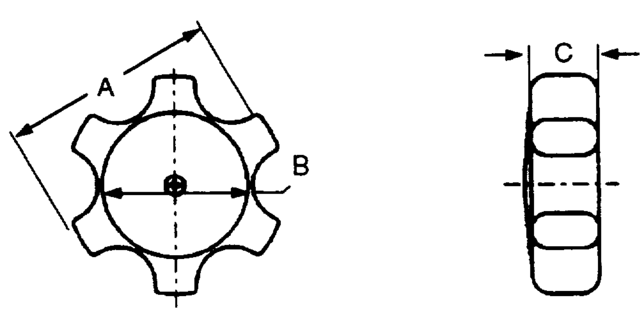
SK118–030–01



10176–20666–01

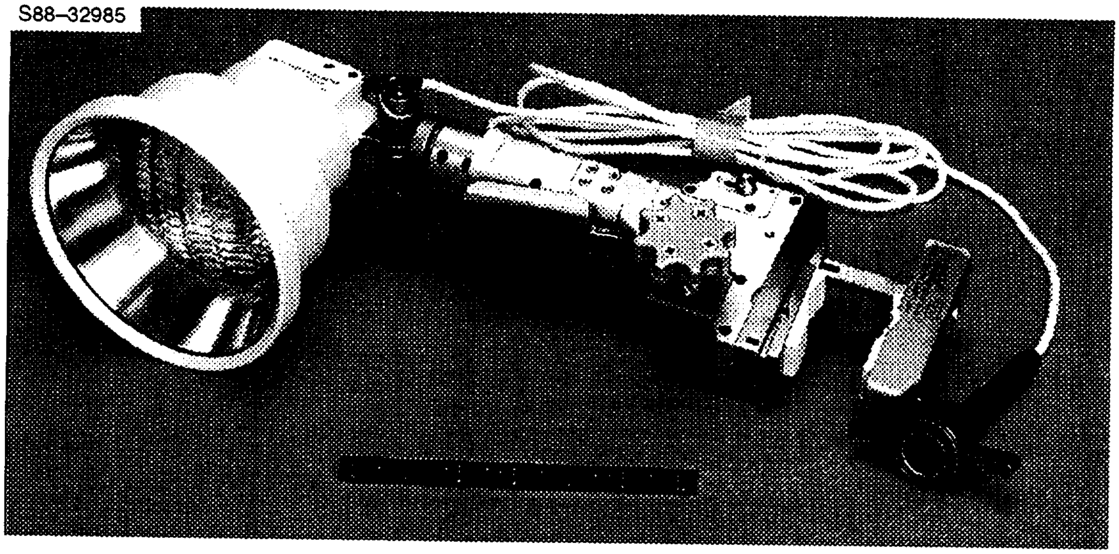


10150–20054–01



LIGHT, PORTABLE FLOOD

S88–32985



OVERVIEW

The portable flood light is designed to provide illumination for Hubble Space Telescope (HST) maintenance and repair work. The light consists of a light head and handles that are connected to each other via an extravehicular activity (EVA)–compatible two–degree–of–freedom swivel disconnect. It receives power solely from HST receptacles.

OPERATIONAL COMMENTS

The light head integrates an 8–foot power cord that interfaces with the HST power receptacles. There are two light intensity levels that the crewmember selects by use of a toggle switch. The light handle integrates quick–action clamping jaws to allow the assembly to be attached to a common EVA handrail or similar structure. The clamping jaws are covered with elastomer to protect the clamped surface. A 20–foot extension cord is also available for use with this light. **The clamping jaws are released for spring–loaded retraction/extension by a squeeze lever and lock button. Clamp force is adjustable by a knob**. Because of glove touch temperature limits, the lamp head should be avoided while on and for 15 minutes after deactivation.

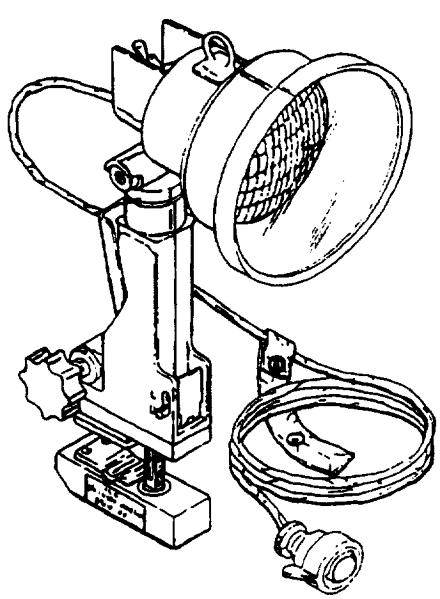
CONTACTS

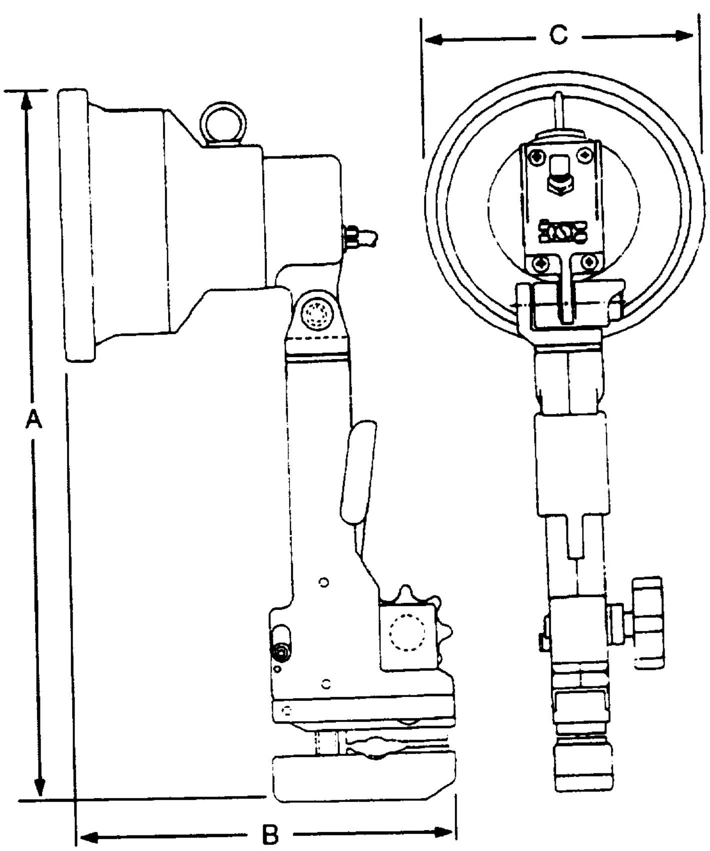
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

LIGHT, PORTABLE FLOOD

Technical Information	
Part number	SED16101–10061–01 (light) SED33105508–301 (light) SED33105587–301 (extension cable)
Weight	10 lb
Material/ construction	Aluminum Stainless steel Lexan
Load rating	
Temperature range	–150° to +250° F (operational)
Head rotation	Vertical –45° through +90° Horizontal 360° continuous
Handle extension opening	3/8 to 3–1/2 in.
Power source	**28 V dc** HST power receptacle
Power consumption	50 watts at 28 V dc
Light intensity	High beam – 30 ft–cd at 10 ft Low beam – 8 ft–cd at 10 ft
Quantity flown	
Stowage	
Availability	Flight specific

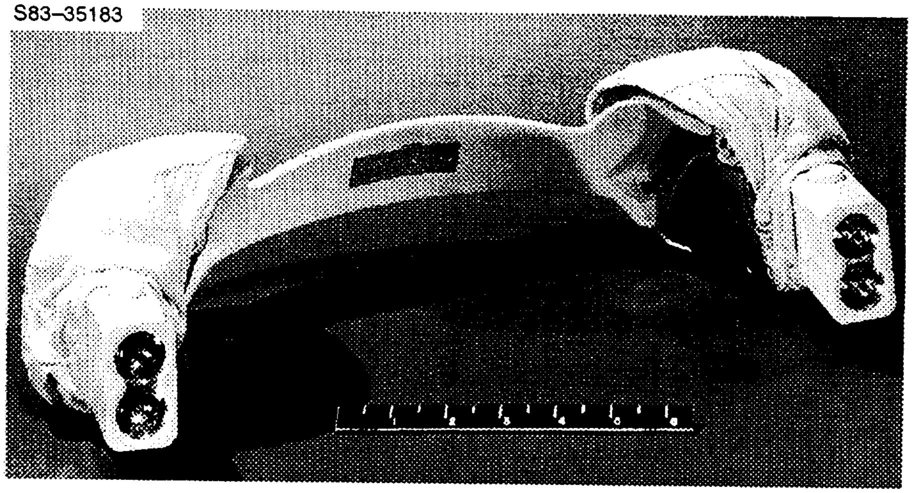
Dimensional Data		
	inches	cm
A	15.70–19.2	39.88–48.77
B	8.00	20.32
C	6.00	15.24





LIGHTS, EMU

S83–35183



OVERVIEW

The extravehicular mobility unit (EMU) lights assembly provides a crewmember with portable lighting during an extravehicular activity (EVA) task. The assembly contains two independent lamp modules connected by a cross member. Each side contains a battery module, two lamps, a switch, and a thermostatic cutoff switch. The battery module can supply power to illuminate one lamp for 6 hours, with less than 10 percent degradation of light intensity. The EMU lights attach to the helmet with simple latches. Receptacles for the EMU TV are also provided.

OPERATIONAL COMMENTS

On the EMU lights, each lamp module has a left–right swing angle of 85° (5° towards the helmet and 80° away from the helmet) and an up–down swing angle of 60° (30° up and 30° down). The switch provides one–handed operation of the lamp module. Repeatedly depressing the switch sequences the upper lamp on, the lower lamp on, **and** both lamps off. Because of battery thermal constraints dual lamp operation **has been eliminated from the latest design**. The lights are useful in providing **localized worksite** illumination during the 45 minutes of darkness of each orbit; **however, they do not provide peripheral vision illumination.**

The lights are launched **without any batteries installed. They have been redesigned to eliminate the electronic lamp sequencer by using a mechanical cam switch**. The lights must be removed from the helmet for entry due to the lack of crash load certification.

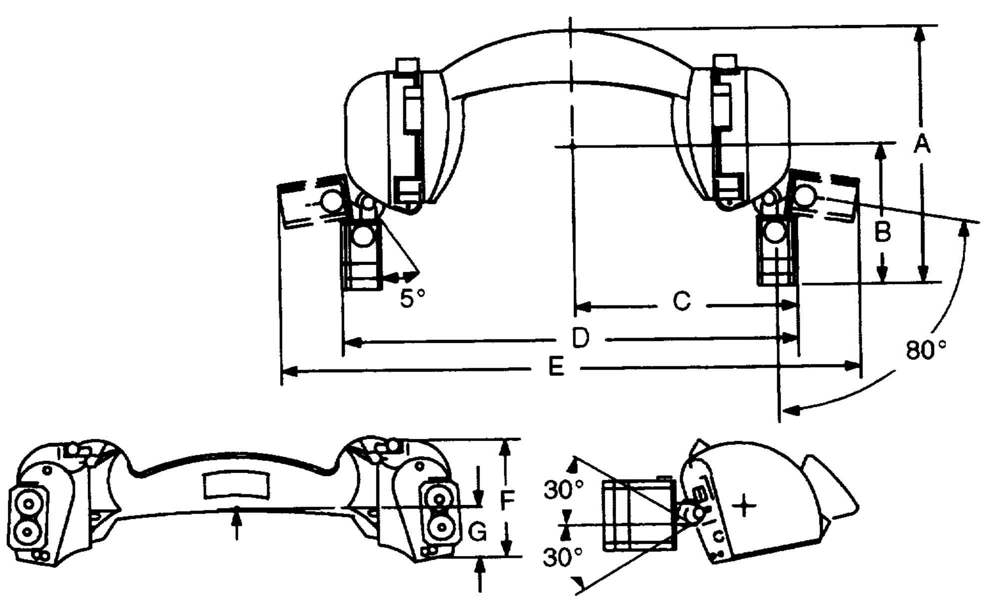
CONTACTS

Operational: **R. K. Fullerton**, NASA/DF42, (713) 483–2589
Technical: W. B. Wood, NASA/EC5, (713)483–9247

LIGHTS, EMU

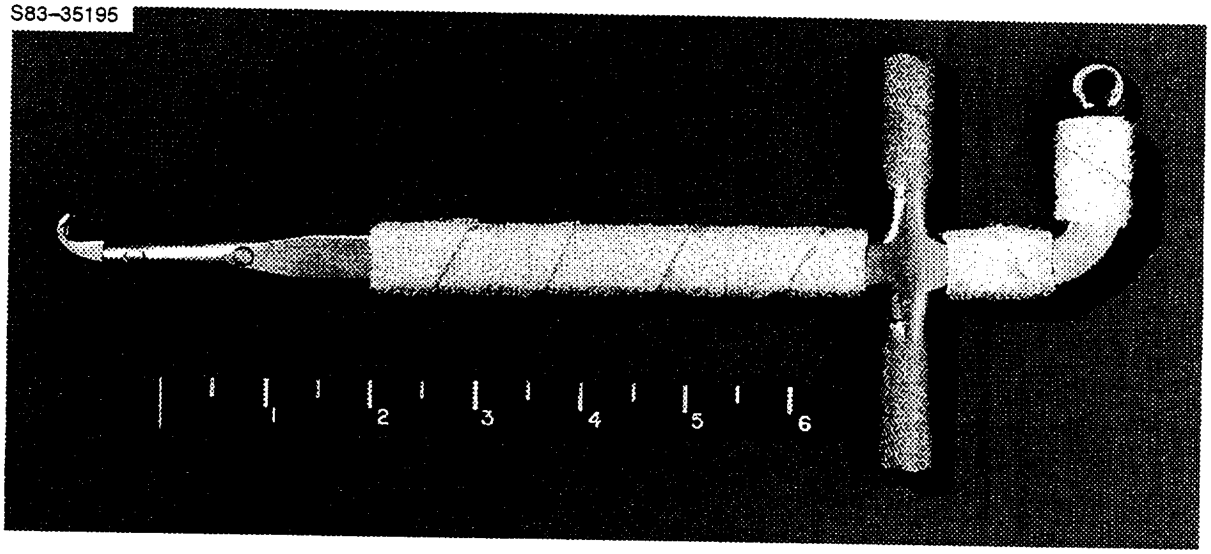
Technical Information	
Part number	10161-10061-06
Weight	5.00 lb (without batteries) 5.88 lb (with batteries)
Batteries	D-size lithium bromine complex **(one per side)** (3.5 V, 8 A-h each)
Battery life	6 hr nominal, one lamp per side operating
Voltage open circuit loaded	 3.77 ± 0.2 V dc 3.25 V dc
Lamps	Two halogen lamps per side (2.5 W each)
Lamp intensity	20 ft-c (min.) per lamp at 3 ft
Lamp life	20 hr
Lighting pattern	16 by 24 in. at 2 ft (four lamps on pointed forward)
Thermal protection	160° ± 5° F thermal cutoff switch, multilayer insulation **and aluminum block heat sink**
Material/ construction	
Load rating	
Temperature range	
Quantity flown	**Two (std)**
Stowage	Volume H locker
Availability	Standard

Dimensional Data		
	inches	cm
A	8.81	22.38
B	4.66	11.84
C	7.76	19.71
D	15.52	39.42
E	19.78	50.24
F	4.30	10.92
G	1.88	4.78



LOOP PIN EXTRACTOR

S83–35195



OVERVIEW

The loop pin extractor was designed to pull or pry loose the loop pins or cotter pins used on the space shuttle. The tool has a hook on one end that is inserted into the eye of the loop pin for removal; near the opposite end is a T–bar that provides grip for the extravehicular activity (EVA) crewmember during pin removal. The handle is wrapped in Velcro and has a ring for tether attachment.

OPERATIONAL COMMENTS

This tool is basic to all nut and bolt disconnects of the bulkhead latches and door drive. The tool is inserted into the eye of the loop pin and the pin is removed by pulling or prying. The tool may also be used for jam removal **or to break safety wire from bolts**. The loop pin extractor is part of the normally manifested orbiter equipment. It is wrapped in a Velcro–lined tool caddy along with the power drive unit (PDU) disconnect and stowed in the **port** provisions stowage assembly (PSA).

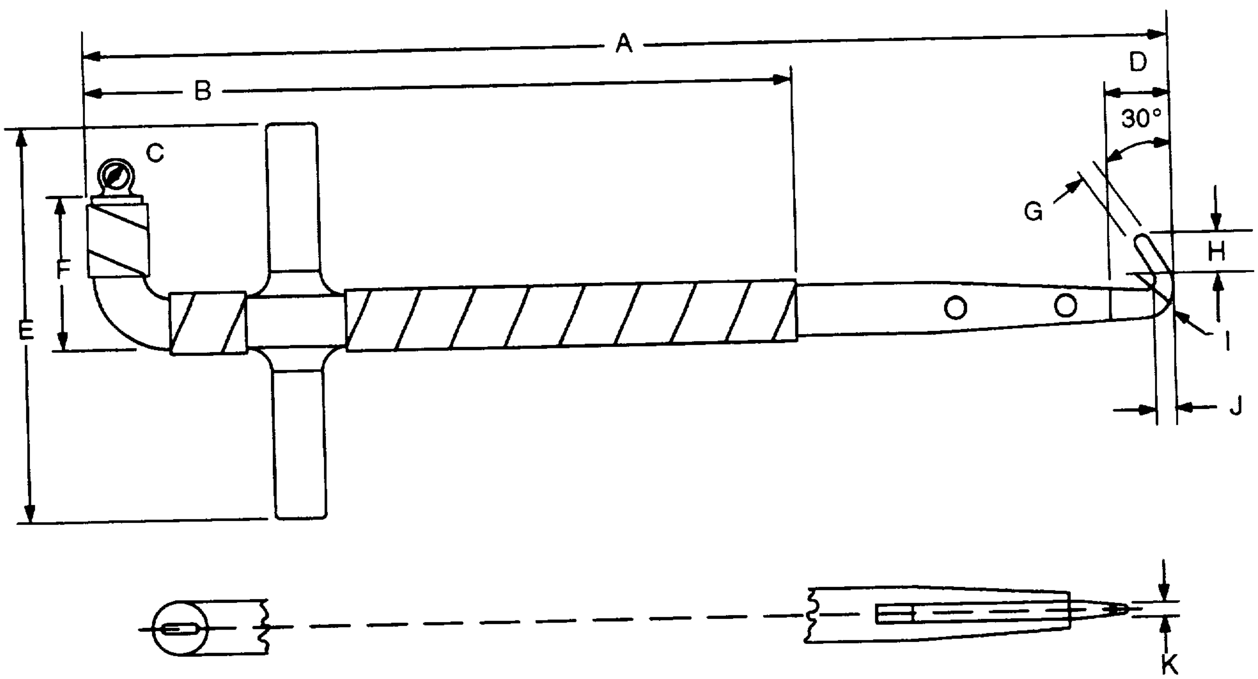
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

LOOP PIN EXTRACTOR

Technical Information	
Part number	V628–650998–001 or SDD33103433–301
Weight	0.8 lb
Material/ construction	Tool steel with aluminum handle
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

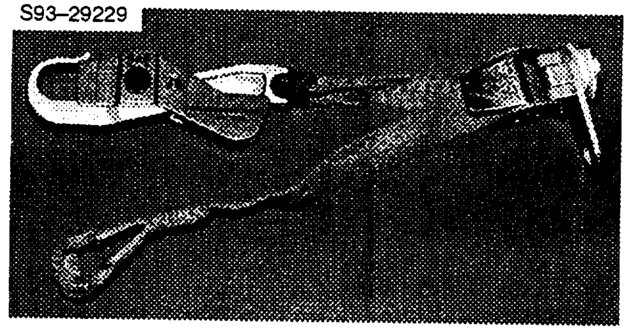
Dimensional Data		
	inches	cm
A	10.00	25.40
B	7.00	17.78
C	0.25	0.64
D	0.43	1.09
E	4.00	10.16
F	1.60	4.06
G	0.10	0.25
H	0.22	0.56
I	0.25	0.64
J	0.10	0.25
K	0.10	0.25



MANIPULATOR FOOT RESTRAINT

S84–27021

S93–29229



OVERVIEW

The manipulator foot restraint (MFR) is a crewmember restraint device and workstation that is grappled by the remote manipulator system (RMS). It consists of a lower base with a standard RMS grapple fixture and a latch and roller assembly for attaching the MFR to the adaptive payload carrier (APC). On top of the lower base is the MFR base, supporting the foot restraint platform and vertical stanchion. The upper portion of the stanchion, the workstation, includes handholds, space for two removable **double–sided** tool boards, and the payload interface mechanism (PIM). **A self–tending** safety tether is attached to the foot restraint platform for crewmember use and **doubles as a release lanyard for foot restraint yaw**. A short tether is provided **as a redundant attachment** of the MFR to the RMS **and hooks to the** end effector handrail.

OPERATIONAL COMMENTS

The MFR provides for EVA crewmember translation, positioning, and restraint in cargo bay worksites within reach of the RMS. Positioning of the MFR is by voice link with the RMS operator in the cabin. **One significant drawback to the MFR is that it precludes use of the RMS and effector for grappling payloads until the MFR is removed. It also typically takes both extravehicular crewmembers to handle the MFR for stowage and installation. The stanchion rotates about its long axis. It also tilts and yaws about the crewmember while still in the foot restraint. The MFR APC includes a short handrail and tether point to aid crew and MFR restraint. A bayonet fitting option now exists for the transport of a camera on top of the vertical stanchion in place of the PIM. Bayonet fitting receptacles have also been added to the stanchion handholds to aid in equipment handling.**

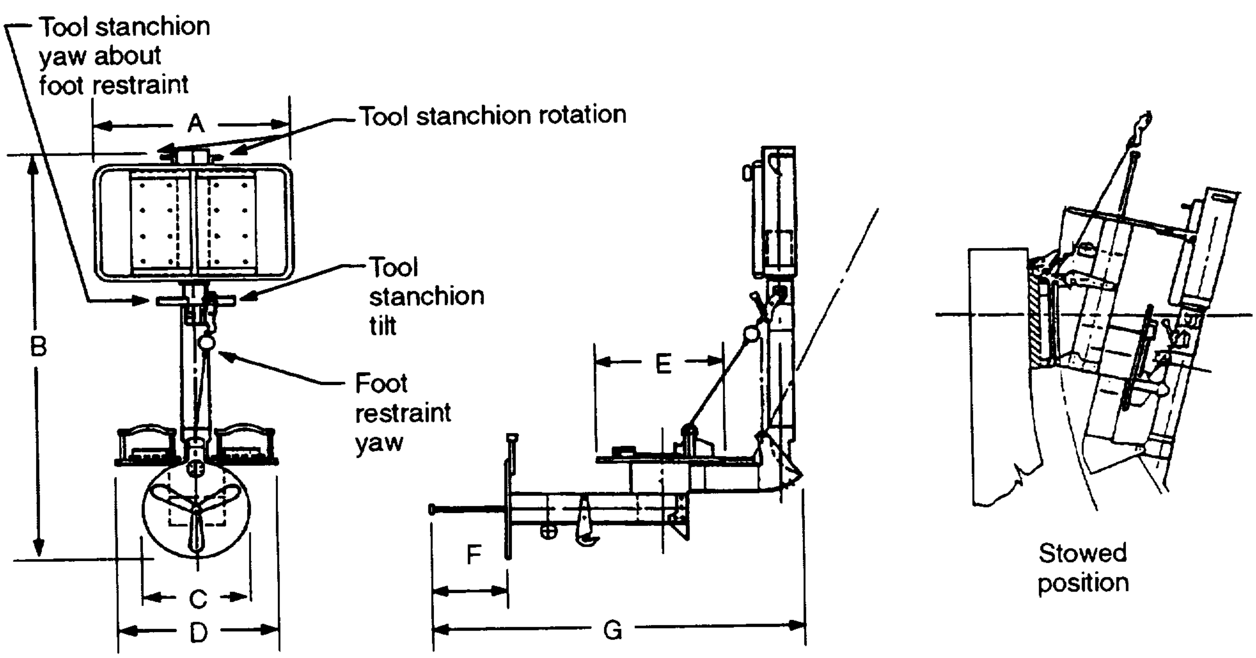
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **N. Gonzalez**, NASA/ES6, (713) 483–8944

MANIPULATOR FOOT RESTRAINT

Technical Information	
Part number	**SED33103150-308 (MFR/APC assembly) SED33102403-305 (MFR) SED43102820-306 (APC) C95-105 (PIM option) 10176-20692-01 (camera mount option) SED33104013-302 (MFR/RMS tether)**
Weight	**60.46 lb (MFR) 32.0 lb (APC)**
Material/ construction	Primarily aluminum
Load rating	**100 lb (stanchion), 343 lb (tether), 140 lb (foot restraint)**
Temperature range	**-260° to +230° F**
Stanchion **handhold yaw**	±180° with locking in 45° increments
Stanchion **tilt**	27° forward with locking in 9° increments
Work stanchion **yaw about foot plate**	±180° with locking in 45° increments
Foot **plate yaw**	Continuous 360° with locking in 30° increments
Quantity flown	**One on STS 41B, 41C, 51A, 51I, 61B, 37, 61**
Stowage	Cargo bay, attached to APC
Availability	Flight specific

Dimensional Data		
	inches	cm
A	25.0	63.50
B	61.5	156.21
C	14.0	35.56
D	20.5	52.07
E	14.5	36.83
F	8.0	20.32
G	52.5	133.35



MANNED MANEUVERING UNIT

OVERVIEW

The manned maneuvering unit (MMU) is a modular, self–supporting backpack, containing its own electrical power, propulsion system, and controls. It readily attaches to the extravehicular mobility unit (EMU) and can be donned, doffed, and serviced by one extravehicular activity (EVA) crewmember for use as required during a nominal 6–hr EVA. It has complete six–degree–of–freedom control authority and automatic attitude hold capability. It provides attachment points for the use of ancillary equipment such as satellite docking mechanisms, tools, portable lights, cameras, and instrument sensors. The propellant is gaseous nitrogen, which is noncontaminating.

OPERATIONAL COMMENTS

The MMU is used to increase the EVA crewmember's mobility by extending the range of activities from the cargo bay to other portions of the spacecraft, to appendages of payloads protruding from the cargo bay, or to other spacecraft. It can be used to carry cargo of moderate size, to stabilize satellites, to retrieve small free–flying payloads, and to provide remote photography/television of shuttle operations.

Two MMU's are normally manifested. On past missions, the MMU has been used with the apogee kick motor capture device (ACD), the trunnion pin attachment device (TPAD), and 35–mm camera provisions. The MMU is stowed in the forward cargo bay (bay 1) on the flight support station (FSS) designed specifically for that purpose.

Potential future upgrades include long life launch bolts, improved control electronics, and range/rate displays and sensors.

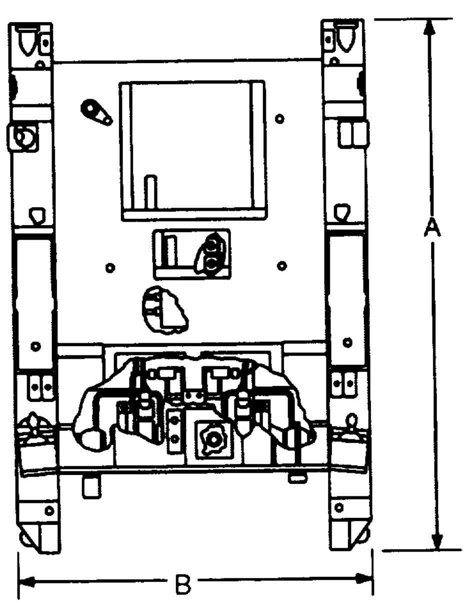
CONTACTS

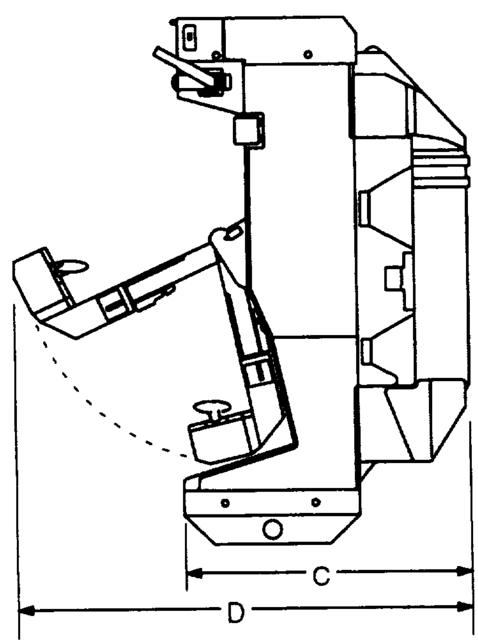
Operational: R. K. Fullerton, NASA/DF4, (713) 483–2589
Technical: **C. Hess**, NASA/ER, (713) 483–**9142**

MANNED MANEUVERING UNIT

Technical Information	
Part number	852MU000000
Weight	338 lb
Material/ construction	Aluminum skin
Control	Three modes of operation – Normal, axis inhibit, and satellite stabilization Automatic attitude hold available in all three modes Left–hand controller – Three DOF translation Right–hand controller – Three DOF rotation Translation acceleration – 0.26 to 0.33 ft/sec^2 Rotational acceleration – 7 to 12 deg/sec^2 Redundant logic
Maximum range	400 ft
Electrical power	Two batteries: total power – 26.6 A–hr (minimum)
Propellant	Gaseous nitrogen (24 lb at 3000 psig) Reservicing in less than 10 min
Load rating	**Launch bolt preload 1300 lb** **Launch bolt torque 140 ±30 lb**
Temperature range	
Quantity flown	**Two on STS 41–B, 41–C, 51–A**
Stowage	Forward cargo bay (bay 1) in FSS
Availability	Flight specific, **recertification reqd for future use**

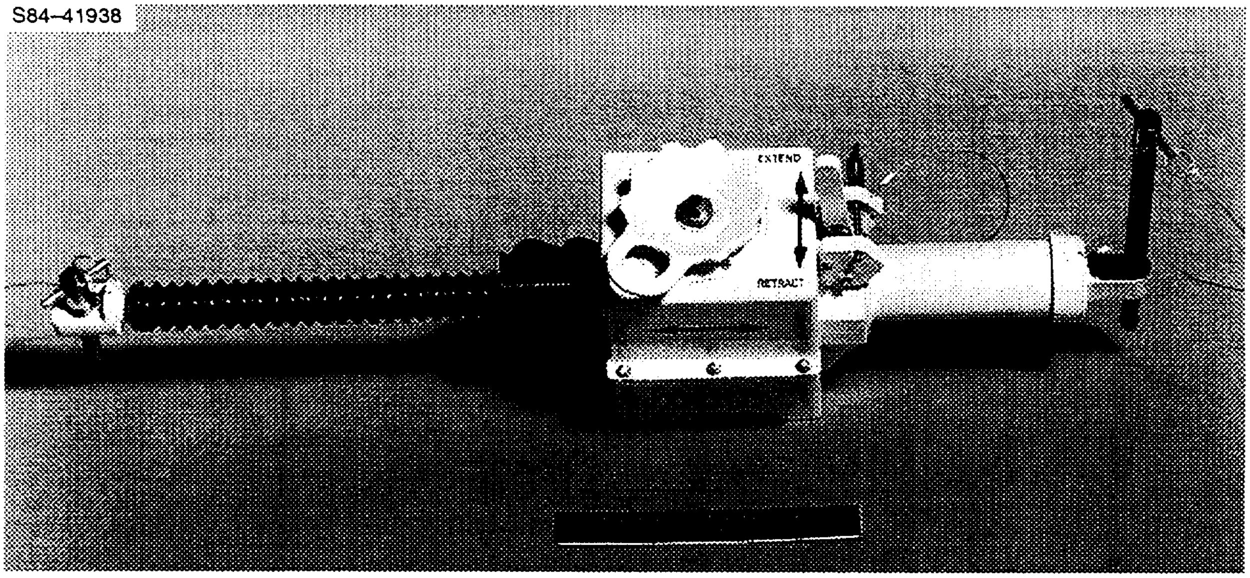
Dimensional Data		
	inches	cm
A	50.0	127.00
B	33.3	84.58
C	27.0	68.58
D	48.0	121.92





MANUAL AFT FRAME TILT ACTUATOR

S84–41938



OVERVIEW

The manual aft frame tilt actuator (AFTA) is a ball nut jack to raise or lower the tilt table of the inertial upper stage (IUS). This tool would be used for IUS deploy in the event that both the primary and secondary AFTA's fail to respond. It may also be used for tilt table stowage prior to reentry to avoid landing load damage.

OPERATIONAL COMMENTS

Normal installation of the manual AFTA requires that the opposite side AFTA be engaged to restrain the IUS and payload. The IUS/payload may not be unrestrained at any time. Before installing the manual AFTA on the chosen side, the corresponding automatic AFTA must be decoupled by pin puller activation. The manual AFTA is then connected to the tilt table slip ring with **1/2–in.–diameter** pip pins after verifying slip ring engagement. The opposite side automatic AFTA is next released by AFTA pin puller or slip ring pin pusher activation. The manual AFTA can then be manually driven to elevate to 45° for deploy or to lower to –6° for stowage. A handwheel provides easy operation. A 7/16–in. wrench must be used to drive the manual AFTA under high loads. A lock lever and 3/16–in. diameter pip pin ensures restraint when the manual AFTA is unattended. **A bayonet fitting is provided for mini–workstation transport and two–handed manual translation to the worksite.**

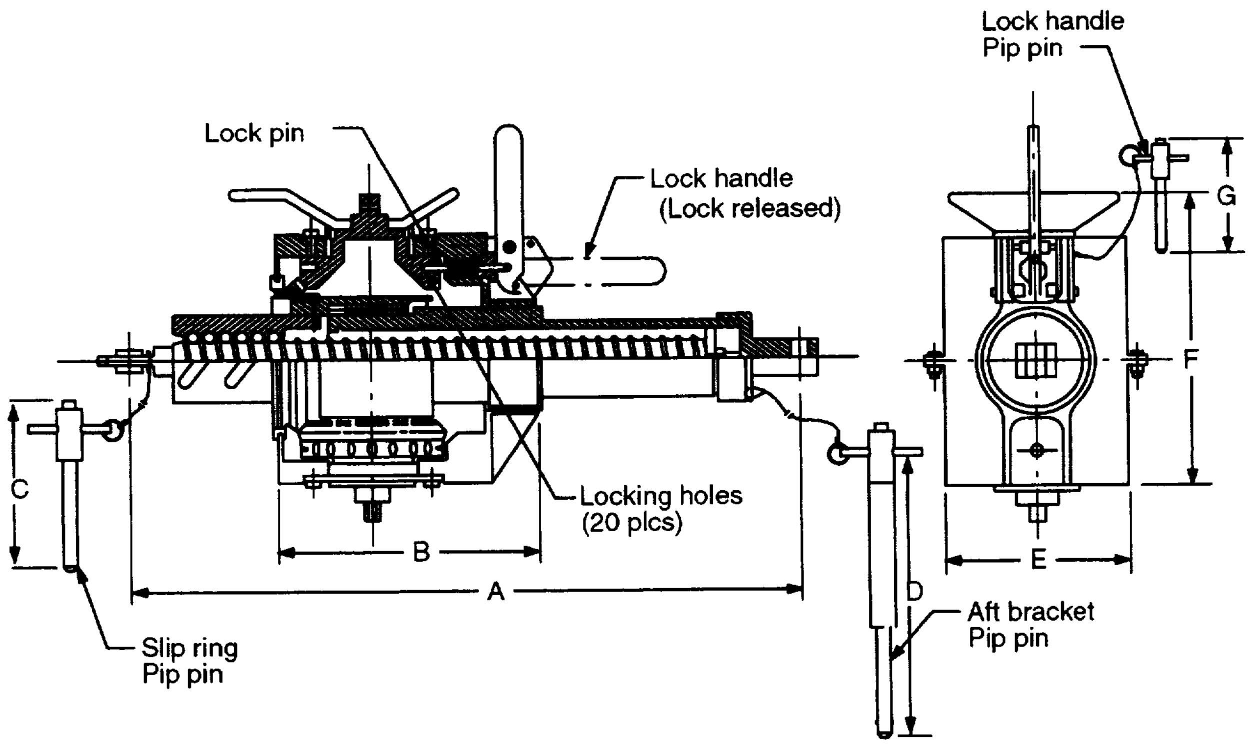
CONTACTS

Operational: S. Rainwater, DF42, (713) 483–1755
Technical: **S. Wylie, Boeing/Houston (713) 280–7631**

MANUAL AFT FRAME TILT ACTUATOR

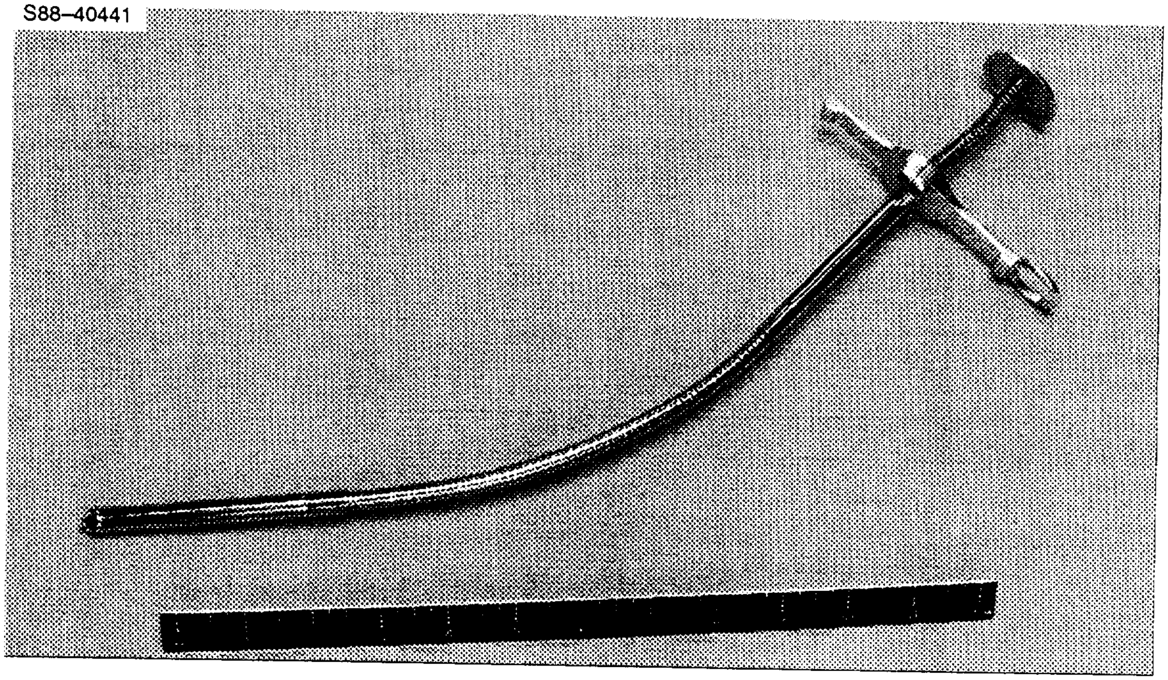
Technical Information	
Part number	**290–30760–9**
Weight	40 lb
Material/ construction	
Load rating	±11,300 lb **(locked)** 1500 lb **(unlocked with** 12.5 lb applied with 12–in. wrench)
Temperature range	–10° to +25° F (operational)
Extension ratio	0.473 in. per handwheel rev
IUS elevation vs. shaft extension	6.75° per 1 in. travel
Quantity flown	**One per IUS flight**
Stowage	**Middeck locker**
Availability	Flight specific

Dimensional Data		
	inches	cm
A	19.93 (retracted) 30.69 (extended)	50.62 77.95
B	**7.875**	20.00
C	**4.625**	11.75
D	**11.00**	27.94
E	**5.125**	13.02
F	**8.50**	21.59
G	**3.625**	9.21



MECHANICAL FINGER

S88–40441



OVERVIEW

The mechanical finger is designed for retrieving loose screws or other small items which are out of reach or in an inaccessible area. The tool has been developed for use in the Hubble Space Telescope program.

OPERATIONAL COMMENTS

The mechanical finger assembly consists of a modified finger ring, a flexible arm, and a knob. By positioning the knob in the palm and grabbing the tether ring handle with the fingers, the crewmember pushes the knob with his/her palm. This action extends the prongs from the tip of the arm. As the knob is pulled back out, the prongs are closed up around the object being retrieved.

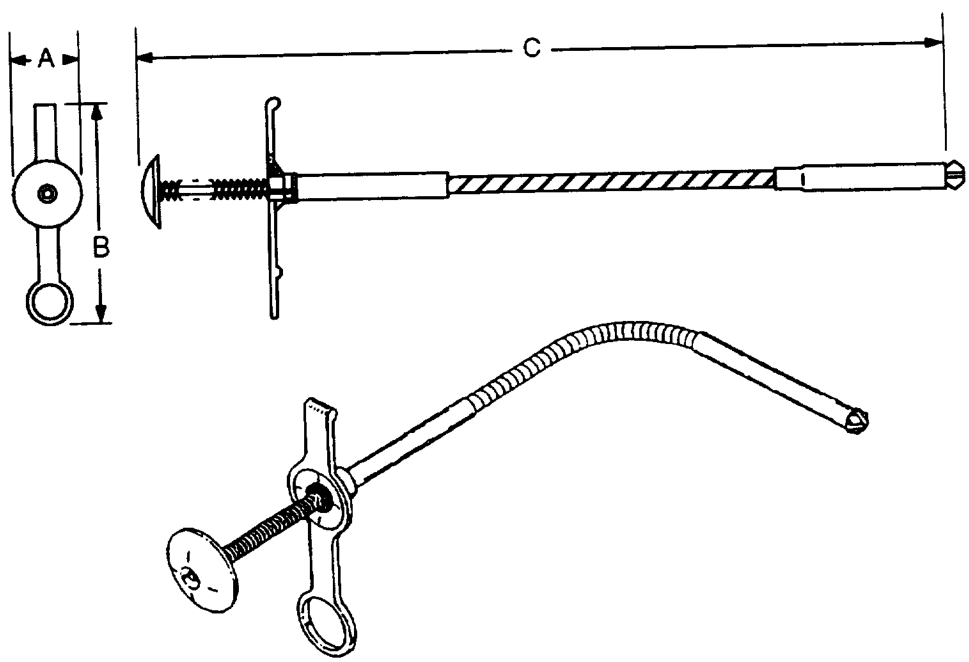
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

MECHANICAL FINGER

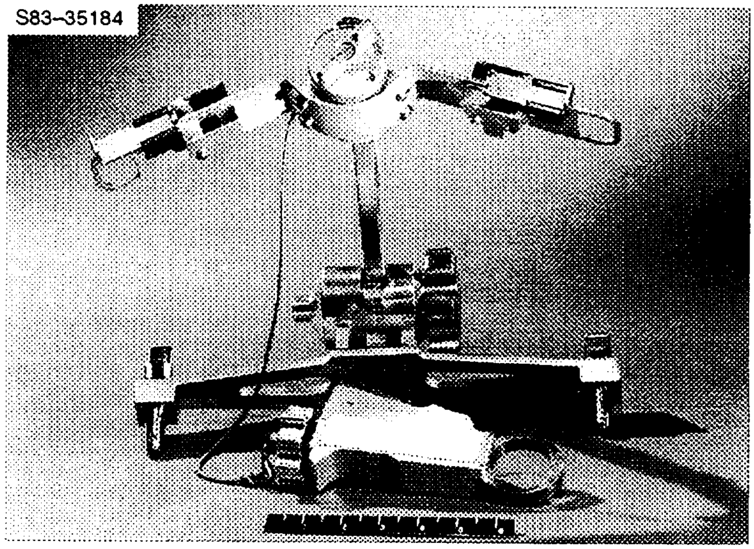
Technical Information	
Part number	10181–10018–01
Weight	0.32 lb
Material/ construction	Chrome–plated carbon steel Aluminum
Load rating	
Temperature range	–150° to +250° F
Maximum grasp opening	1.3–in. dia
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

Dimensional Data		
	inches	cm
A	1.25	3.18
B	4.98	12.65
C	17.38	**44.15**



MINI–WORKSTATION

S83-35184



OVERVIEW

The mini–workstation (MWS) is a mechanical device which mounts on the front of the extravehicular mobility unit (EMU) for tool stowage and to provide a means of tether restraint for an EVA crewmember **or tools** at a worksite. The MWS consists of a clutch assembly and position adjusting knob, two EMU attachment points (pip pins), a work tether and end effector, a tether retraction assembly, a T–bar, two D–rings, and four caddy attach points. The T–bar incorporates the work tether and tether D–rings. The tether is a 4–ft, self–retracting cord with a multipurpose end effector. The tether is released and locked by means of a lever on top of the reel case.

OPERATIONAL COMMENTS

The MWS is mounted on the hard upper torso of the EMU. The crewmember attaches the end effector, **spins the end effector knob to lock its jaws**, positions himself as desired, **and then rotates the lock lever to fix cord length**. The position adjusting mechanism attaches the T–bar to the MWS attaching bracket and allows the T–bar to be pivoted away from the EMU up to 170° and secured in the desired position. **A clutch will slip to prevent overloading the EMU attachment fittings**. Two MWS's are part of the normally manifested orbiter equipment. They are **normally** stowed in the **port** provisions stowage assembly (PSA) **but are best carried in the cabin for scheduled EVA.**

The volumetric carrying capacity of the MWS is very limited and must be preserved to allow two–handed manual translation. Large items should be transported by other means.

Velcro on the the T–bar and the end effector is intended for end effector restraint without interfering with attached tools. Larger tools are better carried on the left side where the T–bar knob causes less interference. A recent change allows other end effectors to be used by simple exchange via a french hook on the end of the retracting cord.

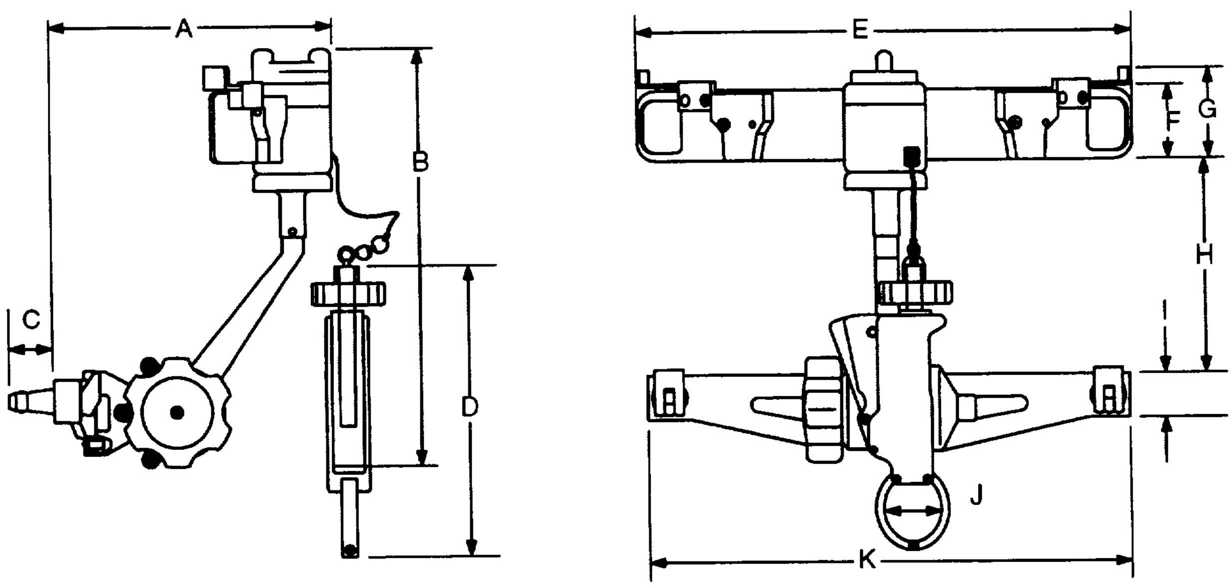
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

MINI–WORKSTATION

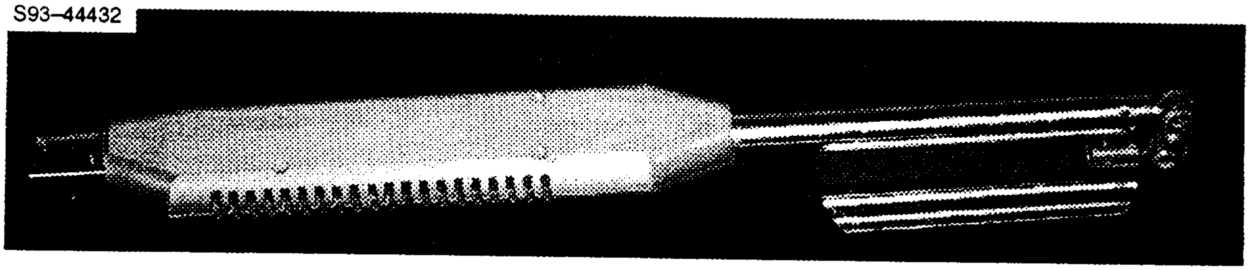
Technical Information	
Part number	10150–10050–07 **(MWS std)** **SED33105213–305 (MWS with french hook)** **10150–20109 (end effector, permanent)** **SED33105241–303 (end effector, detachable)**
Weight	7.85 lb
Material/ construction	Aluminum Lubricant – Molykote 321R Tether cord – PBI
Load rating	Tether clutch will slip at **45–50** lb force Tether cord breakpoint – 80 lb (ave.)
Temperature range	–200° to 250° F (operational)
End effector maximum opening	1.25 in.
Quantity flown	Two **(std)**
Stowage	**Port PSA (std), crew cabin (scheduled EVA)**
Availability	Standard

Dimensional Data		
	inches	cm
A	7.87	19.99
B	11.75	29.85
C	1.30	3.30
D	8.20	20.83
E	14.38	36.53
F	2.12	5.38
G	2.94	7.47
H	6.15	15.62
I	1.20	3.05
J	1.75	4.45
K	13.70	34.80



MIRROR, INSPECTION

S93–44432



OVERVIEW

The inspection mirror was developed as an extravehicular activity (EVA) crew visual aid for the STS–49 Intelsat reboost mission. It provides a nonbreakable reflective surface with a long reach and an adjustable mirror for looking into tight access areas. The movable mirror can be articulated ±90° in the horizontal axis and 360° in the vertical axis. The length is adjustable by a total range of 18.5 in. The mirror has a standard 3/8–in. drive female drop–proof tether attachment for restraint and transport on a small Hubble Space Telescope (HST) tool board attached to the mini–workstation.

OPERATIONAL COMMENTS

The inspection mirror was created to observe mechanisms outside the direct view of the extravehicular (EV) crew during mating operations of Intelsat with its replacement booster motor. Tight access precluded close viewing of docking latches, umbilical mechanisms, and electronic indicator lights. When used with illumination from the extravehicular mobility unit (EMU) helmet lights, visual access was feasible. Like the EMU wrist mirror, this mirror is made of highly polished stainless steel to eliminate any risk of the glass breakage and sharp edges that are possible with standard mirrors.

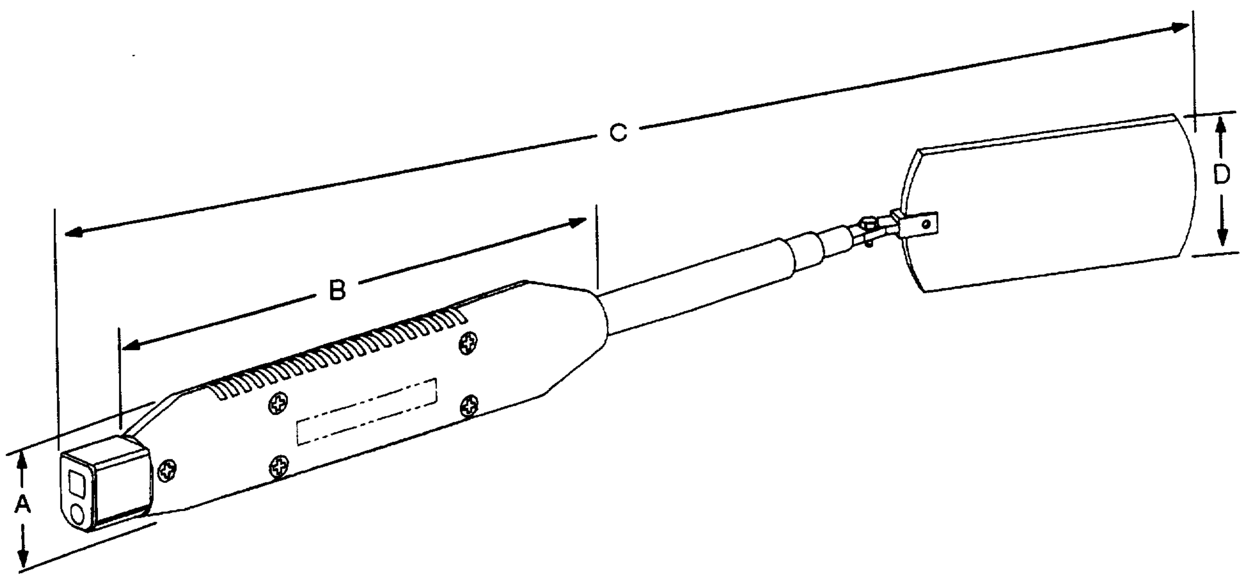
CONTACTS

Operational: W. Wedlake, JSC DF42, (713) 483–2568
Technical: R. Marak, NASA/EC5, (713) 483–9144

MIRROR, INSPECTION

Technical Information	
Part number	SED39122656–303
Weight	1.2 lb
Material/ construction	Aluminum, stainless steel
Load rating	
Temperature range	
Quantity flown	Two on STS–49
Stowage	Starboard PSA for STS–49
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.5	3.81
B	7.25	18.42
C	15.25	38.74
D	1.8	4.57
E		
F		
G		
H		



MIRROR, WRIST

S82–26512

OVERVIEW

The wrist mirror, also called the extravehicular mobility unit (EMU) mirror band, is attached to the wrist of the EMU glove to allow the extravehicular activity crewmember to view the gauges and dials on the front of the EMU. The mirror can be worn on either wrist and is stowed on the left glove before flight. It is provided with each primary EMU as **Government–furnished equipment**.

OPERATIONAL COMMENTS

The wristband of the EMU mirror band is a stainless steel Twistoflex watchband encased in Teflon fabric. The mirror is attached to the band by straps that loop through slits in the mirror edge. The mirror itself is constructed of highly polished chrome–plated steel **to be shatterproof and have no sharp edges. It provides a distortion free image with a 45° specular reflectivity of 50 ± 3 percent of total visible light. The mirror surface on each side is polished to a finish of 600 gloss units.**

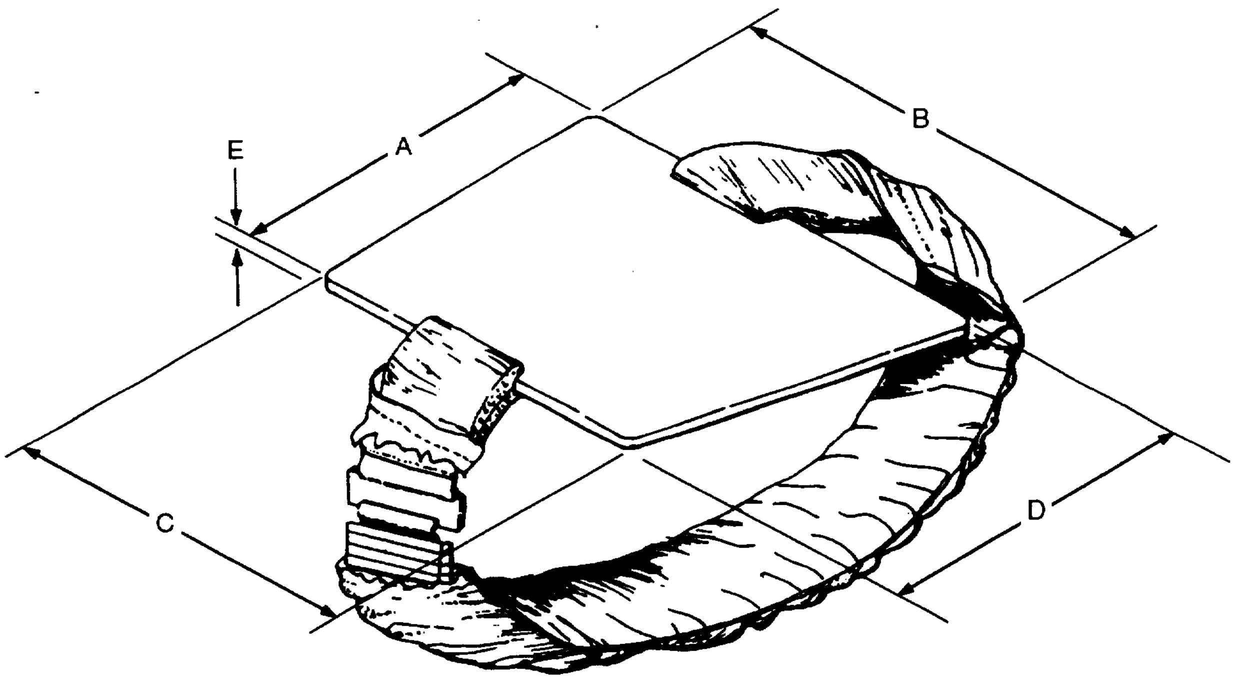
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

MIRROR, WRIST

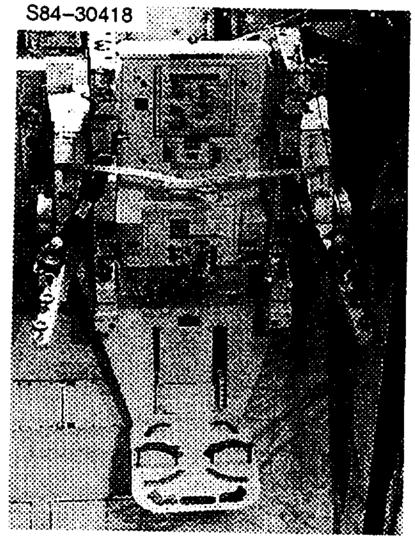
Technical Information	
Part number	10108–10012–02
Weight	0.30 lb
Material/ construction	Mirror – Chrome–plated stainless steel Strap – Stainless steel covered with Teflon
Load rating	
Temperature range	
Quantity flown	One for each prime EMU
Stowage	EMU left glove
Availability	Standard

Dimensional Data		
	inches	cm
A	2.190	5.56
B	3.000	7.62
C	2.310	5.87
D	2.250	5.72
E	0.031	0.08



MMU FLIGHT SUPPORT STATION

S84–30418



OVERVIEW

The manned maneuvering unit (MMU) flight support station (FSS) is a servicing and mounting interface structure between the MMU and orbiter. The FSS provides a stowage port and GN_2 recharge of the MMU. Thermal control of the FSS is provided by extensive use of multilayer insulation (MLI) and by heaters on selected FSS propulsion components. A shock isolation system attenuates the MMU/FSS random vibrations to an acceptable level.

OPERATIONAL COMMENTS

The FSS provides MMU stowage, MMU GN_2 recharge, and power for five MMU heaters when stowed. Crewmember donning and doffing and MMU/FSS restowing are assisted by various devices on the FSS and MMU. By using the FSS handrails, mushroom grips, foot restraints, and donning straps, the EVA crewmember backs into and dons the MMU. The FSS latch release lever is then used to disconnect the MMU from the FSS. Restowing of the MMU is aided by various ramping designs. The rear of the MMU is ramped on the bottom and sides. The FSS handrails converge to guide the astronaut and MMU into the FSS. The FSS seat ramps the MMU to the proper height. A spring–loaded latch on each side of the FSS secures the MMU to the FSS.

The FSS is mounted on the port or starboard side of the orbiter cargo bay **in bay 1** near the airlock. **Potential future upgrades include improved gaseous nitrogen recharge quick disconnects**.

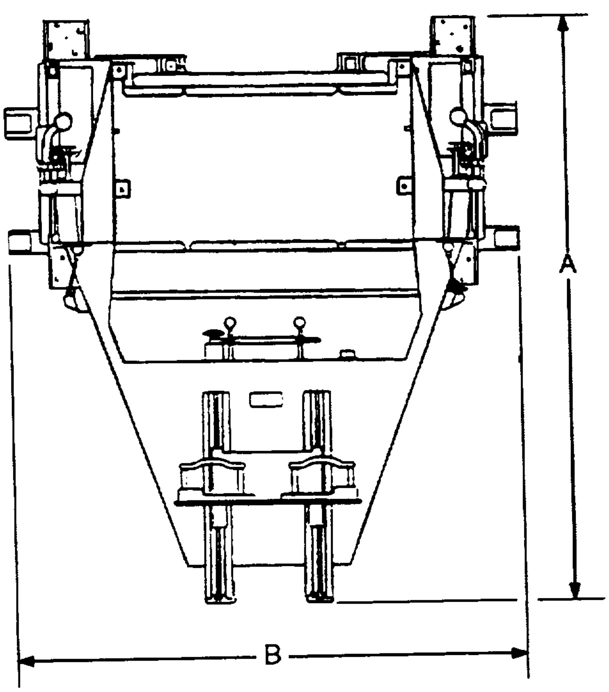
CONTACTS

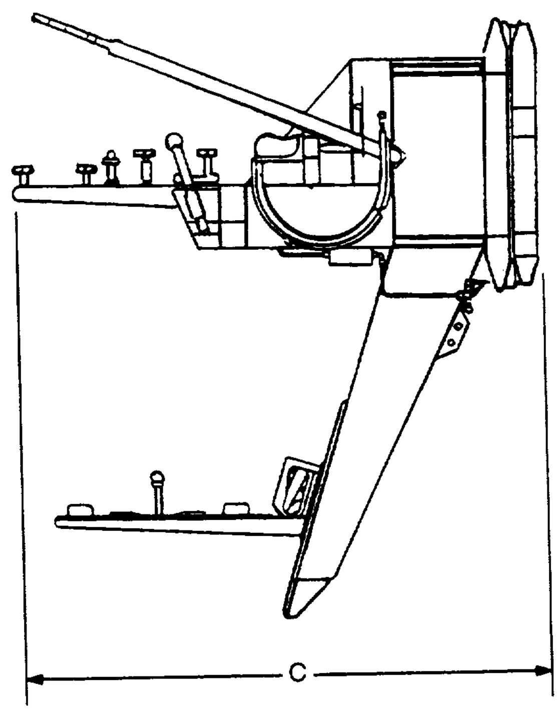
Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: **C. Hess**, NASA/**ER**, (713) 483–**9142**

MMU FLIGHT SUPPORT STATION

Technical Information	
Part number	852MM000000V
Weight	253 lb
Material/ construction	Structure – Aircraft–style aluminum sheet metal Handrails and foot restraint platform – Fiberglass Exterior paint – White Interior surfaces – Low emissivity coating Multilayer insulation – Ten layers of 1/4–mil aluminized (both sides) Mylar with Dacron net separators Heaters on selected propulsion components Shock isolation system – Attenuates FSS/MMU random vibrations
Foot platform	Adjustable over 14–in. range in 1–in. increments
Load rating	
Temperature range	
Quantity flown	**Two on STS 41–B, 41–C, 51–A**
Stowage	On port or starboard side of cargo bay (bay 1)
Availability	Flight specific

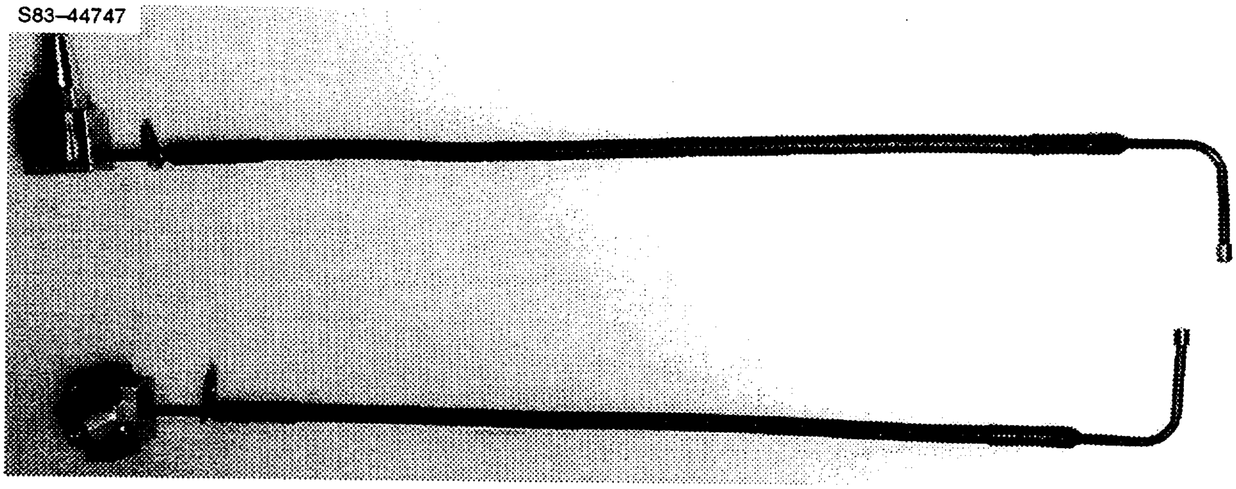
Dimensional Data		
	inches	cm
A	67.0	**170.18**
B	57.0	**144.78**
C	57.9	**147.07**





MMU THRUSTER CUE LIGHT EXTENDER

S83–44747



OVERVIEW

The manned maneuvering unit (MMU) thruster cue light extender is a flexible fiber–optic cable with a metal plug at one end and a light outlet at the other end. These light extenders are used because the original cue lights, which are recessed in holes in the sides of the MMU towers, are not readily visible by the extravehicular activity (EVA) crewmember.

OPERATIONAL COMMENTS

The thruster cue light extenders are plugged in by the EVA crewmember before the MMU is donned. They plug into special sockets on the inside of the MMU towers near the original cue lights. The bendable fiber–optic cable can be positioned by the crewmember to make the lights readily visible when the MMU is donned. **If self–donning the MMU, the cue lights must be installed first. This forces an adjustment to MMU donning techniques since the cue lights protrude into the EMU–MMU donning envelope.**

The MMU has two identical, independent propulsion systems, A and B. The lights are illuminated whenever a thruster of the appropriate system is used, with the light on the crewmember's left representing system A and the one on the right representing system B.

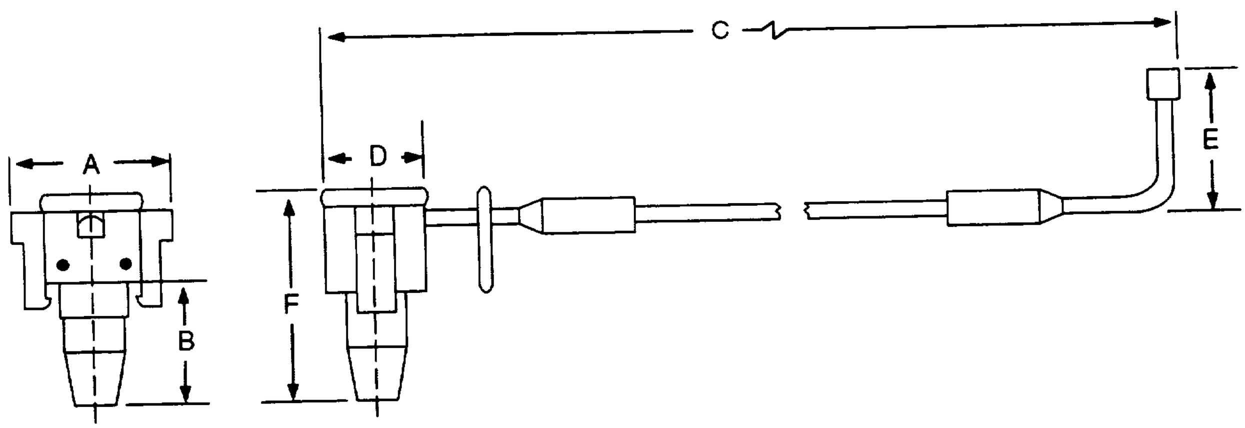
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: **C. Hess**, NASA/**ER**, (713) 483–**9142**

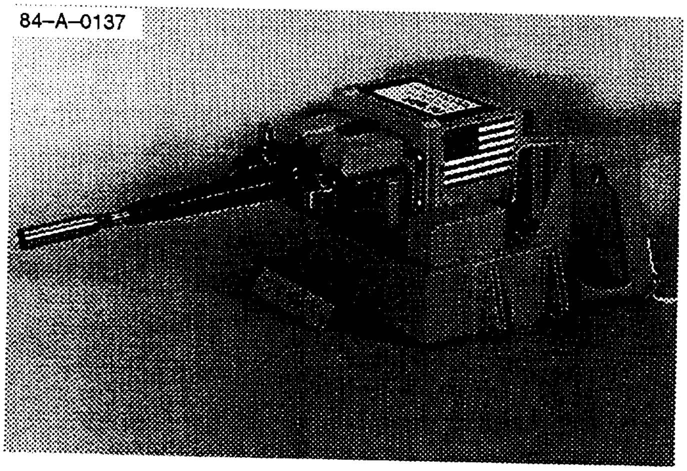
MMU THRUSTER CUE LIGHT EXTENDER

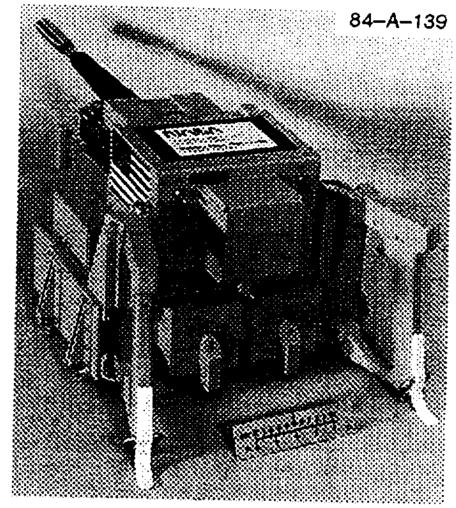
Technical Information	
Part number	10159–10017–01
Weight	0.5 lb each
Material/ construction	Extenders – Fiber–optic cables covered with stiff but bendable material Plug end – Metal Outlet end – Metal cover
Load rating	
Temperature range	
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.594	4.05
B	1.211	3.08
C	18.500	46.99
D	1.109	2.82
E	2.000	5.08
F	2.156	5.48



MODULE SERVICING TOOL





OVERVIEW

The module servicing tool (MST) is a self–contained power tool for use in installing and removing standard multimission modular spacecraft (MMS) subsystem modules to simplify on–orbit maintenance and repair operations and to reduce the time required for the performance of extravehicular activities. The MST is battery–powered and manually operated and therefore does not have any orbiter power or signal interfaces.

OPERATIONAL COMMENTS

The MST is an extravehicular mobility unit (EMU) battery–powered extravehicular activity (EVA) tool that is designed to loosen and tighten the MMS module retention hardware to predetermined torques of up to 160 foot–pounds. A latch system secures the MST to the module and internally reacts against torques when retention hardware is driven. All operations of the MST are controlled by manual controls at the MST rear panel and trigger switches located at the right and left grip assemblies. There is a torque limit select switch that selects the desired torque for both bolt tightening and bolt loosening. Also, the MST has a bolt drive counter which provides the operator visual indication of bolt drive rotation direction and of bolt tightening completion. A separate control circuit provides power to two resistance heaters that thermostatically maintain the minimum battery temperature. Separate external heaters are required to maintain MST battery temperatures prior to EVA use. Two of these power tools were flown on STS 41–C and successfully replaced the attitude control system (ACS) module of the Solar Maximum Satellite.

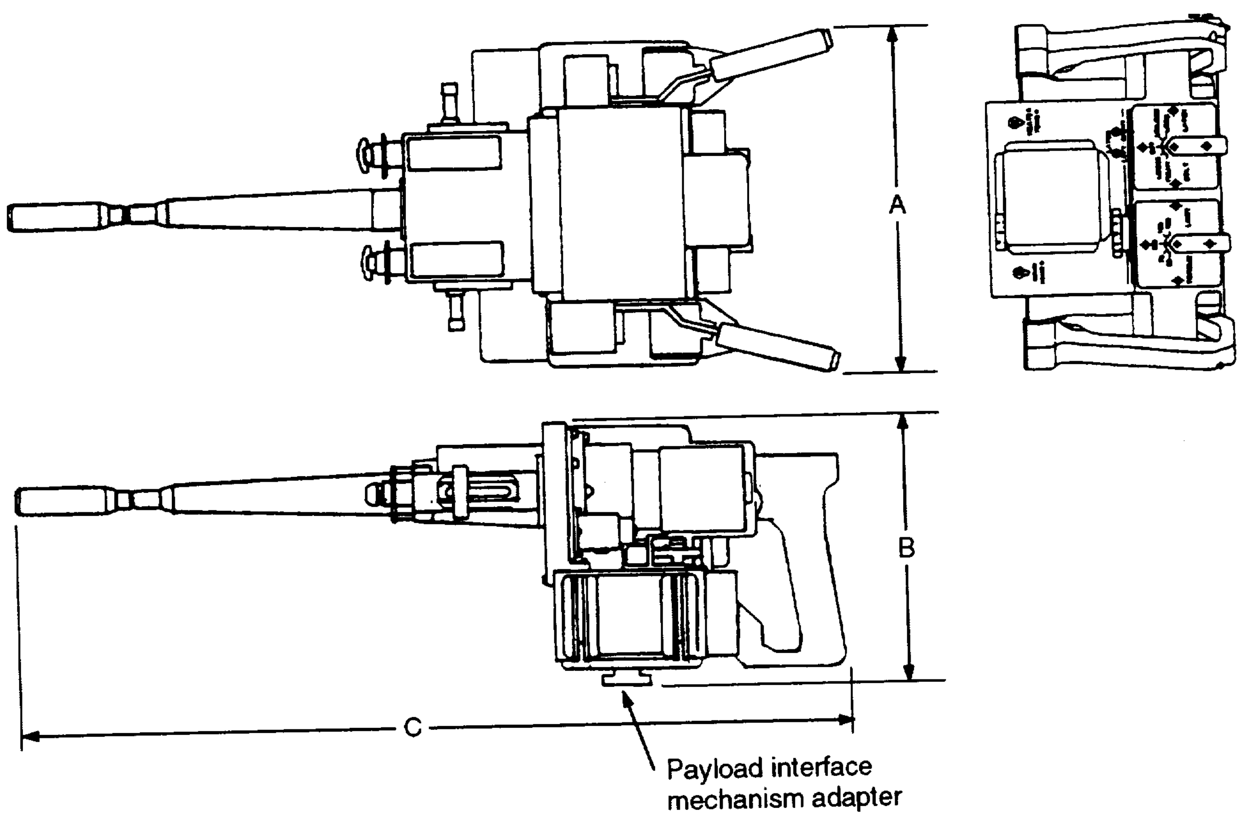
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: K. Olson, NASA/GSFC/442, (205) 772–7660

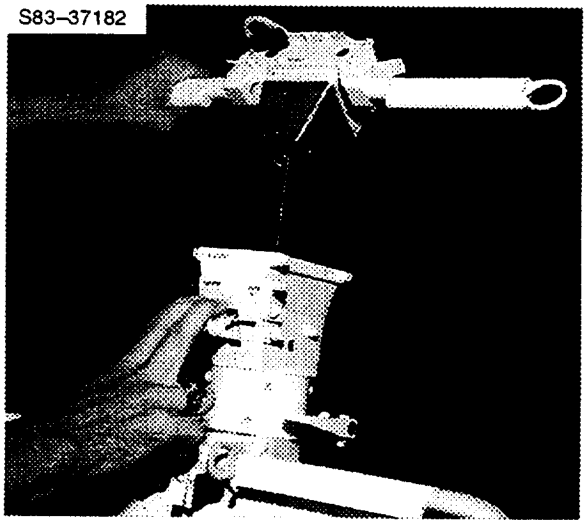
MODULE SERVICING TOOL

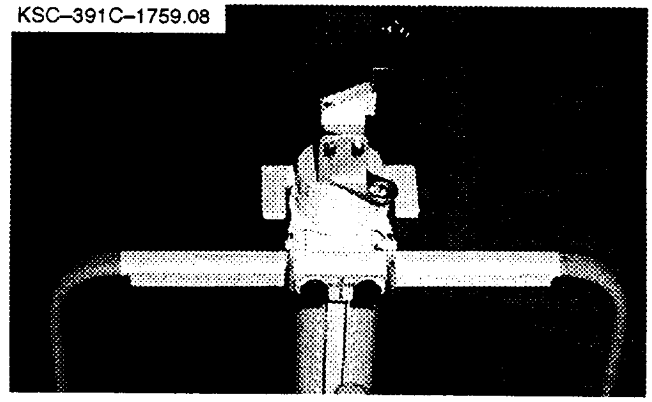
Technical Information	
Part number	GSFC 93972000002
Weight	70.5 lb
Material/ construction	Housing – Not available Surface – Chemglaze blue
Load rating	Settings for 25, 75, 100, 125, and 160 ft–lb
Temperature range	–10° to 104° F
Power requirements	16.5 V EMU battery
Socket depth	
Quantity flown	**Two on STS 41–C**
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	14.75	37.47
B	14.32	36.37
C	35.20	89.41



PAYLOAD INTERFACE MECHANISM


S83-37182


KSC-391C-1759.08

OVERVIEW

The payload interface mechanism (PIM) mounts on top of the manipulator foot restraint (MFR) stanchion. It is a tethering device for attaching a payload to the MFR and consists of three main parts: a payload fitting, a pyramid fitting, and a pyramid housing. The pyramid fitting and the pyramid housing are connected by a retractable 6-ft-long tether. Tether attachment rings are provided on the ends of the pyramid fitting handles and on the payload fitting.

OPERATIONAL COMMENTS

The PIM was designed for temporary stowage and transfer of the module servicing tool (MST). The pyramid fitting attaches to the payload fitting mounted on the MST. Then the pyramid fitting and the MST are pulled over to the MFR and latched onto the pyramid housing. The MST is released from the PIM by turning the lock-unlock lever on the pyramid fitting and depressing the release levers on the payload fitting handles. The pyramid fitting is released from the pyramid housing by pushing the lock-unlock bar on the pyramid housing to the unlock position and depressing the housing latch handle. **A bayonet receptacle option now exists for the transport of an extravehicular activity camera in place of the PIM.**

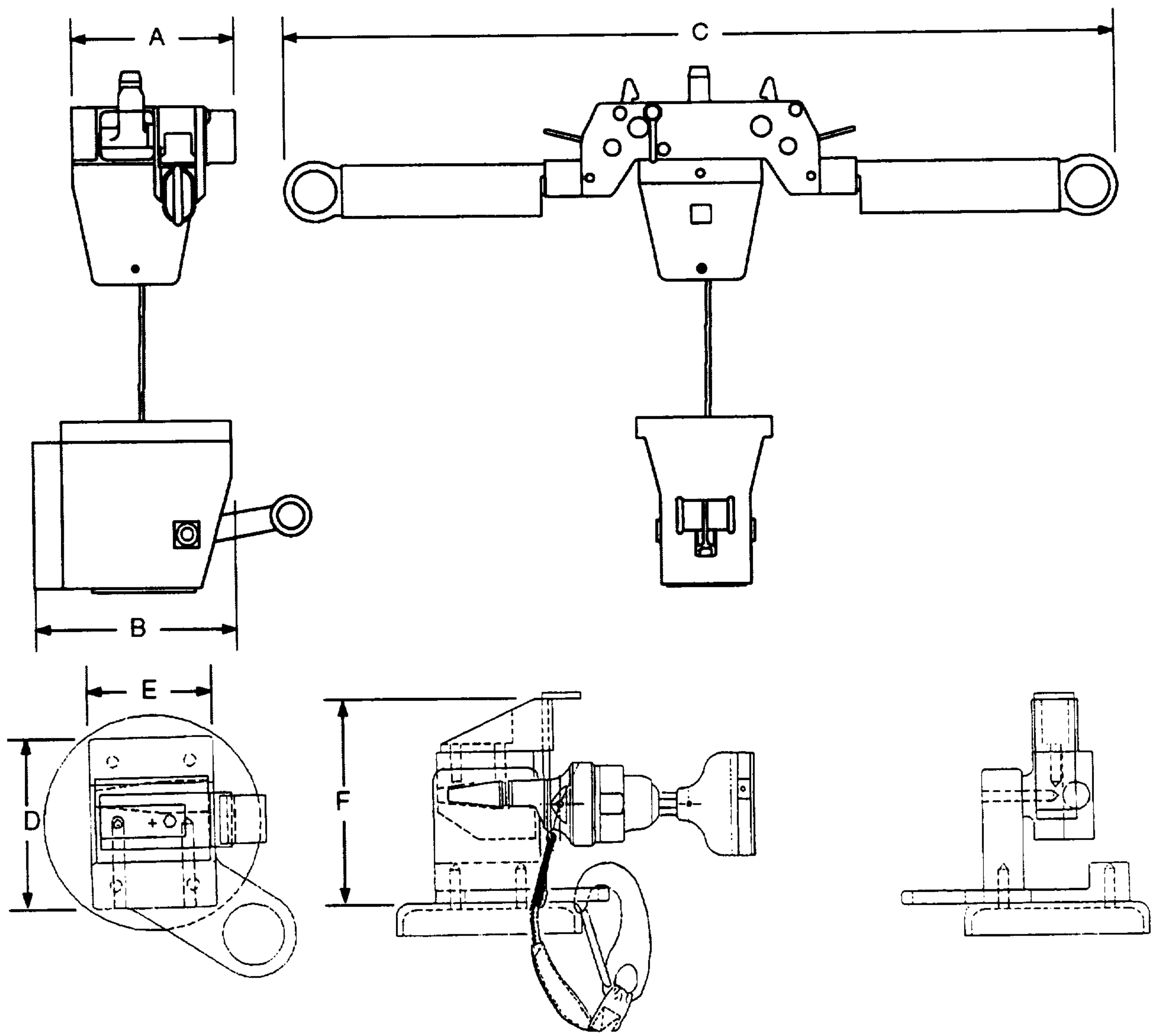
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: N. Gonzalez, NASA/ES6, (713) 483-8944

PAYLOAD INTERFACE MECHANISM

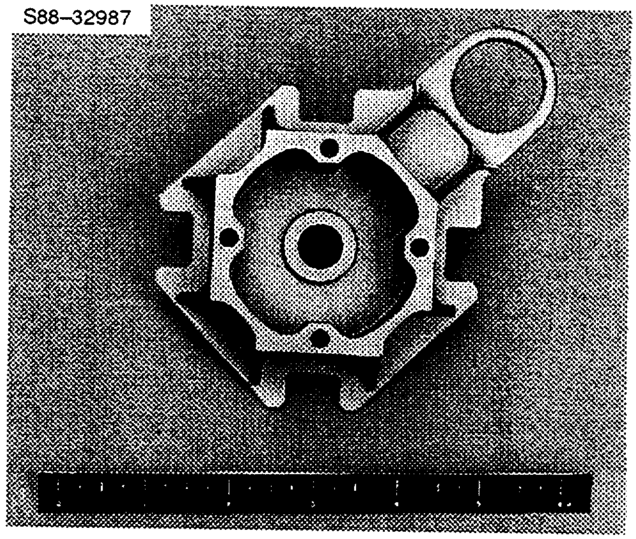
Technical Information	
Part number	C95–105 (PIM) SDD33104036–001 (camera mount)
Weight	5.5 lb (PIM)
Material/ construction	Aluminum, Kevlar cord
Load rating	500 lb (PIM mass liimit)
Temperature range	–260 to +230° F
Quantity flown	One
Stowage	Attached to MFR
Availability	Flight specific

Dimensional Data		
	inches	cm
A	4.06	10.31
B	5.56	14.12
C	20.88	53.02
D	2.75	6.99
E	2.00	5.08
F	3.88	9.84



PAYLOAD INTERFACE MECHANISM ADAPTER

S88–32987



OVERVIEW

The payload interface mechanism (PIM) adapter is the passive half of a latching system that is used to secure items to the manipulator foot restraint (MFR). The active half of the latching system is a part of the MFR. The PIM adapter incorporates four rotational orientations of latching positions; two diagonally opposite points are used at a time. This item can be attached to any instrument by using four no. 10 flathead mounting screws.

OPERATIONAL COMMENTS

The PIM adapter is used by aligning the MFR PIM with the adapter and then pushing the two halves towards each other. This will latch the two locking pawls of the PIM to the adapter. The connection provided results in a stable, positive tethering system.

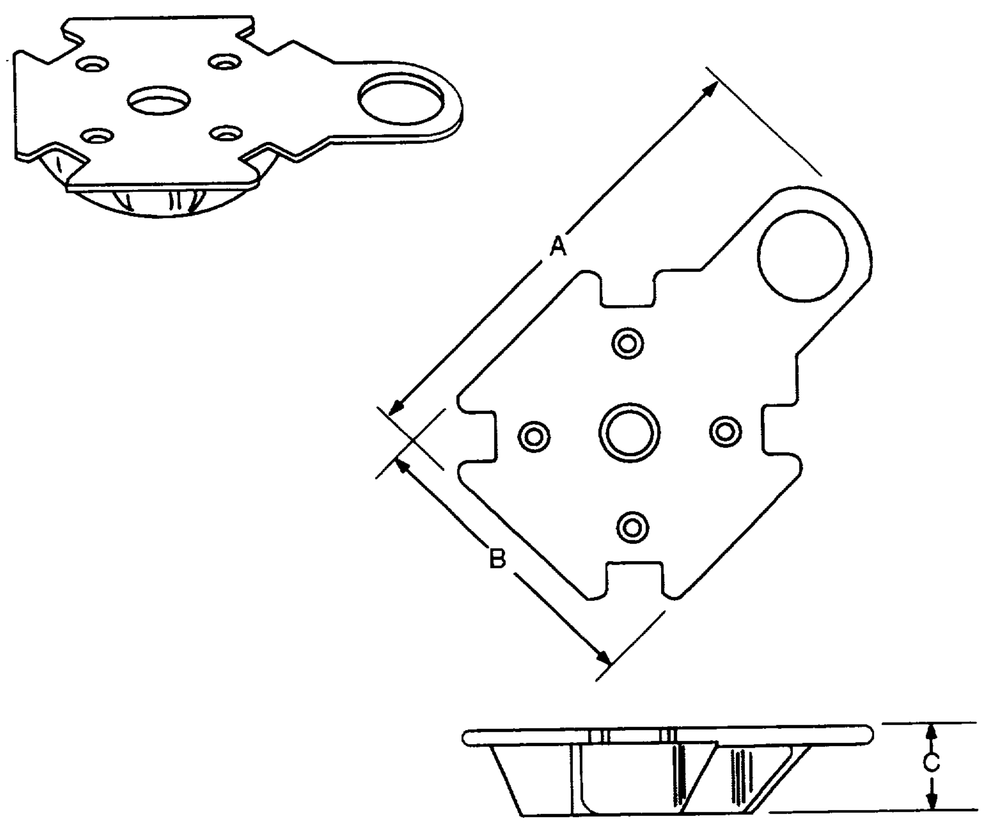
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

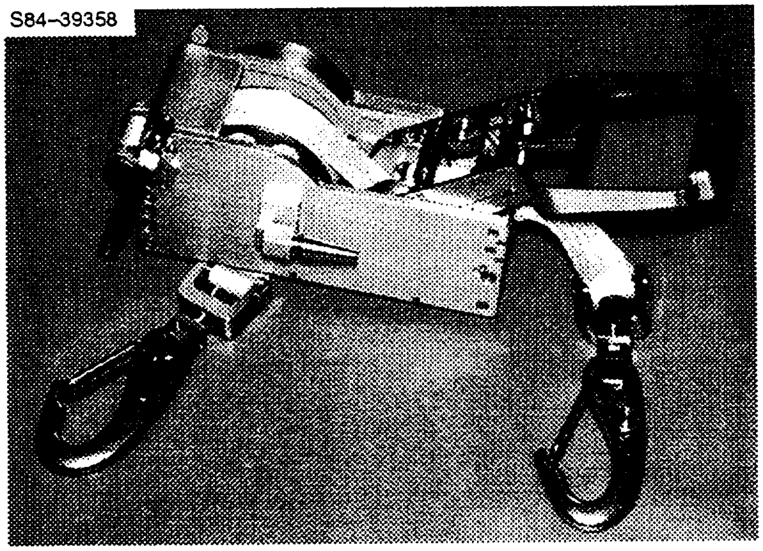
PAYLOAD INTERFACE MECHANISM ADAPTER

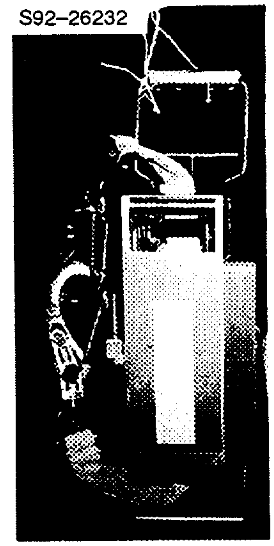
Technical Information	
Part number	10181–10049–01
Weight	0.32 lb
Material/ construction	Aluminum
Load rating	
Temperature range	–150° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	5.55	14.10
B	3.60	9.14
C	1.00	2.54



PAYLOAD RETENTION DEVICE


S84-39358


S92-26232

OVERVIEW

The payload retention device (PRD) is used as a contingency restraint or come–along device for on–orbit use. It consists of a Kevlar webbing strap with french hooks on the ends and a stainless steel and aluminum ratchet mechanism for tightening. The PRD also has a **bayonet fitting** for attachment to a mini–workstation.

OPERATIONAL COMMENTS

The PRD can be attached with french hooks to tether points in the cargo bay or on the equipment to be secured or to another PRD. After both ends of the PRD are hooked in place, the crewmember pulls the handle to operate the ratchet, tightening the strap until the equipment is secure. The ratchet mechanism reels in the strap slowly enough so that the article being secured can be repositioned as necessary to prevent damage. The PRD does not allow controlled release of tension.

The preload capability of the PRD limits its tiedown capability to objects of 500 lb or less. **Except for remote manipulator system tiedown for landing,** the PRD is certified only for on–orbit restraint applications. Webbing tension tends to relax with vibration loading. The strap must be wrapped 2.5 times around the takeup reel for tension assurance.

The PRD can be attached to waist or wrist tethers or to the mini–workstation for transport during EVA. **A patch of Velcro on the bottom of the PRD housing engages the fixed strap/hook for on–orbit restraint**. Two PRD's are nominally stowed in the port provisions stowage assembly (PSA) for launch and entry. **A special stiffened extension strap was used on STS–49 to connect the PRD in a tight access area so that the Intelsat spacecraft could be temporarily restrained on orbit.**

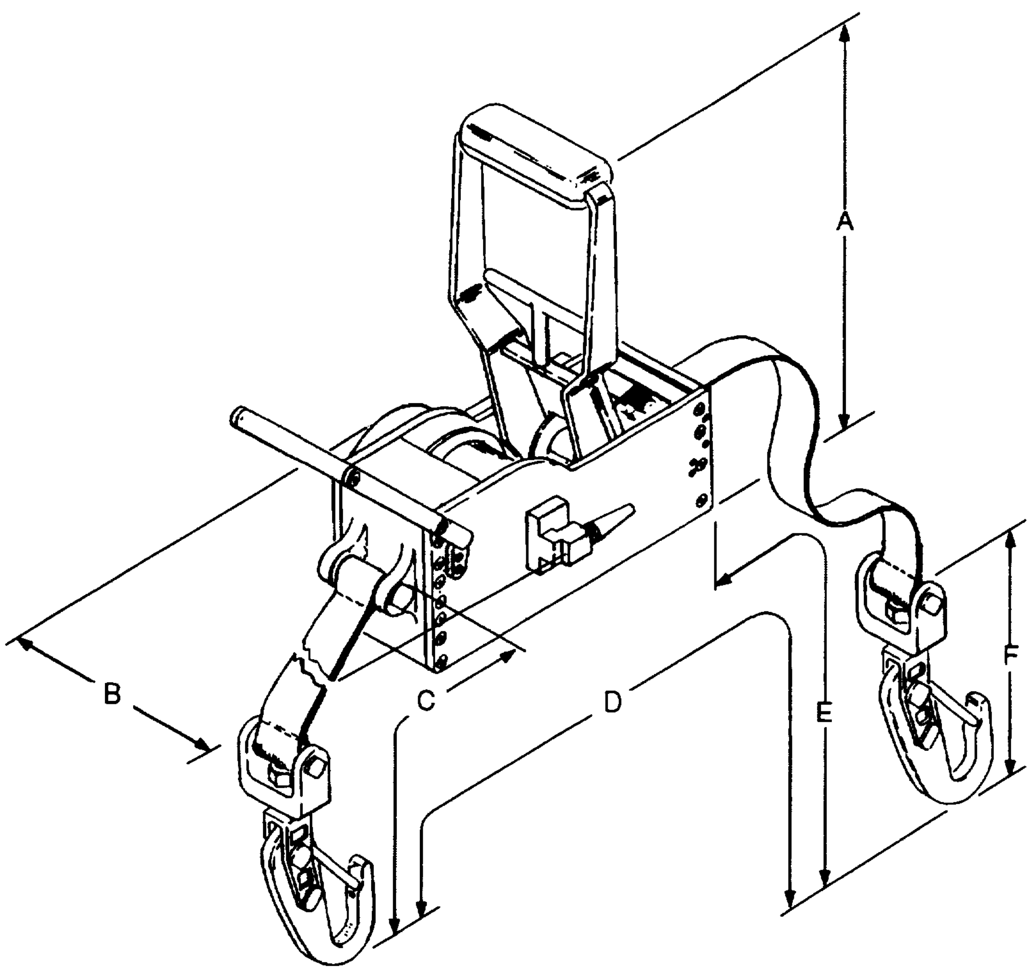
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

PAYLOAD RETENTION DEVICE

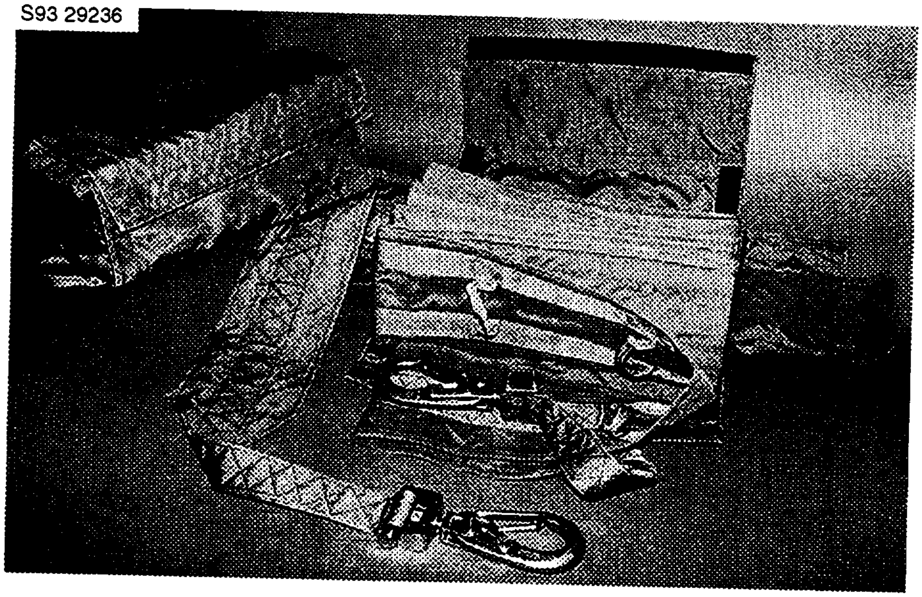
Technical Information	
Part number	10163-10063-03 **(PRD)** **10163-20057-01 (PRD hooks)** **SED39122736-301 (STS-49 extension strap/hook)**
Weight	8.0 lb
Material/ construction	Aluminum, stainless steel, Kevlar (strap), Teflon (bearings)
Load rating	2000 lb **(Maximum operating tensile load)** 350 lb **(Nominal crew inducible strap tension)** **600 lb (maximum crew inducible strap tension)**
Temperature range	–200° to 250° F (operational)
Quantity flown	Two
Stowage	Port PSA
Availability	Standard

Dimensional Data		
	inches	cm
A	9.75	24.77
B	4.63	11.76
C	11.33	28.78
D	15.83 ft	4.75 m
E	13.98 ft	4.19 m
F	6.00	15.21



PAYLOAD RETENTION STRAP

S93 29236



OVERVIEW

The payload retention strap, also known as the tiedown strap, provides the crewmember with a means to restrain payloads during payload jettison operations. The assembly consists of a 27–ft long Kevlar strap stiffened with Armalon. It has 4–in. long french hooks on each end. The strap assembly is housed in an Orthofabric bag for stowage and EVA handling.

OPERATIONAL COMMENTS

To secure the payload, each end of the strap is intended to be attached to a strong structure on the payload carrier, with the middle passing over the payload itself. On each end, the strap is looped around the structure and the hooks are attached back onto one of the webbing loops. A payload retention device is attached to two of the various loops sewn into the strap and is tightened to secure the strap around the payload.

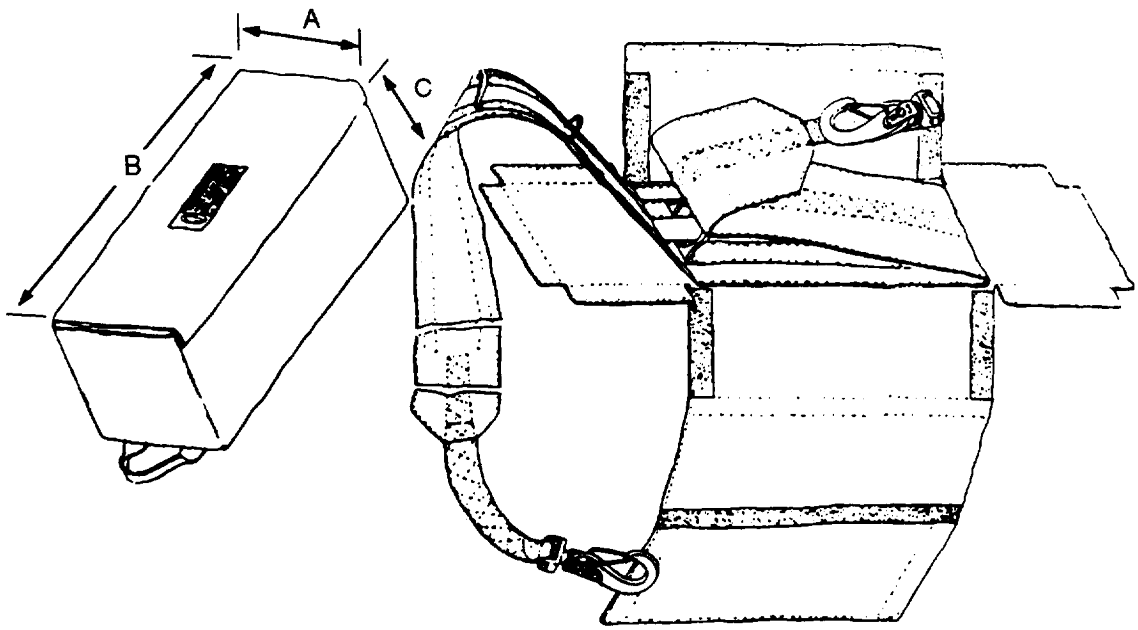
CONTACTS

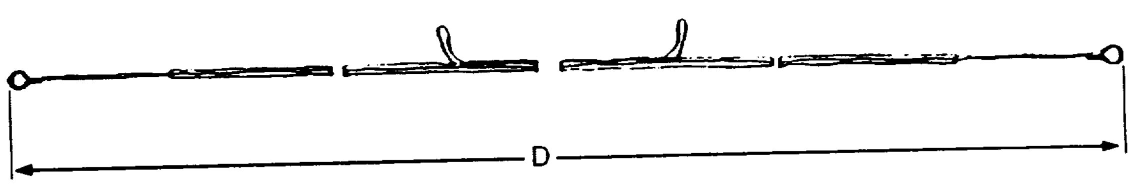
Operational: J. Thornton, JSC DF42, (713) 483–2572
Technical: R. Marak, NASA/EC5, (713) 483–9144

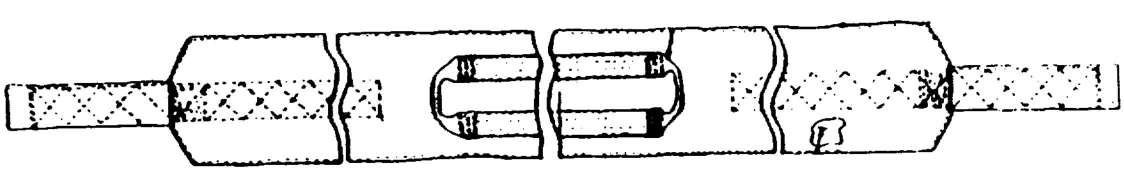
PAYLOAD RETENTION STRAP

Technical Information	
Part number	10159–20413–01
Weight	5.4 lb
Material/ construction	Kevlar strap with Armalon stiffener Orthofabric bag
Load rating	3600 lb 8056 lb (ultimate)
Temperature range	
Quantity flown	Two
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	5.0	12.7
B	14.0	35.56
C	5.0	12.7
D	324.0	822.92

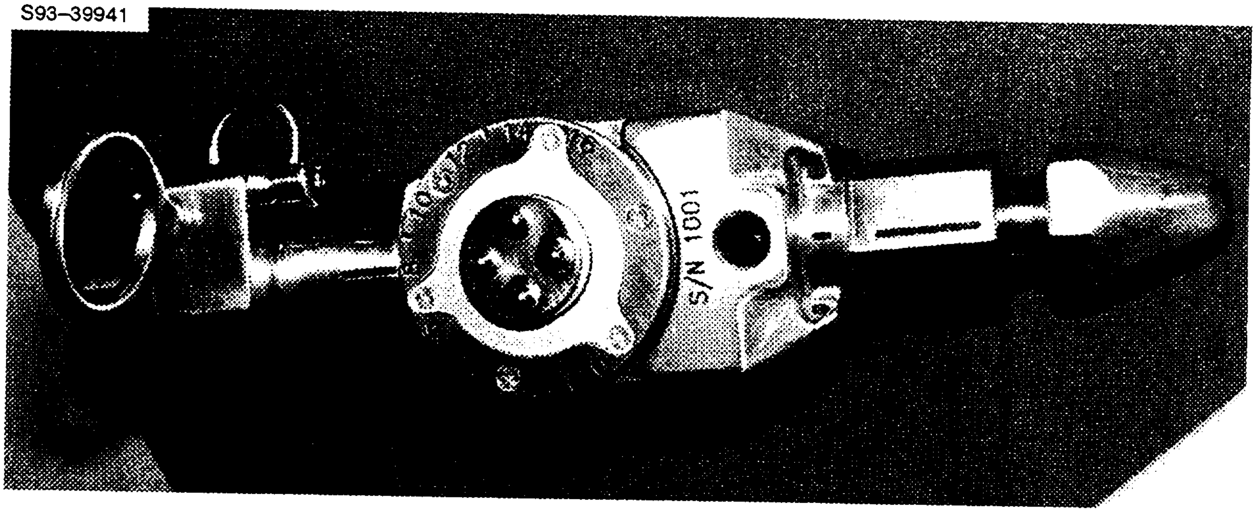






PFR ARTICULATING SOCKET, PUSHBUTTON

S93–39941



OVERVIEW

The pushbutton articulating socket is a device that interfaces with any portable foot restraint (PFR) or PFR socket. It provides extra length, height, and angle adjustment articulation for any attached foot restraint. One end has a standard socket and the other end has a hex probe. The joint in the middle can be rotated to provide various foot restraint orientations and can be actuated with one hand. The hex–shaped probe interfaces with a PFR 12–point socket, where yaw adjustment is available. In one design, the pushbutton gimbal has a set of balls that roll in slots when opposing plunger buttons are depressed and lock into detents when the buttons are released. A second design uses locking splines.

Previous versions of this articulating socket featured a lockable knob that required intensive effort to reposition and was not orginally intended for frequent worksite reconfiguration. This new design will help to minimize the overhead and fatigue associated with foot restraint reconfiguration.

OPERATIONAL COMMENTS

These gimbal systems are identical to those used on the pushbutton PFRs. Besides minimizing setup and adjustment times, the new gimbals increase the operational workload limits. By depressing both spring–loaded plungers in each gimbal joint, the crewmember can set the articulating socket at the position desired for extravehicular activity. A captive 1/4 turn pin locks any mechanism with a hex probe into the socket end. This pin replaces the standard pip pin to ease crew workload. This pin replaces the standard pip pin to ease crew workload. Engraved markings on the gimbals key crewmembers to the various joint adjustment positions.

The hex probe of this device has also been modified to make socket installation easier. Its end is very tapered with minimal hex surface to assist with initial linear socket alignment and insertion. Socket alignment marks on this new probe have also been improved. One side of the probe has a single line on the probe and hex faces to match the clock marks on the socket. The opposite side has a pair of parallel lines that can be used for a bidirectional approach to socket installation.

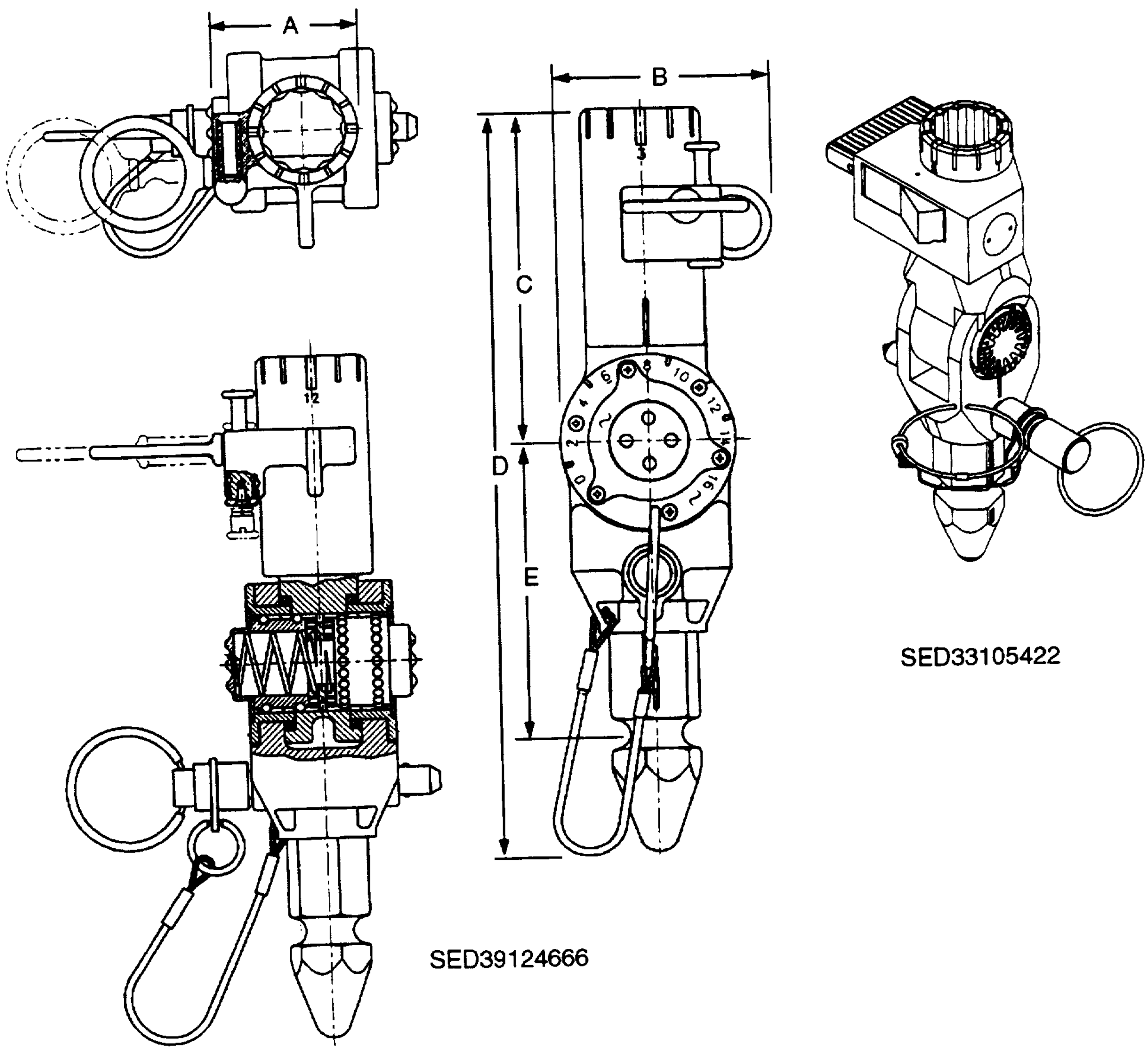
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: R. Marak, NASA/EC5, (713) 483–9144

PFR ARTICULATING SOCKET, PUSHBUTTON

Technical Information	
Part number	SED39124666–302 (ball detent jts) SED33105422–301 (spline jts)
Weight	6.0 lb
Material/ construction	Aluminum alloy and steel
Load rating	TBD
Temperature range	TBD
Quantity flown	One on STS–51 (SED39124666) One each on STS–61
Stowage	TBD
Articulation	± 105°, 15° increments
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.97	5.00
B	2.72	6.91
C	4.20	10.69
D	9.35	23.75
E	3.665	9.309

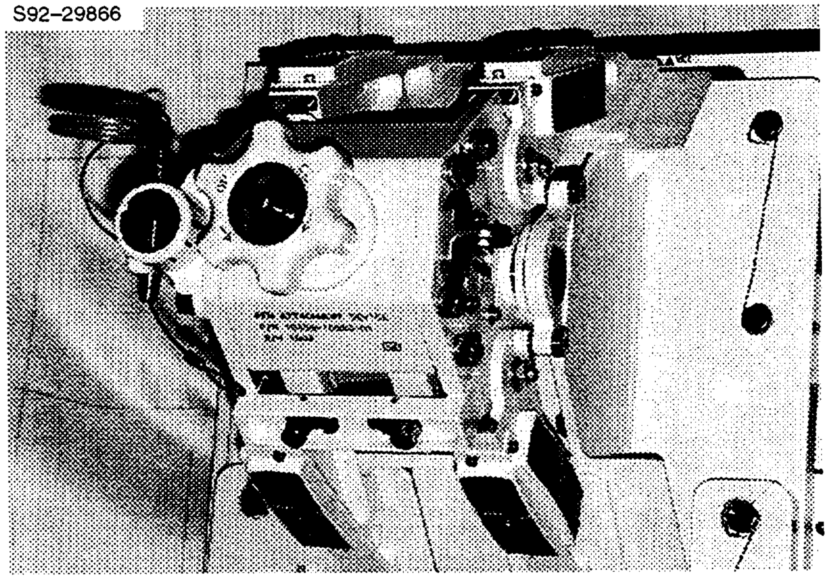


SED39124666

SED33105422

PFR ATTACHMENT DEVICE, RMS

S92–29866



OVERVIEW

The portable foot restraint (PFR) attachment device is an adapter which allows a PFR to be attached to a striker bar of the remote manipulator system (RMS) manipulator retention latches. The striker bar nearest the RMS end effector provides a PFR configuration much like an manipulator foot restraint (MFR) while leaving the RMS free to grapple payloads. The device is manually attached to the striker bar by the crewmember after the RMS has been deployed. The PFR is attached to the device via a built–in PFR socket. The design allows the device's outrigger feet to be folded for minimum stowage envelope in a tool box or cabin locker.

OPERATIONAL COMMENTS

After the PFR attachment device is unstowed, its outrigger feet are unfolded. The device is unlocked by rotating the knob counterclockwise approximately 45°, and soft–dock is selected by further rotation of the knob. The device is soft docked onto the striker bar and secured by rotating the knob clockwise. The knob's locking feature is actuated to prevent inadvertent backout. The probe of the PFR is then secured into the built–in PFR socket.

Removal of the PFR attachment device is required to allow stowage of the RMS. The knob is unlocked and rotated to the open position to allow removal of the device. An overtorqued or jammed knob can be overidden by high torque applied with a ratchet to the knob's 7/16–in. hex stud. A contingency release bar can be unbolted if the latch or knob jams, preventing nominal release. When used with a PFR and PFR workstation stanchion, the PAD provides MFR functionality with minimal weight and storage impact (except for foot restraint and stanchion articulation). Eight reflectors have been added to the PAD as an RMS operator visual aid (blue fore and aft, red on sides).

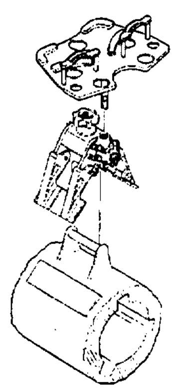
CONTACTS

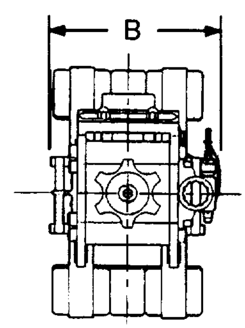
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

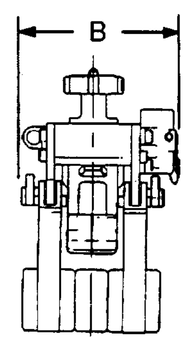
PFR ATTACHMENT DEVICE, RMS

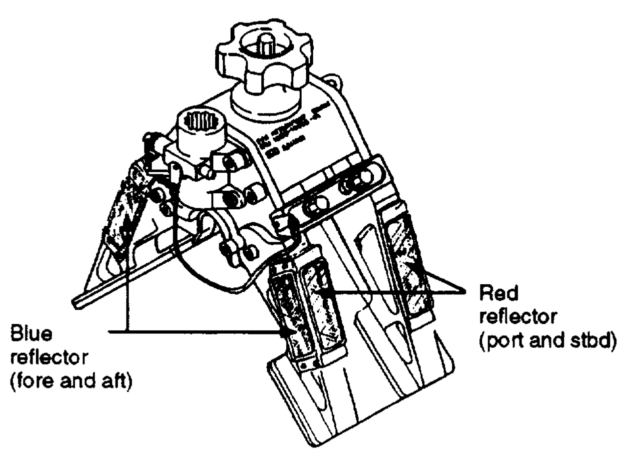
Technical Information	
Part number	10159–10053–01
Weight	10.5 lb (est)
Material/ construction	Aluminum alloy Teflon shrink tube Vespel Loctite Epoxy Chemglaze paint
Load rating	5 ft–lb contingency bolts 30 ± 5 in–lb knob 100 lbf, 1800 in–lb at 88 inches above PFR socket
Temperature range	–150° to +180° F (operational)
Quantity flown	One on STS–49, 46, 57, 61
Stowage	In cabin locker, PSA, or PLB sidewall carrier
Availability	Flight specific

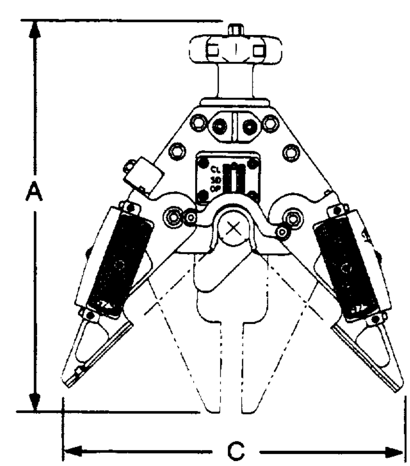
Dimensional Data		
	inches	cm
A	12.87 stowed 11.94 max. open	32.69 30.33
B	7.35	18.67
C	7.50 stowed 11.37 max. open	19.05 28.88





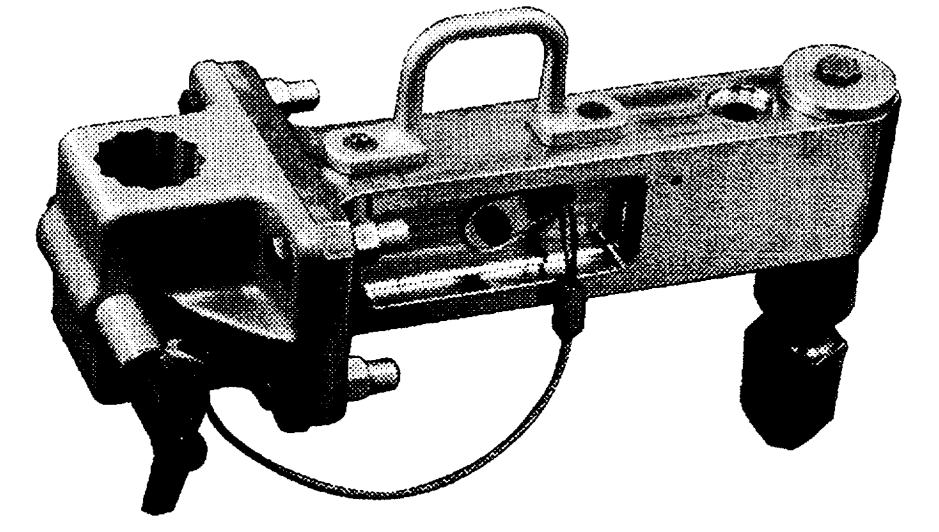






PFR EXTENDER

L88–08–04 P13 400



OVERVIEW

The Hubble Space Telescope (HST) portable foot restraint (PFR) extender has a 12–point socket on one end and a hex **probe** on the other. There is a tether loop on the extender and a pip pin for securing the extender in the PFR socket. The PFR extender was originally designed to use on HST PFR foot restraint receptacles 10 and 18 to avoid contact with the magnetic torquer assembly. However, this extender is applicable for all PFR sockets.

OPERATIONAL COMMENTS

The PFR extender interfaces with the PFR socket at the hex **probe** end and the PFR **probe** at the socket end. The PFR extender **probe** can be placed in a PFR socket in any position; however, some positions are limited for a few PFR sockets. A tethered pip pin locks the PFR hex probe into the 12–point socket.

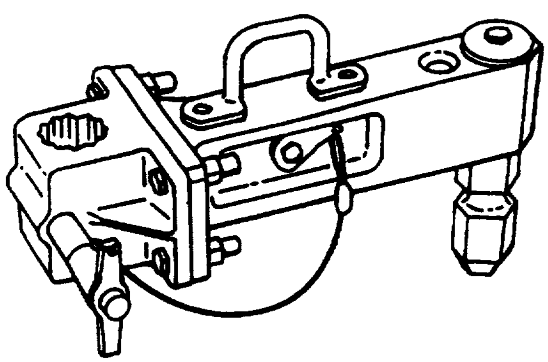
CONTACTS

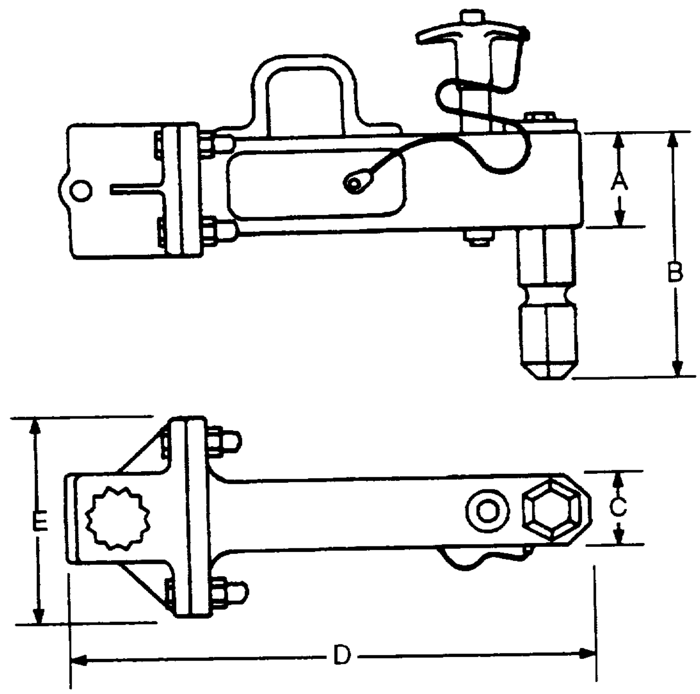
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. L. Sheffield, LMSC/Dept. G4–10, (408) 742–8464

PFR EXTENDER

Technical Information	
Part number	4177502
Weight	3.0 lb
Material/ construction	Aluminum/stainless steel
Load rating	
Temperature range	–250° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

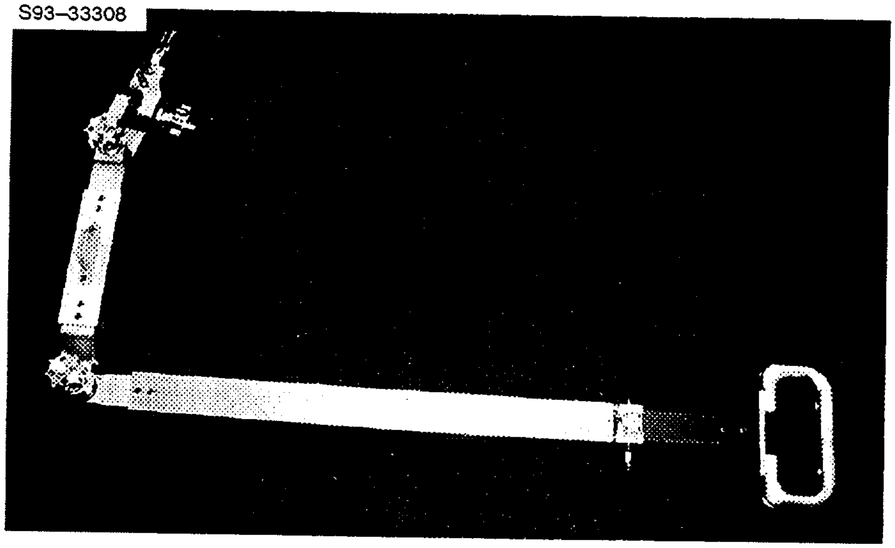
Dimensional Data		
	inches	cm
A	2.000	5.08
B	5.375	13.65
C	2.000	5.08
D	9.390	23.85
E	3.620	9.19





PFR INGRESS AID

S93–33308



OVERVIEW

The portable foot restraint (PFR) ingress aid serves multiple uses and was developed to support maintenance of the Hubble Space Telescope (HST). As a foot restraint ingress aid, it provides a small handhold with position adjustment via three articulating joints and a telescoping boom. The same handhold is also useful as a reach aid for extravehicular activity translations between the orbiter and the HST during servicing. Using this pole as a short cut to reach worksites avoids long translations over sensitive structures.

OPERATIONAL COMMENTS

The joints of the ingress aid are designed to articulate relative to an STS foot restraint after attachment to a PFR socket under its foot plate. Repositioning of the joints and probe allows the boom and handhold to be placed in multiple yaw, pitch, and roll attitudes relative to the crewmember in the foot restraint. There are seven length positions for the telescoping boom which are fixed by a 3/8–in.–diameter pip pin. The hex probe can be installed in any standard PFR socket so the unit can be used as a translation aid. Should the locking knobs of the articulating joints require extra force to release, 7/16–in. hex studs on the knobs can be driven with a tool. A tether loop is provided for limited transport.

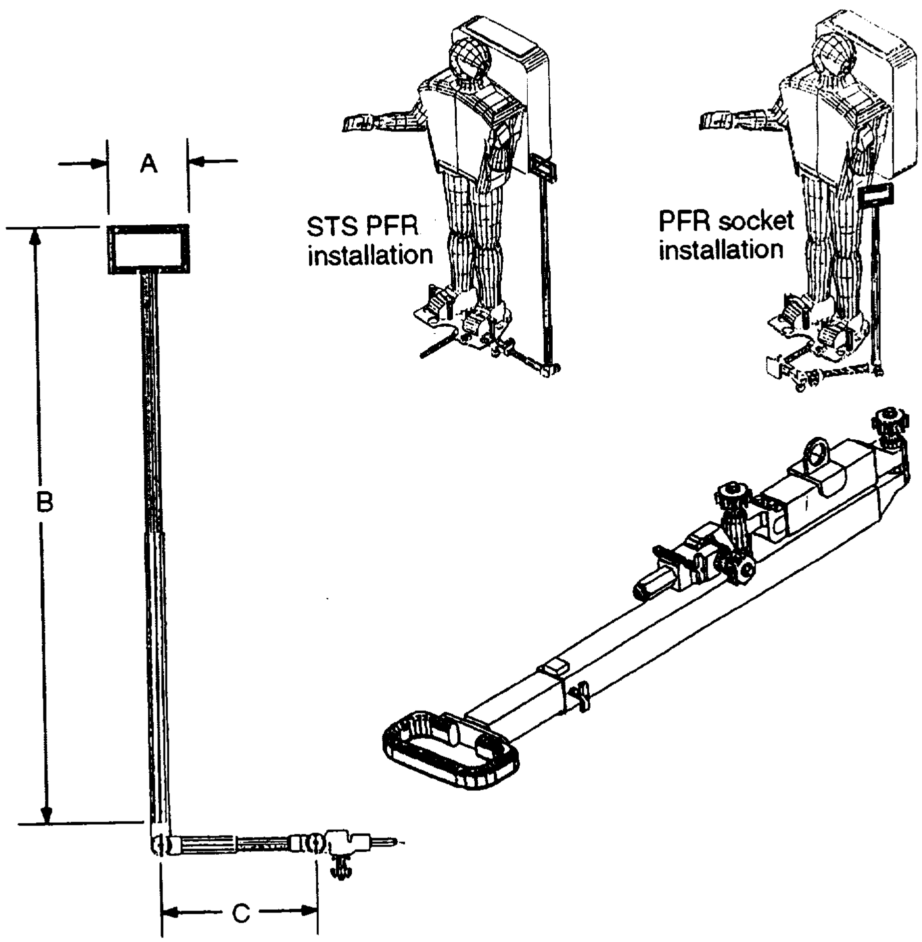
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: **R. Werneth, NASA/GSFC, (301) 286–4338**

PFR INGRESS AID

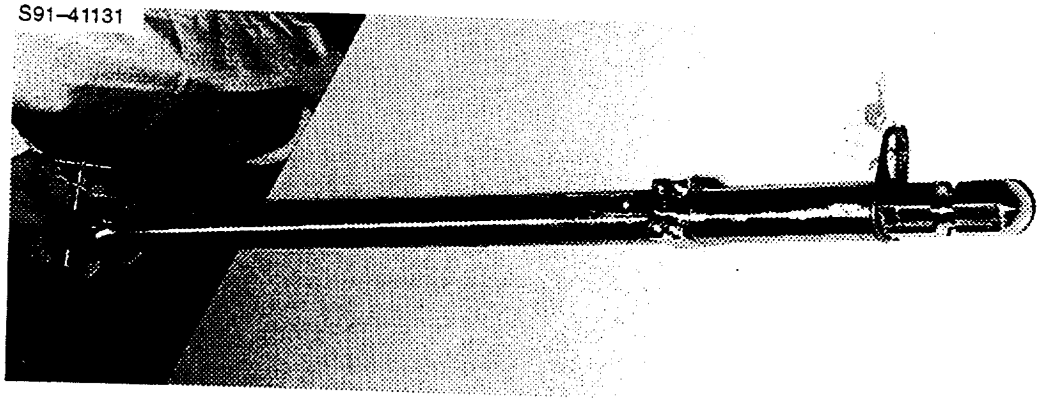
Technical Information	
Part number	GE1525375
Weight	13.5 lb
Material/ construction	Aluminum
Load rating	**20 lb (fully extended)** **50 lb (partially extended)**
Temperature range	
Quantity flown	Two (STS–61)
Stowage	Payload bay
Availability	Flight specific

Dimensional Data		
	inches	cm
A	5.81	14.76
B	38.0 to 56.0	96.52 to 142.24
C	15.0	38.1



PFR PROBE EXTENSION

S91-41131



OVERVIEW

The portable foot restraint (PFR) probe extension, also known as the extension bar, serves as a connecting linkage between the bridge fitting PFR socket and the PFR. The probe extension was specifically designed to support contingencies related to the upper atmosphere research satellite (UARS). It gives the extravehicular activity (EVA) crewmember extra height above the payload bay for solar array repair. This extension is approximately 30–in. long and is constructed of titanium. It is stowed in the UARS EVA tool box when not in use.

OPERATIONAL COMMENTS

The probe extension mates with the bridge fitting PFR socket through a standard hex–head probe and is locked in place by a pip pin provided by the bridge clamp socket. A PFR socket and pip pin on the upper end of the extension secure the foot restraint. Since the mate/demate tolerances of any foot restraint probe/socket interface allow a small amount of wobble, the addition of this extension results in a more pronounced instability in the foot restraint. It has a rotating tether point and bayonet fitting to facilitate transport and handling. Alignment marks are provided on the socket end for foot restraint yaw clocking and on the probe end for fixed socket orientation.

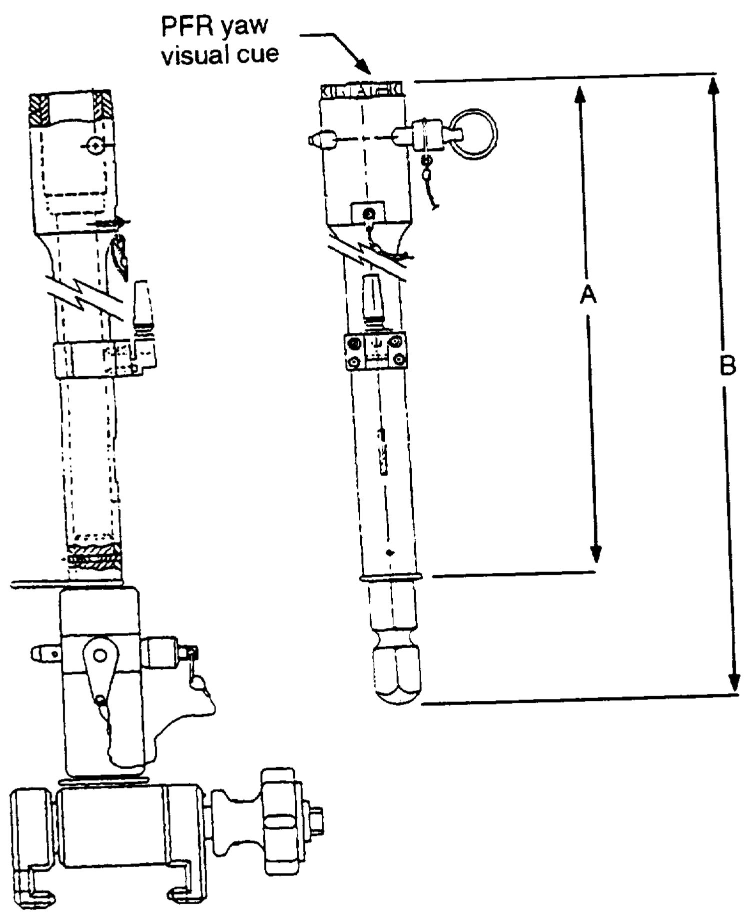
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: R. Rashford, GSFC, (301) 286–7183

PFR PROBE EXTENSION

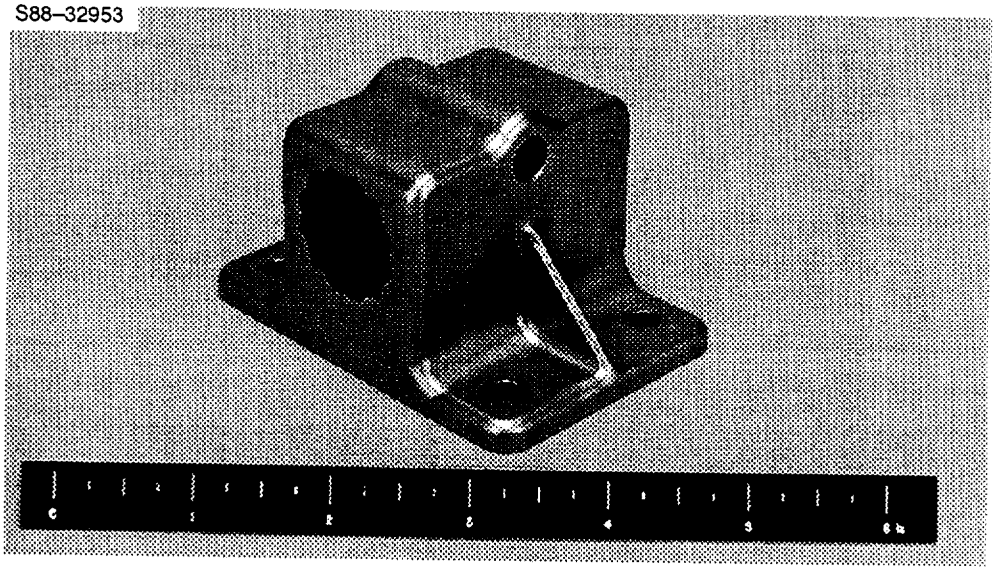
Technical Information	
Part number	47-284552-G1
Weight	
Material/ construction	Titanium
Load rating	
Temperature range	
Quantity flown	One for STS-48
Stowage	UARS EVA tool box
Availability	Flight specific

Dimensional Data		
	inches	cm
A	28.72	72.95
B	31.61	80.29



PFR SOCKET (HST)

S88–32953



OVERVIEW

The Hubble Space Telescope (HST) portable foot restraint (PFR) socket is a dual ended 12–point socket that mates with the HST PFR hex probe. It provides a stable foot restraint for an extravehicular activity crewmember performing HST maintenance or repair. The PFR socket receptacles are located at various work stations along the shell of the HST.

OPERATIONAL COMMENTS

The PFR socket is equipped with a pip pin hole. When the HST PFR is inserted into the socket, a pip pin attached to the PFR is inserted to prevent the PFR from coming out of the socket. **To provide adequate socket–probe mate/ demate mechanical tolerance an attached PFR tends to wobble slightly**. The PFR socket structure has four mounting holes 0.287 inch in diameter for mounting. Because of the large number of PFR sockets on the HST, each socket does not have an attached pip pin but relies on a pip pin from the PFR. This item is also known as the foot restraint receptacle (FRR) in HST terminology.

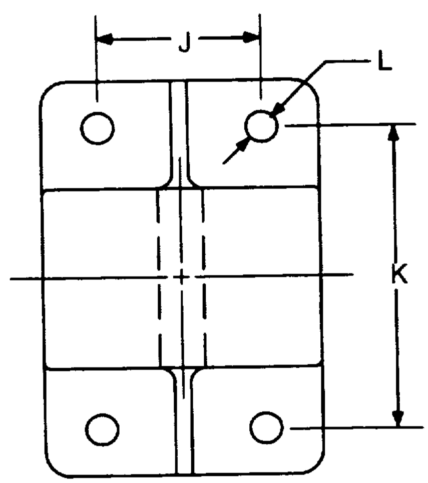
CONTACTS

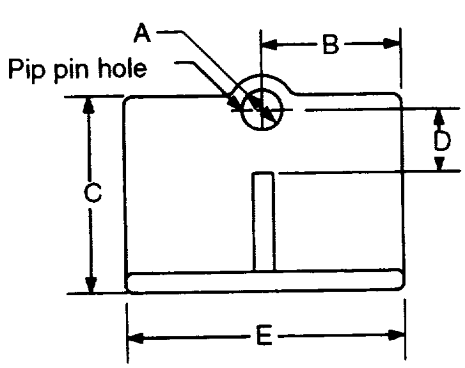
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. Sheffield, LMSC/DEPT 64–10, (408) 742–8464

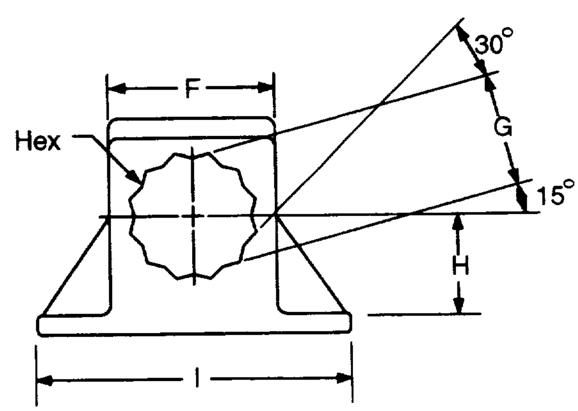
PFR SOCKET (HST)

Technical Information	
Part number	4173704
Weight	0.78 lb
Material/ construction	Aluminum alloy
Load rating	
Temperature range	
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

Dimensional Data		
	inches	cm
A	0.3750	0.95
B	1.2500	3.18
C	2.0000	5.08
D	0.5440	1.38
E	2.5000	6.35
F	1.6250	4.13
G	1.0055	2.55
H	1.2500	3.18
I	3.6200	9.19
J	1.6250	4.13
K	2.7500	6.99
L	0.287	0.73

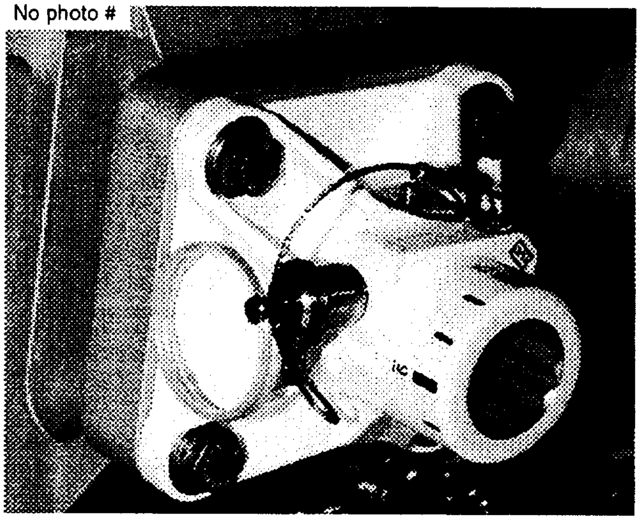




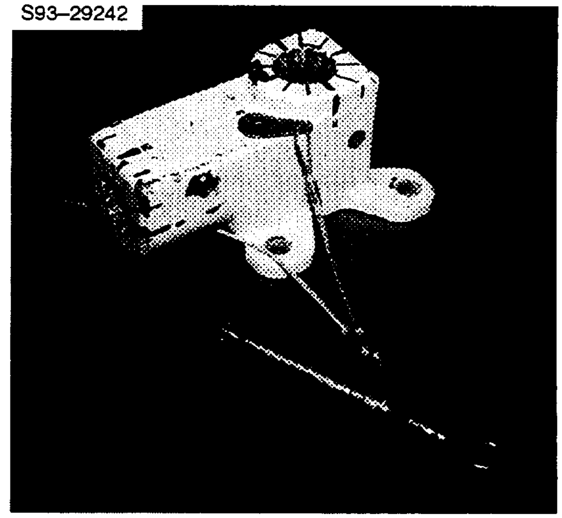


PFR SOCKET (STS)

No photo #



S93–29242



OVERVIEW

The portable foot restraint (PFR) socket, also called the 12–point socket, secures the PFR probe to a stationary location. There are several types of shuttle PFR sockets. One type has only one socket position; another has separate socket positions for stowage and use. Each type has a 12–point polygon–shaped receptacle into which the hex–shaped probe of a PFR is inserted and secured by a tethered 3/8–inch–diameter pip pin.

OPERATIONAL COMMENTS

The PFR socket used on the Solar Maximum Satellite (Solar Max) Repair Mission (10172–20433–01) is made of stainless steel and has one PFR receptacle. The PFR socket 10174–20019–01 is made of aluminum and has two PFR receptacles in which the PFR extension arm may be secured, one for launch, the other for use. The PFR socket 10176–20648–01 is similar to the Solar Max socket except that it is made of aluminum and has a thicker base to withstand greater loads. The PFR can be mounted to the socket for launch and extravehicular activity use. To provide adequate socket–probe mate/demate mechanical tolerance, an attached PFR tends to wobble slightly. A tethered pip pin is incorporated to lock the socket to the PFR. The lanyard is long enough for bidirectional pin insertion. The lanyard is fixed to the body of the pip pin as opposed to the pull ring to prevent accidental release. All earlier single socket designs have been superseded by a stronger version (SED39122648) as a result of recent flight and test data for crew loads. The latest version also has alignment marks and numbers to aid PFR setup. A hitch pin (that is difficult to reinstall) backs up the pip pin when a foot restraint is launched in one of these sockets.

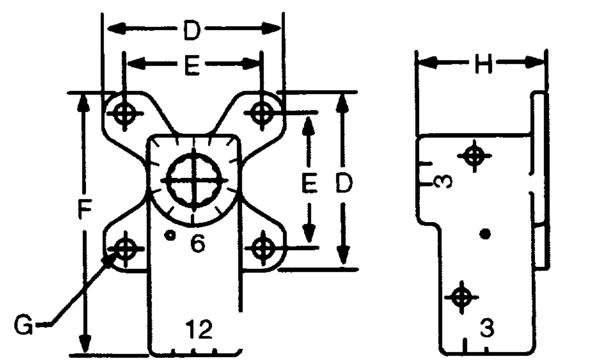
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

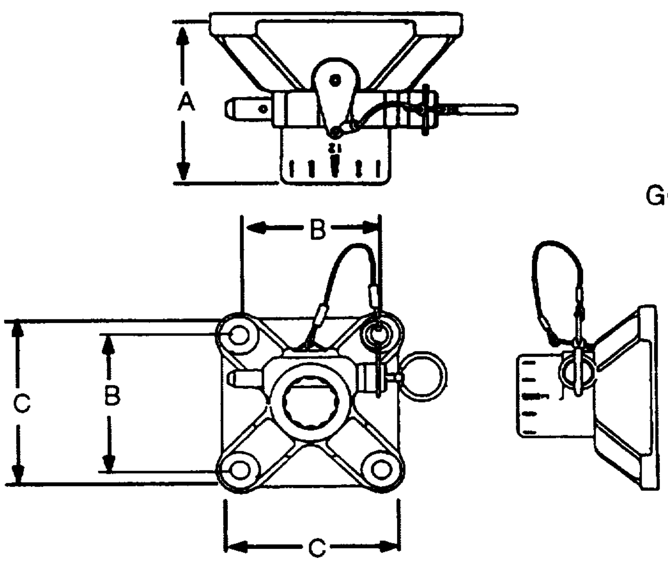
PFR SOCKET (STS)

Technical Information	
Part number	10172–20433–01 10174–20019–01 10176–20648–01 SED 39122648/10159–10087
Material/weight	10172–20433–01 – Stainless steel/6.0 lb 10174–20019–01 – Aluminum/2.813 lb 10176–20648 – Aluminum/2.0 lb SED39122648/10159 – 10087– Aluminum/1.1 lb
Load rating	100 lb applied 72 inches above socket base 1800 in–lb torque
Temperature range	–120° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific (only SED39122648 and 10174–20019)

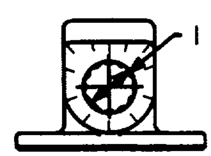
Dimensional Data		
	inches	cm
A	2.88	7.32
B	3.0	7.62
C	4.0	10.16
D	4.000	10.16
E	3.000	7.62
F	5.880	14.935
G	0.406 dia.	1.03
H	2.880	7.32
I	1.0045 across flats (SS) 1.0065 across flats (A1)	2.55



10174–20019–01

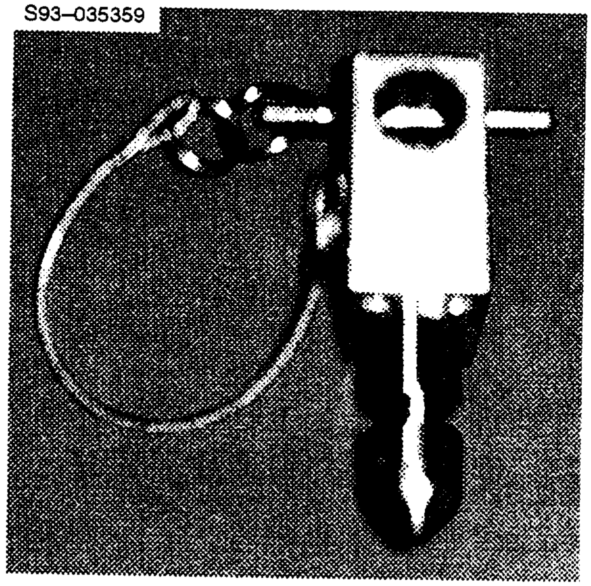


10159–10087–01



PFR SOCKET CONVERTER, 90°

S93–035359



OVERVIEW

The 90° portable foot restraint (PFR) socket converter was developed to support maintenance of the Hubble Space Telescope (HST). It is used to alter the orientation of a fixed PFR socket for improved extravehicular activity access to an orbital replacement unit located in hard to reach areas inside the HST aft shroud. Early ground testing has shown that access to the HST rate sensor unit (RSU) was enhanced with this device. A training unit is shown above.

OPERATIONAL COMMENTS

Since all the HST foot restraint sockets have receptacles oriented parallel to their mounting surface, this biases the orientation of an installed foot restraint. To aid foot restraint positioning in tight quarters, this socket converts the receptacle to be oriented perpendicular to the mounting surface. It is secured to the fixed PFR socket with a 3/8–in.–diameter pip pin.

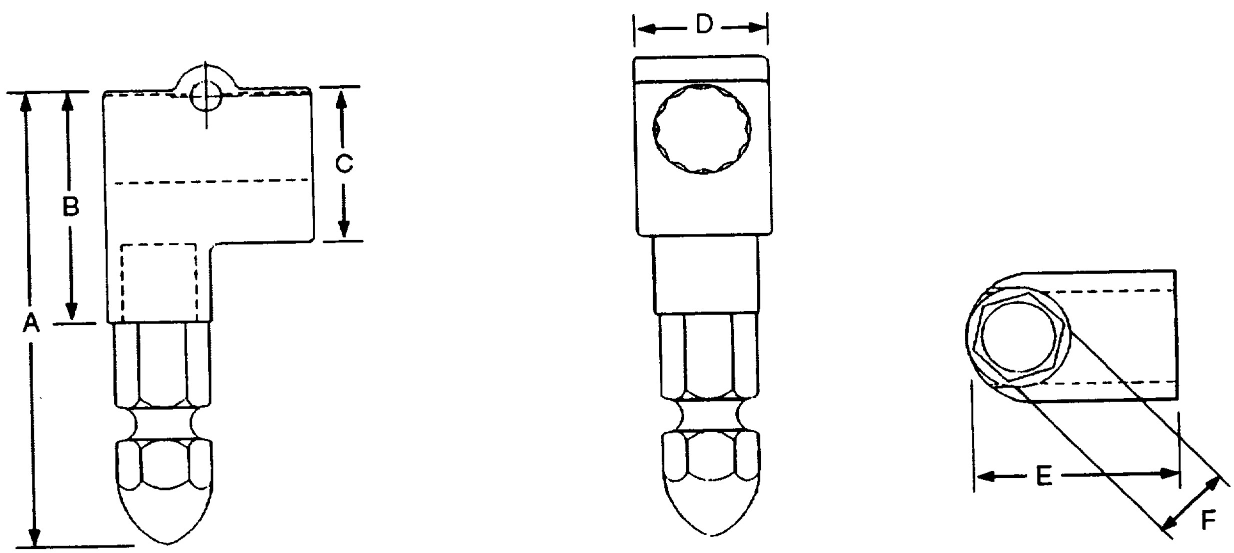
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. **Werneth, NASA/GSFC, (301) 286–4338**

PFR SOCKET CONVERTER, 90°

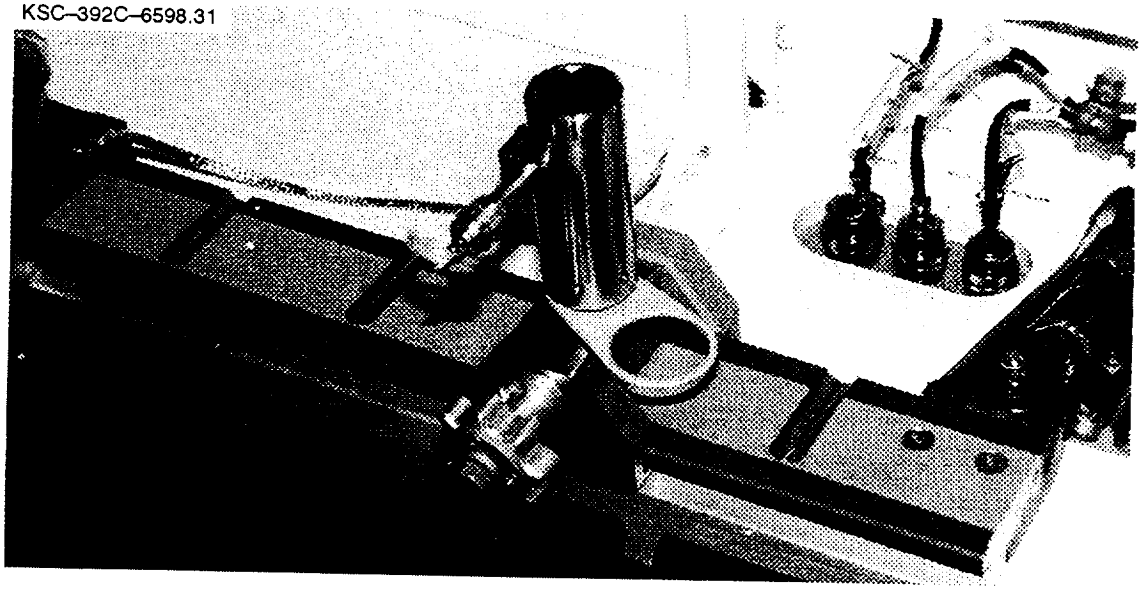
Technical Information	
Part number	GD1525425
Weight	2.5 lb
Material/ construction	**Aluminum, stainless steel**
Load rating	Fx = 50 lb, Fy = 40 lb, Fz = 100 lb Mx = 1320 in–lb, My = 1080 in–lb, Mz = 600 in–lb
Temperature range	
Quantity flown	One (STS–61)
Stowage	Starboard PSA
Availability	Flight specific

Dimensional Data		
	inches	cm
A	5.75	14.61
B	3.00	7.62
C	**2.00**	**5.08**
D	1.625	**4.128**
E	2.5	6.35
F	0.990	2.515



PFR SOCKET, BRIDGE FITTING

KSC–392C–6598.31



OVERVIEW

The bridge fitting portable foot restraint (PFR) socket, also known as the PFR bridge attachment clamp, provides the capability to mount a PFR along the sill longeron to longeron bridge **rails**. It consists of a screw–driven clamp with a locking knob and a 12–point **socket** into which the hex–shaped probe of a PFR or articulating socket is inserted and secured by use of a tethered **3/8–in.–diameter** pip pin.

The bridge fitting PFR socket is designed to mount to the longeron bridges used to secure the payload retention latch assemblies (PRLA's) to the sill longeron. Space is usually available on the top of the longeron bridge to mount the clamp forward or aft of the PRLA. The bridge fitting PFR socket allows the PFR to be mounted in the vicinity of the payload.

OPERATIONAL COMMENTS

The bridge fitting PFR socket is clamped **with knob facing inboard** to the longeron bridge fitting by turning **the** fluted knob. The knob has a locking feature that ensures that the clamp will not loosen once the desired clamping force has been attained. **The adjustment knob features a 7/16–in. hex stud for contingency release of an overtorqued or jammed knob. The clamp/socket is not certified for launch or landing on the bridge rail. Bridge rail stability shoes at each end of a rail tend to interfere with clamp attachment. The clamp is prevented from sliding under load by a protrusion under the socket that engages half holes in the bridge rail.**

A permanently tethered pip pin holds the PFR in place at the desired orientation. **Alignment marks and numbers have been added to the latest configuration to aid PFR probe setup. The pip pin side of the socket is baselined as 12 o'clock. The lanyard is fixed to the pip pin body as opposed to the pull ring to prevent accidental release. The lanyard is long enough for bidirectional insertion.** This device can withstand a load of 100 pounds applied 72 in. above the base of the 12–point socket. A **1.5–in.–diameter rotating** tether ring is part of the socket assembly. **Future improvements include the addition of a bayonet fitting for mini–workstation transport.**

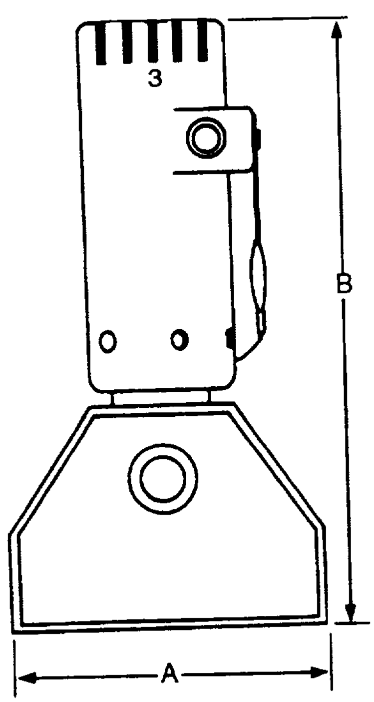
CONTACTS

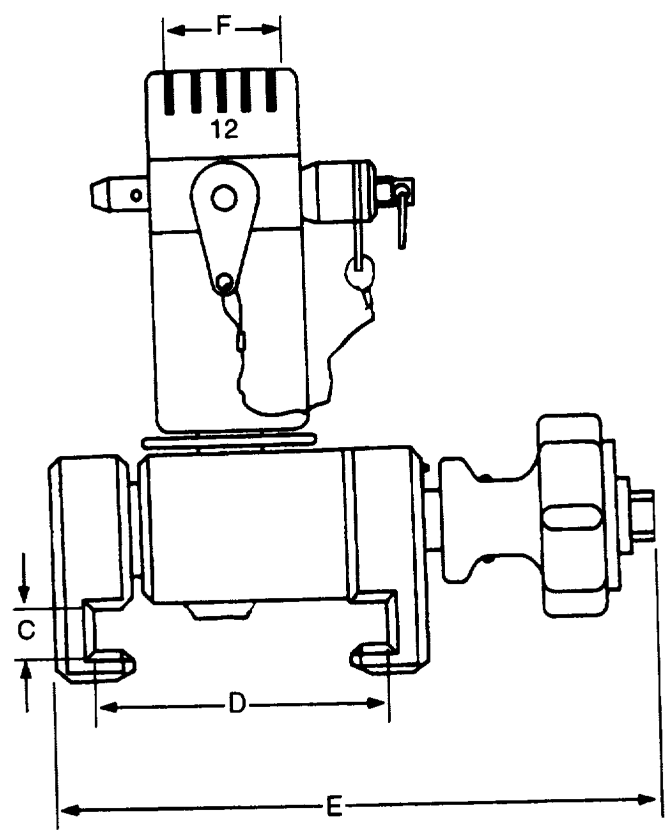
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

PFR SOCKET, BRIDGE FITTING

Technical Information	
Part number	10159–10037–**02** SED39124229–301
Weight	**3.5** lb
Material/ construction	Aluminum Stainless steel **Molykote lubrication**
Load rating	**100 lb applied 72 inches above socket base** **1800 in–lb torque**
Temperature range	–130° to +150° F (operational)
Quantity flown	One
Stowage	Port PSA
Availability	**Standard**

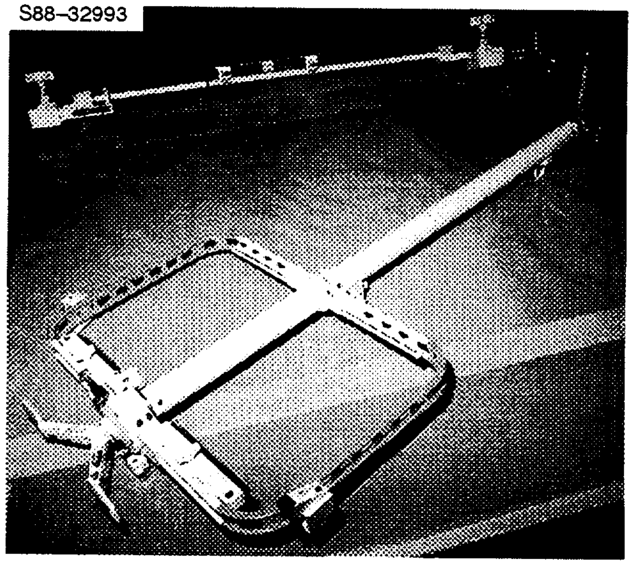
Dimensional Data		
	inches	cm
A	3.2500	8.26
B	6.1250	15.56
C	0.4700	1.19
D	2.9400 closed 3.4400 open	7.47 closed 8.74 open
E	5.8700 closed 7.3700 open	14.91 closed 18.72 open
F	1.0045 across flats	2.55





PFR WORKSTATION STANCHION

S88–32993



OVERVIEW

The portable foot restraint (PFR) workstation stanchion is a support structure that attaches to a modified PFR **as an ingress aid and** to hold tool boards during extravehicular activity satellite repair operations. The tool boards are held in close proximity to the crewmember, who is supported by the foot restraint. **The stanchion is not intended for long manual transport between worksites.**

OPERATIONAL COMMENTS

The PFR workstation stanchion has a hexagonal probe on the stanchion end that fits into a socket on the PFR. The stanchion **tilts at** its contact point with the PFR. The tool board holder frame can also be **rotated** at 45° increments about the stanchion support. A locking device is provided to secure the tool boards in the desired position. Four mini–workstation (MWS) fittings are located on the stanchion for attachment of tool caddies or any device with an MWS bayonet fitting. **The handrails have lightening holes that double as tether attach points for equipment restraint.** A tether ring near the probe is used when relocating the stanchion. The tool boards are locked in when the lock knob is parallel to the stanchion tube and are free when the knob is horizontal. Ten pounds of force are required to operate the rotation controller.

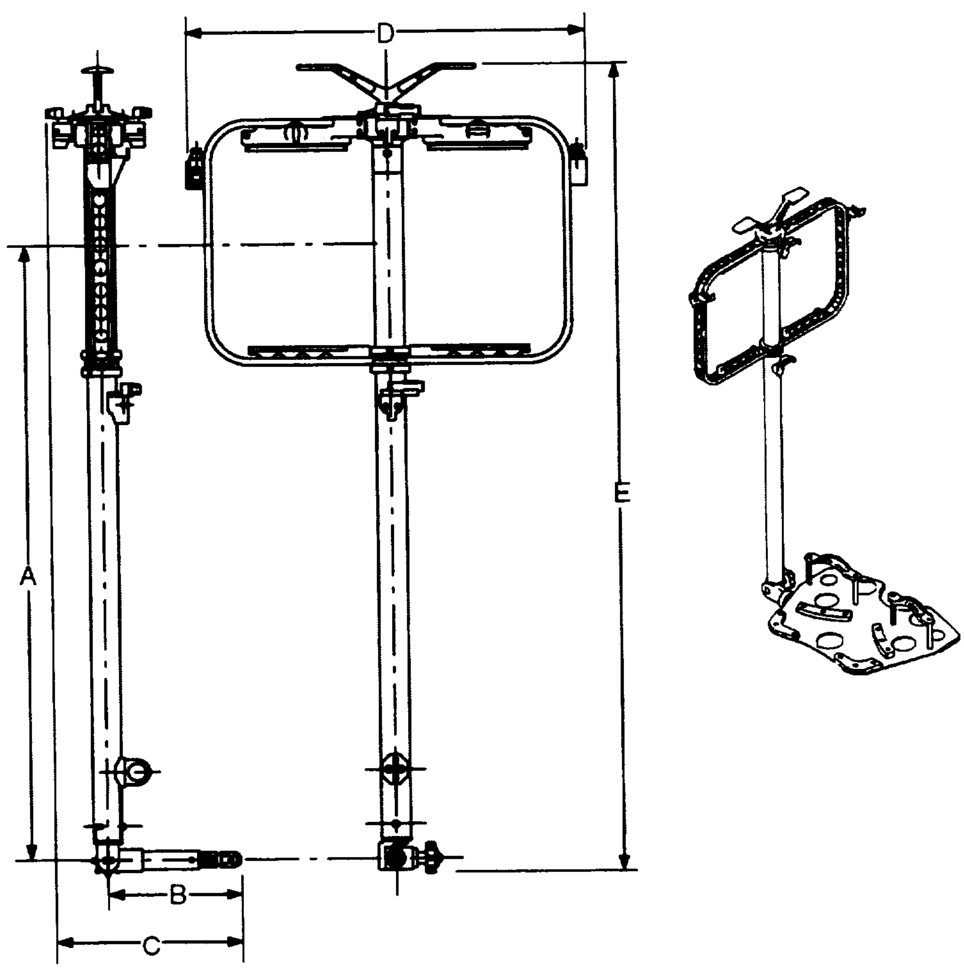
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

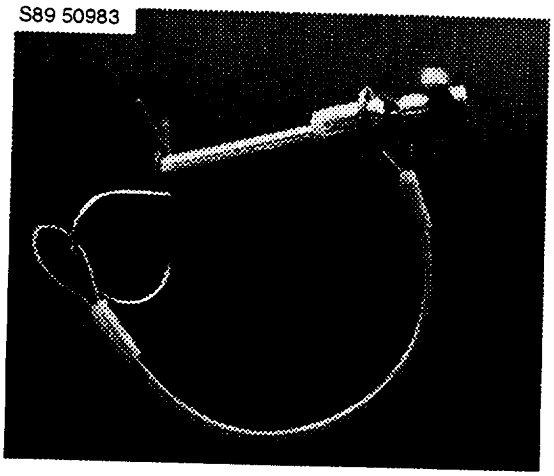
PFR WORKSTATION STANCHION

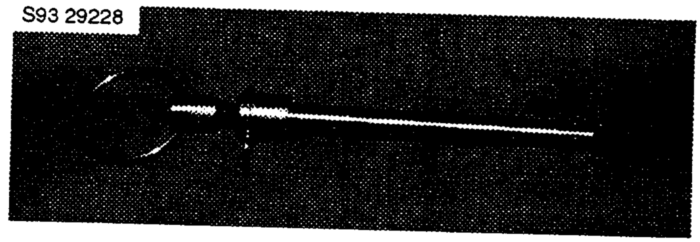
Technical Information	
Part number	10176–20004–01
Weight	17.4 lb
Material/ construction	Aluminum
Load rating	**XX lb applied at top of stanchion**
Temperature range	
Tilt angles	0° to 180° in 15° increments
Rotation angles	360° in 45° increments
Quantity flown	**One for STS 51–I**
Stowage	Starboard bay no. 4 for STS 51–I
Availability	Flight specific

Dimensional Data		
	inches	cm
A	42.000	106.68
B	9.000	22.86
C	12.625	32.07
D	27.500	69.85
E	55.750	141.61



PIP PIN





OVERVIEW

The pip pin, also known as a quick release pin, is a retaining device to allow relatively easy connection, disconnection, and positioning of objects without the use of tools. They are made of stainless steel and are available in a variety of standard diameters and grip lengths, with the most common for extravehicular activity (EVA) being **3/8 in.** in diameter and 4 to 6 in. in length. **Double acting** ring pull and T–handle pins are equally preferable for ease of gloved hand grasp and actuation. When not used in a captive housing, each pin has a lanyard attached to the body of the pin to prevent accidental release.

OPERATIONAL COMMENTS

All pip pins have a spring–loaded shaft **that** locks and releases a set of retaining balls. Double–acting pins that allow the shaft to be pushed in or pulled out are overwhelmingly preferred. The one drawback to the T–handle version versus the ring pull version is that the T–handle can be **accidentally** snagged and pulled free if located in an exposed area. The pull ring diameter must be at least **1.5** in. for gloved finger insertion. The ring should be welded or covered with Teflon shrink tubing to eliminate sharp edges. L–handled pins may be used only when access constraints cannot be eliminated. The restraining lanyard should always be long enough for easy insertion in all feasible directions.

To satisfy safety concerns, pins with four locking balls should be utilized whenever launch and landing loads are applicable. Pins must also be two–fault tolerant against inadvertent release, so two pins may be required. For launch, pins should be inserted so **that** they fall into their holes as another fail–safe precaution. Hitch pins are not **recommended** as a means of fault protection if they have to be reinstalled for landing.

The tip of the pin beyond the balls should extend roughly 1/2 in. to serve as a simple soft–dock feature. The hole should have a chamfered edge to aid initial installation. The end of the pin should always be visible to the crew after full insertion to verify that the balls have fully engaged. For backup release, the balls and drive out shaft end must be accessible. Parking of a released pin must be accommodated. A second hole is preferred, but a Velcro tab is also adequate.

For more detailed information on pip pin design criteria, refer to NSTS 07700, vol. XIV, appendix 7, Description and Design Criteria – EVA.

CONTACTS

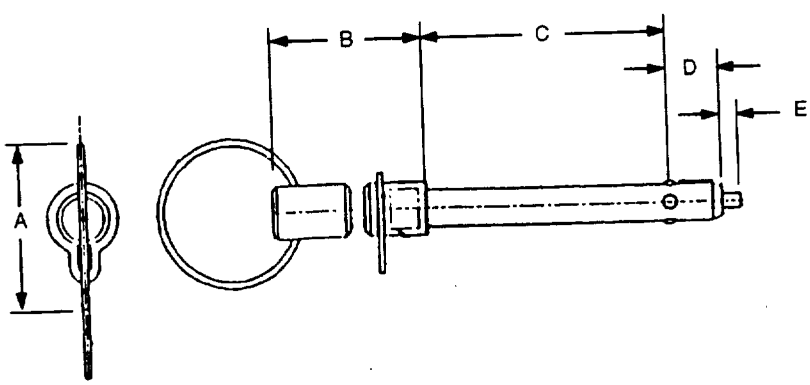
Operational: **B. Adams, JSC/DF42,** (713) 483–2567
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

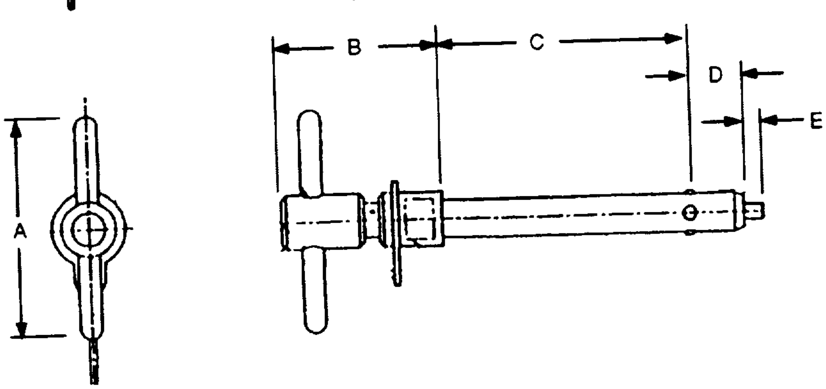
PIP PIN

Technical Information	
Part number	56789 (double–acting ring pull and T–handle)
Weight	
Material/ construction	CRES Molycoat 321 lubricant
Load rating	575 lb (two–ball 3/8–in.–dia pin under tension) 747 lb (four–ball 3/8–in.–dia pin under tension)
Temperature range	–150° to 250° F (operational)
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data

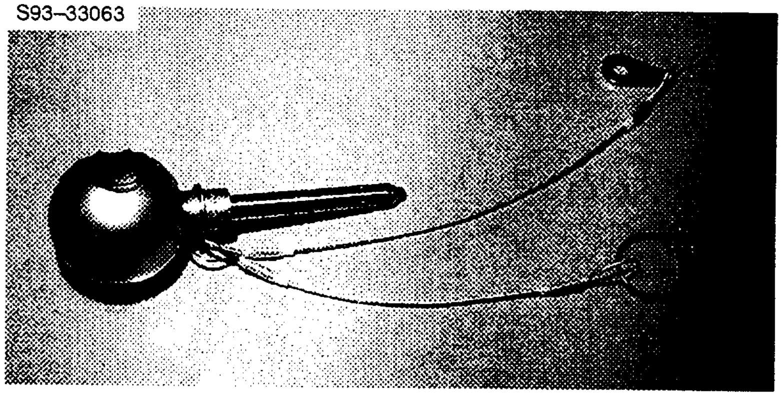
Pin dia	A		B		C	D	E
	T	Ring	T	Ring	Incr. of 0.10		
3/16	2.25	1.67 – 1.795	1.562	1.415	0.3–9.9	0.410	0.09
1/4			1.580	1.430			
5/16						0.440	0.11
3/8	2.50		1.812	1.650	0.5–9.9	0.510	0.13
7/16							
1/2			1.920	1.760	0.7–9.9	0.590	0.19
9/16	3.00			1.770		0.660	0.16
5/8		1.75 – 1.94	2.187	2.020	0.9–9.9	0.750	0.18
3/4			2.375	2.190		0.790	0.21
7/8			2.500	2.300	1.0–9.9	0.950	0.23
1.0			2.750	2.600		1.100	0.25





PIP PIN, LOCK–LOCK

S93–33063



OVERVIEW

This pip pin, also known as the extravehicular activity (EVA) space pin, is a retaining device that features a pair of buttons that must be depressed together to release the locking balls. With this lock function, the possibility of inadvertent release by snagging tethers is eliminated. Since this pin has four locking balls and the lock–lock feature, use of a hitch pin for redundant launch/landing restraint may not be required. This lock–lock design is particularly suited for applications where there is room only for a single pin and the end of the pin is inaccessible for hitch pin installation once in place.

Like other pip pins, this unit is available in a variety of standard diameters and grip lengths, with the most common for EVA being 3/8–in. in diameter and 4 to 6–in. long. Double–acting ring pull and T–handle pins are still preferred over this design, because they require no finger squeezing action or precise positioning in the gloved hand.

OPERATIONAL COMMENTS

All pip pins have a spring–loaded shaft which locks and releases a set of retaining balls. The double–acting function of this and similar pins allows the knob to be pulled for release and pushed for installation by actuating the single shaft. When not used in a captive housing, each pin has a lanyard attached to the body of the pin to prevent accidental release. The restraining lanyard should always be long enough for easy insertion in all feasible directions. The large diameter knob on this pin is intended to better fit the gloved hand.

To satisfy safety concerns, pins with four locking balls should be utilized whenever launch and landing loads are applicable or fault tolerance is of concern. For launch, pins should be inserted so they fall into their holes as another fail–safe precaution. Hitch pins are not recommended as a means of fault protection if they have to be reinstalled for landing.

The tip of the pin extends roughly 1/2 in. beyond the balls to serve as a simple soft–dock feature. The hole should have a chamfered edge to aid initial installation. The end of the pin should always be visible to the crew after full insertion to verify that the balls have fully engaged. For backup release, the balls and driveout shaft end must be accessible. Parking of a released pin must be accommodated. A second hole is preferred, but a Velcro tab is also adequate.

The ORFEUS telescope door closure latch **was to use** this pip pin design to prevent the door from opening after failure of nominal latch locking. For this application, the pin **would have been** inserted through a pair of latch indicator flags to ensure latch closure. **An alternate means of door securing was ultimately used because of hole/pin diameter incompatibility.**

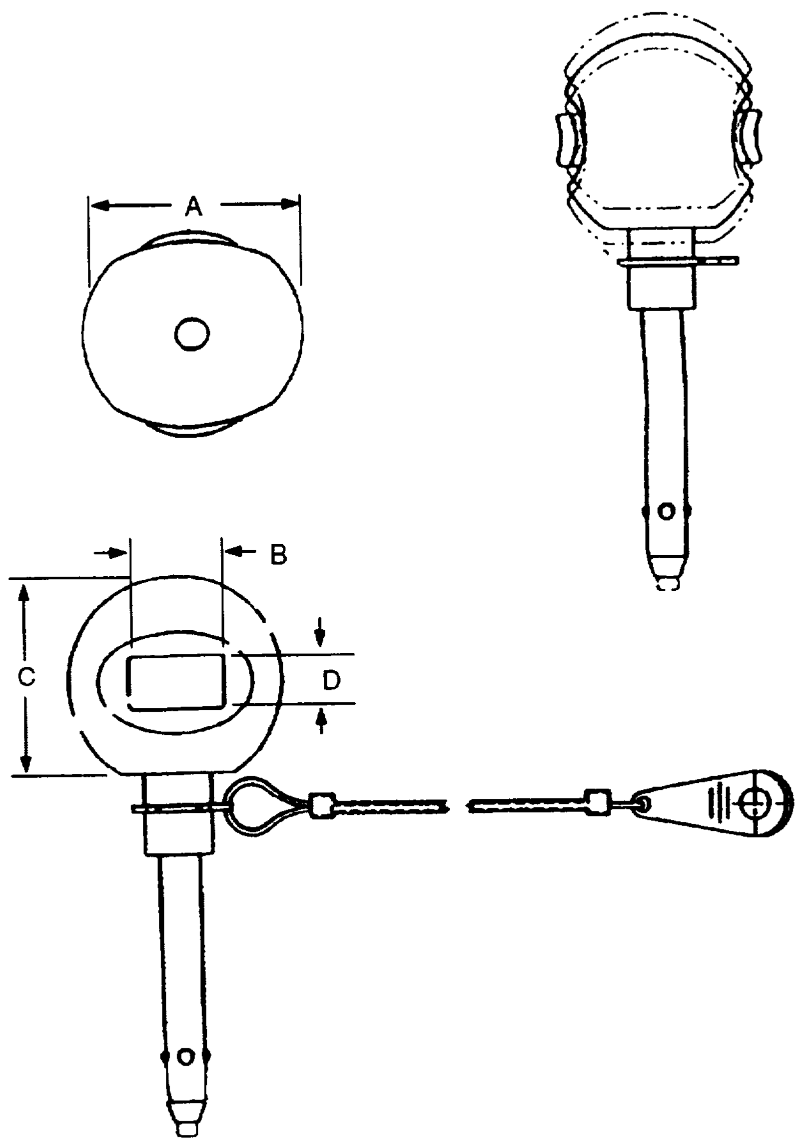
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

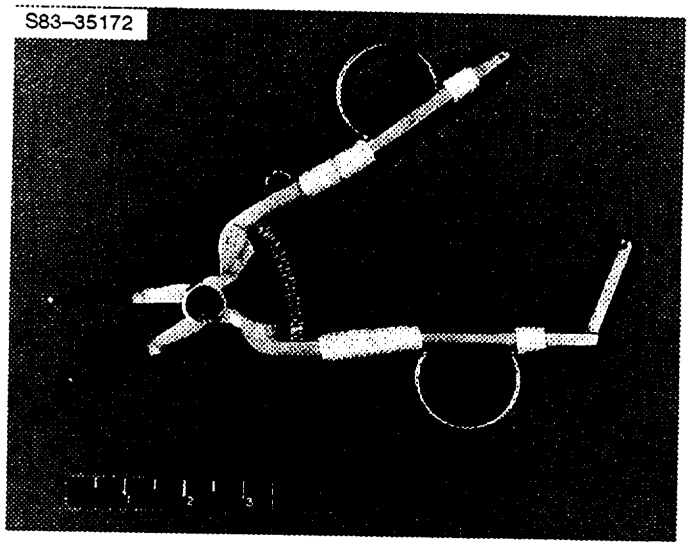
PIP PIN, LOCK-LOCK

Technical Information	
Part number	56589
Weight	0.55 lb
Material/ construction	CRES, aluminum Molycoat 321 lubricant
Load rating	747 lb (four ball 3/8-in. dia pin under tension)
Temperature range	–150° to + 250° F (operational)
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	2.0	5.08
B	0.864	2.195
C	1.85	4.70
D	0.49	1.24



PLIERS, NEEDLE NOSE



OVERVIEW

The needle nose pliers have a maximum opening of 2 in., and the angle between the handles and the jaws is approximately 60°. The needle nose pliers have finger rings designed to fit the crewmember's gloved hand, a latch to hold the handle in the closed position, a spring to force the handles apart, and a ring for tether attachment.

OPERATIONAL COMMENTS

The needle nose pliers are used as a disconnect and jam removal tool. The 60° bend between handle and jaws allows easy access into tight places. **This tool is especially good for breaking and removing lockwire from bolts.**

This tool is part of the normally manifested orbiter equipment. It is wrapped in a Velcro–lined tool caddy along with diagonal cutters and is stowed in the **port** provisions stowage assembly (PSA).

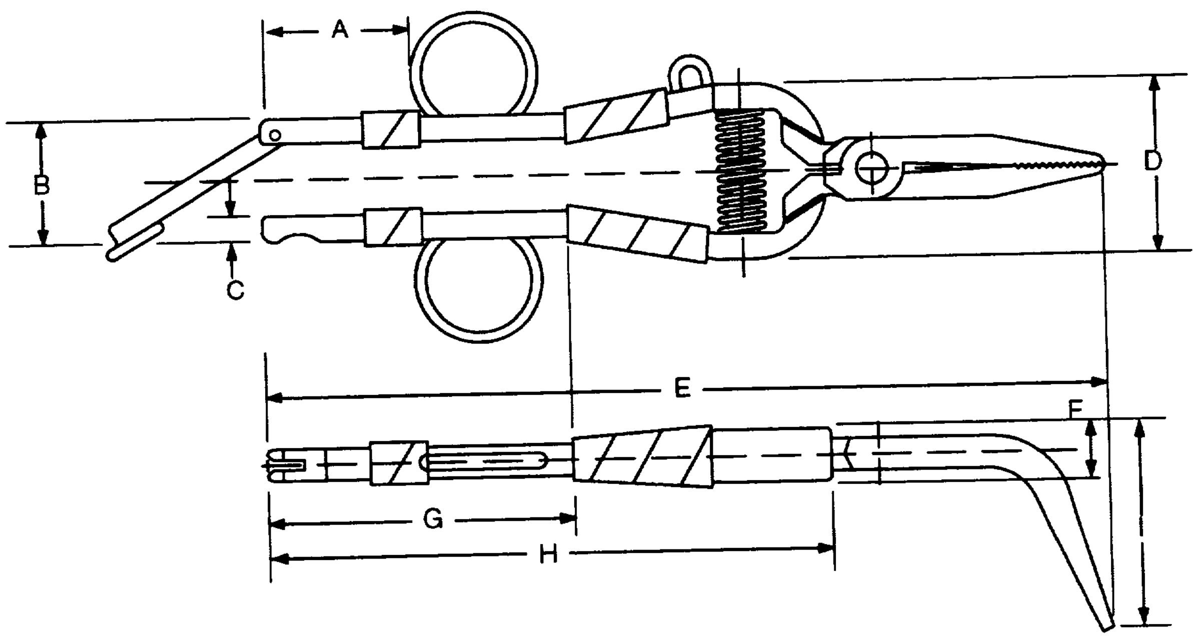
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

PLIERS, NEEDLE NOSE

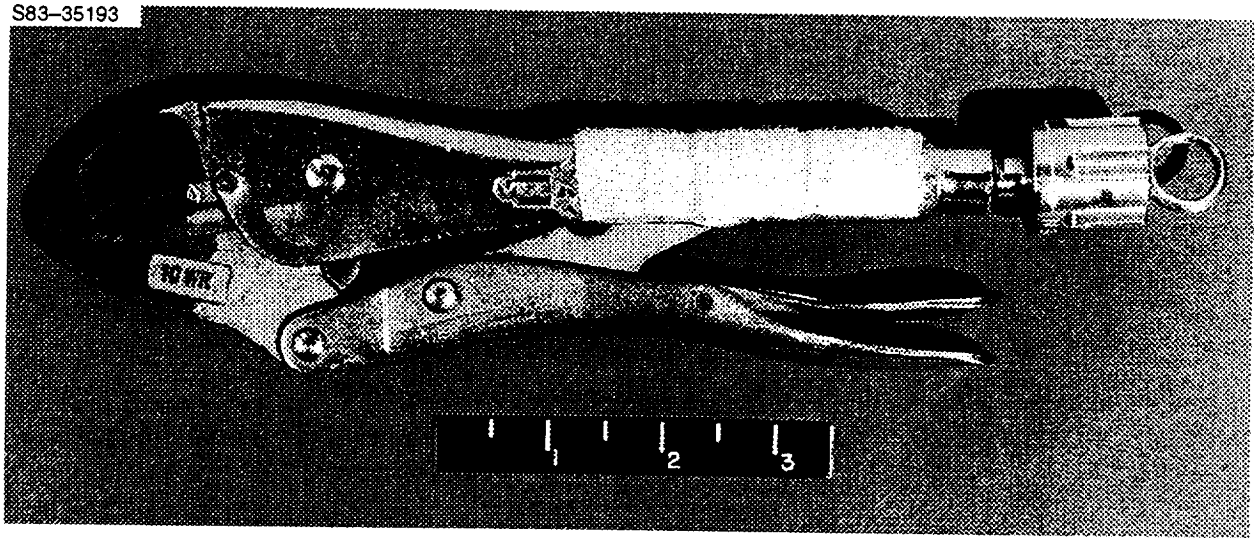
Technical Information	
Part number	V628-650865-015 or SDD33103438-301
Weight	0.6 lb
Material/ construction	AISI 4063 steel, RC 40 to 45 Commercial electroless nickel plating Handle – Velcro–wrapped, finger rings, one tether ring Jaws – 60° bend, serrated tips
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Max. opening	2.0 in.
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	1.125	2.86
B	1.500	3.81
C	0.250	0.64
D	2.000	5.08
E	8.900	22.61
F	0.500	1.27
G	3.000	7.62
H	6.000	15.24
I	2.680	6.81



PLIERS, VISE–GRIP

S83–35193



OVERVIEW

The Vise–Grip pliers are a common tool modified for extravehicular activity use. The pliers have a clamping jaw design equipped with an adjuster. Turning this adjuster controls the size and force required for bolt gripping. A spring in the mechanism holds the jaws clamped. The handle is wrapped with Velcro and has a ring for tether attachment. The tool has a maximum opening of 1–5/8 in.

OPERATIONAL COMMENTS

The normal use for the Vise–Grip pliers is to grasp the nut during nut and bolt removals. They can also be used for jam removal. Both the size and force adjustments are controlled by the knob on the end of the handle. This tool is part of the normally manifested orbiter equipment. It is stowed in a Velcro–lined tool caddy along with the bolt puller in the port provisions stowage assembly (PSA). The standard Vise–Grip wire cutters have not been modified for this tool.

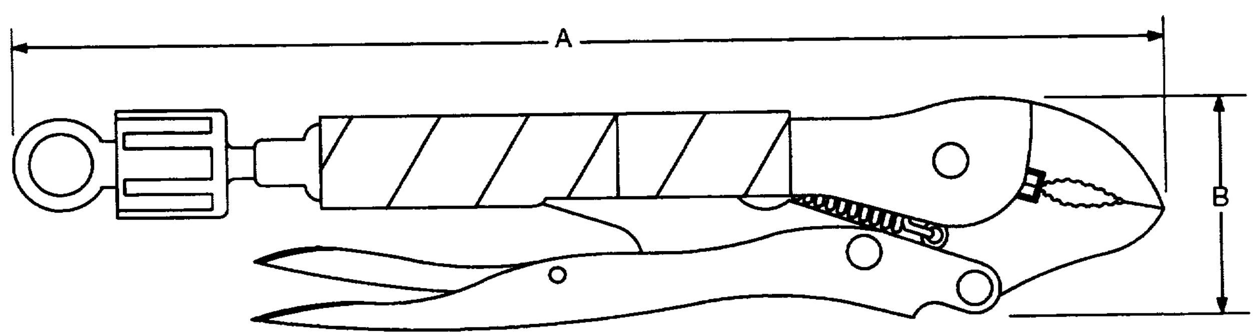
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

PLIERS, VISE–GRIP

Technical Information	
Part number	V628–650876–001 or SDD33103436–301
Weight	1.61 lb
Material/ construction	Forged steel, standard Snap–On tool modified for EVA Handle – Velcro–wrapped, control knob Jaws – Serrated, notched Lubricant – Molykote 321R
Maximum opening	1–5/8 in.
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	10.06	25.55
B	2.50	6.35



POLE, LEAVY

S91–37867

OVERVIEW

The leavy pole, also known as the umbilical access pole, is a body restraint and reach aid which was flown on the upper atmosphere research satellite (UARS) deployment mission. The pole rotates up into position to provide quick access to the UARS EVA umbilical connector. It consists of a long telescoping pole with a handle and tether attachment on one end and a bracket attachment on the other. The bracket restrains the pole to the payload carrier for launch and landing. The pole base has a bend of 40° for clearance.

OPERATIONAL COMMENTS

Releasing a pip pin from the bracket frees the leavy pole to rotate to a preset angle. Once the desired angle is achieved, the pole will automatically lock into position using a spring–loaded lock pin. A second pin is released to adjust the length of the pole. Use of the pole as a body restraint avoids the need for the crew to translate along sensitive structures on the payload. It provides simple and easy access to a task well suited to low–force free–float operations.

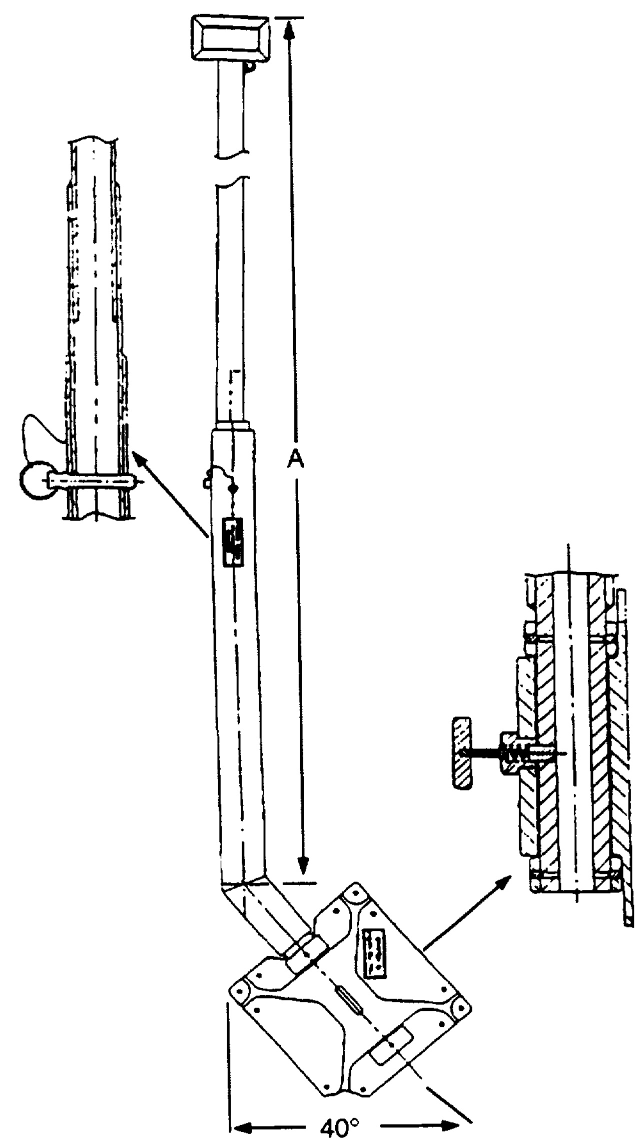
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: R. Rashford, GSFC, (301) 286–7183

POLE, LEAVY

Technical Information	
Part number	GF1477668
Weight	
Material/ construction	Aluminum
Load rating	
Temperature range	
Quantity flown	One for STS–48
Stowage	Launched on UARS carrier
Availability	Flight specific

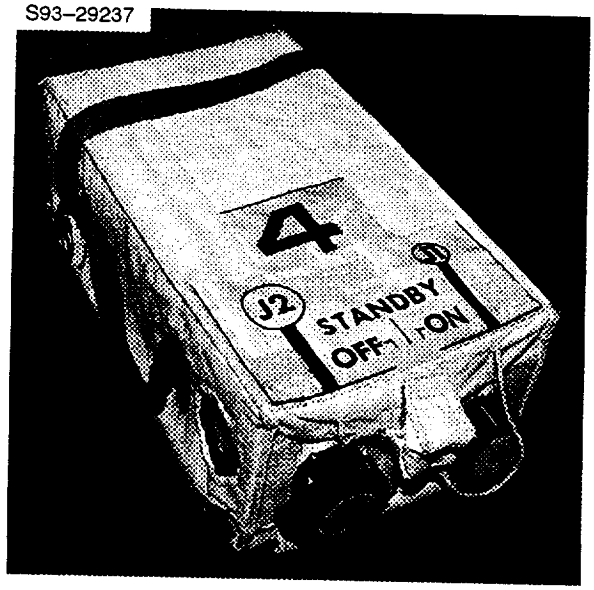
Dimensional Data		
	inches	cm
A	52	132



IL_6

PORTABLE DATA ACQUISITION PACKAGE

S93–29237



OVERVIEW

The portable data acquisition package (PDAP) is a portable, standalone data recording system. It consists of a battery–powered, dual, hard disk recorder. The PDAP provides an excitation voltage to sensors. It also records electronic outputs from external strain gauges (for forces and moments) and Hall effect time/velocity sensors, as well as internal thermistors, accelerometers, and pressure sensors. It can be used to support any situation where electronic data need to be recorded.

OPERATIONAL COMMENTS

On STS–37, data were generated while using the various carts of the crew and equipment translation aid (CETA) and the body restraints of the crew loads instrumented pallet (CLIP). These data were recorded for postflight retrieval and processing. For STS–37, PDAP recorded 31 analog channels and 1 digital channel, with each channel being sampled 150 times per second. The sampling rate is internally adjustable prior to flight. The analog sensor signals are digitized to 12–bit resolution, time tagged, and then recorded on an internal hard disk. With its 12 D–size batteries and the 100–Mbyte hard disks, PDAP has a 6–hour operational life. No orbiter interfaces are required to support its operation. PDAP's have supported data gathering for orbiter and experiment data (not related to extravehicular activity (EVA)) on subsequent flights.

For thermal concerns and to allow pre–EVA checkout, each PDAP was launched and returned in the middeck lockers. A set of indicator lights provides feedback to the user on PDAP system status. Various combinations of red and green lights indicate how many of the disks are available for recording, if self–test is occurring, if the unit is in standby, or if a system failure has taken place. Wing tab electrical connectors linked each unit to its external sensors. Mechanical latches on CETA and CLIP provided restraint during data recording.

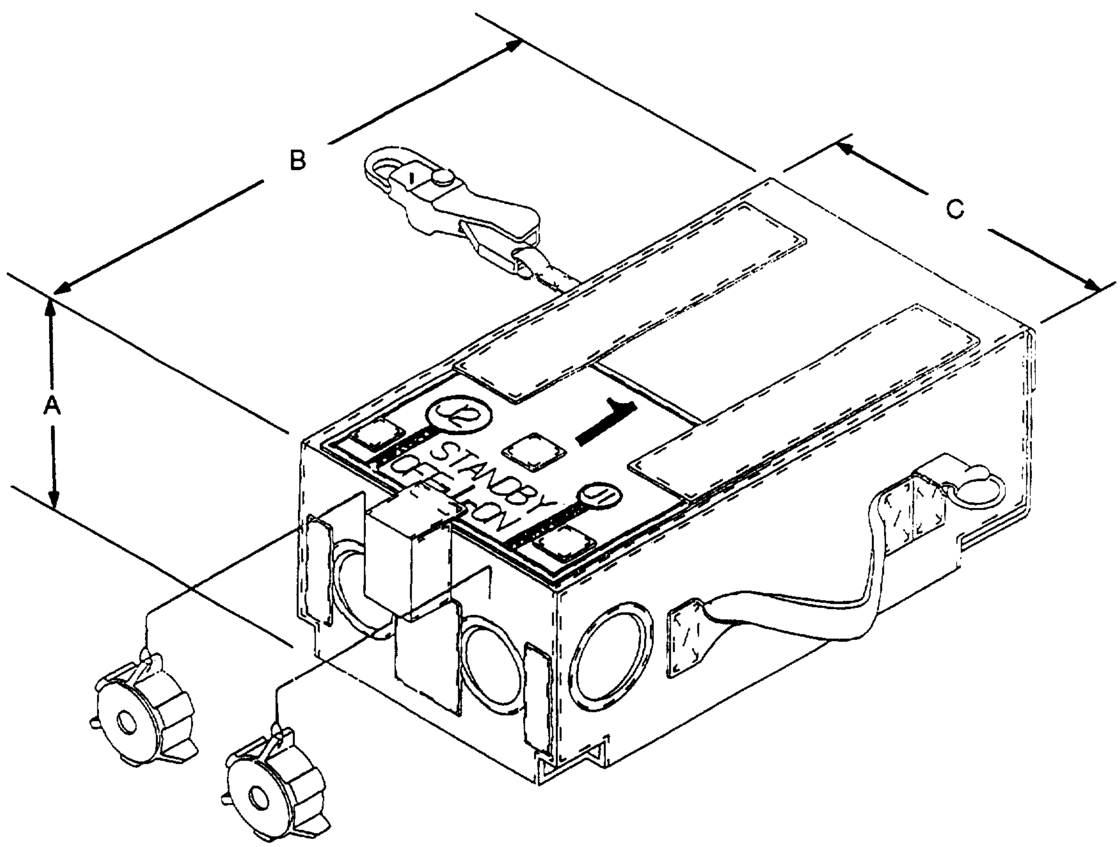
CONTACTS

Operational: B. Adams, JSC/DF42, (713) 483–2567
Technical: J. O'Kane, NASA/EC5, (713) 483–9229

PORTABLE DATA ACQUISITION PACKAGE

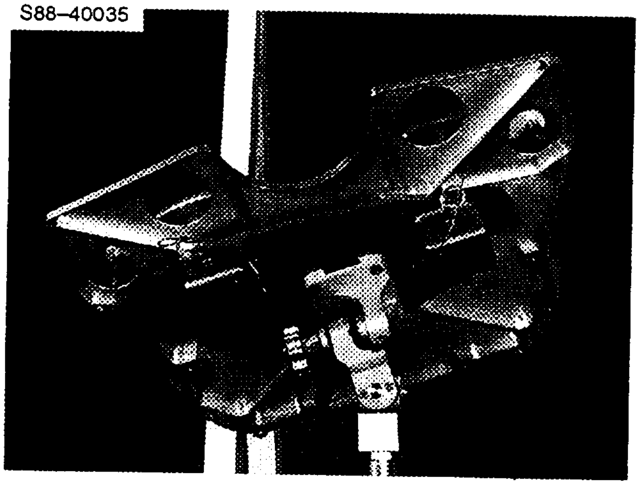
Technical Information	
Part number	SED39121420–301
Weight	29 lb
Material/ construction	Aluminum
Load rating	N/A
Temperature range	–120° to +165° F
Quantity flown	Three for STS–37
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	7	17.8
B	15	38.1
C	10	25.4

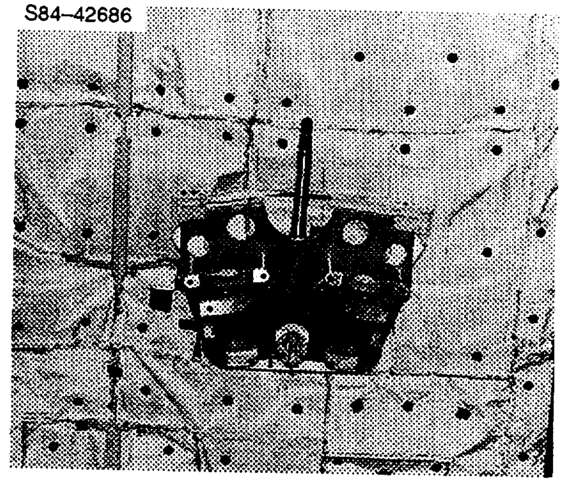


PORTABLE FOOT RESTRAINT

S88–40035



S84–42686



OVERVIEW

The portable foot restraint (PFR) is a working platform that restrains the crewmember during the performance of extravehicular activity (EVA) tasks. The platform consists of a system of toe guides and heel clips that interface with the extravehicular mobility unit (EMU) boots. A two–axis (roll and pitch) gimbal system with lock knobs is provided for adjustment and positioning. A **1.0 in.** hex–shaped probe enables the PFR assembly to interface with the worksite at a PFR socket, where yaw adjustment is available.

OPERATIONAL COMMENTS

The PFR was originally **provided as** a contingency restraint system for **orbiter payload bay** door latch repairs. As EVA operations increased in frequency, new applications for its use were identified, and improvements were made in the design to minimize setup and adjustment times as well as to increase the operational work load limits from 25 to 75 lb. Several configurations of the PFR exist, varying in workstation mounting socket design and probe lengths, and are capable of attachment to a variety of work surfaces. Spring–loaded lock knobs have also been incorporated into the later configurations to prevent inadvertent unlocking of the gimbal system. **Each knob has a 7/16–in. hex stud for contingency release of a jammed or overtorqued knob.** One PFR (10159–10034–05) is part of the normally manifested orbiter equipment. Two PFR styles allow the EVA crewmember to mount one (10176–20060–01) or two (**10176–20060–03**) workstation stanchions to the PFR by the addition of mounting sockets to the foot restraint platform. **To provide adequate socket–probe mate/demate mechanical tolerance, the PFR tends to wobble slightly.**

PFR's are best utilized when preconfigured for launch and ready for use. Manual transport and reconfiguration is cumbersome. All frequently used worksites (like tool boxes) should have dedicated foot restraints. Alignment marks have been added to the probe to aid setup repeatability. The probe side away from the roll knob is baselined for the location of a set of marks on the probe flats and the probe extension. In an upcoming design, the joints and knobs will be replaced by a pushbutton–actuated assembly to reduce on–orbit reconfiguration time and effort. Recent designs have EMU–releasable toe bar bolts to free a stuck boot.

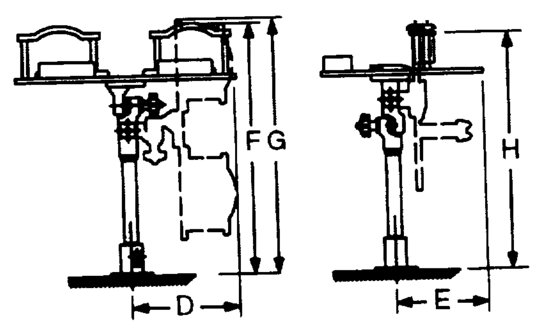
CONTACTS

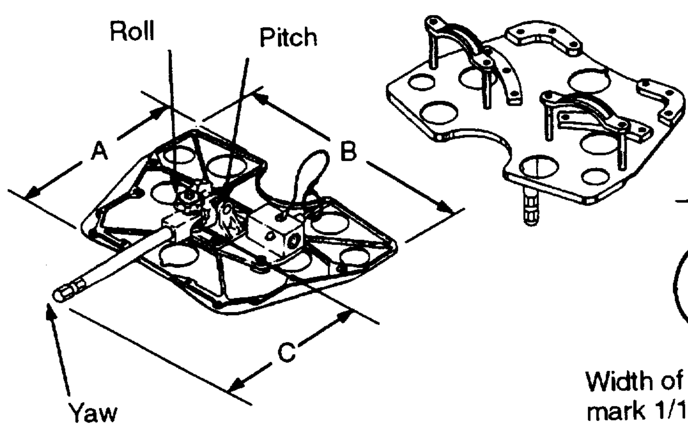
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

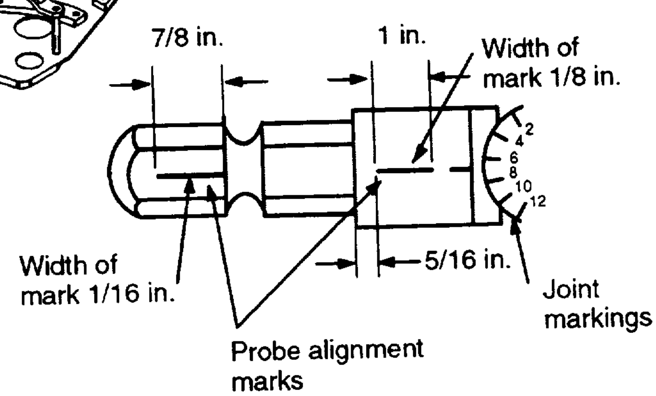
PORTABLE FOOT RESTRAINT

Technical Information	
Part number	10159-10034-**05 (std length probe ext)** **-02 (long length probe ext)** 10176-20060-01 **(single stanchion socket)** 10176-20060-**03 (dual stanchion socket)**
Weight	9.7 lb (10159-10034-05) 11.4 lb (10176-20060-01)
Material/ construction	Aluminum alloy Stainless steel – Probe
Load rating	**75** lb in any direction **applied 88 in. above PFR socket** **1800 in-lb torsion**
Temperature rating	
Platform-pitch	-75° to +105° in **thirteen** 15° increments
Platform-roll	± 90° in **twelve** 15° increments
Platform-yaw	± 360° in 30° increments via 12 pt socket
Quantity flown	One 10159-10034-**05**
Stowage	Orbiter forward bulkhead
Availability	10159-10034-**05** standard **10176-20060-03 flight specific** 10176-20060-01 flight specific

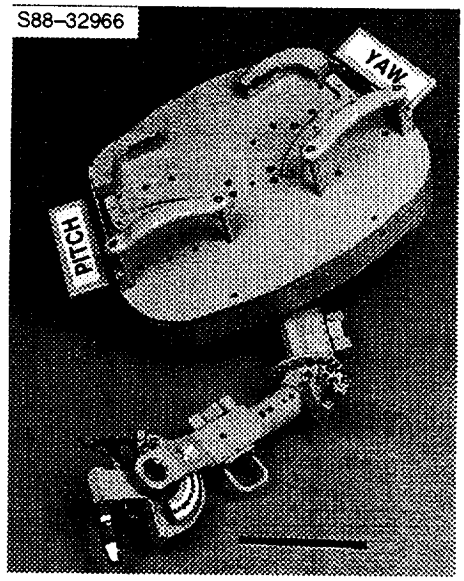
Dimensional Data						
	10159-10034-05		10159-10034-02		10176-20060-03 and 10176-20060-01	
	inches	cm	inches	cm	inches	cm
A	14.800	37.59	14.800	37.59	14.800	37.59
B	20.400	51.82	20.400	51.82	20.400	51.82
C	13.150	33.40	27.300	69.34	13.150	33.40
D	10.200	25.91	10.200	25.91	10.200	25.91
E	8.400	21.34	8.400	21.34	8.400	21.34
F	22.560	57.30	36.710	93.24	22.940	58.27
G	23.350	59.31	37.500	95.25	23.230	60.27
H	19.550	49.66	33.700	85.60	19.930	50.62







PORTABLE FOOT RESTRAINT (HST)



OVERVIEW

The portable foot restraint (PFR) for the Hubble Space Telescope (HST) is a working platform that allows the extravehicular activity (EVA) crewmember to perform HST servicing tasks that would be difficult without a solid platform. The foot restraint assembly consists of a foot platform, boom, and mounting stud. The foot platform has yaw and pitch controls that can be operated by the crewmember's feet. The foot restraint can also be elevated and rolled to a desired location.

OPERATIONAL COMMENTS

The HST PFR is provided to aid the EVA crewmembers in space telescope maintenance activities. Numerous PFR sockets are located at various locations on the HST to allow PFR mounting at any desired workstation along the vehicle. **Various PFR socket extenders may be required for selected HST worksites. Transport of this large device relies upon the semirigid tether to keep both hands free for body control. It is typically tucked behind the back for minimal interference during transport. While foot pedal adjustment of the platform is an improvement over the standard orbiter PFR, pulling one foot out during pedal actuation can lead to the release of both feet, especially during large yaw maneuvers. The stowage plate has a short handrail to aid installation and removal of the PFR.**

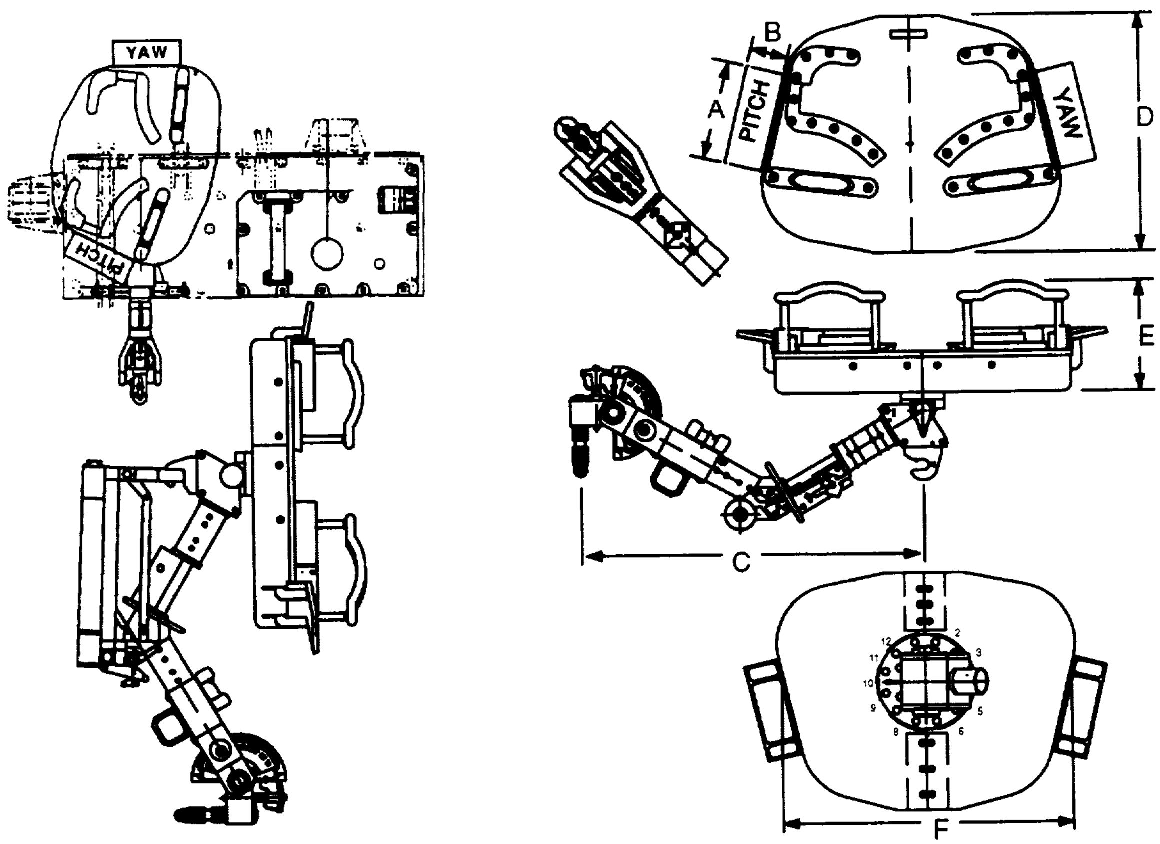
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. Sheffield, LMSC/DEPT 64–10, (408) 742–8464

PORTABLE FOOT RESTRAINT (HST)

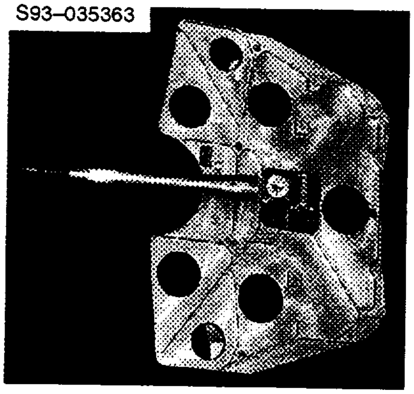
Technical Information	
Part number	4177097–**501 (PFR)** **SED39119295–501/503 (sidewall carrier and PFR)**
Weight	45.4 lb
Material/ construction	Aluminum and steel
Load rating	**Fx = 50 lb, Fy = 40 lb, Fz = 100 lb** **Mx = 1320 in lb, My = 1000 in lb, Mz = 600 in–lb (applied 64 in. above foot plate)**
Temperature range .	
Roll positions	0° to 340° in 20° increments (A–S)
Yaw positions	0° to 330° in 30° clockwise increments (1–12)
Pitch positions	Up 30° to down 90° in 15° increments (ZZ–HH)
Elevation positions	Up 90° to down 30° in 15° increments (JJ–RR)
Quantity flown	
Stowage	Adaptive payload carrier using standard manipulator foot restraint latch and roller system
Availability	Flight specific, **existing units reserved for HST**

Dimensional Data		
	inches	cm
A	6.70	17.02
B	2.40	6.10
C	23.40	59.44
D	16.13	40.96
E	7.25	19.69
F	20.13	51.12

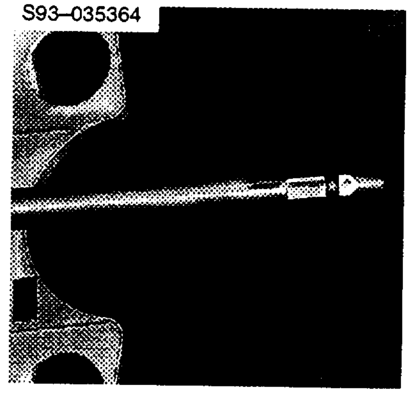


PORTABLE FOOT RESTRAINT, PUSHBUTTON

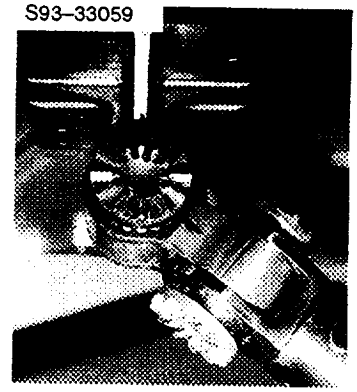
S93–035363



S93–035364



S93–33059



OVERVIEW

The pushbutton portable foot restraint (PFR) is a worksite platform which restrains the crewmember during the performance of EVA tasks. The platform has toe guides and heel clips which interface with the EMU boots. A two–axis pitch and roll gimbal system is provided for adjustment and positioning. The gimbal system can be actuated with one hand by depressing two buttons on either side of the joint to be adjusted. A hex–shaped probe enables the PFR to interface with the worksite at a 12–point socket, where yaw adjustment is available.

Two designs exist for the pushbutton gimbals. One has a set of balls, which roll in slots when opposing plunger buttons are depressed and lock into **secure detents** when the buttons are released (SED39124700). The other design (shown above) extends and retracts radial splines that engage slots (SED33104757–301).

Previous versions of this foot restraint featured lockable knobs that required intensive effort to reposition each gimbal joint and were not orginally intended for frequent worksite reconfiguration. This new design will help to minimize the overhead and fatigue associated with foot restraint reconfiguration.

OPERATIONAL COMMENTS

The pushbutton PFR is targeted for first use during Hubble Space Telescope (HST) maintenance. It can, however, be used anywhere the existing PFR is used since its envelope and stowage dimensions are the same. Besides minimizing setup and adjustment times, the new gimbals also increase the operational work load limits. The gimbal components are designed to be redundant. Engraved markings on the gimbals key crewmembers to the various joint adjustment settings.

The hex probe of this foot restraint has also been modified to make socket installation easier. Its end is very tapered, with minimal hex surface to assist with initial linear socket alignment and insertion. Socket alignment marks on this new probe have also been improved. One side of the probe has a single line on the probe and hex faces to match the clock marks on the socket. The opposite side has a pair of parallel lines which can be used for a bidirectional approach to PFR installation.

There are two versions of the foot restraint with the ball detent joints. One is designed with a plate between the toe bars that is used as a structural attach point to pin the folded foot restraint securely for launch loads (SED39124700–**301**). This plate also provides attach points for one of two restraining tethers during contingency ingress when no structural ingress aid is available. The other plate lacks this extra feature (SED39124700–**302**).

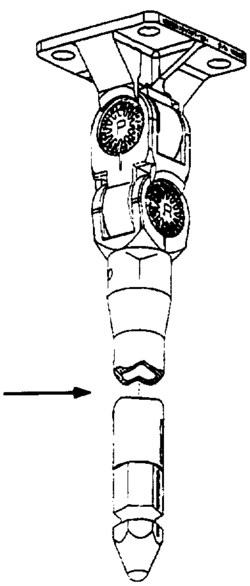
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: R. Marak, NASA/EC5, (713) 483–9144

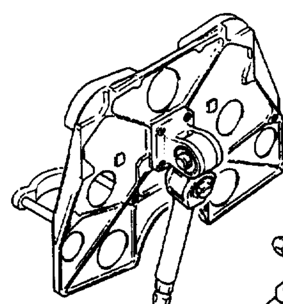
PORTABLE FOOT RESTRAINT, PUSH BUTTON

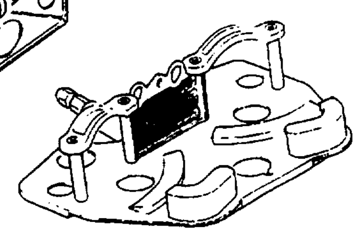
Technical Information	
Part number	SED39124700-301 (ball detent jts with toe bar restraint) **SED39124700-302** (ball detent jts w/o toe bar restraint) SED33105308-301 (spline jts)
Weight	11.5 lb (SED39124700)
Material/ construction	Aluminum alloy, titanium and steel
Load rating	Fx = 190 lb, Fy = 70 lb, Fz = 185 lb Mx = 3200 in-lb, My = 2900 in-lb, and Mz = 2000 in-lb (all simultaneously)
Temperature range	
Quantity flown	One on STS-51 and STS-61 (SED39124700) Three on STS-61 (SED33105308)
Stowage	Orbiter forward bulkhead
Articulation	Platform-Pitch ±105° in 15° increments Platform-Roll ±90° in 15° increments Platform-Yaw ±360° in 30° increments via 12 pt socket
Availability	Flight specific

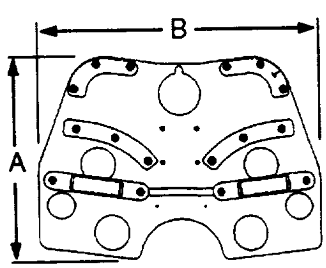
Dimensional Data		
	inches	cm
A	14.74	37.4
B	20.40	51.8
C	23.55	59.8
D	14.57	37.0

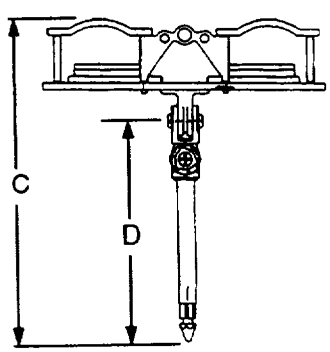


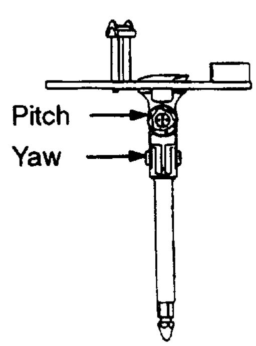
SED 33105308

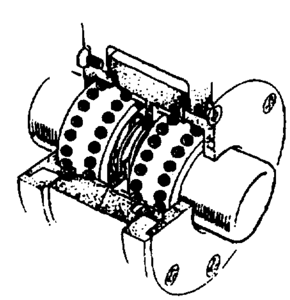








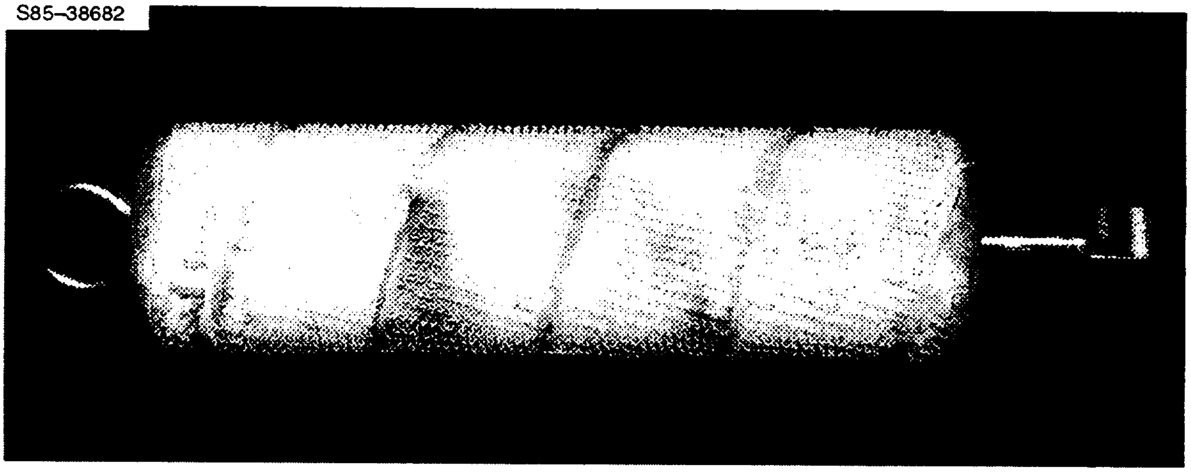




SED 39124700

POWER DRIVE UNIT DISCONNECT

S85-38682



OVERVIEW

The power drive unit (PDU) disconnect tool is a 3/8-in. square drive extension with a Velcro-wrapped handle and an attached tether ring. The drive extension extends 1 in. from the handle and has a smooth 3/8-in. cube on the end. This tool is part of the normally manifested orbiter equipment. It is wrapped in a Velcro-lined caddy with the loop pin extractor and stowed in the starboard provisions stowage assembly (PSA).

OPERATIONAL COMMENTS

If the payload bay doors will not close, the PDU disconnect is used to disengage the PDU from the PDU torque shaft, allowing the torque shaft to be rotated so the payload bay doors can be winched shut. **The square drive tends to fit tightly when inserted into flight PDU's.**

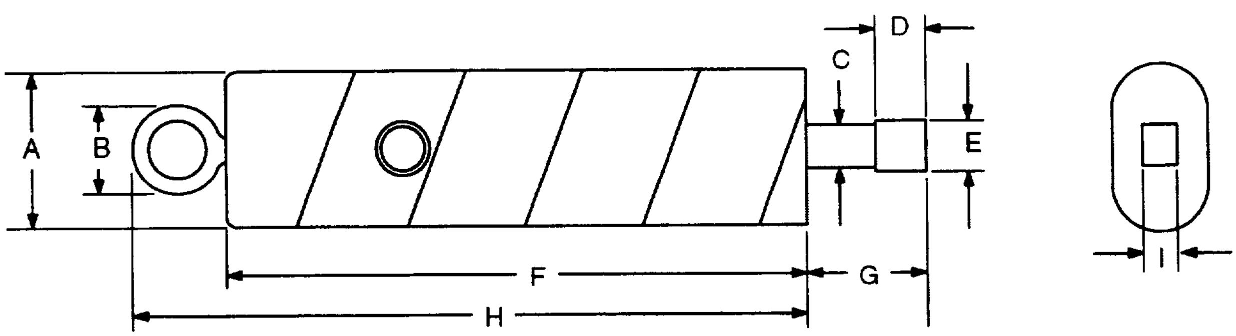
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC5, (713) 483-9247

POWER DRIVE UNIT DISCONNECT

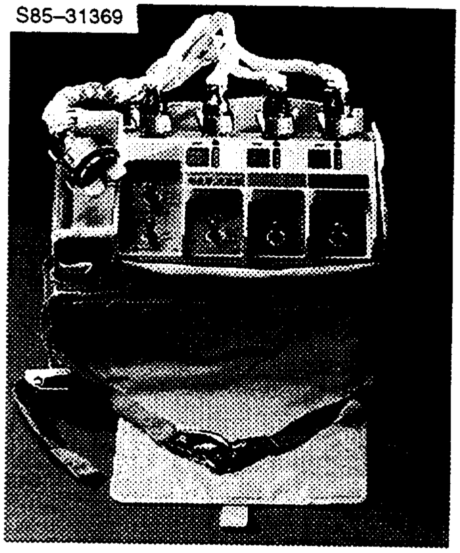
Technical Information	
Part number	V628–651001–001 or SDD33103442–301
Weight	0.5 lb
Material/ construction	Handle – Aluminum Drive – Tool steel
Load rating	
Temperature range	–200° to +250° F (operational), **+350° F (stowage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	1.350	34.29
B	0.750	1.91
C	0.300	0.76
D	0.375	0.95
E	0.375	0.95
F	5.000	12.7
G	1.000	2.54
H	6.750	17.15
I	0.375	0.95

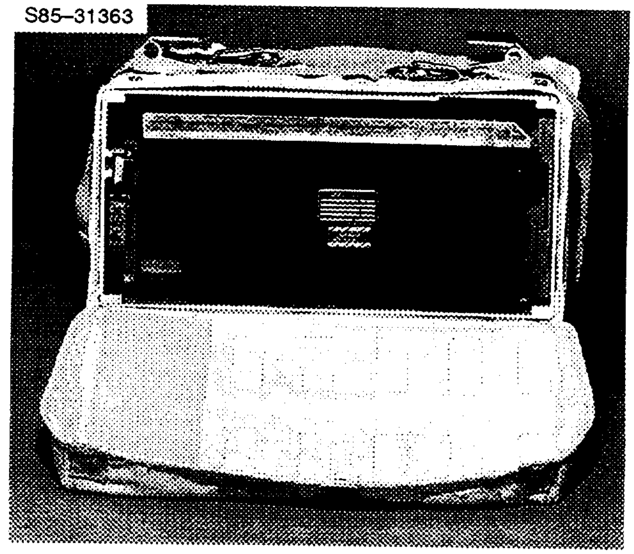


POWER PACKAGE, EVA

S85–31369



S85–31363



OVERVIEW

The extravehicular activity (EVA) power package (EPP) is a portable, direct–current power supply designed for specific, as well as general purpose, applications. Currently, it may be configured for payload assist module D (PAM–D) or tether satellite system (TSS) operations.

OPERATIONAL COMMENTS

The EPP provides 28–V, 6.0–A dc power with four bipolar output circuits, each of which has a built–in overcurrent interrupter externally selectable at 3.5 A, 5.5 A, or 6.5 A. The output circuits can be externally set as four independent circuits or four exclusive circuits in which one energized circuit excludes the activation of a second circuit. Three of the four circuits provide a current bar graph meter externally selectable for 2.0 A, 5.0 A, or 7.0 A full scale.

System level includes main power ON/OFF, a self–test sequence to confirm system operation under a simulated load, a backup overcurrent interrupter set at 6.8 A, and an overheat warning mechanism. Control for each circuit is via a three–position, lift–to–unlock toggle switch for outputting forward polarity 28 V, off selection, and reverse polarity 28 V. ON/OFF 28–V inputs are received and annunciated, and remote power cutoff capability is provided.

Input/output for each circuit is via a 19–pin aerospace circular connector. Labels to indicate the function of each switch position can be replaced for different mission applications. The EPP hardware includes a handgrip, two adjustable tethers, and a passive thermal protection for a 6–hr EVA.

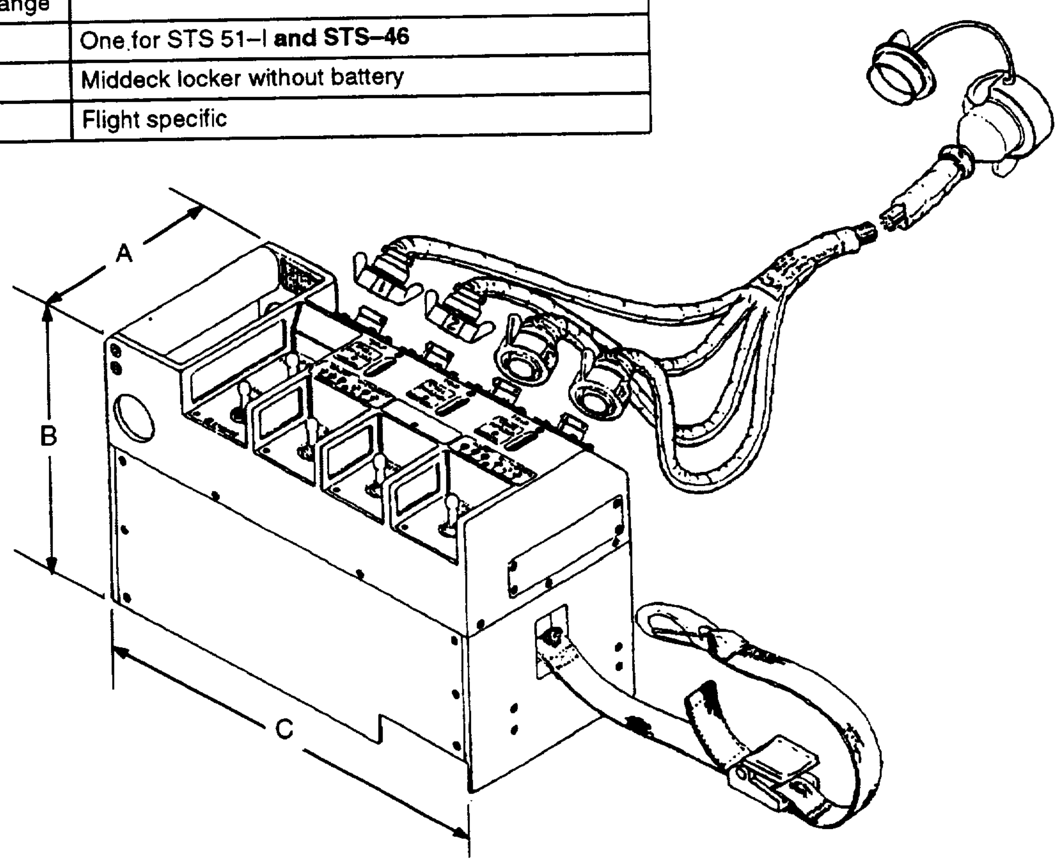
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

POWER PACKAGE, EVA

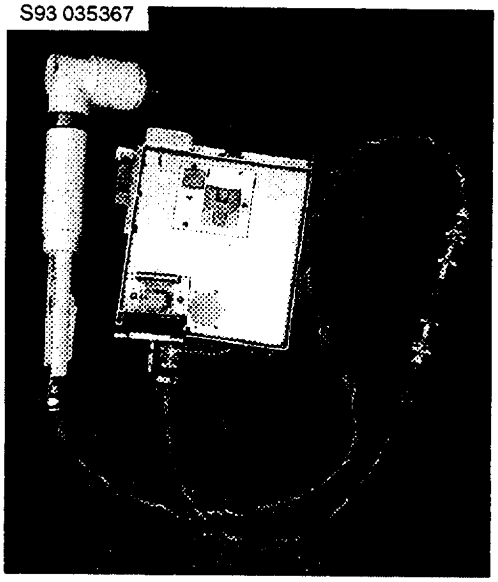
Technical Information	
Part number	10175-10075-02/03
Weight	27 lb (without battery)
Material/ construction	Ortho, Teflon fabrics, aluminized Mylar, and polyester scrim **for thermal garment**
Continuous output capability	28 V dc ±2 V dc, 6 A
Surge capability	8.0A without instantaneous tripping
Capacity	Up to 10 A-hr
Overcurrent meter settings	3.5, 5.5, 6.5 A, externally selectable
Current bar graph meter settings	3.0 A, 5.0 A, 7.0 A, externally selectable
Max. battery temp for 12 min	115° F
Max. temp for 1 hr 10 min operation	160° F
Battery	26.6 A-hr EMU (see EMU battery)
Load rating	
Temperature range	
Quantity flown	One for STS 51-I **and STS-46**
Stowage	Middeck locker without battery
Availability	Flight specific

Dimensional Data		
	inches	cm
A	6.3	16.00
B	9.4	23.88
C	13.0	33.02

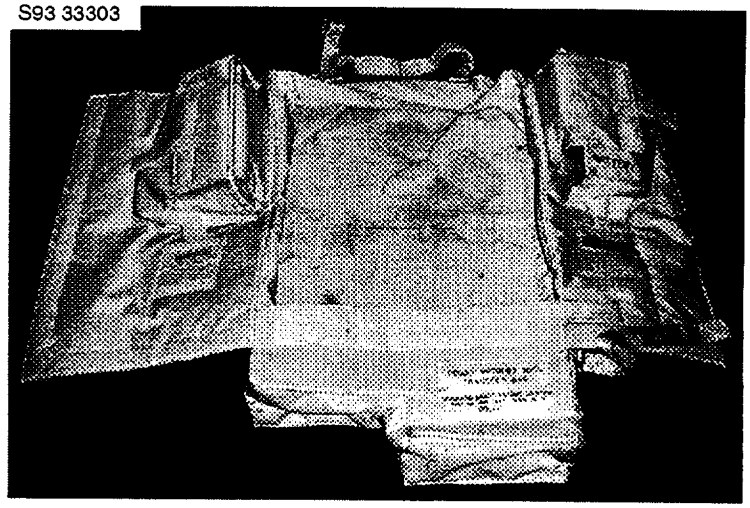


POWER RATCHET TOOL

S93 035367



S93 33303



OVERVIEW

The power ratchet tool (PRT) is a self–contained, power–driven, 3/8–in.–drive ratchet tool with brushless dc motor for extravehicular use. It was flown on STS–31 as an alternative means to deploy the Hubble Space Telescope (HST) solar arrays after automatic mechanism failure. It is intended for use as a general purpose power tool during HST maintenance missions.

OPERATIONAL COMMENTS

The PRT is battery powered and is controlled by a dedicated electronic controller, which is designed to be carried on the crewmember's mini–workstation. Fourteen discrete combinations of torque, turns, and speed may be programmed prior to the mission. The crewmember selects these parameters by a switch mounted on the controller. Fault lights are provided to indicate overtemperature, low battery charge, and electronic fault. A **large** trigger located on the handle is the start/stop control for the tool. The tool may also be used in a manual mode similar to a nonpowered ratchet wrench **by setting the motor controller switching ring to off**. The direction of the **manual** ratcheting action **is selected** using an external switching ring surrounding the gearhead/ratchet assembly **(RCW, RCCW)**. **To use the motorized mode, this gearhead switch ring must be set to motor while the motor switch ring is set to MCW or MCCW to select turn direction.** The silver–zinc battery module located in the controller is replaceable during an EVA and has a spring–loaded handle **lock** release and tether point. **To protect the battery from cold environments, the controller should be left on at all times during exposures outside the airlock**. The ratchet has a mini–workstation bayonet fitting and 6–ft retractable tether **with small french hook** to accommodate transport and worksite use. The controller has a tether ring, bayonet fitting, two bayonet fitting receptacles, **and a handrail clamp**. The **bayonet** receptacles permit ratchet attachment to the controller or tool caddy attachment so that the mini–workstation has full carrying capability even after the PRT is installed. **The handrail clamp is secured with a pull–to–release large 1/4 turn fastener and will rotate 360° for worksite customization.** **A tool** bag has been added to **restrain** one ratchet **with attached torque limiter**, one controller, and **two spare** batteries. **Velcro flaps below each spare battery packet are marked CHRG and DISCHRG to help track state of charge.**

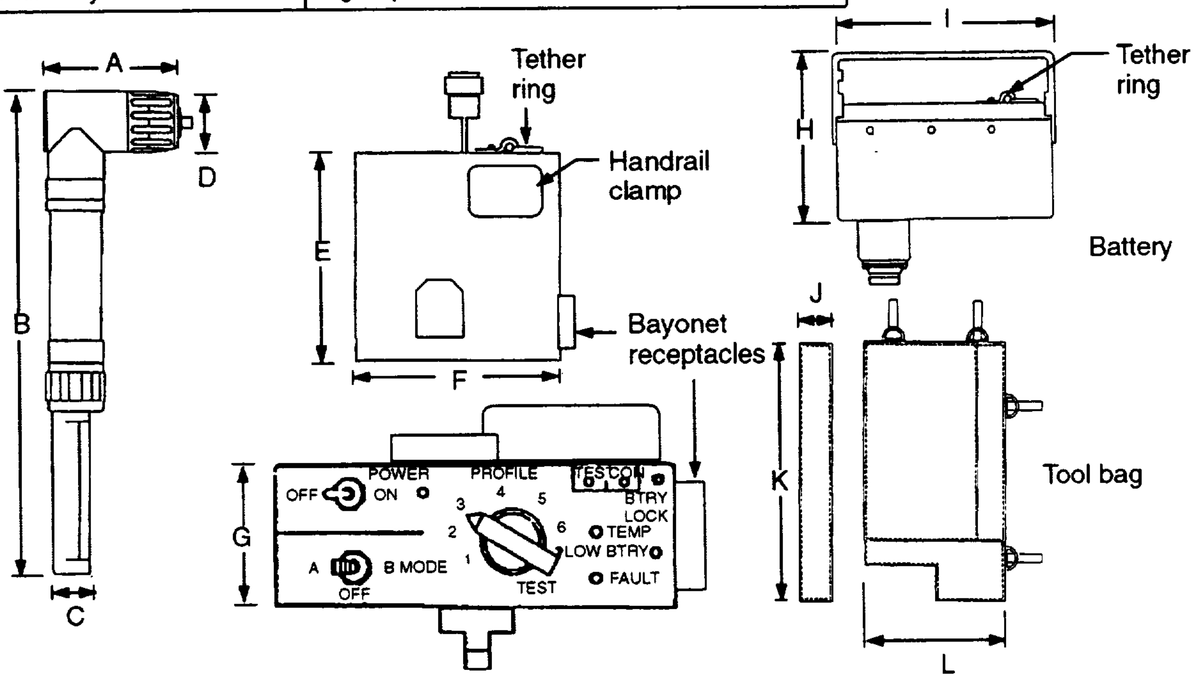
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1775
Technical: P. Richards, NASA/GSFC, (301) 286–1434

POWER RATCHET TOOL

Technical Information	
Part number	1525100 (PRT assembly) 1525270/2351700 (ratchet/umbilical) 96332503000 (battery) 96332500000 (controller) PRT–TBO2 (tool bag)
Weight	8.5 lb (ratchet) 1.0 lb (umbilical) 7.5 lb (controller) 2.9 lb (battery) 2.9 lb (transfer bag)
Material/construction	Anodized titanium and aluminum (ratchet) Flouroglas beta fabric and armalon (transfer bag)
Load rating	75 ft–lb (maximum manual torque) 10 ft–lb (at 30 rpm) 25 ft–lb (peak motorized torque)
Programmable parameters Torque Turns Speed	 0 to 25 ft–lb (increments of 1.0) 0.25 to 873 (increments of 0.25, 0.5, or 0.75) 10 to 30 rpm
Power supply	28 V dc silver–zinc battery, 42 W–hr capacity, 7 W nominal load
Cable length	6 ft
Temperature range	
Quantity flown	One for STS–31 and STS–51, two for STS–61
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	5.45	13.84
B	16.9	42.93
C	1.5	3.81
D	2.5	6.35
E	9.65	24.51
F	8.2	20.83
G	2.9	7.37
H	5.5	14.0
I	8.3	21.0
J	3.00	7.62
K	22.00	55.88
L	13.00	33.02



POWER TOOL, EVA

S83–44719

OVERVIEW

The extravehicular activity (EVA) power tool is a battery–powered, two–speed/four–torque unit with a 3/8–in. drive drop–proof tether fitting for attaching tools such as screwdrivers, sockets, and drill bits. It has a two–speed switch, a four–position torque control ring, and a forward/reverse switch. Power is provided by a 7.2–V NiCd rechargeable battery which fits into the tool's back end.

OPERATIONAL COMMENTS

The EVA power tool can be used for any EVA task that requires a portable torque device for tightening/loosening bolts, drilling, or assisting in any manual cranking. Normally one power tool is stored in a middeck locker along with several battery packs to allow pre–EVA checkout. A second power tool without a battery can be stored in the payload bay.

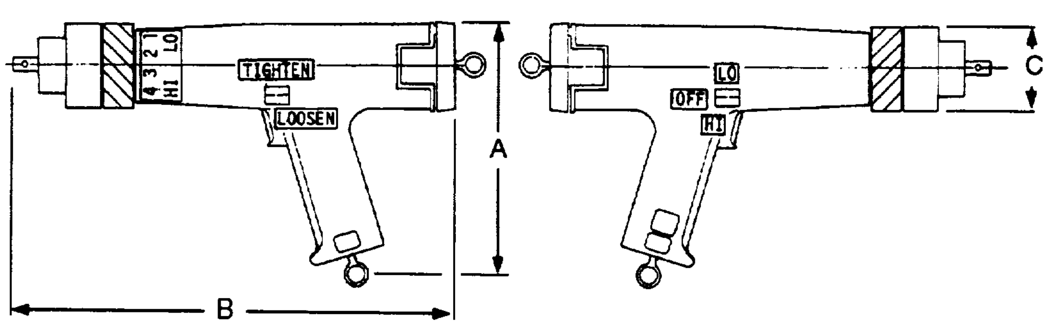
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

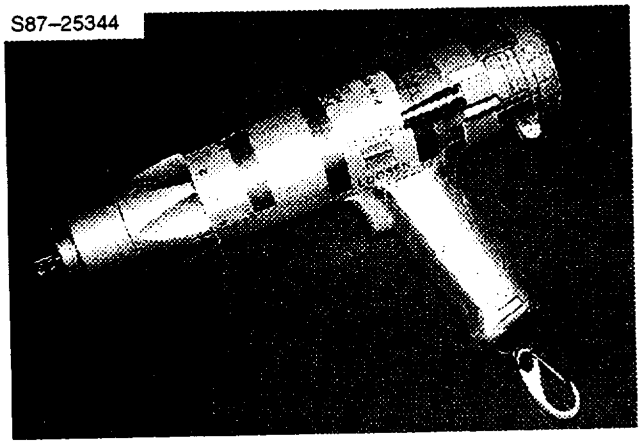
POWER TOOL, EVA

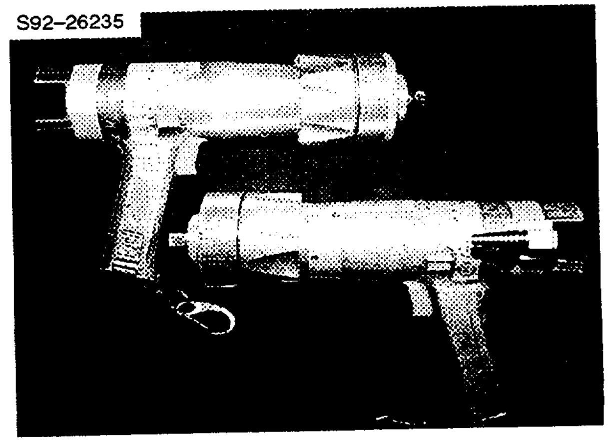
Technical Information				
Part number	10172–20500–01			
Weight	2.09 lb (without battery)			
Material/ construction	Case – Glass–filled Lexan body, polymide gear housing covered with reflective aluminum tape **Battery pack – 7.2 V NiCd**			
Speed	50 rpm, 100 rpm (with low torque loads)			
Direction	Forward/reverse (tighten/loosen)			
Capacity	375 to 450 screws/battery pack			
Stall torque values (in–lb)		Position	Tighten	Loosen
	Low speed	1	15	15
		2	29	27
		3	54	40
		4	166	150
	High speed	1	10	12
		2	26	20
		3	41	34
		4	192	175
Load rating				
Temperature range				
Quantity flown				
Stowage	Middeck locker or insulated external tool locker without battery			
Availability	Flight specific			

Dimensional Data		
	inches	cm
A	6.50	16.51
B	11.75	29.85
C	2.25	5.72



POWER TOOL, EVA (HST)


S87-25344


S92-26235

OVERVIEW

This extravehicular activity (EVA) power tool is a modified, battery-operated power tool with torque and rpm control. The clutch torque is controlled by use of a serrated adjustment ring. The design includes a 3/8-in. drive drop-proof tether fitting, forward and reverse drive rotation, torque ranges from 50 to 300 in-lb in four clutch positions, a bayonet fitting which allows attachment of the tool to the mini work station, a tether point on the removable battery pack, and a 6-ft retracting tether with a french hook in the tool handle. The tether uses steel cable for improved resistance. This tool was developed for use in Hubble Space Telescope (HST) maintenance.

OPERATIONAL COMMENTS

The crewmember has three choices to make in the operation of this tool: torque limit, direction, and rpm. The crewmember selects torque by setting the clutch ring. Forward or reverse rotation is selected by setting the tighten/loosen switch. The tool has fixed speeds of 20 and 50 rpm which are controlled by a switch on the side of the tool opposite the tighten/loosen switch. The motor is engaged by pulling back on the trigger-style control switch in the handle. Releasing the control switch disengages the motor. The tool direction switch should be returned to the OFF position when it is not in use. The tool uses a replaceable/rechargeable 7.2 V dc nickel-cadmium battery pack. The battery pack life is dependent on the duration and loads that it will see. The EVA power tool and its battery packs are usually stored in a middeck locker for launch. The tool can be stored in the payload bay in a tool container, but without the battery packs.

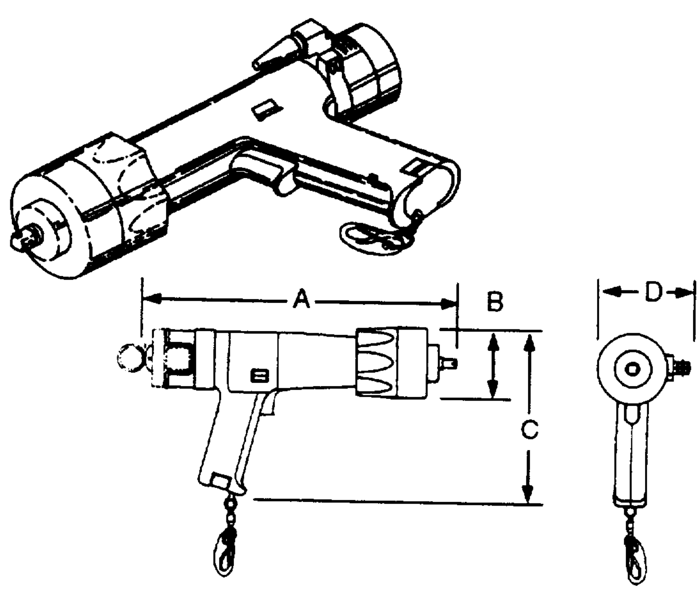
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

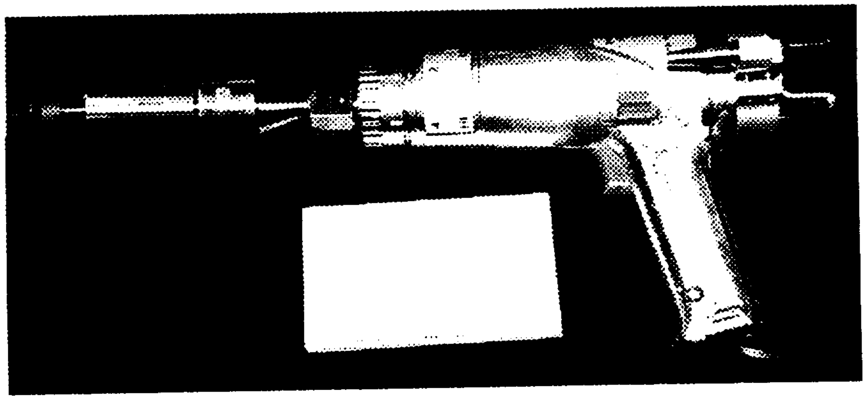
POWER TOOL, EVA (HST)

Technical Information	
Part number	10181–10001–03
Weight	**3.17** lb (without battery)
Material/ construction	Body: Glass–filled Lexan Reflective aluminum tape Lubricants: Flourinated polyether Vacuumized grease
Power source	7.2 V rechargeable Ni–Cd battery pack
Speed	20 rpm, 50 rpm (with low torque loads)
Load rating **(stall torque (ft–lb))** at ambient temperature	Position / Tighten/Loosen Low speed: 1 2.92–4.38; 2 5.00–7.29; 3 10.42–13.13; 4 12.50–16.25 High speed: 1 2.50–4.17; 2 5.42–8.13; 3 11.25–13.54; 4 18.75–23.13
No. fasteners per battery charge	48 – LO speed, no. 8 screws, 1/2–in. length, fine threads 44 – HI speed, 1/4–in. screws, 1/2–in. length, fine threads
Temperature range	–150° to +250° F
Quantity flown	Two for STS–31, STS–37, STS–49, and STS–61
Stowage	Middeck locker or external tool locker without battery
Availability	Flight specific

Dimensional Data		
	inches	cm
A	12.20	30.99
B	2.75	6.99
C	6.70	17.02
D	3.13	7.95



POWER TOOL, ROTARY IMPACT



OVERVIEW

This power tool system formally known as the rotary impact torque tool system, is composed of a power tool and a rotary impact torque tool attachment. This combination has been developed for Hubble Space Telescope (HST) maintenance as a contingency device to break free bolts that do not release at expected low torques. It utilizes a brush type dc motor with manually selected speed, torque, and direction control. It operates with a removable 7.2–V NiCd battery pack. Maximum impact torque output is 360 in.–lb, corresponding to the approximate breakaway torque required to loosen a fastener torqued to 450 in.–lb. Each component has drop–proof tether interfaces for 3/8–in. square drive attachments. The power tool has a pistol grip handle and trigger. A bayonet fitting on the body of the power tool and a fixed tether ring at the end of the power tool handle are provided for tool transport and restraint.

OPERATIONAL COMMENTS

Since existing small EVA power tools can generate limited torque, they are inadequate for the release of stuck fasteners. This design solution provides sufficient torque without subjecting the vehicle structure near the fastener to high impact loads. It also can be easily controlled by the EVA crew since the full torque is not transmitted to the handle. The high speed power tool control operation is the same as the HST EVA power tool. No load output speeds are 300 and 600 rpm, and the high speed setting provides approximately three to four times the impact torque load output as the low speed setting. In order to provide adequate torque to the Rotary Impact Torque Tool, the power tool clutch must be set in either position 3 or position 4. Socket extensions are attached to the impact tool to interface with various size EVA fasteners. Short extensions provide higher loads at the bolt head interface than long extensions. Battery operating life will vary between 3 minutes and 15 minutes, depending on the amount of time the impact feature of the impact tool is functioning and the running torque of the fastener being loosened. Torque output capability of the tool is highly dependent on charge status of the battery. Batteries are stowed separately.

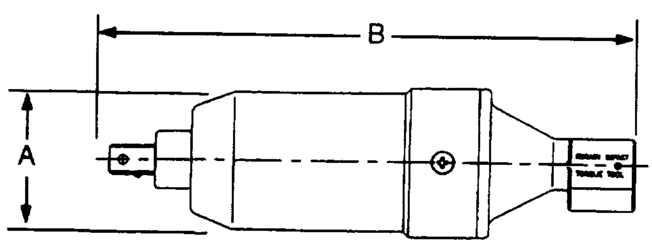
CONTACTS

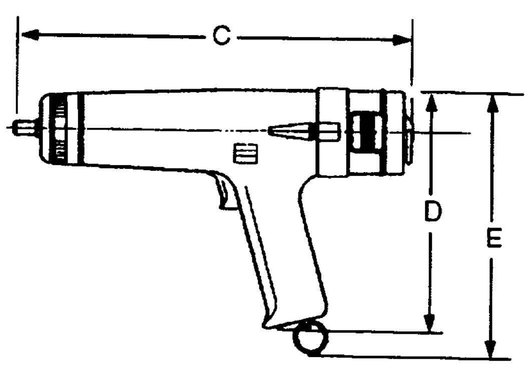
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. Marak, NASA/EC5, (713) 483–9144

POWER TOOL, ROTARY IMPACT

Technical Information	
Part number	10181–10073–01 (impact wrench attachment) 10181–10072–01 (high speed power tool) 10181–10002–01 (battery)
Weight	3.00 lb (impact wrench attachment) 2.50 lb (high speed power tool without battery)
Material/ construction	Limited life items – (battery) Lubricants – Dry film lubricant, flourinated polyether vacuumized grease Metallics – Stainless steel impact wrench housing Nonmetallics – Glass–filled Lexan body, reflective aluminum tape
LOAD rating	300 and 600 rpm (no load) 15 to 120 in–lb (low speed) 15 to 360 in–lb (high speed)
Temperature range	–20 to +150° F (power tool/impact wrench) –90 to +150° F (impact wrench)
Quantity flown	One on STS–61
Stowage	Middeck locker
Availability	Flight specific

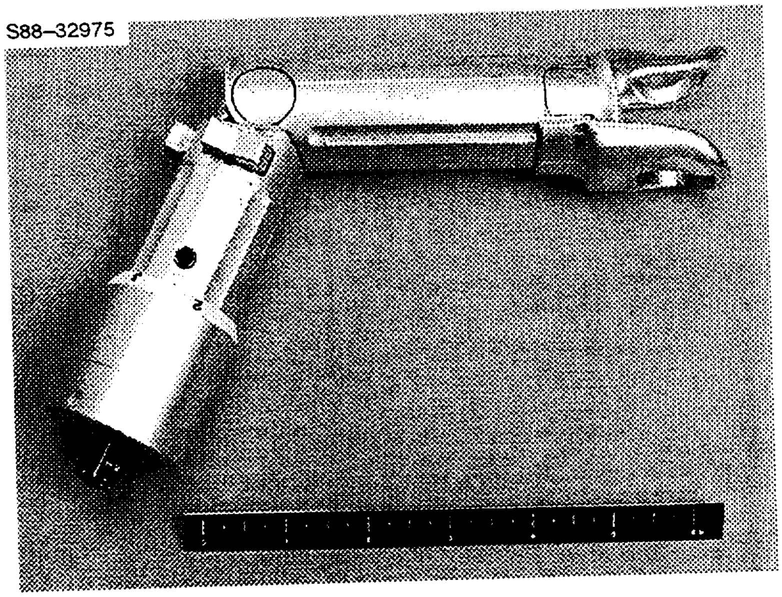
Dimensional Data		
	inches	cm
A	1.94	4.93
B	6.89	17.50
C	10.49	26.64
D	6.59	16.74
E	7.29	18.52





POWER TOOL, MINI

S88–32975



OVERVIEW

The mini power tool is a battery–operated screwdriver intended for use when a larger power tool is not required and when work space is limited. The tool can be used as a power tool or, with the power off, the output shaft is locked automatically for use as a manual driver. The design includes a 3/8–in. drive drop–proof tether fitting, forward and reverse drive rotation, six clutch settings from **6** to **13** in–lb, and tether points on the removable battery pack and the tool handle.

OPERATIONAL COMMENTS

After one of the six clutch settings has been selected, the crewmember depresses a thumb lever switch to initiate forward or reverse rotation. Releasing the control switch disengages the motor. The tool has a single no–load speed (forward or reverse) of 170 rpm. It incorporates a replaceable/rechargeable 2.4 V dc, 1.7 A–hr nickel–cadmium battery pack with a 30–amp fuse.

The drive locks when the power is off, allowing the tool to be used as a manual driver. The maximum locking torque for manual tightening is **120** in–lb. The housing is hinged to allow **68°** articulation, giving a mechanical advantage in manual tightening. The STS intravehicular activity version of the tool does not have extravehicular activity–**compatible** lubricants.

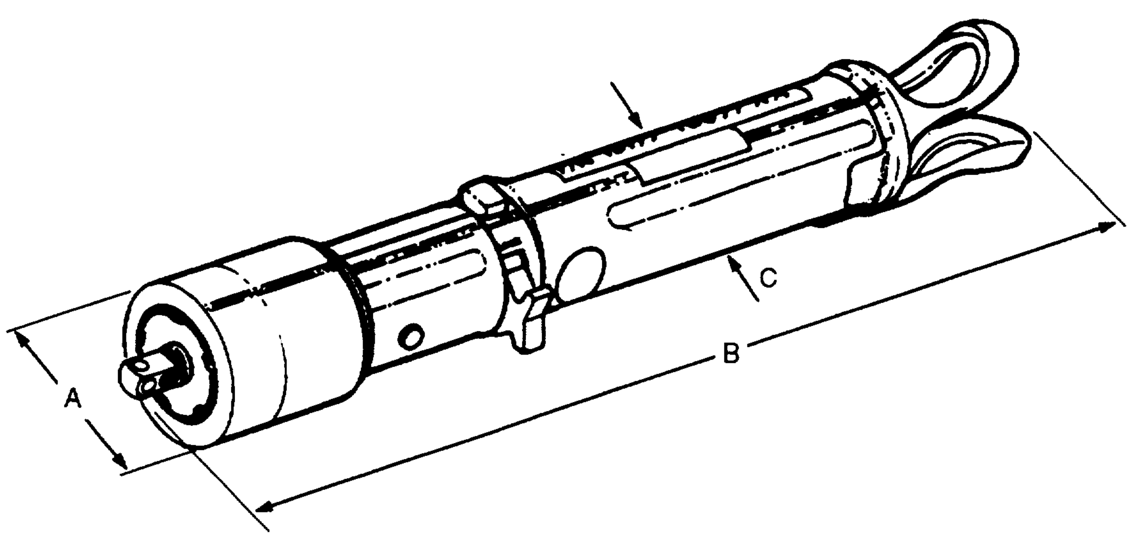
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

POWER TOOL, MINI

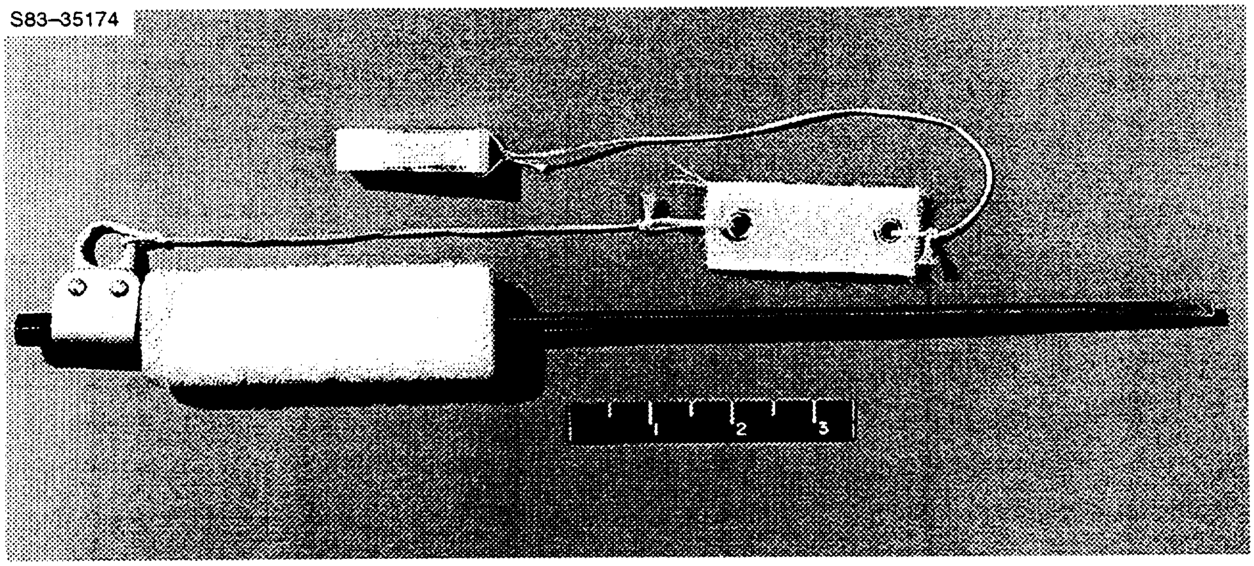
Technical Information	
Part number	10177–10001–01
Weight	**0.82** lb **without battery** **1.20** lb **with battery**
Material/ construction	Housing – ABS Cycolac Reflective aluminum tape
Power source	2.4 V rechargeable NiCd battery pack
Clutch settings at ambient (72°)	1 **2–7** in–lb 2 **5–11** in–lb 3 **7.5–14** in–lb 4 **10.5–17** in–lb 5 **13–20** in–lb 6 **14–22** in–lb
Load rating	**120 in–lb (manual mode), 190 rpm (unloaded)**
Temperature range	–130° to +150° F (operational)
Quantity flown	Two for STS–48
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.77	4.50
B	10.95	27.81
C	1.42	3.61



PROBE

S83-35174



OVERVIEW

The probe is a 0.188-in. diameter rod with a flattened screwdriver-type tip. Made of tool steel with a Velcro-wrapped aluminum handle, the 14.5-in. probe has a ring for tether attachment and a Teflon protective cap for the tip.

OPERATIONAL COMMENTS

The tool is used for probing jammed equipment, loosening, and determining bolt-hole alignment. It is part of the normally manifested STS equipment and is wrapped in a Velcro-lined tool caddy along with the hammer and stowed in the port provisions stowage assembly (PSA).

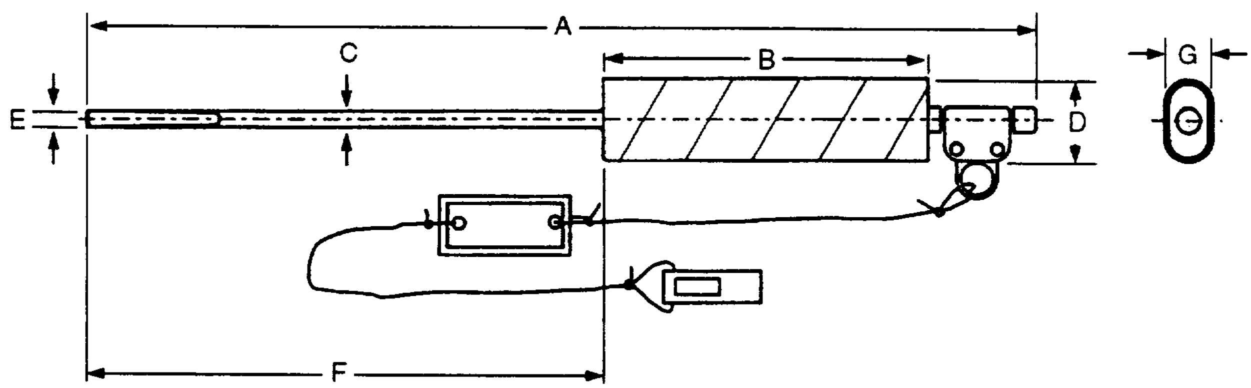
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC5, (713) 483-9247

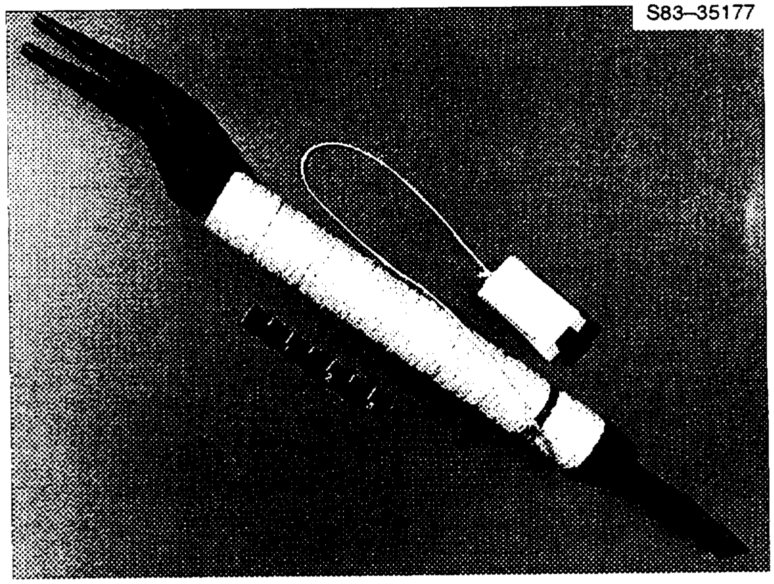
PROBE

Technical Information	
Part number	V628–650879–005 or SDD33103434–301
Weight	0.6 lb
Material/ construction	Rod – Tool steel Handle – Aluminum, Velcro–wrapped, tether ring
Load rating	**30 lb to induce permanent 10° bend**
Temperature range	–200° to 250° F (operational), +350° F (stowage)
Quantity flown	One
Stowage	Port PSA
Availability	Standard

Dimensional Data		
	inches	cm
A	11.0000	27.94
B	4.0000	10.16
C	0.1880	0.48
D	1.2500	3.18
E	0.1875	0.48
F	8.7500	22.23
G	0.7500	1.91



PRY BAR



OVERVIEW

The pry bar has a 1/2–in. slot on one end and a blunt chisel on the other end. The slotted end is 3–7/8 in. long, and the chisel end is 3–3/8 in. long. The handle may be extended 4–1/2 in. for extra leverage. The bar itself is partially wrapped with Velcro for tool caddy stowage and has a tether ring to prevent loss of the tool during extravehicular activity. A Teflon protective cap on a lanyard protects against inadvertent punctures.

OPERATIONAL COMMENTS

The pry bar is a general purpose jam removal tool with no specific tasks designated. It is part of the normally manifested STS equipment. It is wrapped in a Velcro–lined tool caddy along with the forceps and is stowed in the port provisions stowage assembly (PSA).

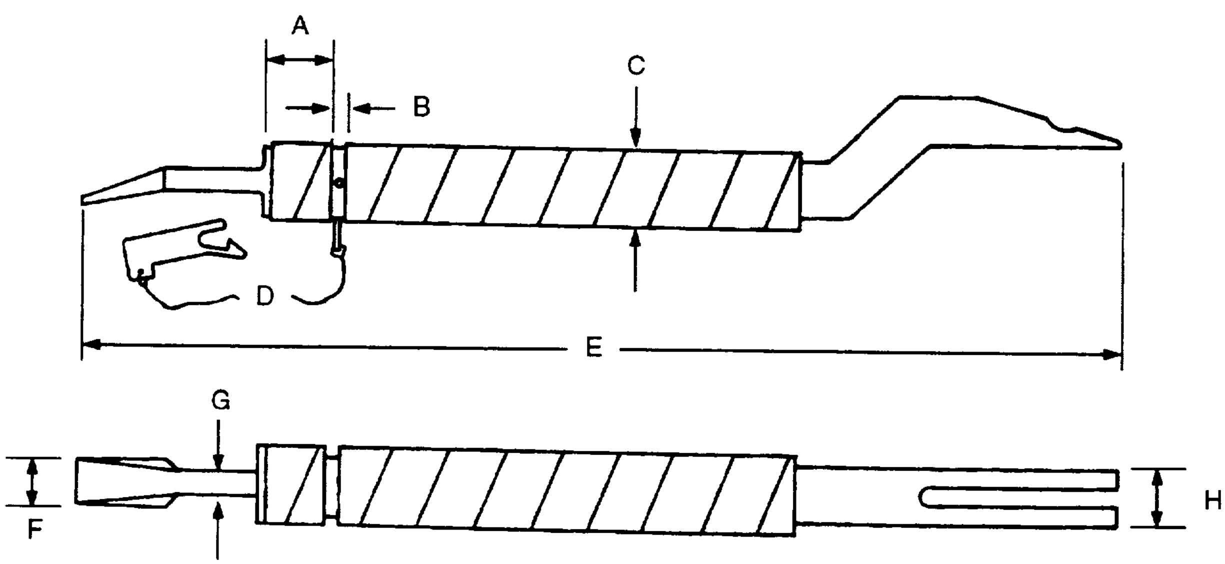
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

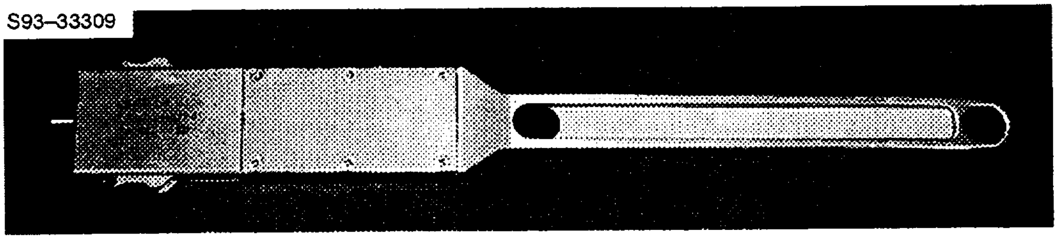
PRY BAR

Technical Information	
Part number	V628–650990–006 or SDD33103444–301
Weight	3.2 lb
Material/ construction	Tool steel, Velcro–wrapped handle Lubricant – Molykote 321R
Load rating	**30 lb input**
Temperature range	–200° to 250° F (operational), +350° F (storage)
Quantity flown	One
Stowage	Port PSA
Availability	Standard

Dimensional Data		
	inches	cm
A	1.12	2.84
B	0.25	0.64
C	1.24	3.15
D	12.00	30.48
E	17.40 min. 21.90 max.	44.20 min. 55.63 max.
F	0.60	1.52
G	0.40	1.02
H	1.00	2.54



RATCHET WRENCH CHEATER BAR



OVERVIEW

The ratchet wrench cheater bar, also known as the cheater bar assembly, is designed as an extension for the extravehicular activity (EVA) ratchet wrench to achieve higher torques. It was created for the STS–37 gamma ray observatory (GRO) deployment mission to assist with the latches for solar array and high gain antenna deployment/ restow. Maximum drive shaft torque for the latch actuator overrides was anticipated to be high enough that a basic power tool or ratchet wrench would be inadequate.

OPERATIONAL COMMENTS

Spring–loaded tabs lock the cheater bar onto the segmented grip of the ratchet wrench handle. Squeezing the tabs releases the cheater bar from the ratchet. A drop–proof tether mounted on the end of the cheater bar allows it to be attached to a tool small tool board for hands–free transport or a large tool board for workstation stanchion mounting. Since the EVA ratchet has only a 3/8–in. drive, care must be used to avoid overloading the ratchet by applying too much force to the cheater bar. A pair of tether rings on the handle is provided for equipment handling at the worksite.

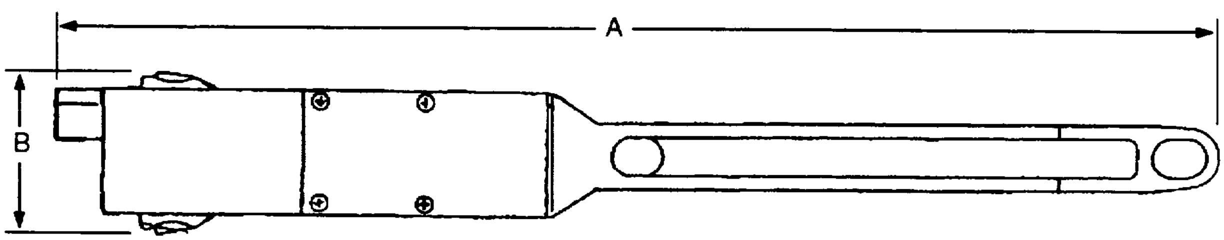
CONTACTS

Operational: B. Adams, JSC/DF42, (713) 483–2567
Technical: R. Marak, NASA/EC5, (713) 483–9144

RATCHET WRENCH CHEATER BAR

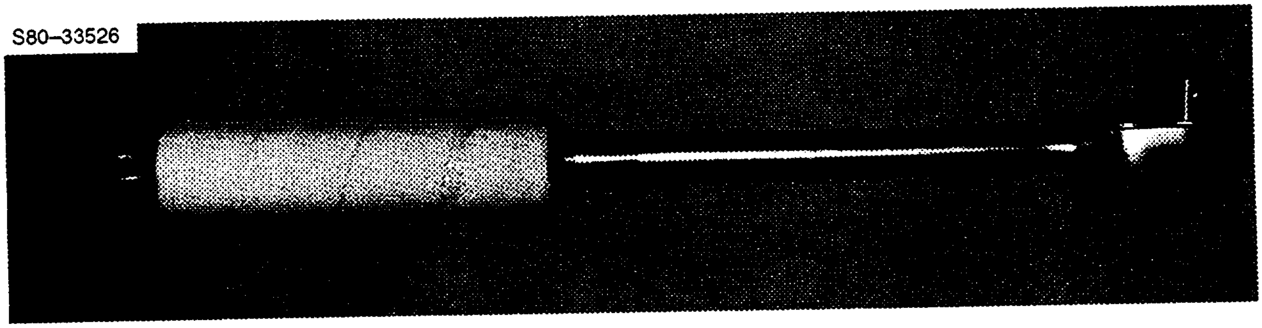
Technical Information	
Part number	10159–10065–01
Weight	2.5 lb
Material/ construction	Aluminum
Load rating	60 ft–lb with ratchet
Temperature range	–120° to +250° F
Quantity flown	One (STS–37) One (STS–61)
Stowage	Middeck locker (STS–37) STBD PSA (STS–61)
Availability	Flight specific

Dimensional Data		
	inches	cm
A	21.89	55.60
B	3.13	7.95



RATCHET, 3/8–INCH DRIVE

S80–33526



OVERVIEW

The 3/8–in. drive ratchet is a common tool modified for **contingency** EVA use. It allows ratcheting in both directions; a small lever is used to select direction. A tether ring is mounted on the end of the handle for tethering.

OPERATIONAL COMMENTS

The 3/8–in. drive ratchet is used as a contingency radiator disconnect tool in conjunction with a 3/8–in. drive extension and a 1/4–in. hex. This ratchet is part of the normally manifested orbiter equipment. It is wrapped in a Velcro–lined tool caddy along with the 1/4–in. allen wrench extension and is stowed in the **port** provisions stowage assembly (PSA). **This tool lacks a drop–proof tether interface.**

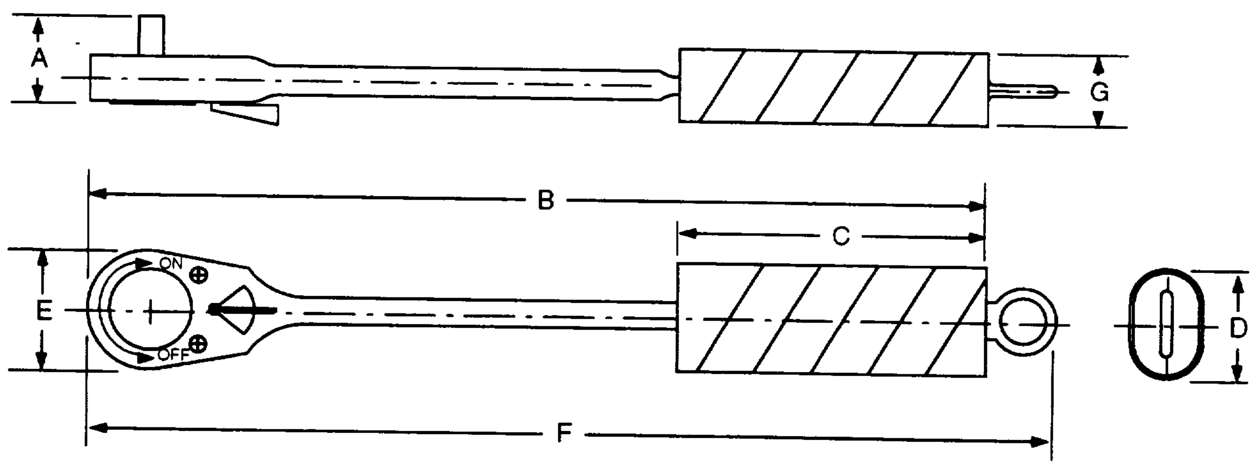
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

RATCHET, 3/8–INCH DRIVE

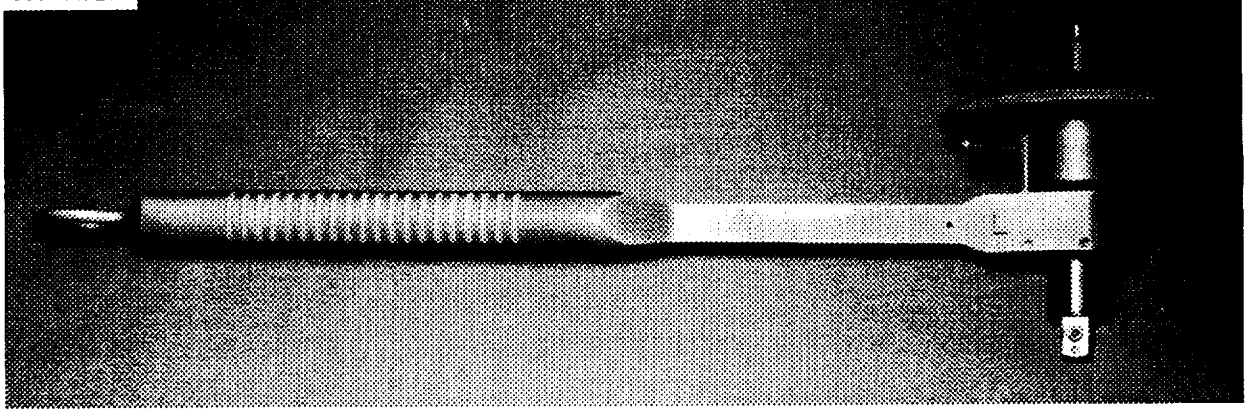
Technical Information	
Part number	V628–650881–004 or SDD33103447–301
Weight	**0.90** lb
Material/ construction	Tool steel, Velcro–wrapped handle with tether ring Lubricant – Molykote 321R
Load rating	**45 ft–lb**
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	One
Stowage	**Port** PSA
Availability	Standard

Dimensional Data		
	inches	cm
A	1.000	2.54
B	11.000	27.94
C	4.000	10.16
D	1.500	3.81
E	1.125	2.86
F	11.500	29.21
G	0.750	1.91



RATCHET, 3/8–INCH DRIVE (EVA)

S83–44726



OVERVIEW

The extravehicular activity (EVA) 3/8–in. drive ratchet, also known as an Essex wrench, is specially designed for EVA use. It allows 360° ratcheting in either direction with a lever for selection of direction. The tool is equipped with a palm wheel that is turned by hand when overtorquing needs to be avoided, or when resistance (backdriving) is insufficient to operate the ratchet. The handle is grooved for better grip and has a tether ring at the end.

OPERATIONAL COMMENTS

The 3/8–in. drive ratchet has a drop–proof tether interface and is intended for use with sockets or extensions equipped with a drop–proof tether. This tool is not normally manifested, but has flown as a backup for the EVA power tool. **Sockets are released from the ratchets by depressing a button on top of the mushroom knob.**

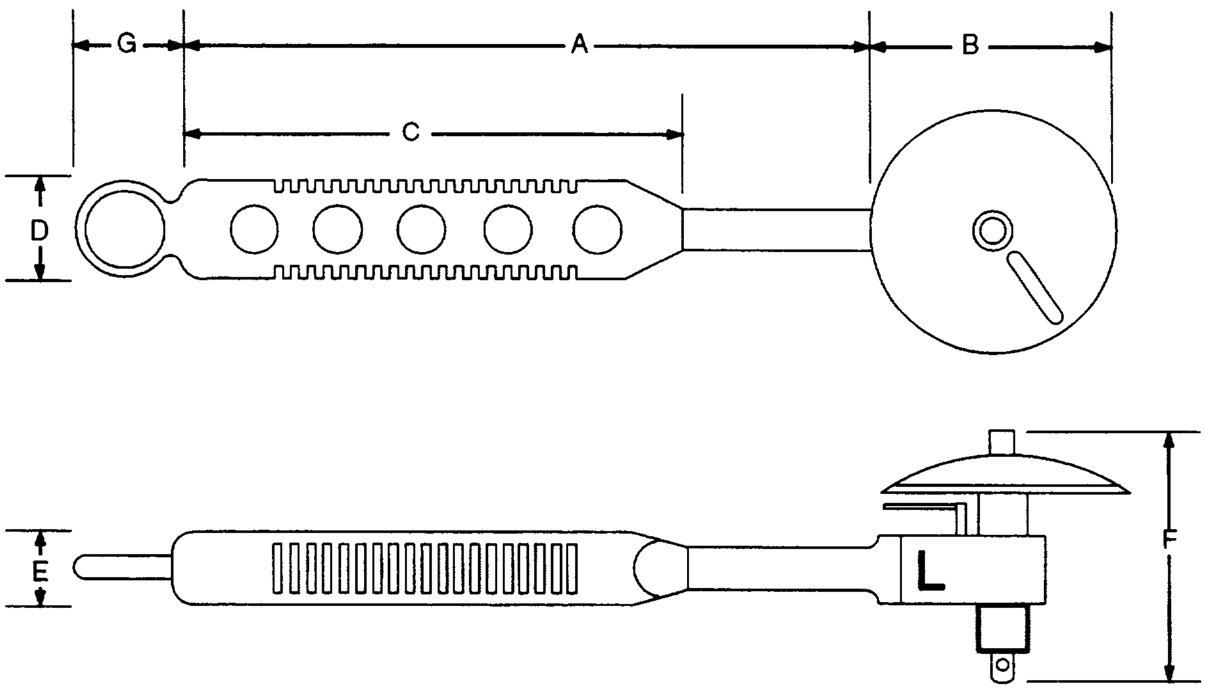
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

RATCHET, 3/8–INCH DRIVE (EVA)

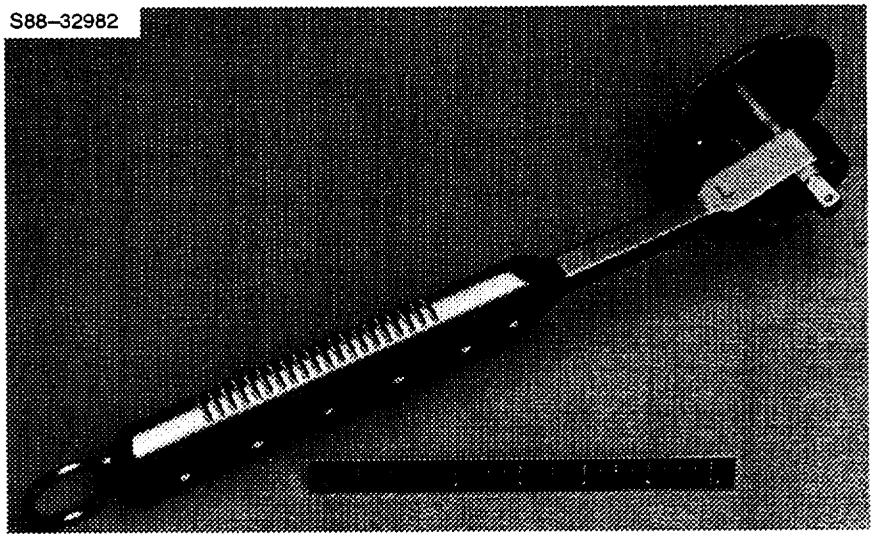
Technical Information	
Part number	10172–20530–01
Weight	1.18 lb
Material/ construction	Aluminum, tether ring on handle Grooved handle with holes
Load rating	
Temperature range	–100° to 200° F
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	10.50	26.67
B	3.50	8.89
C	7.12	18.08
D	1.50	3.81
E	0.75	1.91
F	4.06	10.31
G	1.75	4.45



RATCHET, 3/8–INCH DRIVE McTETHER

S88–32982



OVERVIEW

The 3/8–in. drive McTether ratchet is an Essex–style wrench with a built–in drop–proof tether interface. The tool has a palm wheel, a grooved handle, and a tether ring. It has been designed specifically for Hubble Space Telescope (HST) maintenance **as an alternative or backup to power tools.**

OPERATIONAL COMMENTS

The 3/8–in. drive McTether ratchet is intended for use with sockets or extensions equipped with a drop–proof tether. The –02 ratchet incorporates a double pawl to decrease the backdrive and improve the performance of the tool. Extravehicular activity (EVA) restraint for this tool can be provided by the ratchet tool caddy described later in this catalog. **Sockets are released from the ratchet by depressing a recessed button on top of the mushroom knob. The handle lacks Velcro to protect against particulate contamination in the vicinity of HST.**

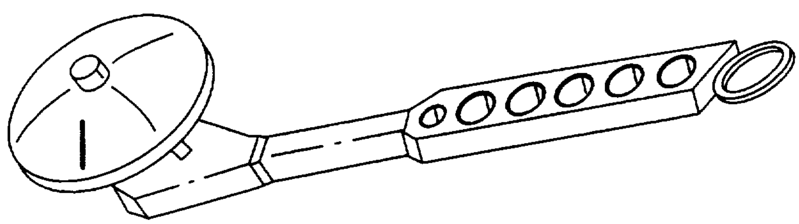
CONTACTS

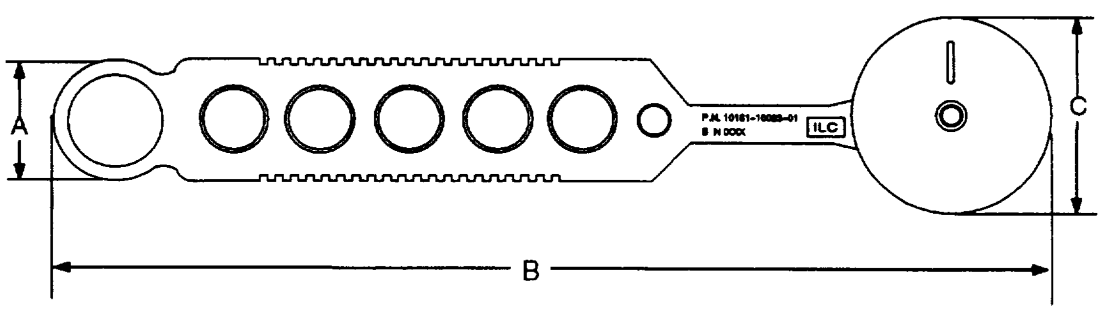
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

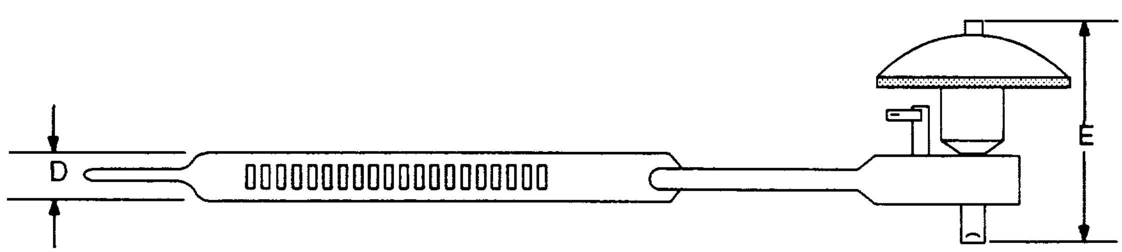
RATCHET, 3/8–INCH DRIVE McTETHER

Technical Information	
Part number	10181–10023–01 10181–10023–02 (double pawl–low back drive)
Weight	1.34 lb
Material/ construction	Anodized aluminum
Load rating	**70** ft –lb **7 in–oz** backdrive
Temperature range	–150° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.50	3.81
B	15.62	39.67
C	3.50	8.89
D	0.75	1.91
E	3.34	8.48

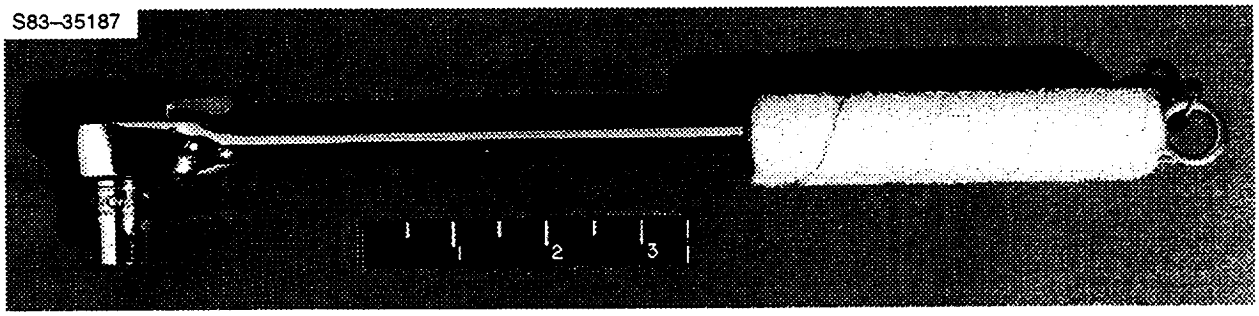






RATCHET, 3/8–INCH DRIVE ,WITH 7/16–INCH SOCKET

S83–35187



OVERVIEW

The 3/8–in. drive ratchet with 7/16–in. socket is flown as a contingency disconnect tool. The 3/8–in. drive ratchet is a standard commercially available tool modified for EVA support. It allows ratcheting in both the clockwise and counterclockwise directions. The 7/16–in. **12–point** socket is permanently pinned to the ratchet and allows for the removal of 7/16–in. nuts or bolts.

OPERATIONAL COMMENTS

The 3/8–in. drive ratchet with 7/16–in. socket is dedicated for use in dismantling the airlock inner hatch if the EVA crew cannot open the hatch to enter the middeck. **This ratchet has also been found necessary for EVA override of sill longeron mounted payload retention latches because of its low profile ratchet head and socket.** The 11–in. length of the ratchet allows an adequate lever arm for torquing. This tool is part of the normally manifested orbiter equipment and is used with the adjustable wrench. It is stowed **in the airlock** in the EVA bag during EVA operations.

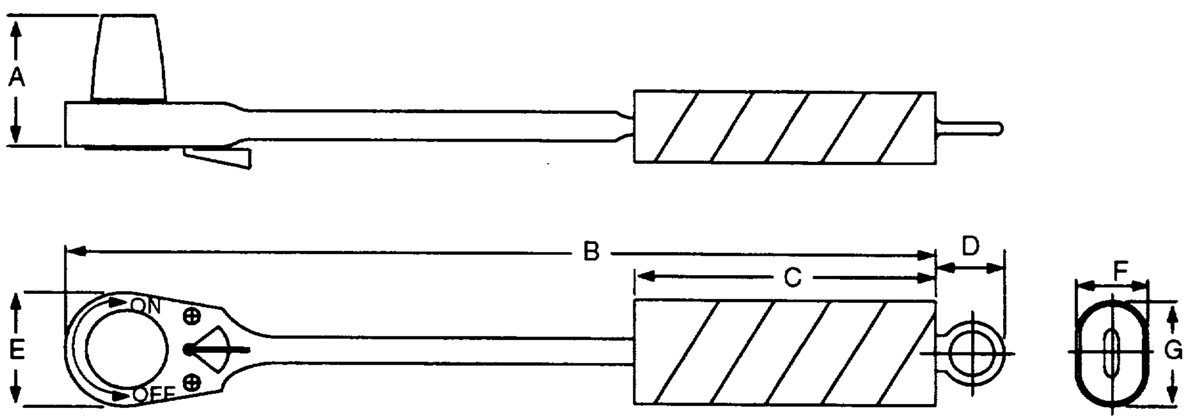
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

RATCHET, 3/8–INCH DRIVE, WITH 7/16–INCH SOCKET

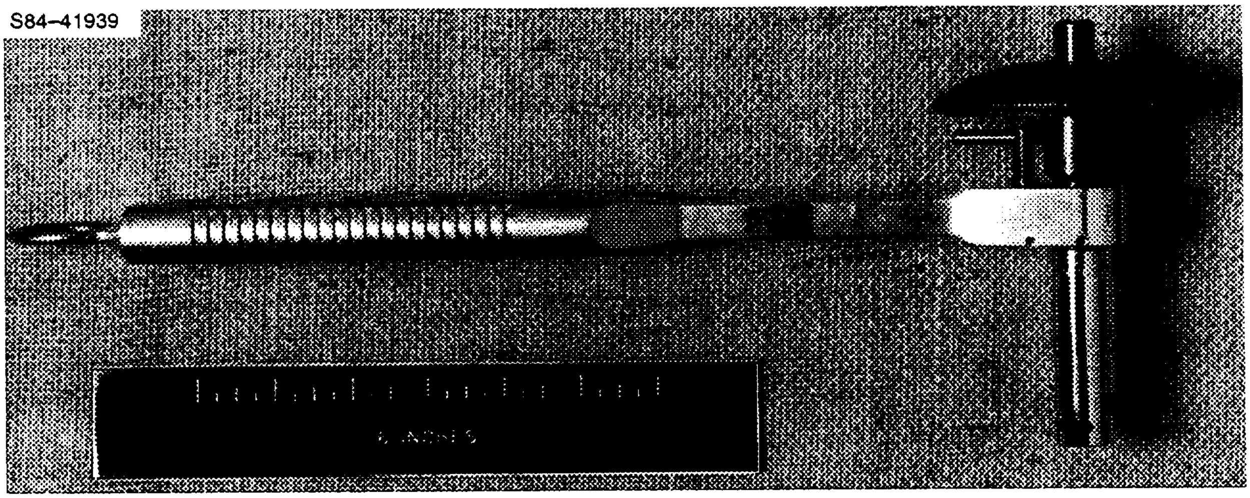
Technical Information	
Part number	V628–650860–**001** or SDD33103432–**303**
Weight	1.0 lb
Material/ construction	Tool steel, Velcro–wrapped handle Lubricant – Molykote 321R
Socket depth	0.5 in.
Load rating	**30–lb input**
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	One
Stowage	EVA bag
Availability	Standard

Dimensional Data		
	inches	cm
A	1.750	4.45
B	11.000	27.94
C	4.000	10.16
D	1.000	2.54
E	1.125	2.86
F	0.750	1.91
G	1.400	3.56



RACHET, 3/8–INCH DRIVE WITH 7/16–INCH SOCKET (EVA)

S84–41939



OVERVIEW

The EVA 3/8–in. drive ratchet with 7/16–in. socket is a specially designed tool for EVA use. A deep–well, 7/16–in. socket is stowed attached to the 3/8–in. drive. The tool allows continuous ratcheting in both the clockwise and counterclockwise directions. It is equipped with a lever for selection of drive direction and a palm wheel for fast, easy use during tightening or loosening. A tether ring is attached to the handle.

OPERATIONAL COMMENTS

The EVA 3/8–in. drive ratchet with 7/16–in. socket can be used on any accessible 7/16–in. bolt or nut. It was originally designed to extend the aft frame tilt actuator (AFTA) of the inertial upper stage (IUS) manually. This tool, also called the IUS socket wrench, is flown with IUS payloads.

A **recessed** button on top of the palm wheel can be depressed with a pointed object to release the socket. A collar around the button prevents inadvertent socket release.

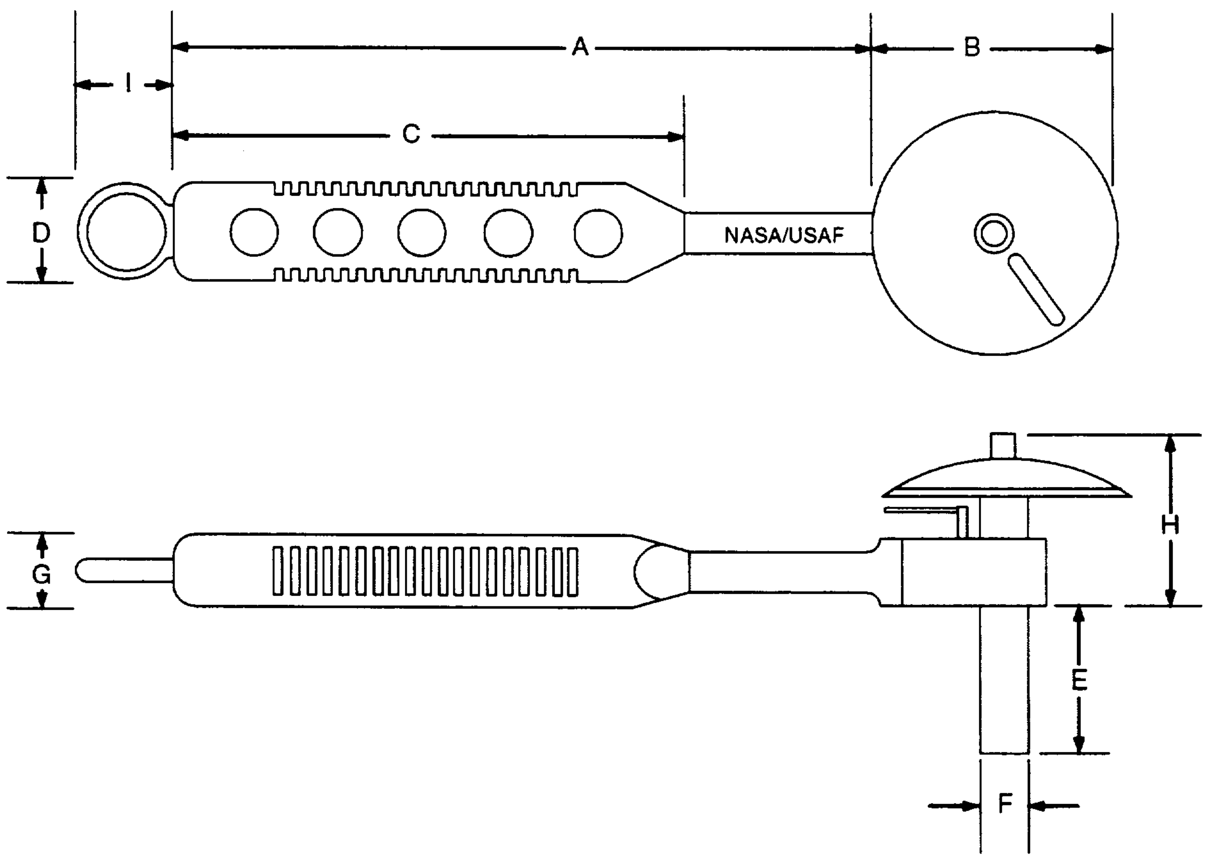
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

RATCHET, 3/8–INCH DRIVE WITH 7/16–INCH SOCKET (EVA)

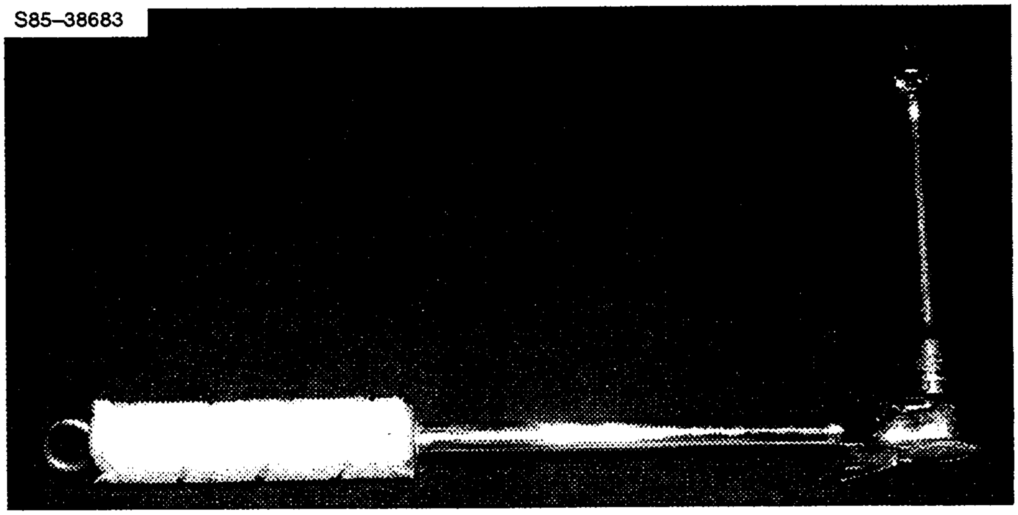
Technical Information	
Part number	Wrench ESEX–82–27–10 Socket 47–61–21–2
Weight	1.251 lb
Material/ construction	Drive housing–aluminum Drive and socket – tool steel
Socket depth	2.0 in.
Load rating	
Temperature range	–100° to 200° F
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	10.25	26.04
B	3.50	8.89
C	7.18	18.24
D	1.50	3.81
E	2.60	6.60
F	0.65	1.65
G	0.75	1.91
H	2.78	7.06
I	1.50	3.81



RATCHET, 3/8–INCH DRIVE WITH 7/16–INCH SOCKET AND EXTENSION

S85–38683



OVERVIEW

The 3/8–in. drive ratchet with 7/16–in. socket and extension is flown as a contingency disconnect tool. The 3/8–in. drive ratchet is a standard commercially available tool modified for EVA use. It allows ratcheting in both the clockwise and counterclockwise directions. The 7/16–in. **12–point** socket **and** extension **are** permanently **pinned** to the ratchet. The extension allows a 4–in. reach to **install** or remove 7/16–in. nuts and bolts. A tether ring is attached to the base of the handle.

OPERATIONAL COMMENTS

The 3/8–in. drive ratchet with 7/16–in. socket and extension is dedicated for use in dismantling the airlock outer hatch if the EVA crew cannot open the hatch to enter the airlock. **With its 4–in. extension, this ratchet is also used for IUS aft ASE slip–ring pin–pusher override.** The 11–in. tool length allows an adequate lever arm for torquing. This tool is part of the normally manifested orbiter equipment. It is wrapped in a Velcro–lined tool caddy along with the adjustable wrench and is stowed in the **port** provisions stowage assembly (PSA).

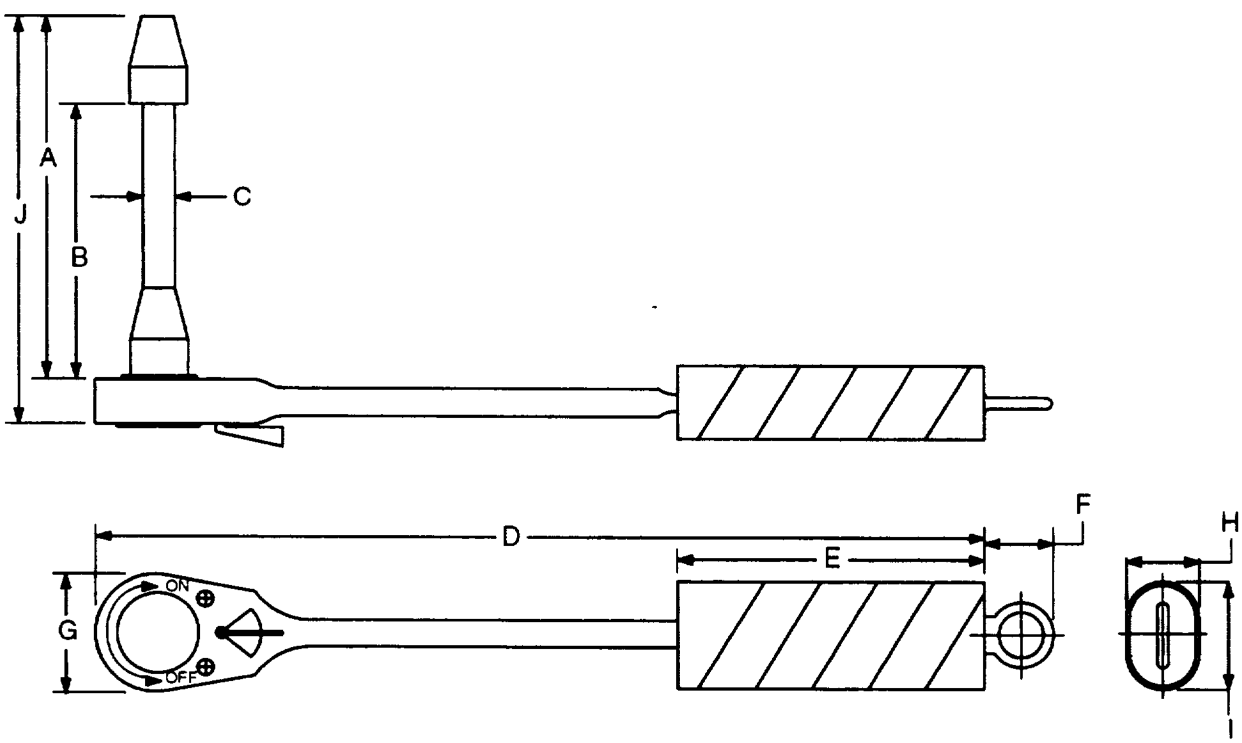
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

RATCHET, 3/8–INCH DRIVE, WITH 7/16–INCH SOCKET AND EXTENSION

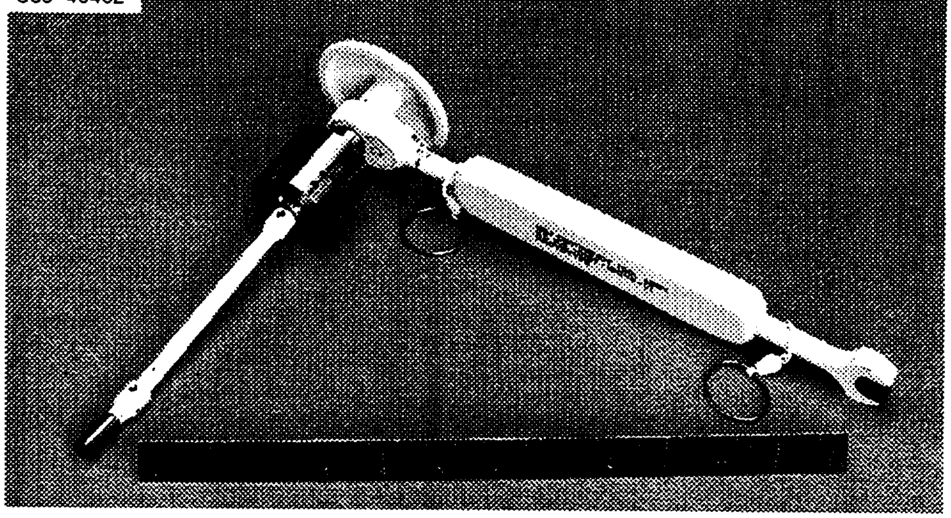
Technical Information	
Part number	V628–650860–**003** or SDD33103432–**301**
Weight	1.2 lb
Material/ construction	Forged steel, Velcro–wrapped handle Lubricant – Molykote 321R
Load rating	**45 ft–lb**
Temperature range	**–200° to +250° F (operational), +350° F (stowage)**
Quantity flown	One
Stowage	Tool caddy in **port** PSA
Socket depth	0.5 in.
Availability	Standard

Dimensional Data		
	inches	cm
A	4.900	12.45
B	4.000	10.16
C	0.400	1.02
D	11.000	27.94
E	4.000	10.16
F	1.000	2.54
G	1.125	2.86
H	0.750	1.91
I	1.400	3.56
J	5.500	13.97



RATCHET, MMU FSS CONTINGENCY

S88-40462



OVERVIEW

The manned maneuvering unit (MMU) flight support station (FSS) contingency **ratchet** is stowed on the MMU FSS for use as needed. The tool has a 9/16-in. open-end wrench at one end and a ratchet for a 5/16-in. socket at the other. The original tool (10159-10006-01) has been replaced by an improved model (10159-10045-01).

OPERATIONAL COMMENTS

The MMU FSS contingency ratchet is approximately 13 in. long and has two tether points. The ratchet has a mushroom-shaped spinner on one side to facilitate use by the gloved crewmember. A clutch is attached to the ratchet and will slip in the clockwise direction when a maximum force is applied. The clutch does not slip in the counterclockwise direction. The ratchet is reversible. The original flexible socket has been replaced by a deep well socket; torque limit has been doubled in the improved clutch. **Two pip pins hold the tool to the FSS for launch/ landing.**

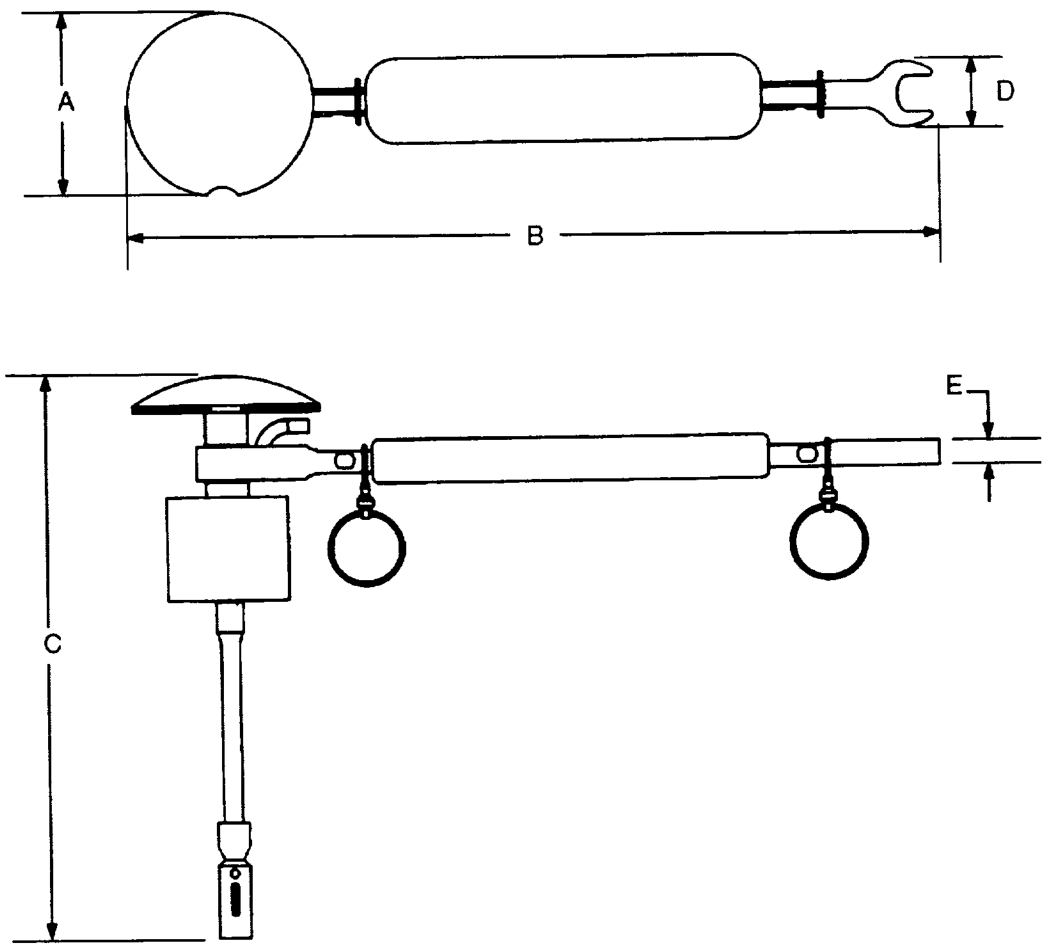
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: **C. Hess**, NASA/**ER**, (713) 483-**9142**

RATCHET, MMU FSS CONTINGENCY

Technical Information	
Part number	10159–10045–01
Weight	1.81 lb
Material/ construction	Handle – Steel, epoxy–covered Mushroom handle – Aluminum
Load rating	140 ± 30 in–lb (**clutch slip in** clockwise direction) 190 in–lb (counter clockwise direction)
Temperature range	–100° to +160° F (operational)
Socket depth	0.78 in.
Quantity flown	**One per MMU FSS**
Stowage	MMU FSS
Availability	Flight specific

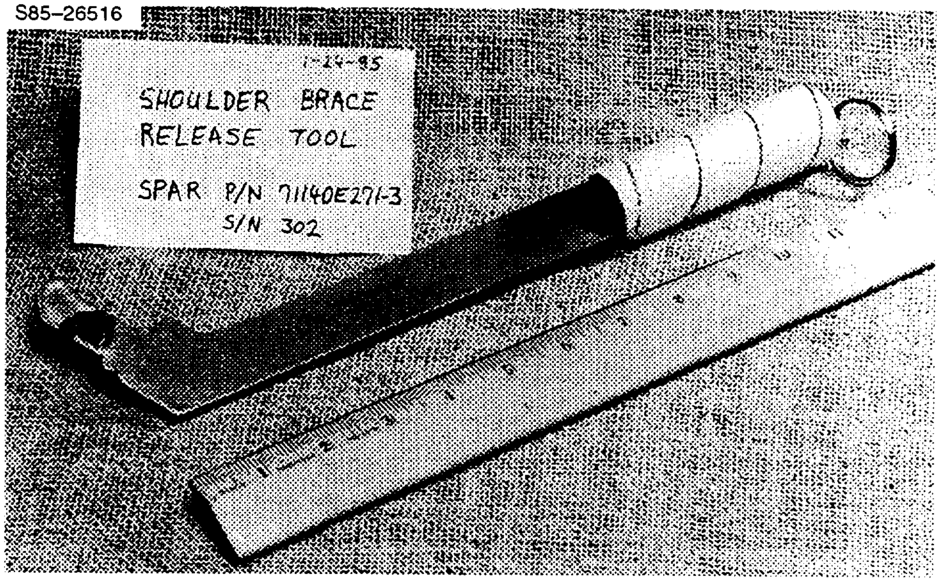
Dimensional Data		
	inches	cm
A	3.00	7.62
B	13.20	33.53
C	10.40	26.42
D	1.10	2.79
E	0.35	0.89



C1-4

RMS SHOULDER BRACE RELEASE TOOL

S85–26516



OVERVIEW

The remote manipulator system (RMS) shoulder brace release tool is a flat bar with an angled foot tip. It has a built–up handle covered with Velcro for a positive grip. A tether ring has been added for tether attachment.

OPERATIONAL COMMENTS

The RMS shoulder brace release tool is a disconnect tool used in the event of failure of the RMS shoulder brace **launch lock**. The shoulder brace must be removed before the RMS can be used. The RMS shoulder brace release tool is used to push up a retaining bracket, thus releasing the shoulder brace. This tool is part of the normally manifested STS equipment and is stowed in the port provisions stowage assembly (PSA).

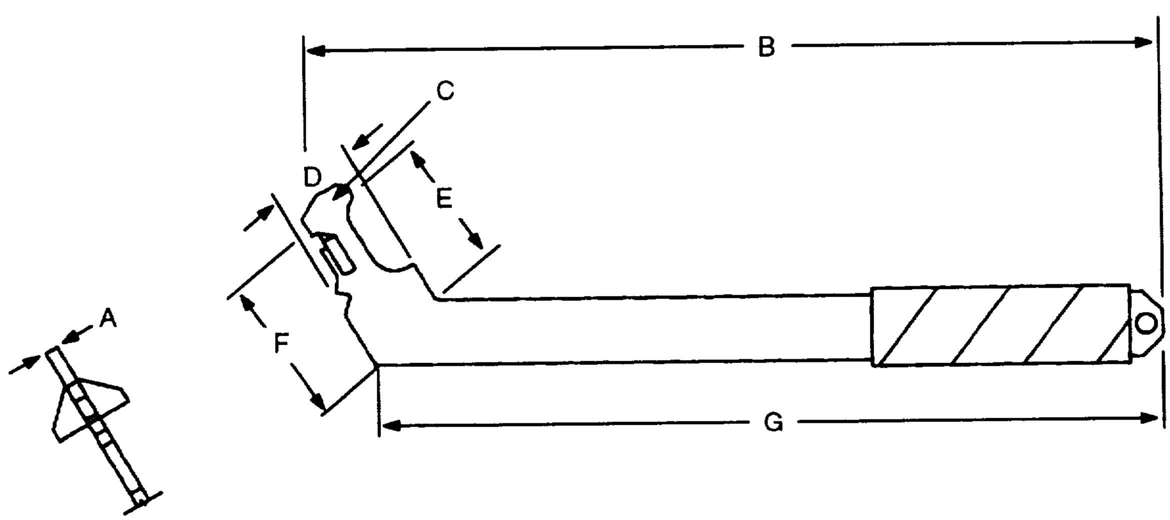
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: **W. B. Wood**, NASA/EC5, (713) 483–**9247**

RMS SHOULDER BRACE RELEASE TOOL

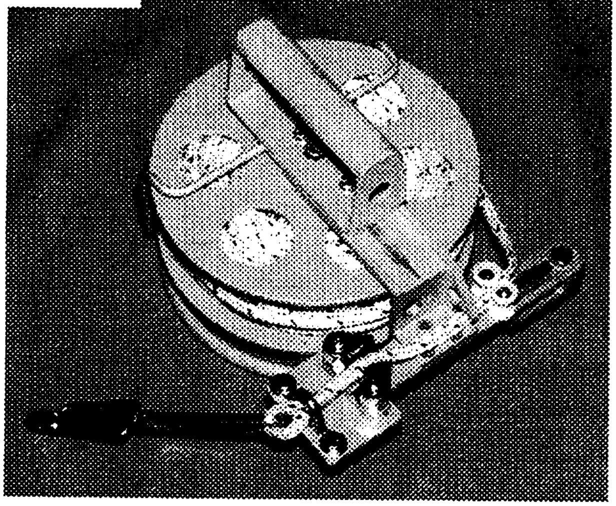
Technical Information	
Part number	71140E271-3
Weight	1.875 lb
Material/ construction	Tool blade – 304 steel Guide attachment – 304 steel Handle – Aluminum
Load rating	**19 lb (shoulder brace plunger initial release force)** **5 lb (shoulder brace plunger running force)**
Temperature range	**–200° to +250° F (operational), +350° (stowage)**
Quantity flown	One
Stowage	Port PSA
Articulation	
Availability	Standard

Dimensional Data		
	inches	cm
A	0.23	0.58
B	13.00	33.02
C	0.22	0.56
D	1.12	2.84
E	2.28	5.79
F	2.69	6.83
G	12.00	30.48

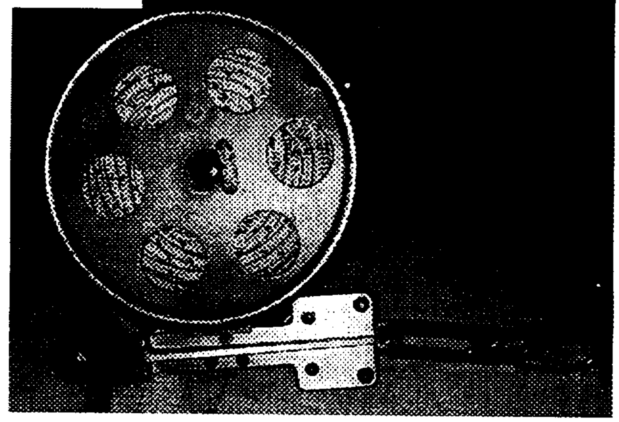


ROPE REEL, RMS

S84–39359



S93–29251



OVERVIEW

The remote manipulator system (RMS) rope reel comprises a rope spool with handle, spool bracket, rope guide and rollers, and cam cleats. The RMS rope reel holds 80 ft of 5/16–in.–diameter rope. The rope has a 7–3/4–in. hook on the end, with a spring clip for positive attachments.

OPERATIONAL COMMENTS

The RMS rope reel is used in conjunction with the winch and snatch blocks in the event of RMS joint failure. The rope is routed through the snatch blocks and attached to the handrail on the tip of the RMS. The crewmember then back–drives the RMS into the stowed position using the RMS rope reel. The winch can also be used for additional length or pull capability. The spool bracket and the rope spool both have handles. The rope reel has two cam cleats that clamp down on the rope to prevent it from being pulled off the reel. To achieve maximum loading of the rope reel, the rope must be routed around both cleats. Up to a 0.78–in.–diameter cross section will be accepted by the hook. This tool is part of the normally manifested STS equipment and is stowed in the port provision stowage assembly (PSA).

The cord of the rope reel has been used for in–flight demonstrations as a temporary translation path under varying tensions (STS-37) and as utility cable simulator (STS 61–B). A modified version was flown for the UARS deploy mission (STS–48) as a solar array restraint during array retention bolt release. Modifications for this purpose included the addition of a bayonet fitting to aid mini–workstation transport and hands–free rope deployment from a tool stanchion. It also had a shorter length of rope for this application (45 ft).

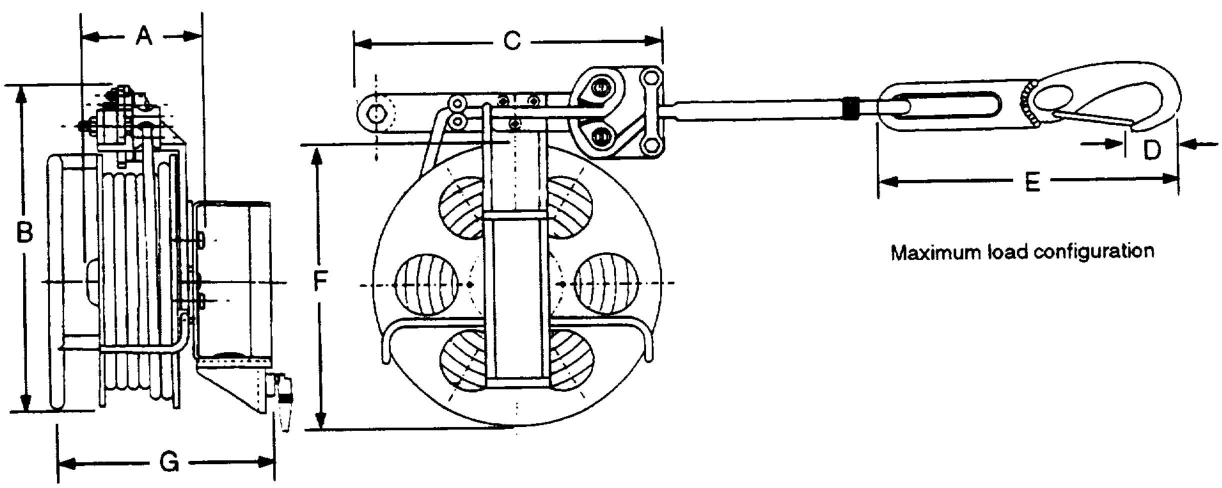
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: N. Gonzalez, NASA/ES6, (713) 483–8944

ROPE REEL, RMS

Technical Information	
Part number	SED33102348–303 (without MWS bayonet, 80 ft of rope) SED33102348–305 (with MWS bayonet, 45 ft of rope)
Weight	8.00 lb
Material/ construction	Spool and spool bracket – Aluminum Rope guides, cam cleats, and hook – Tool steel Rope – 5/16–in. diameter (Kevlar inner cord, Kexlon outer wrap)
Load rating	725 lb (nominal) 840 lb (proof)
Temperature range	–200° to 250° F (operational)
Quantity flown	One (–303)
Stowage	Port PSA
Availability	Standard

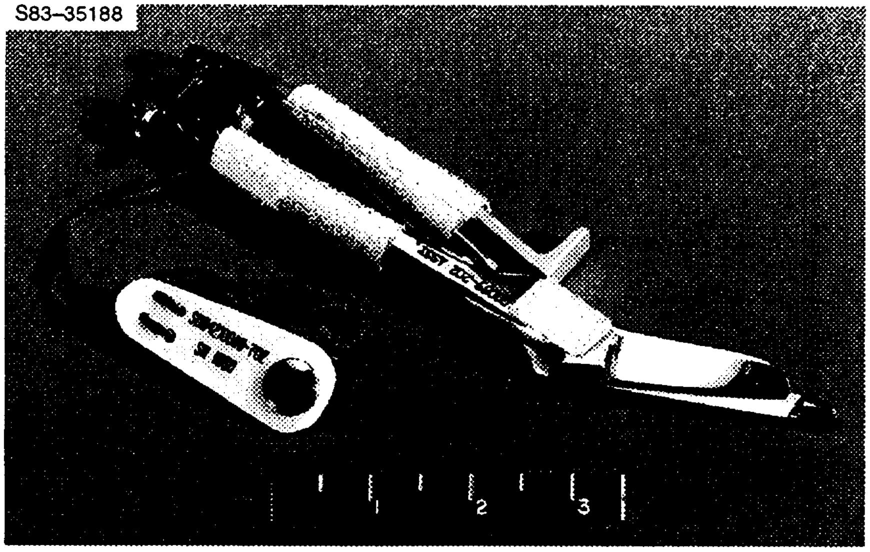
Dimensional Data		
	inches	cm
A	4.250	10.80
B	11.800	29.97
C	9.875	25.08
D	1.250	3.18
E	7.750	19.69
F	9.250	23.50
G	9.250	23.50



Maximum load configuration

SCISSORS, EMU

S83-35188



OVERVIEW

The extravehicular mobility unit (EMU) scissors are commercially available steel cast cutters with one serrated edge which have been modified with a hand stop for ease in performing EVA tasks. The handles are partially wrapped with Velcro. The scissors are stowed in a pocket on the front of the right thigh of the EMU.

OPERATIONAL COMMENTS

These scissors are capable of cutting anything from fabric bags and straps to lightweight steel cable, **bistem metal** and Kevlar **cloth**/cord. A special cutting blade near the scissor hinge point will accept up to 0.125-in.-diameter cable or cord. They are restrained by a 4.5-ft lanyard that is snapped inside the pocket of the EMU. Once the EMU scissors are unstowed from their pocket, they are not easily restowed because of reach and visibility limitations.

Standard orbiter provisioning for each mission includes one pair of scissors for each EMU.

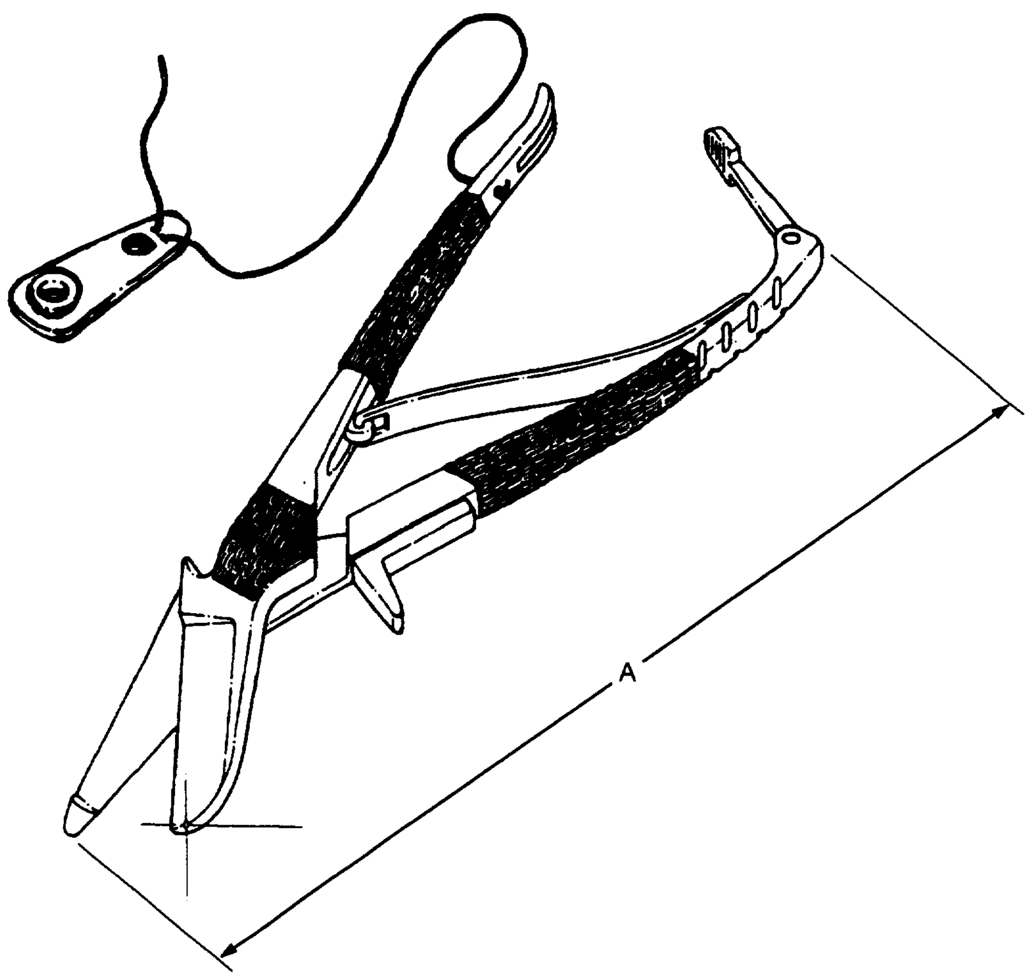
CONTACTS

Operational: **R. K. Fullerton**, NASA/DF42, (713) 483-2589
Technical: W. B. Wood, NASA/EC5, (713) 483-9247

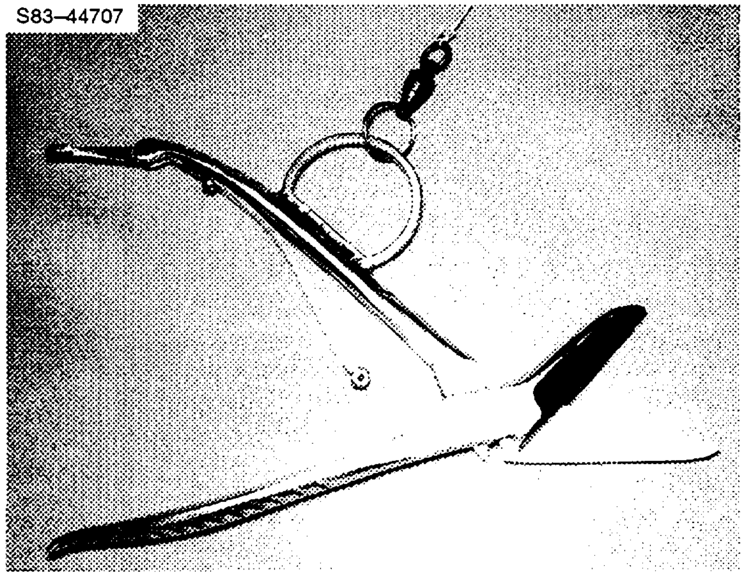
SCISSORS, EMU

Technical Information	
Part number	10159–20001–02
Weight	**1.13** lb
Material/ construction	Scissors – commercial steel cast cutters with one serrated edge Tether – 4.5–ft PBI cord
Tether breaking strength	94 lb
Load rating	
Temperature range	
Quantity flown	One pair for each EMU
Stowage	EMU
Availability	Standard

Dimensional Data		
	inches	cm
A	8.25	20.96



SCISSORS, MODIFIED



OVERVIEW

The modified scissors are commercially available steel cast cutters adapted for EVA use. They have one serrated cutting edge and are **typically mounted on a tool board for ease of use**. These scissors are a modification of the original extravehicular mobility unit (EMU) scissors with more sharply pointed blades and a tether ring welded to one handle.

OPERATIONAL COMMENTS

The modified EVA scissors can cut anything from fabric bags and straps to lightweight steel cable, **bistem metal,** and Kevlar **cloth**/cord. A special cutting blade near the scissor hinge point will accept up to 0.125–in.–diameter cable or cord. The sharper points were designed to pierce insulation blankets. They have been successfully used on orbit to cut thermal blankets (multilayer insulation), grounding straps, Kapton tape, and nylon tie–wraps.

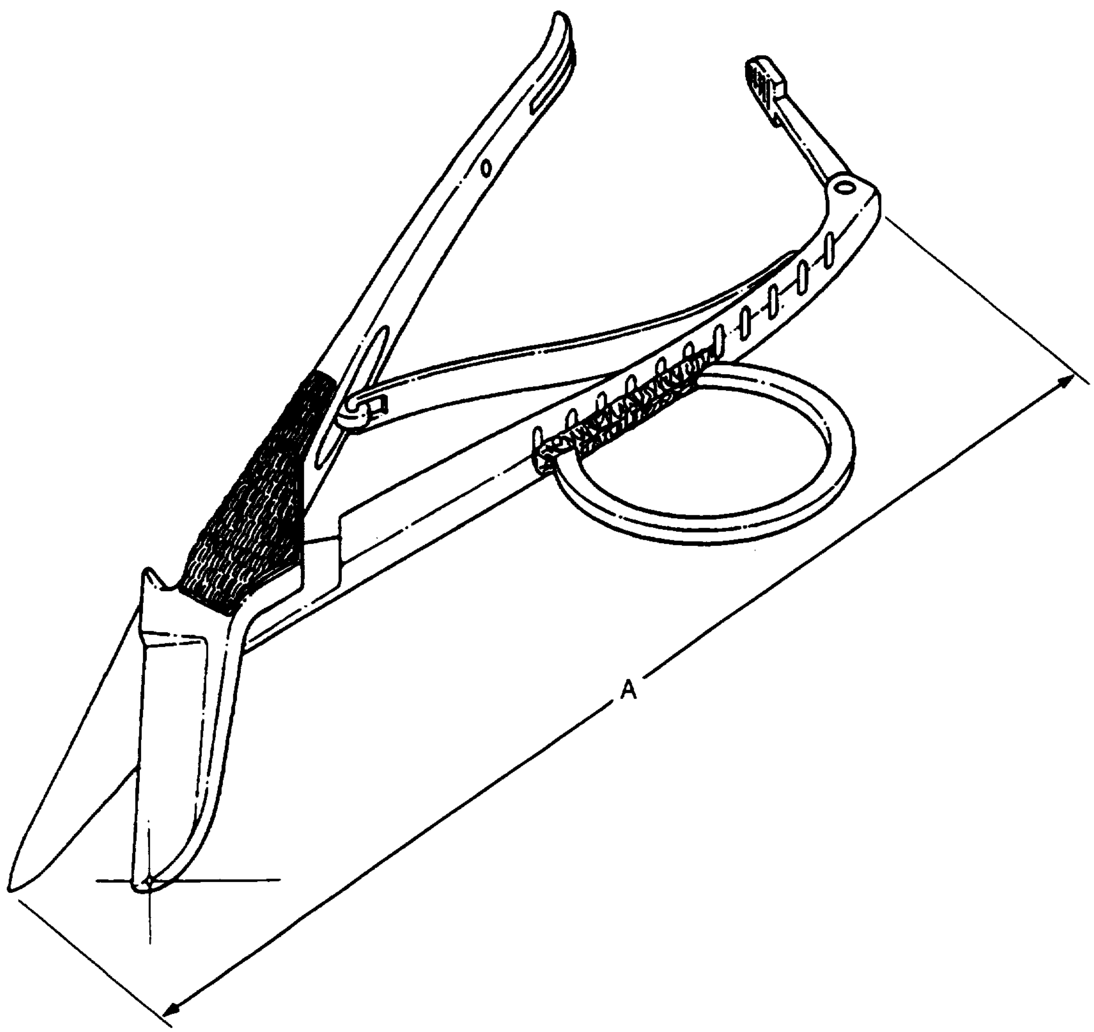
CONTACTS

Operational: **R. Trevino**, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

SCISSORS, MODIFIED

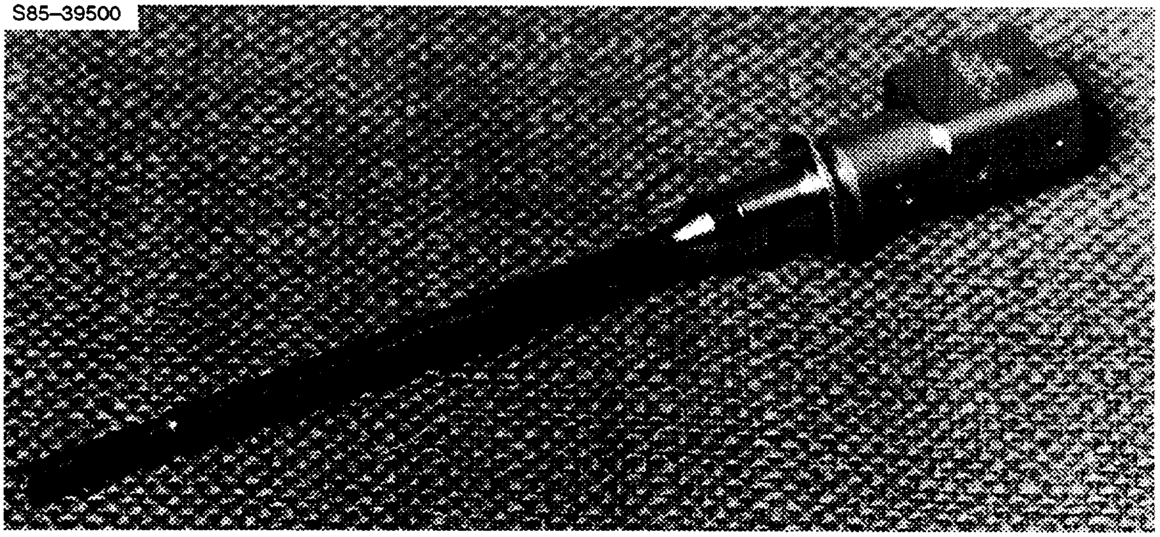
Technical Information	
Part number	10159–20076–01
Weight	0.75 lb
Material/ construction	Stainless steel
Load rating	
Temperature range	
Quantity flown	As needed
Stowage	Tool board #1 in special equipment stowage assembly for STS 41–B Tool board #1 on STS 51–A Tool board #6 on STS 51–I
Availability	Flight specific

Dimensional Data		
	inches	cm
A	8.25	20.96



SCREWDRIVER, EXTENSION WITH SHROUDED

S85–39500



OVERVIEW

The shrouded screwdriver extension is a straight slot screwdriver tip with a static shroud to capture number 4 screws. It has a drop–proof tether to prevent loss and can be used with any 3/8–in. drive tool that has a drop–proof tether attachment.

OPERATIONAL COMMENTS

The shrouded screwdriver extension was designed for use on the Solar Maximum Satellite (Solar Max) Repair Mission. It was stowed in the flight support system (FSS) locker. A quick–release pin is used to connect the shrouded screwdriver extension to, or disconnect it from, 3/8–in. drive tools.

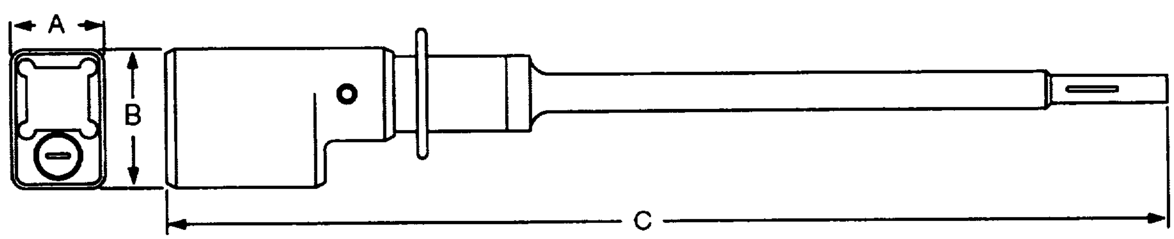
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

SCREWDRIVER, EXTENSION WITH SHROUDED

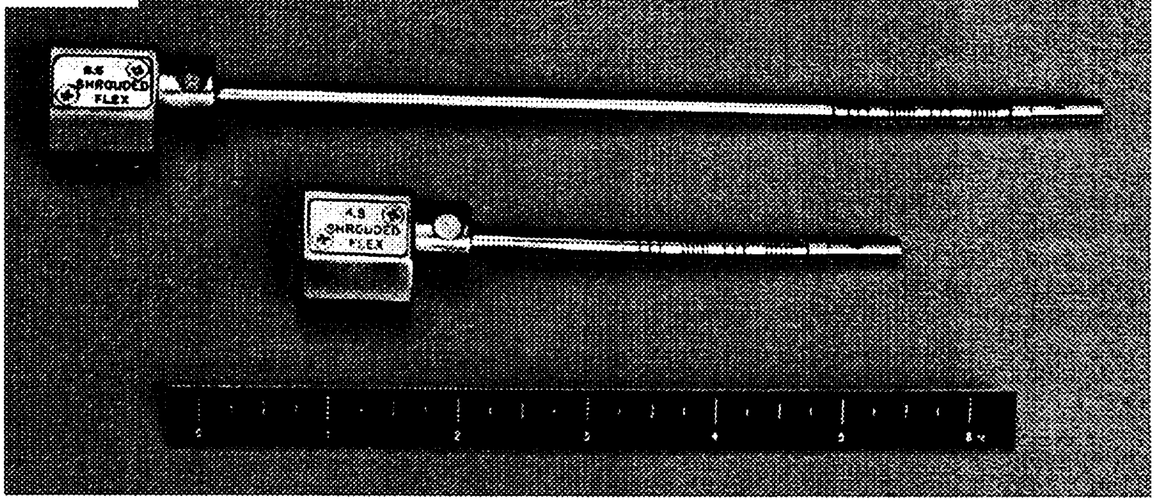
Technical Information	
Part number	10172-20556-01
Weight	0.35 lb
Material/ construction	Base – Stainless steel
Load rating	
Temperature range	
Quantity flown	**One on STS 41-C**
Stowage	FSS locker, in a tool caddy
Availability	Flight specific

Dimensional Data		
	inches	cm
A	0.70	1.78
B	1.00	2.54
C	7.50	19.05



SCREWDRIVER, SHROUDED FLEX

S88–32997



OVERVIEW

The shrouded, flexible screwdrivers have a straight slot screwdriver tip with a static shroud to capture number 4 fillister–head screws. One design has a 7–1/4–in. shaft extension and the other has a 3–1/2–in. extension. Both provide a **30° total flex** at the tip **(15° half angle)**. Each tool has a drop–proof tether fitting to prevent accidental loss.

OPERATIONAL COMMENTS

These screwdrivers were designed for use during maintenance of the Hubble Space Telescope (HST). A typical HST application involves small screws restraining electrical D–connectors. The approximate 40° total flex angle of the shrouded tip allows access to difficult–to–reach areas, especially around bends. **There are rotation marks on the tip and shroud for counting screw turns**.

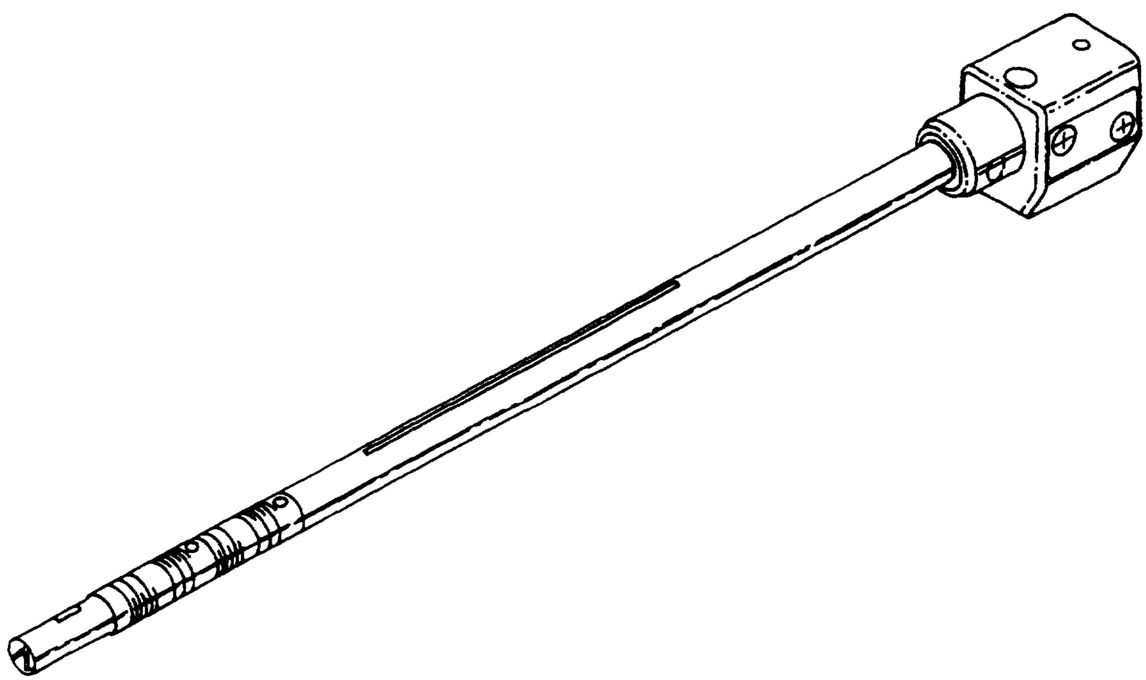
CONTACTS

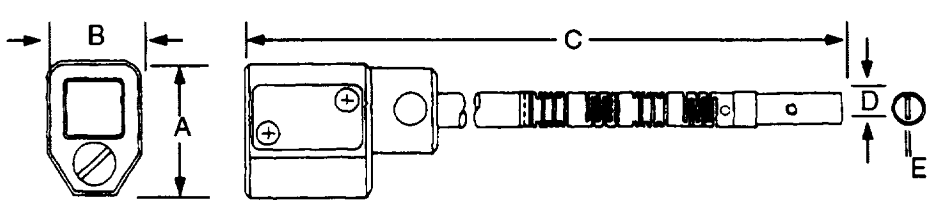
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

SCREWDRIVER, SHROUDED FLEX

Technical Information	
Part number	10181–10019–01 4.8 in. 10181–10019–02 8.6 in.
Weight	10181–10019–01 0.17 lb 10181–10019–02 0.22 lb
Material/ construction	Stainless steel
Load rating **(use/proof)**	**9/11 in–lb**
Temperature range	–150° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

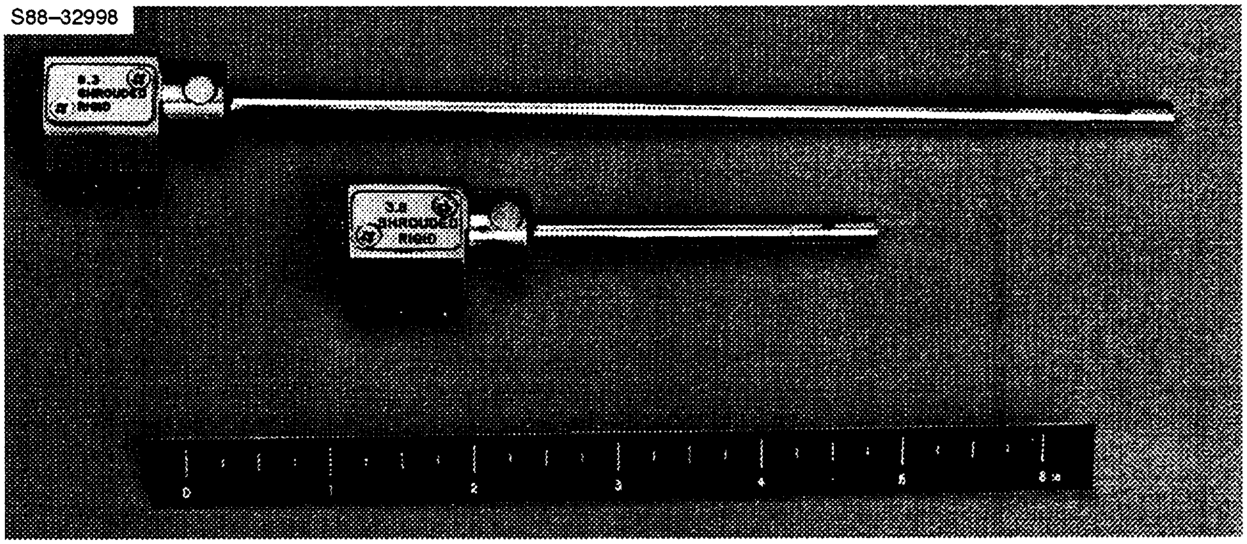
Dimensional Data		
	inches	cm
A	0.93	2.36
B	0.66	1.68
C	4.83 (–01) 8.58 (–02)	12.27 (–01) 21.79 (–02)
D	0.22 (OD) 0.183 (ID)	0.56 (OD) 0.46 (ID)
E	0.03	0.08





SCREWDRIVER, SHROUDED RIGID

S88–32998



OVERVIEW

The shrouded rigid screwdrivers have a straight slot screwdriver tip with a static shroud to capture number 4 fillister–head screws. They were designed with two extension lengths for optimum worksite selection. The screwdriver has a drop–proof tether to prevent accidental loss.

OPERATIONAL COMMENTS

The shrouded rigid screwdrivers were designed for use during maintenance of the Hubble Space Telescope (HST). A typical HST application involves small screws restraining electrical D–connectors. **There are rotation marks on the tip and shroud for counting screw turns.**

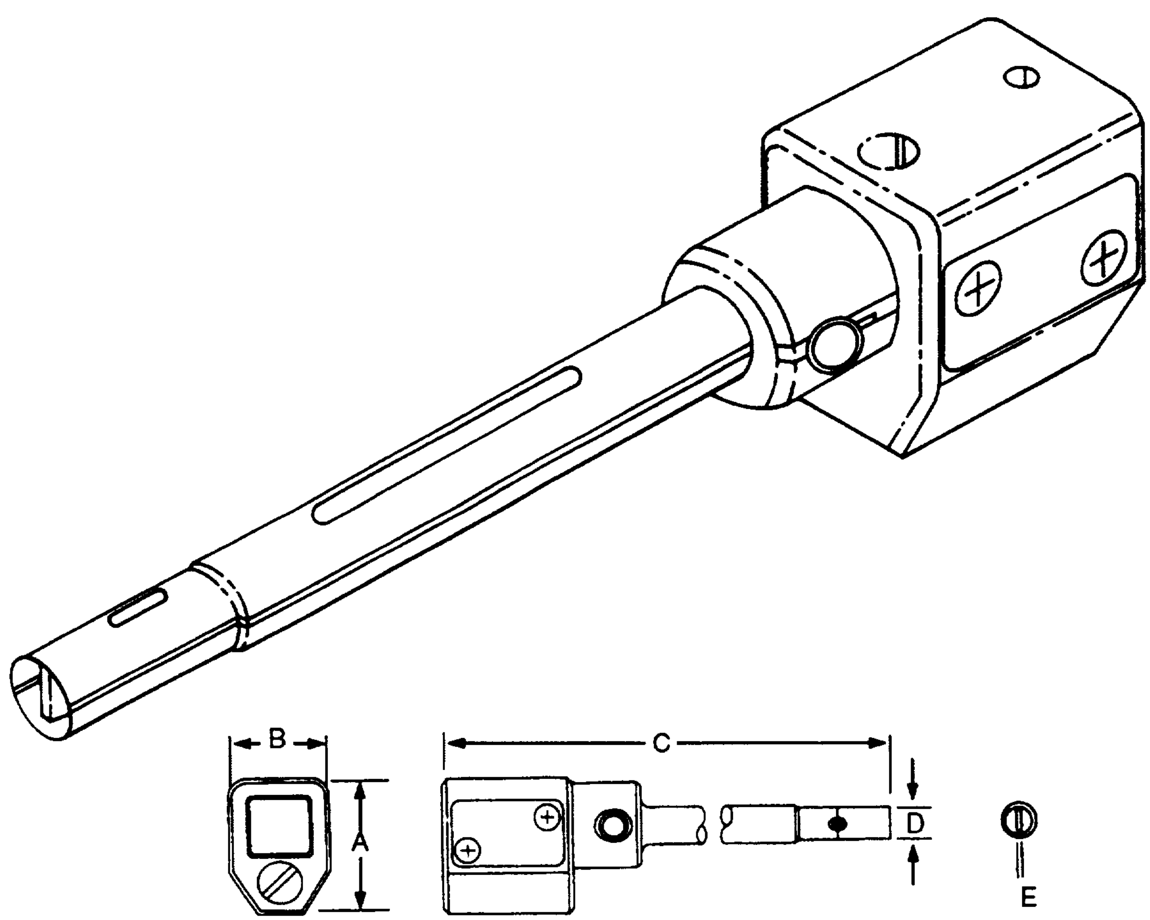
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

SCREWDRIVER, SHROUDED RIGID

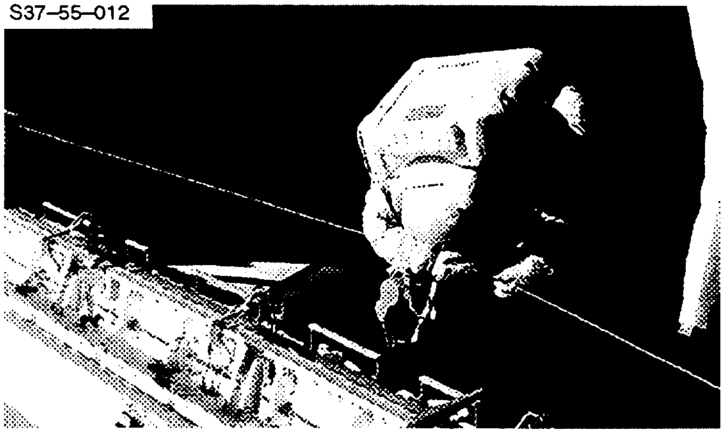
Technical Information	
Part number	10181–10020–01 3.8 in. 10181–10020–02 8.3 in.
Weight	10181–10020–01 0.**16** lb 10181–10020–02 0.**22** lb
Material/ construction	Stainless steel
Load rating **(use/proof)**	**9/11 in–lb**
Temperature range	–150° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

Dimensional Data		
	inches	cm
A	0.93	2.36
B	0.66	1.68
C	3.83 (–01) 8.30 (–02)	9.73 (–01) 21.08 (–02)
D	0.22 (OD) 0.183 (ID)	0.56 (OD) 0.46 (ID)
E	0.03	0.08

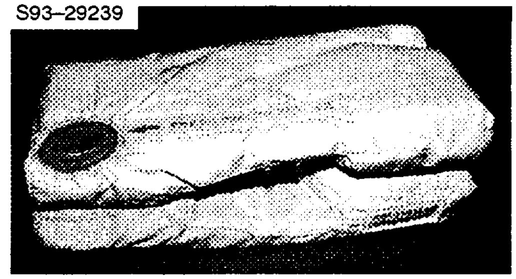


SLIDEWIRE (STS)

S37–55–012



S93–29239



OVERVIEW

The slidewire is installed on both sides of the orbiter payload bay along the sill longerons. Each slidewire provides a pair of sliding tether points for the safety tethers of up to two EVA crewmembers. These continuous cables allow crewmembers to freely translate without having to disconnect and reconnect safety tether lines. This reduces crew overhead and facilitates rapid crew return to the airlock during an emergency. The slidewires are used in combination with the waist tether and self–tending safety tether reel for access to the entire payload bay and attached payloads. The waist tether provides load alleviation to protect the slidewire from potentially high crew–induced loads. Each slidewire has a cushion installed over the forward end to prevent the sliders and preattached safety tether reel hooks from slipping down the cable during launch or between EVA's. The cushions also preclude damage to the stowed payload bay door radiators from the attached tether hooks.

OPERATIONAL COMMENTS

During airlock egress, the EVA crew destows the mated tether hooks and sliders from the cushions by releasing a small 1/4–turn fastener and Velcro. To avoid dragging the second loose slider, the aft slider is used when plans are for only one crewmember to use each slidewire. The cushion is kept attached to the forward end of the slidewire during EVA by a second 1/4–turn fastener that is not intended for nominal crew use. Nominal handholds for translation along the slidewire utilize a combination of parallel mounted handrails and the slidewire cable. At the end of the EVA, during airlock ingress, the hooks and sliders are restowed in the cushions and the Velcro and 1/4–turn fasteners are resecured. This particular fastener is not recommended for similar applications because of its small size and attachment to a base that is not rigidly restrained. This makes it a multihanded operation, which is not easy at the end of a long EVA when fingers tend to be fatigued. A pushbutton replacement for the cushion 1/4–turn fastener is under development (**see photo above**).

The cable is made of a Teflon–jacketed Kevlar cord with mechanical terminations. This design replaced the earlier braided cable cover, which had a tendency to develop a snag that bunched up and impeded slider travel. The earlier bonded ends were replaced with a mechanical fitting for better reliability. The cable ends have a built–in pretensioning device to assist in installation and test prior to flight. The slidewire standoffs articulate to maintain clearances during payload bay opening and closing. They have a connecting link with the sill longeron that is secured by a pip pin and safety lanyard. **Translation using only the cable is not recommended because of its small grip size, lack of body control in roll about the cable, and the potential for damage to nearby structure. The preferred translation technique uses one hand on the slidewire and the other on parallel handrails.**

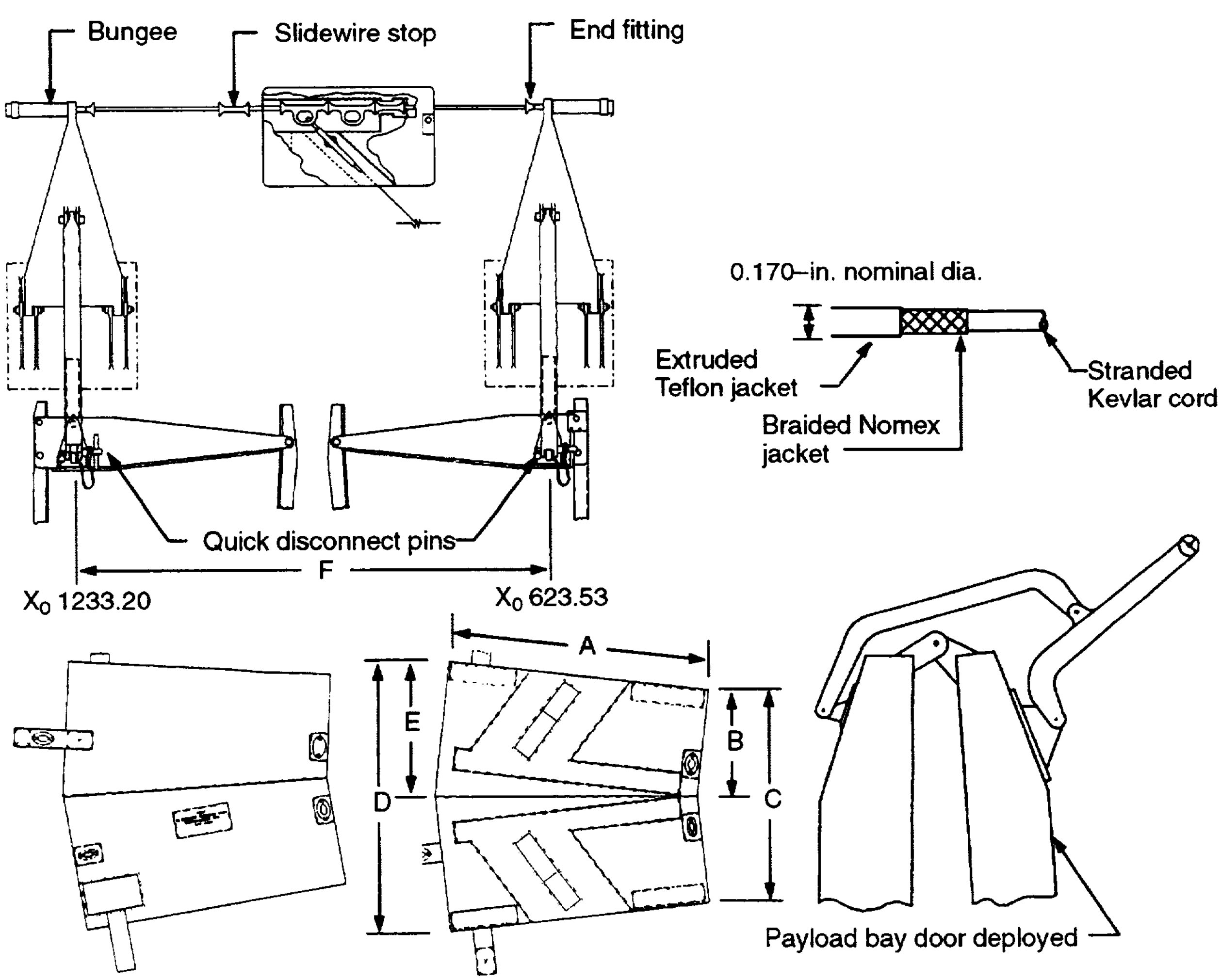
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

SLIDEWIRE (STS)

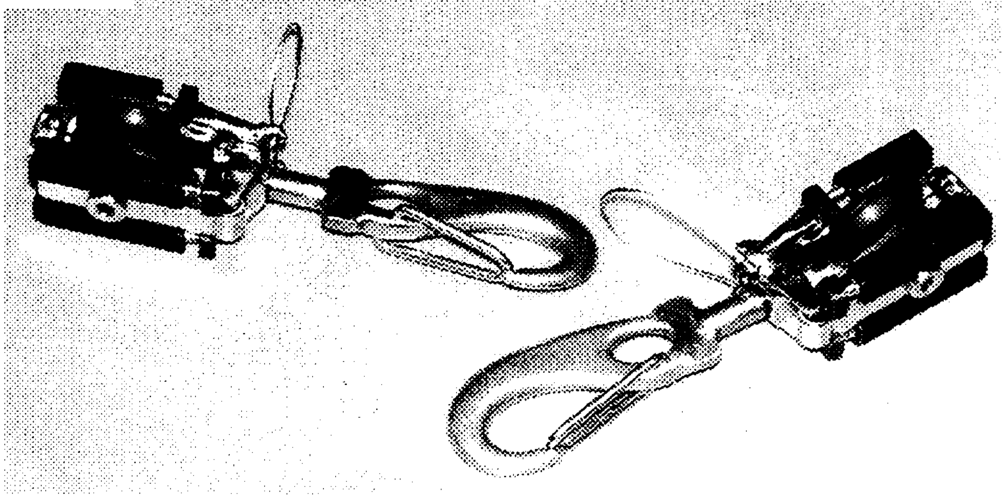
Technical Information	
Part number	SED33103376–303 **SED33104550–301/302 (standard cushions)** RK69–000852–001 (prototype cushion)
Weight	
Material/ construction	Polyimide foam, Nomex fabric cover (cushion) Teflon–jacketed Kevlar cord (cable) Aluminum (articulating standoff)
Load rating	**20 ± 5 lb (nominal cable tension)** **Two EVA crewmembers (1100 lb) moving at 4 ft/sec in any direction with load alleviating waist tether**
Temperature range	–200° to +250° F
Quantity flown	Two
Stowage	Port and stbd payload bay sill longeron
Availability	Standard

Dimensional Data		
	inches	cm
A	14.625	37.148
B	5.75	14.605
C	11.5	29.21
D	14.875	37.782
E	7.44	18.90
F	**50.8 ft**	**15.5 m**



SNATCH BLOCK

S84–39407



OVERVIEW

The snatch block is a common marine device modified for EVA use. It is commonly used with a 3/8–in.–diameter rope. The snatch block hook has a snap lock to provide a more secure attachment. The hook has an opening of 0.78 in. and is attached by a swivel shaft allowing 360° rotation.

OPERATIONAL COMMENTS

The snatch block is used to route the cargo bay winch line to support payload tasks. In the event of remote manipulator system (RMS) failure, it is also used in conjunction with the RMS rope reel to backdrive the RMS to a stowed position. If a failure should occur in the inertial upper stage (IUS) tilt table, the snatch block can be used to raise and lower the IUS for deploy and stowage. It is part of the normally manifested Space Transportation System (STS) equipment and is stowed in the **port** provisions stowage assembly (PSA).

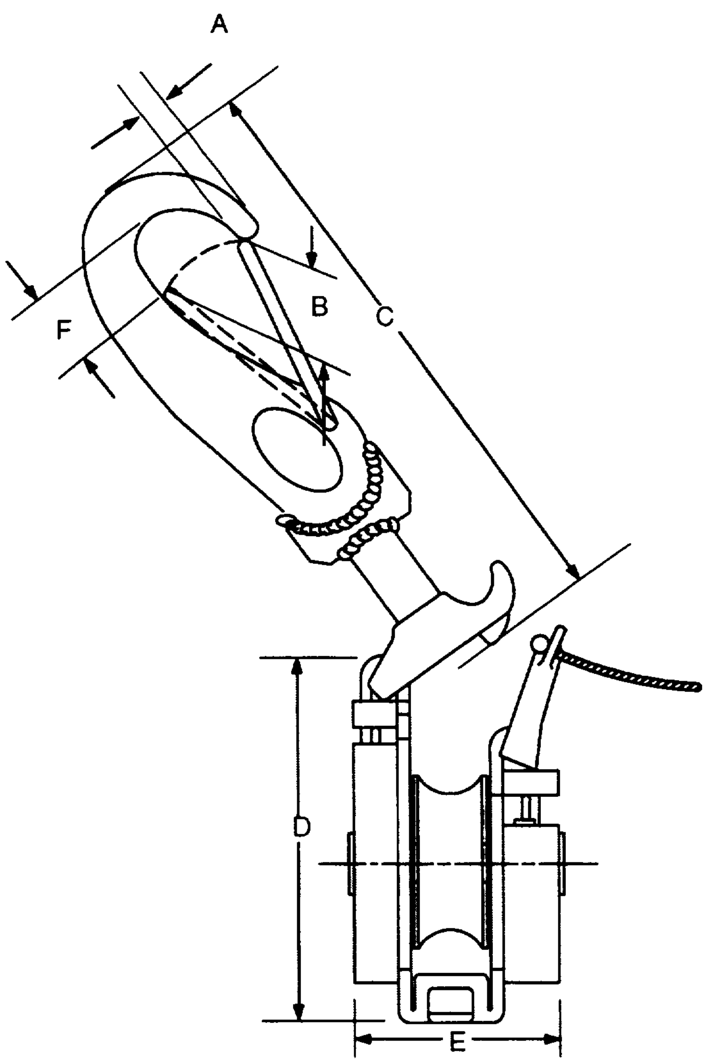
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: **N. Gonzalez**, NASA/ES6, (713) 483–8944

SNATCH BLOCK

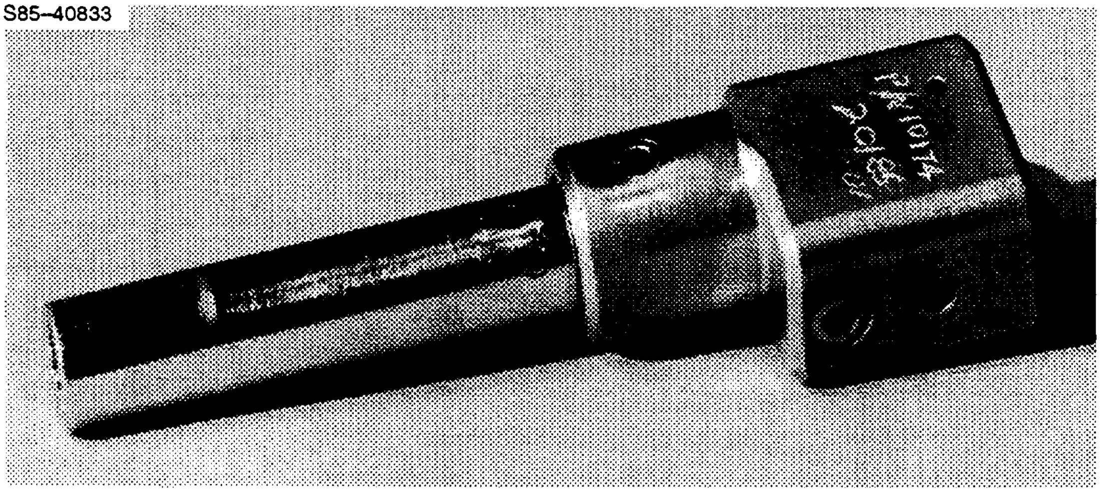
Technical Information	
Part number	SED33102357–303. (10163–20057–01 hook)
Weight	1.66 lb
Material/ construction	Stainless steel frame and hook Aluminum pulley wheel
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	Two
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	0.25	0.64
B	0.78	1.98
C	6.00	15.24
D	3.75	9.53
E	2.00	5.08
F	0.75	1.91



SOCKET, 5/16–INCH

S85–40833



OVERVIEW

The 5/16–in. socket is attached to a drop–proof tether by an adapter and two spring pins. The extension is a commercially available socket modified for EVA use. One side of the drop–proof tether is Velcro–covered to allow attachment to a Velcro surface during use.

OPERATIONAL COMMENTS

The 12–point 5/16–in. socket can be used on a variety of hand and power tools which have drop–proof tether attachments. The 5/16–in. hex socket fits the manned maneuvering unit (MMU) launch bolts and was used on the STS 51–A Satellite Retrieval Mission. A quick release pin is used to connect the socket to and disconnect it from the 3/8–in.–drive tools.

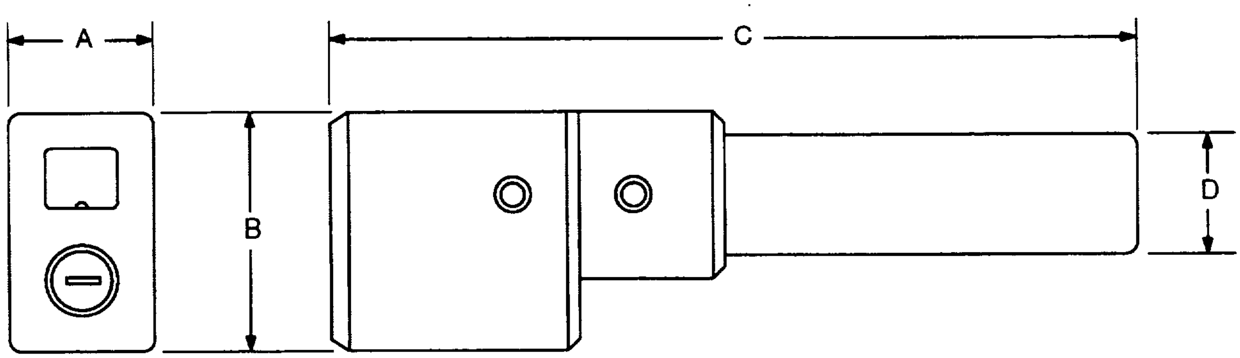
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

SOCKET, 5/16-INCH

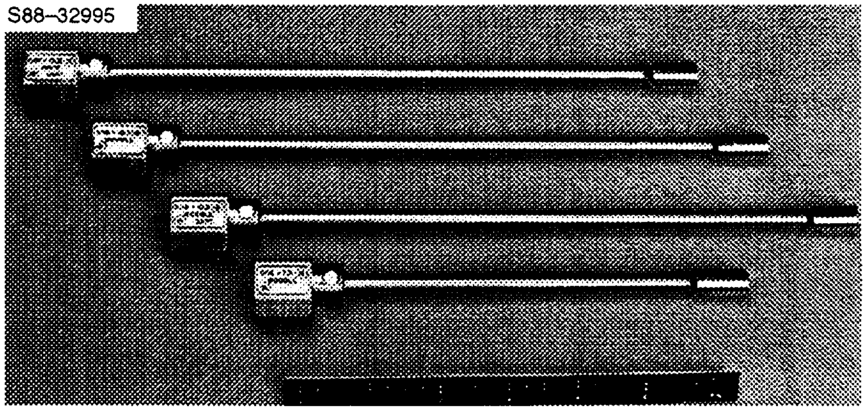
Technical Information	
Part number	10174–20185–01
Weight	0.27 lb
Material/ construction	Socket – Chrome–plated steel Drop–proof tether – Stainless steel
Socket depth	1.81 in.
Load rating	
Temperature range	
Quantity flown	One
Stowage	Crew compartment
Availability	Flight specific

Dimensional Data		
	inches	cm
A	0.70	1.78
B	1.01	2.57
C	3.67	9.32
D	0.50	1.27



SOCKET, 5/16–INCH (HST)

S88–32995



OVERVIEW

Each of the 5/16–in. sockets is designed for use on the Hubble Space Telescope (HST) maintenance and repair missions. Each tool has a 12–point socket attached to a shaft with a 3/8–in. drop–proof tether. Capture pins are used to secure the socket and drop–proof tether to the shaft. Each shaft and socket has engraved rotation marks which act as a guide to counting revolutions.

OPERATIONAL COMMENTS

The 10.3–in. rigid capture tool (10181–10004–01) has a 9–in. solid shaft. The internal snap ring capture device secures the fastener in the tool's socket so that it will be easier for the crewmember to control. The crewmember places the tool over the fastener and pushes it so that the fastener is captured in the internal snap ring device. The capture sockets are chrome plated prior to the installation of the capture ring. The capture feature is specifically designed to work on HST 5/16–in. hex screws and may not function with other hexes having more rounded corners.

The 10.3–in. wobble capture tool (10181–10005–01) has a 9–in. shaft and 5° half angle self–centering wobble feature which aids the suited crewmember when installing or removing hex screws in a limited access area. This tool also incorporates the internal snap ring for fastener capture.

The 7.3–in. wobble noncapture tool (10181–10006–01) has a 5–in. shaft, and the 10.3–in. wobble noncapture tool (10181–10006–02) has a 9–in. shaft. Each incorporates the 5° half angle self–centering wobble feature for ease of access.

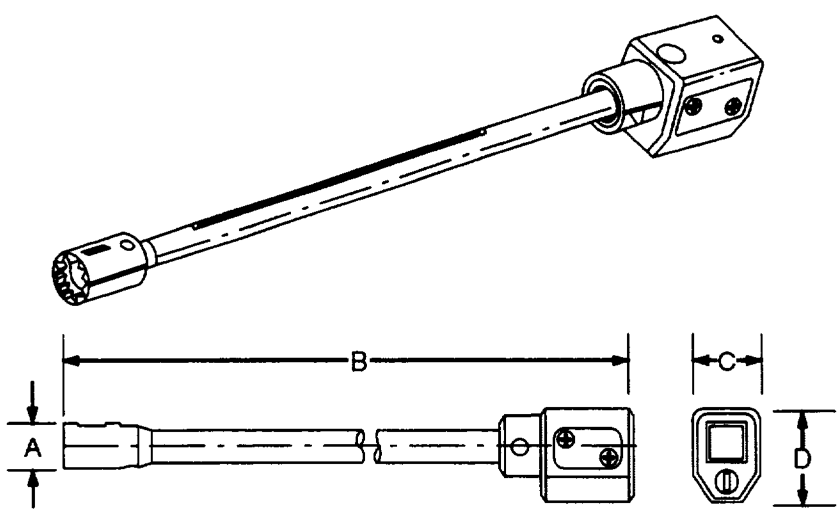
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

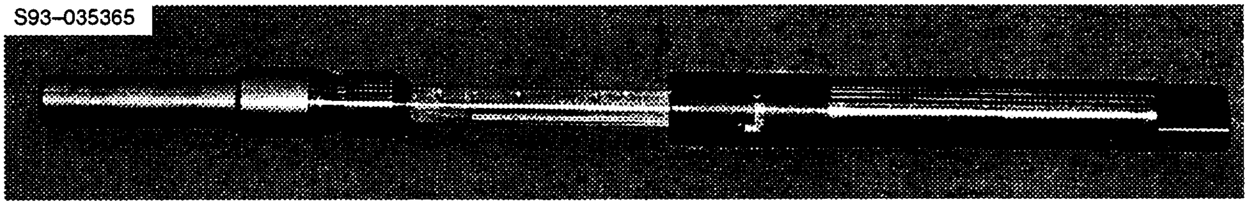
SOCKET, 5/16–INCH (HST)

Technical Information	
Part number	10181–10004–01 Rigid, capture, 10.3 in. 10181–10005–01 Wobble, capture, 10.3 in. 10181–10006–01 Wobble, non–capture, 7.3 in. 10181–10006–02 Wobble, non–capture, 10.3 in. 10181–10067–301 Rigid, 10.3 in., wide tolerance socket
Weight	10181–10004–01 0.33 lb 10181–10005–01 **0.33** lb 10181–10006–01 0.26 lb 10181–10006–02 **0.33** lb 10181–10067–301 0.33 lb
Material/ construction	Stainless steel
Socket depth	10181–10004–01 0.146 in. 10181–10005–01 0.146 in. 10181–10006–01 0.235 in. 10181–10006–02 0.235 in.
Load rating (use/proof)	10181–10004–01 **52/63** in–lb 10181–10005–01 **52/63** in–lb 10181–10006–01 **52/167** in–lb 10181–10006–02 **52/167** in–lb 10181–10067–301 52/63 in–lb
Temperature range	–150° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

Dimensional Data		
	inches	cm
A	0.**442**	1.12
B	10.300 (10004)	26.16
	10.300 (10005)	26.16
	7.300 (10006–01)	18.54
	10.3000 (10006–01)	26.16
C	0.660	1.68
D	0.930	2.36



SOCKET, 7/16–INCH ADJUSTABLE



OVERVIEW

This socket extension is intended to replace the functions of several separate fixed–length extensions. Instead of multiple tools to perform different tasks, this concept allows one tool to cover several activities. When retracted, it is easier to transport than longer fixed–length versions that tend to degrade suit mobility and snag vehicle structure. Avoiding socket changeout during EVA helps to reduce overhead.

OPERATIONAL COMMENTS

There are two sizes to cover lengths for 12–to 24–in. applications. Each telescopes in 1–in. increments and has a 12– point socket. The sockets also have a wobble feature for improved access in close quarters. Both attach to ratchets or power tools with a 3/8–in. square–drive drop–proof tether. A pip pin is required to mate or demate each extension. They are commonly transported on a tool board or tool caddy. Each extension has engraved/painted rotation marks to assist in counting revolutions.

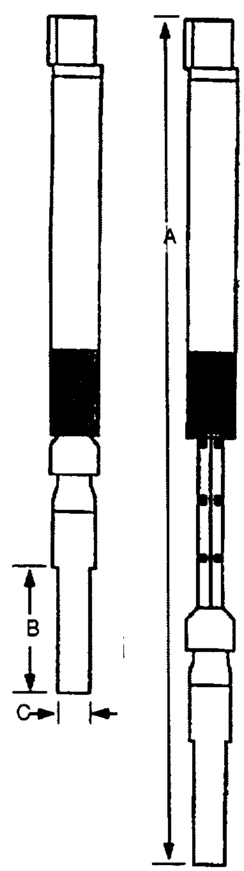
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: P. Richards, GSFC/714.2, (301) 286–1434

SOCKET, 7/16 INCH ADJUSTABLE

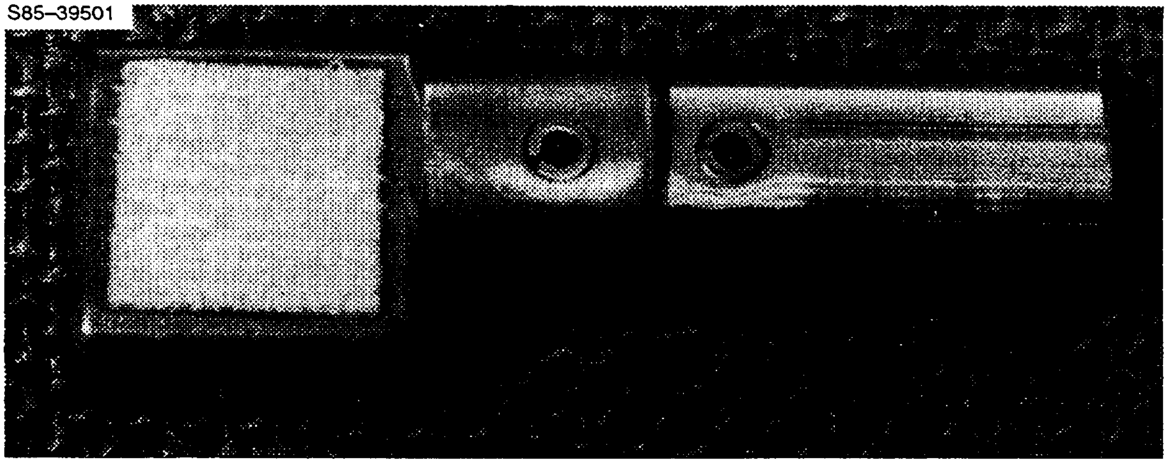
Technical Information	
Part number	1528652 (short) 1528653 (long)
Weight	**2.0** lb (short) **2.0** lb (long)
Material/ construction	Limited–life items – TBD Lubricants – TBD Metallics – **Aluminum, stainless** Nonmetallics – TBD
Load rating	50 ft–lb
Temperature range	
Quantity flown	One each (STS–51) Two each (STS–61)
Stowage	
Socket depth	**0.75** in.
Availability	Flight specific (existing units reserved for HST)

Dimensional Data		
	inches	cm
A	15 – 24 (long) 12 – 16.5 (short)	38.10 – 60.96 30.48 – 41.91
B	1.125 (short) 2.125 (long)	2.86 5.40
C	0.68	1.73



SOCKET, 7/16–INCH

S85–39501



OVERVIEW

The 7/16–in. socket is attached to a drop–proof tether by an adapter and two spring pins. One side of the drop–proof tether is Velcro–covered to allow attachment to a tool caddy.

OPERATIONAL COMMENTS

The tool was originally created to support the STS 41–C Solar Max repair mission. It can be used on a variety of hand and power tools that have drop–proof tether attachments. The socket assembly may be stowed in a Velcro–lined tool caddy or on a manipulator foot restraint (MFR) tool board. A quick–release pin is used for connecting and disconnecting the socket from the 3/8–in.–drive tools.

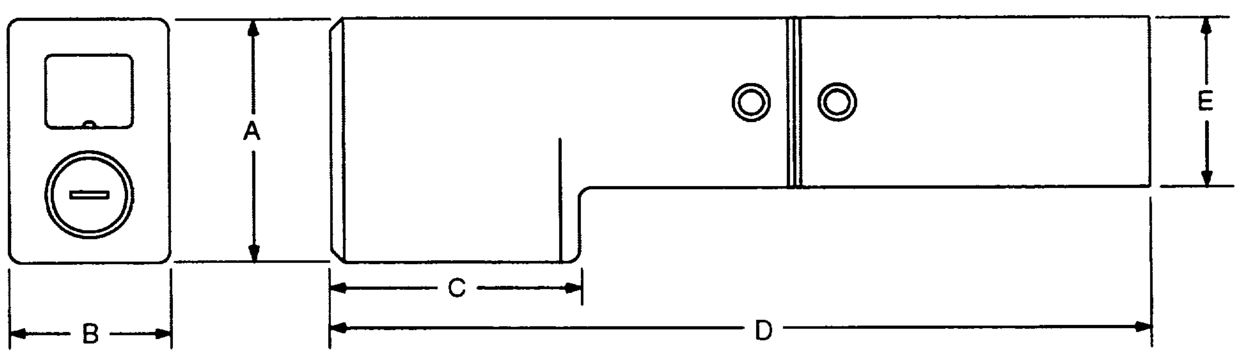
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

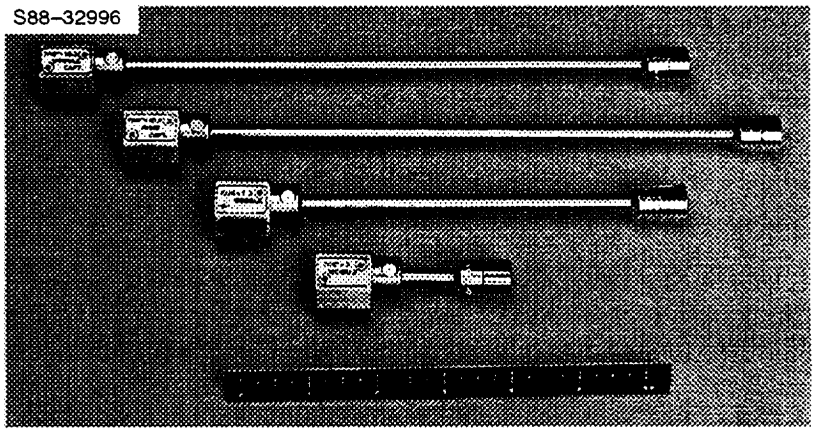
SOCKET, 7/16–INCH

Technical Information	
Part number	10172–20552–01
Weight	0.31 lb
Material/ construction	Sleeve – stainless steel Adapter – stainless stee Drop–proof tether – stainless steel Velcro – hook
Socket depth	0.85 in.
Load rating	
Temperature range	
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.000	2.54
B	0.700	1.78
C	0.875	2.22
D	3.030	7.70
E	0.700	1.78



SOCKET, 7/16–INCH (HST)



OVERVIEW

Each of the 7/16–in. sockets designed for use on the Hubble Space Telescope (HST) maintenance and repair missions. Each tool has a 12–point socket attached to a shaft with a 3/8–in. drop–proof tether. Capture pins are used to secure the socket and drop–proof tether to the shaft. Each shaft and socket has engraved rotation marks which act as a guide to counting revolutions.

OPERATIONAL COMMENTS

The 10.3–in. rigid capture tool (10181–10007–01) has a 9–in. solid shaft. The internal snap ring capture device secures the fastener in the tool socket so that it will be easier for the crewmember to control. The crewmember places the tool over the fastener and pushes it so that the fastener is captured in the internal snap ring device. The capture sockets are chrome plated prior to the installation of the capture ring. The capture feature is specifically designed to work on HST 7/16–in. hex screws and may not function on other hexes having more rounded corners.

The 10.3–in. wobble capture tool (10181–10008–01) has a 9–in. shaft and 5° half angle, self–centering wobble feature that aids the suited crewmember when installing or removing hex screws in a limited access area. This tool also incorporates the internal snap ring for fastener capture.

The 3–inch wobble noncapture tool (10181–10025–01) has a 1.67–in. shaft and is sized for use with a torque limiter. The 7.3–in. wobble noncapture tool (10181–10025–02) has a 6–in. shaft. Each tool incorporates the 5° half angle, self–centering wobble feature for ease of access.

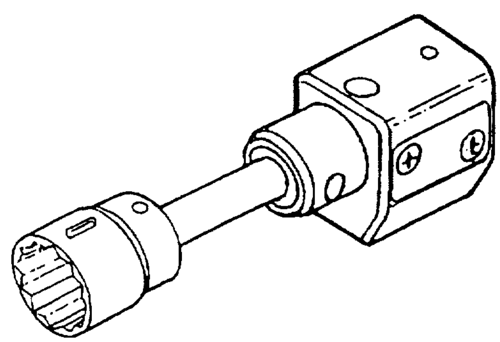
CONTACTS

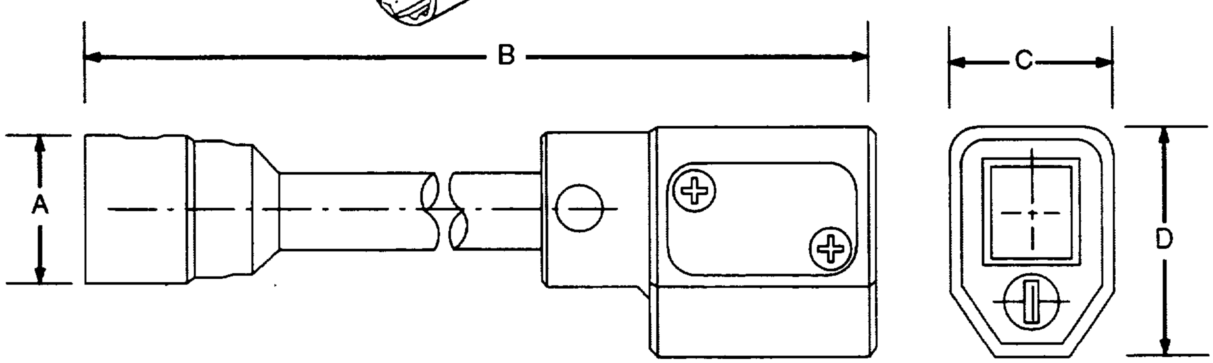
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

SOCKET, 7/16–INCH (HST)

Technical Information		
Part number	10181–10007–01 10181–10008–01 10181–10025–01 10181–10025–02	Rigid, capture, 10.3 in. Wobble, capture, 10.3 in. Wobble, non–capture, 3.0 in Wobble, non–capture, 7.3 in.
Weight	10181–10007–01 10181–10008–01 10181–10025–01 10181–10025–02	0.34 lb 0.34 lb 0.18 lb 0.27 lb
Material/ construction	Stainless steel	
Socket depth	10181–10007–01 10181–10008–01 10181–10025–01 10181–10025–02	0.205 in 0.205 in. 0.281 in. 0.281 in.
Load rating **(use/proof)**	10181–10007–01 10181–10008–01 10181–10025–01 10181–10025–02	**128/154** in–lb **139/167** in–lb **139/167** in–lb **139/167** in–lb
Temperature range	–150° to +250° F	
Quantity flown		
Stowage		
Availability	Flight specific, **existing units reserved for HST**	

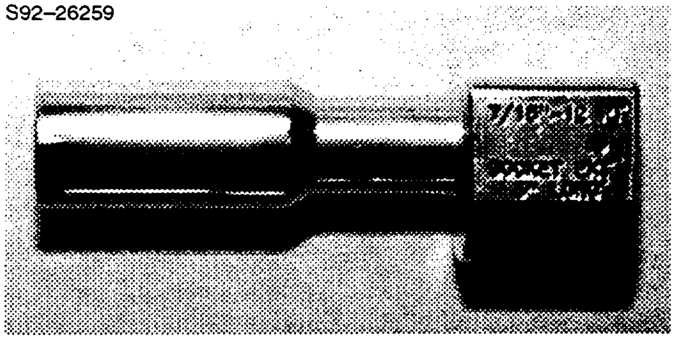
Dimensional Data		
	inches	cm
A	0.625	1.59
B	10.33 (7–01) 10.33 (8–01) **3.10** (25–01) 7.30 (25–02)	26.24 26.24 **7.87** 18.54
C	0.66	1.68
D	0.93	2.36



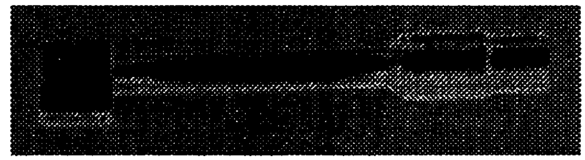


SOCKET, 7/16–INCH GFE

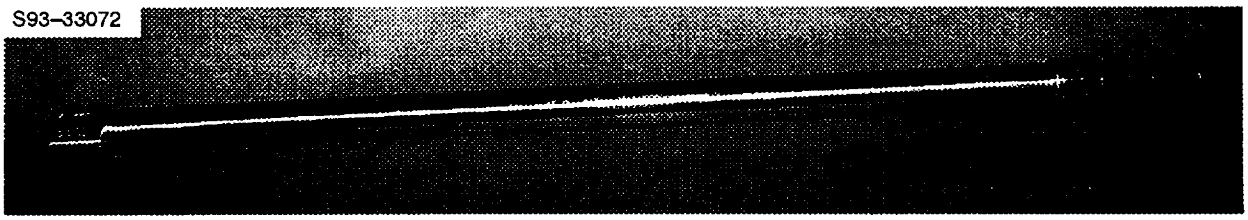
S92–26259



S93–44428



S93–33072



OVERVIEW

To avoid using the Hubble Space Telescope (HST) socket extensions that were designed, fit checked, and now reserved for exclusive use for telescope maintenance, several alternative sockets have been developed for other users. These 7/16–in. socket extensions come in four lengths (3, 6, 12, and 18 in.). Each has a 12–point socket and uses the EVA standard socket dimensions and tolerances. The 3– and 12–in. units have fixed sockets while the 6– and 18–in. extensions have a wobble feature. All attach to ratchets or power tools with a 3/8–in. square drive drop–proof tether. A pip pin is required to mate or demate each extension. They are commonly transported on a tool board, a tool caddy, or are attached to the drive tool.

OPERATIONAL COMMENTS

Each extension has engraved/painted rotation marks to assist in counting revolutions. The sockets interface with 7/16–in. hex–head bolts with flat–to–flat dimensions of 0.434 to 0.439 in.. To provide for added strength, the socket extension and drop–proof tether are all machined from one piece of metal. The 6– and 18–in. extensions have a self–centering 14.5° half angle wobble feature to aid in bolt alignment in tight access areas. The 3– and 6–in. extensions are short enough to be flown in the cabin for pre–EVA attachment to a drive tool and do not excessively snag while attached to a tool during EVA. This avoidance of socket changeout during EVA helps to reduce overhead. The 6–in. extension was flown on STS–37 to support gamma ray observatory (GRO) solar array and high gain antenna contingencies, as well as launch restraint bolts for the crew/equipment translation aid (CETA) experiment. The 3– and 12–in. extensions were flown and used on STS–49 for the Intelsat rescue mission and to support contingency jettison of experiment components for the assembly of station by EVA methods (ASEM). The 3– and 18–in. extensions are being flown to support EVA bolt–torquing experiments on STS–57 and STS–51.

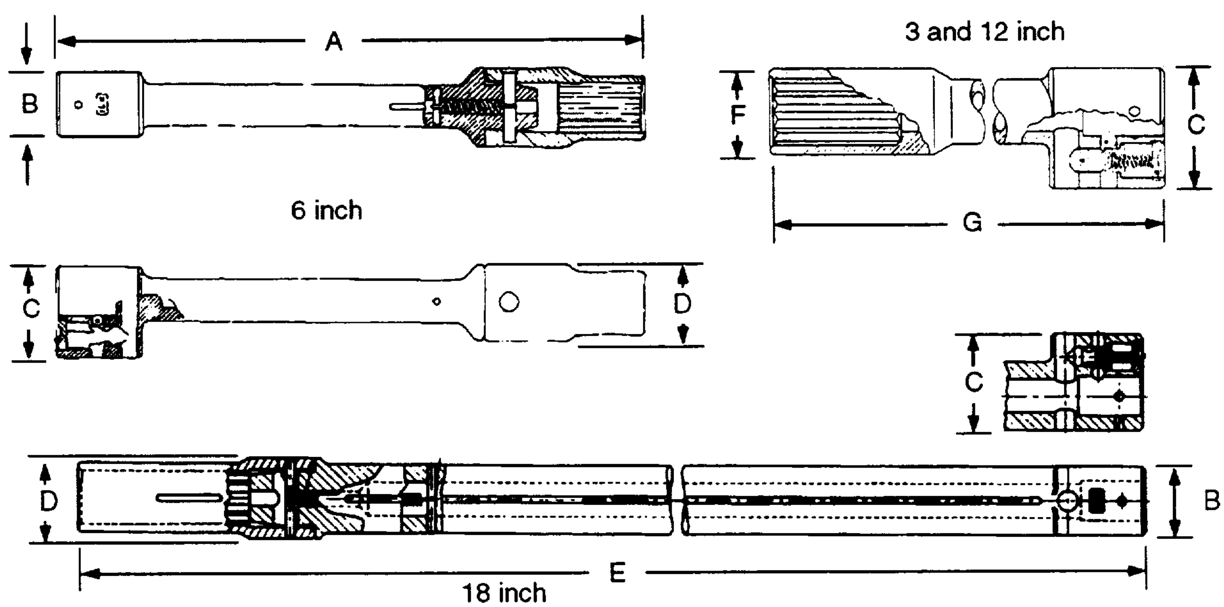
CONTACTS

Operational: R. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. Marak, NASA/EC5, (713) 483–9144

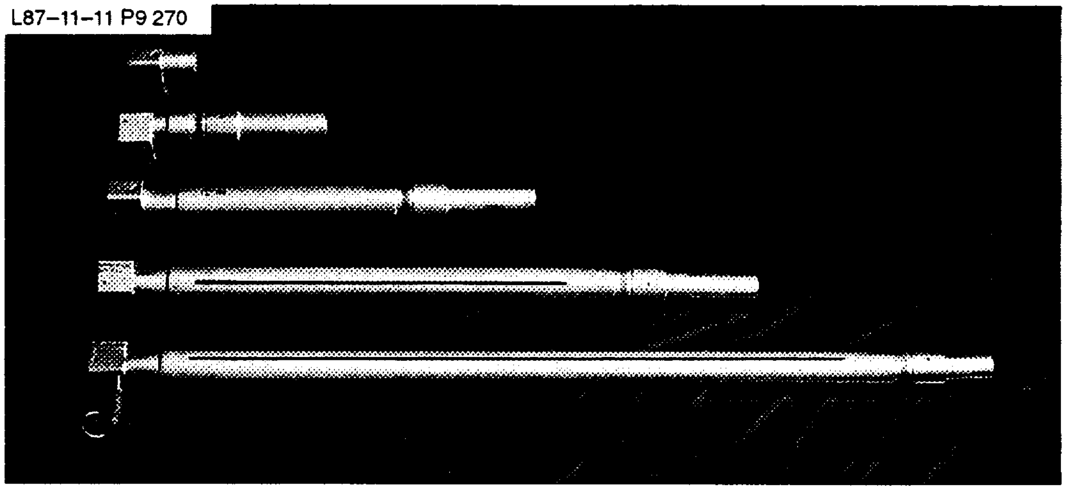
SOCKET, 7/16–INCH GFE

Technical Information	
Part number	10159–10084–01 (3 in.) 10159–10066–01 (6 in.) 10159–10084–03 (12 in.) 18901–10012–303 (18 in.)
Weight	0.20 lb (3 in.) 0.37 lb (6 in.) 0.54 lb (12 in.) 1.40 lb (18 in.)
Material/ construction	Limited life items – None Lubricants – None Metallics – MP35N or 455 socket, CRES shaft Nonmetallics – Chemglaze paint
Load rating	70 ft–lb (3 and 12 in.) 70 ft–lb (6 in.) 50 ft–lb (18 in.)
Temperature range	–120° to +250° F (3 and 12 in.) –180° to +150° F (18 in.)
Quantity flown	Two each 6–in. extensions (STS–37) Two each 3–and 12–in. extensions (STS–49) One each 3–and 18–in. extensions (STS–57) Two of 3–in. extensions (STS–51)
Stowage	Middeck locker (STS–37 6–in. extensions) Middeck locker (STS–49 3–in. extensions) Starboard PSA (STS–49 12–in. extensions) Middeck locker (STS–51, STS–57)
Socket depth	0.9 in. (3–, 6–and 12–in. extensions) 1.6 in. (18–in. extensions)
Availability	Flight specific

Dimensional Data		
	inches	cm
A	6.00	15.24
B	0.66	1.68
C	0.93	2.36
D	0.78	1.98
E	18.0	45.72
F	0.67	1.70
G	3.00 or 12.00	7.62 or 30.48



SOCKET, EXTENSION AND 7/16-INCH (HST)



OVERVIEW

The extension and 7/16-in. socket for the Hubble Space Telescope (HST) comes in five different lengths: 2 in., 6 in., 12 in., 18 in., and 24 in. Each one has a 12-point, 7/16-in. socket pinned to the end. All the extensions, except the 2-in., have an internal wobble alignment of 32° full angle. This feature has a self-aligning device which assures that the extension and socket will return to center. All extensions have drop-proof tethers.

OPERATIONAL COMMENTS

The 7/16-in. hex socket extensions are intended for use with any drive tool equipped with a drop-proof tether interface. The drop-proof tether requires that the pin be inserted before the drive tool can be attached. When the pin is pulled out, the drive will be locked into the extension until the pin is inserted again. This set of extensions is created for use during an HST maintenance mission.

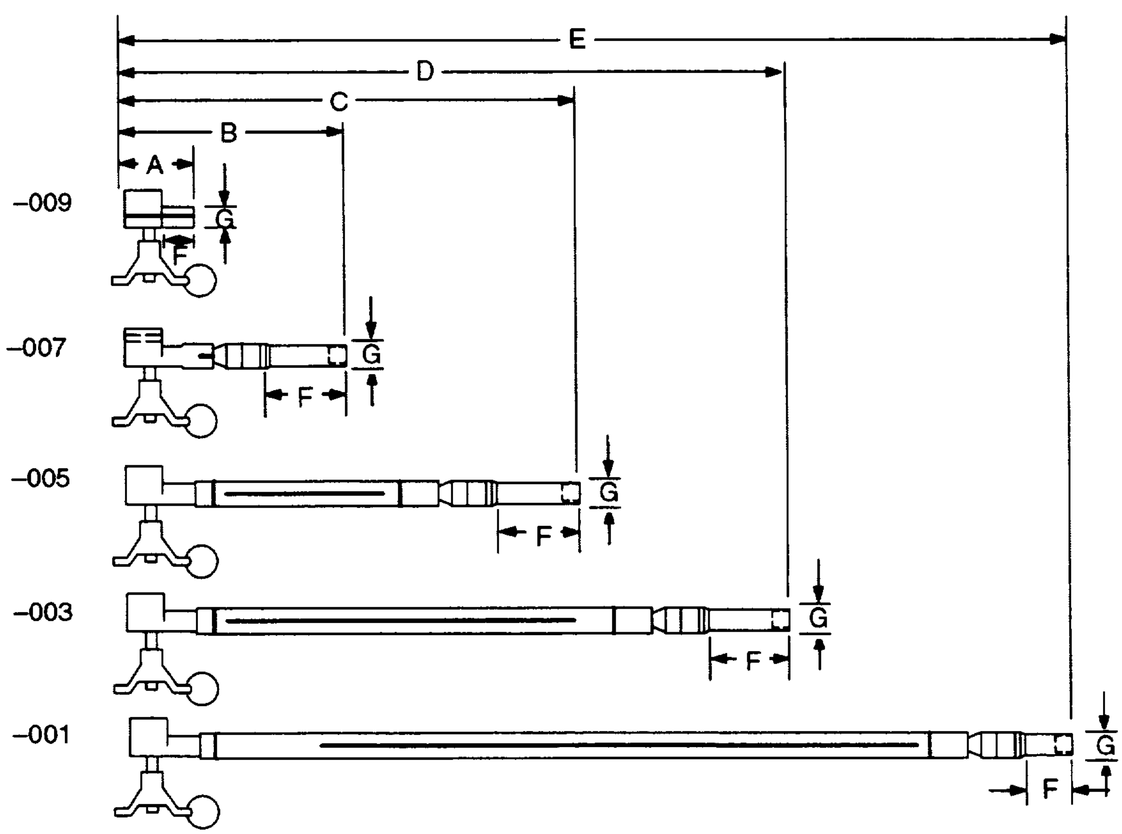
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483-1755
Technical: R. Sheffield, LMSC, (408) 742-8464

SOCKET, EXTENSION AND 7/16–INCH (HST)

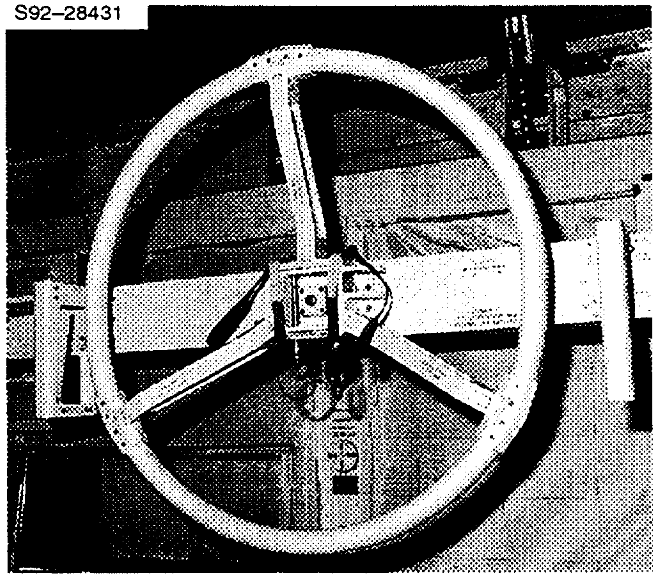
Technical Information	
Part number	2.0 in. – 4177656–009 6.0 in. – 4177656–007 12.0 in. – 4177656–005 18.0 in. – 4177656–003 24.0 in. – 4177656–001
Weight	2.0 in. – 0.22 lb 6.0 in. – 0.64 lb 12.0 in. – 1.00 lb 18.0 in. – **1.27** lb 24.0 in. – **1.52** lb
Material/ construction	Stainless steel 15–5 PH CRES
Socket depth	0.62 in.
Load rating	50/70 ft–lb (use/proof)
Temperature range	–200° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

Dimensional Data			
	inches		cm
A		2.0	5.08
B		6.0	15.24
C		12.0	30.48
D		18.0	45.72
E		24.0	60.96
F	–001	1.250	3.17
	–003 –005 –007	2.125	5.40
	–009	1.000	2.54
G		0.68	1.73



STEERING WHEEL

S92–28431



OVERVIEW

The steering wheel was designed for the STS–49 Intelsat reboost mission as an EVA crew handhold to despin and stabilize the satellite for subsequent remote manipulator system (RMS) capture. The circular design of this handhold allows continuous grasp without having to release to apply input forces in different directions. For STS–49, it was a component of the Intelsat capture bar and was stowed on a port sidewall carrier on the capture bar. A pair of double acting pip pins secured the steering wheel to its stowage fitting and to the capture bar.

OPERATIONAL COMMENTS

As opposed to multiple handrails, the steering wheel provides six–degree–of–freedom control in one continuous circular handrail. This design is particularly useful when simultaneously controlling rotations in yaw, pitch, and roll. The two 3/8–in.–diameter pip pins which secured the steering wheel use the latest safety features, including a redundant pair of locking balls (four total) and a set of Velcro straps that hold the pins in place in case of a mechanical failure.

The steering wheel was also supposed to be used for the STS–49 SSF EVA demonstration (ASEM) as a handhold for large mass manipulation. It is attached to a square hub on the lid of the ASEM starboard node box to allow mission–peculiar equipment support structure (MPESS) handling from an RMS foot restraint.

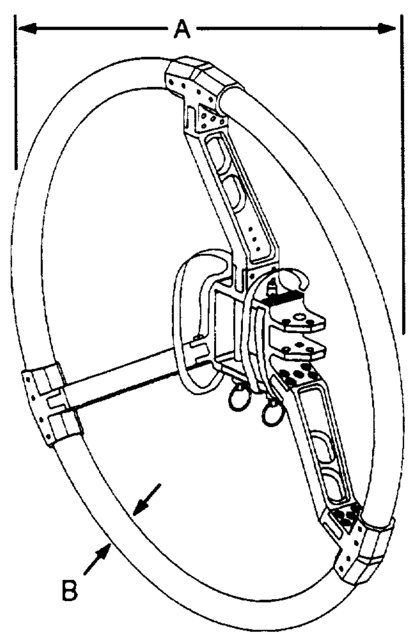
CONTACTS

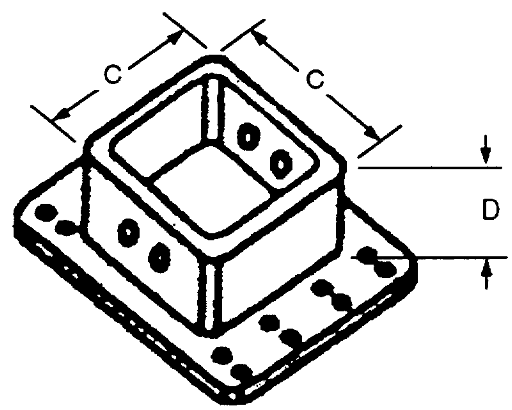
Operational: W. Wedlake, JSC/DF42, (713) 483–2568
Technical: C. Seaman, NASA/EC5, (713) 483–5843

STEERING WHEEL

Technical Information	
Part number	SED39122220–301
Weight	10 lb
Material/ construction	Aluminum
Load rating	25 lb per hand (50 lb and 600 in–lb)
Temperature range	–80° to 150° F
Quantity flown	One on STS–49
Stowage	Payload bay sidewall carrier
Availability	Flight specific

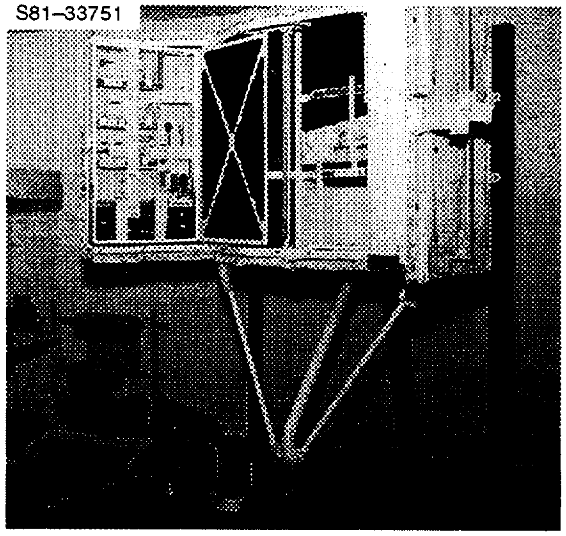
Dimensional Data		
	inches	cm
A	24.0	60.96
B	1.25	3.175
C	3.215	8.15
D	2.0	5.08





STOWAGE ASSEMBLY, CARGO BAY

S81–33751



OVERVIEW

The cargo bay stowage assembly (CBSA) is a tool stowage assembly which mounts to a get–away special (GAS) beam in the cargo bay. The CBSA is a double–doored, compartmentalized stowage assembly. A dedicated portable foot restraint is normally mounted at the bottom of the CBSA structure. The CBSA has a useful volume of 18.3 ft^3 and can contain a maximum weight of 469 lb.

OPERATIONAL COMMENTS

Prior to the development of the provisions stowage assembly (PSA), the CBSA contained the tools that would be required in an unscheduled/contingency EVA situation in which the extravehicular crewmembers would be required to close the cargo bay doors. The CBSA has been replaced by the PSA for standard orbiter tool stowage. One CBSA has been modified to become the special equipment stowage assembly (SESA), and two remaining CBSA's can be modified to carry mission–specific EVA tools for a scheduled EVA.

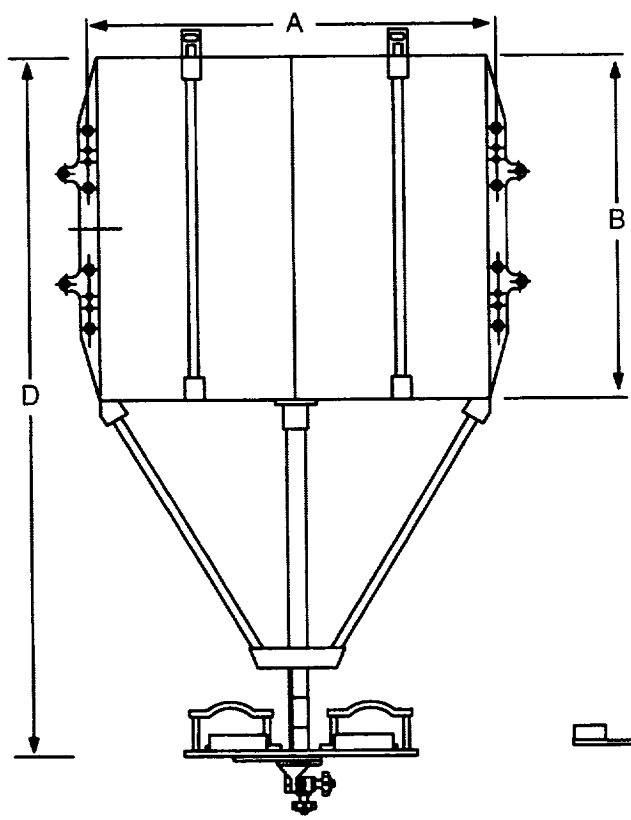
CONTACTS

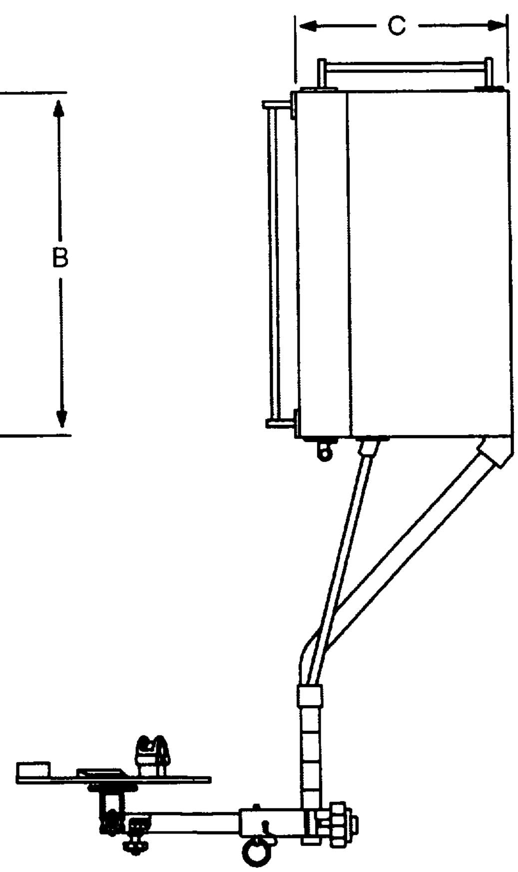
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

STOWAGE ASSEMBLY, CARGO BAY

Technical Information	
Part number	V567–340400
Weight	238.6 lb (empty without GAS beam)
Material/ construction	Aluminum
Load rating	469 lb contents
Temperature range	
Quantity flown	One for STS–2 through STS–13
Stowage	18.3 ft^3 capacity
Availability	Flight specific

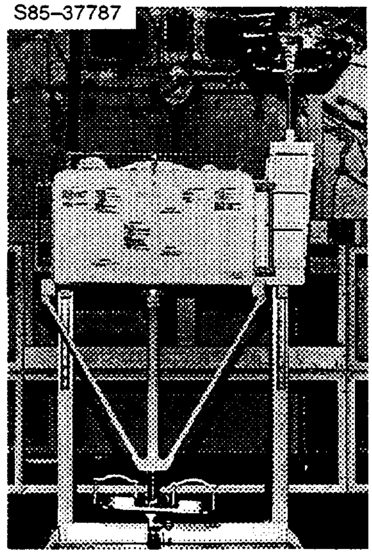
Dimensional Data		
	inches	cm
A	42.0	106.68
B	36.0	91.44
C	22.0	55.88
D	86.6	219.96





STOWAGE ASSEMBLY, LEASAT EQUIPMENT

S85-37787



OVERVIEW

The Leasat equipment stowage assembly (LESA) consists of a tool container assembly (TCA) with tools and equipment stowed inside on tool boards and tool caddies, a TCA foot restraint structure (not shown in drawing front view), a workstation foot restraint, a workstation support structure, and a mounting plate to which the TCA and workstation support structure are attached. The mounting plate is match-drilled for attachment to a get-away special (GAS) beam on the starboard side of the cargo bay (to avoid interference with the operation of the remote manipulator system).

OPERATIONAL COMMENTS

The LESA stows tools and parts used in satellite salvage and repair operations and supports crewmembers while removing and replacing tools in the TCA and while working on the satellite. It was designed specifically for the LEASAT Salvage Mission, STS 51-I. For that mission, the TCA contained five tool boards and three caddies, although the LESA interior could be modified to accommodate different tool requirements for future EVA missions.

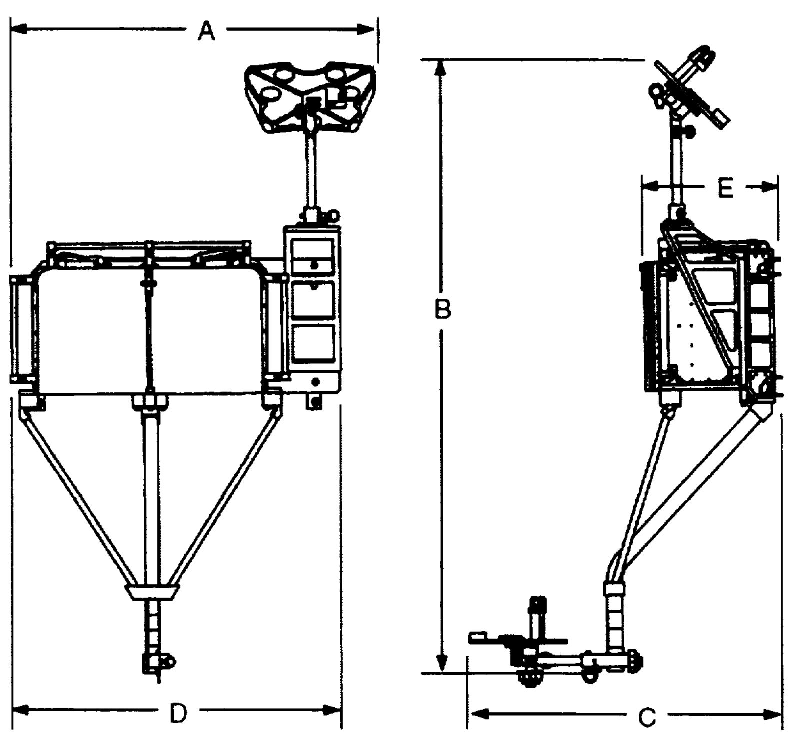
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

STOWAGE ASSEMBLY, LEASAT EQUIPMENT

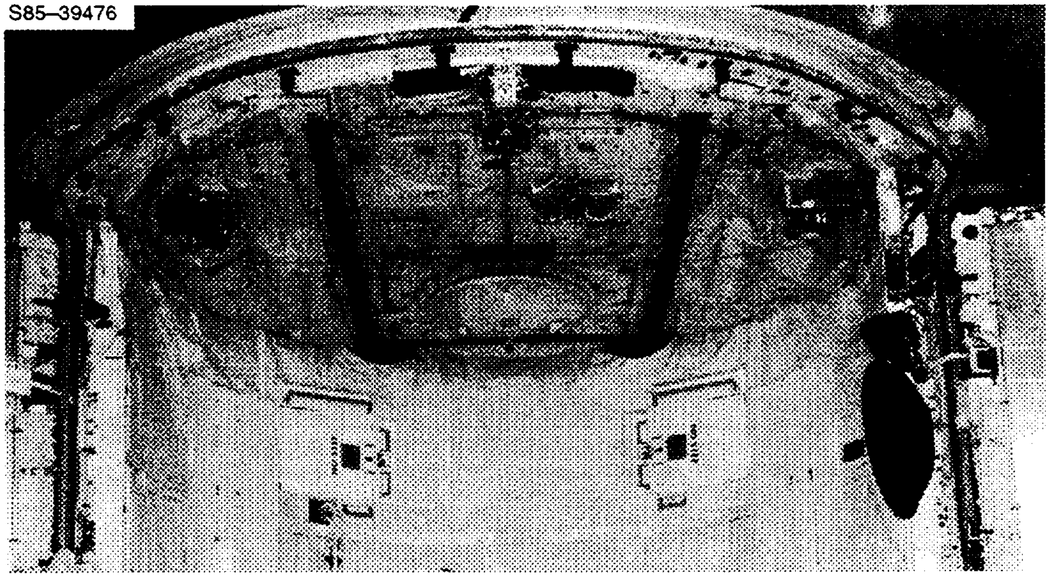
Technical Information	
Part number	10176–20005–01
Weight	188.0 lb 259.2 lb (full with 2 PFRs) 441.2 lb (full with 2 PFRs and GAS beam)
Material/ construction	
Components: TCA TCA foot restraint structure Mounting plate Work station support structure Portable foot restraint	 10176–20003–01 10176–20060–01 and 10173–20168–01 10176–20005–01 10176–20601–01 10176–20060–01
Internal stowage volume of TCA	2.14 ft^3
Load rating	
Temperature range	
Quantity flown	**One on STS 51–I**
Stowage	Cargo bay
Availability	Flight specific

Dimensional Data		
	inches	cm
A	53.60	136.14
B	92.00	233.68
C	45.75	116.21
D	49.75	126.37
E	18.25	46.36



STOWAGE ASSEMBLY, PROVISIONS

S85–39476



OVERVIEW

The provisions stowage assembly (PSA) is a container mounted under the cargo bay liner area for stowage of tools and equipment. Both the port and starboard sides of the orbiter fuselage have the capability for one container. The PSA is built from aluminum sheet metal and machined parts. The PSA will stow various tools and equipment necessary to support orbiter EVA contingency tasks as well as a limited number for specific EVA missions. Most of the tools are wrapped in tool caddies or tool bags and stowed in designated compartments. The compartments are custom cut dividers lined with fabric. Tool caddies are friction fitted in place, with tether rings visible. The PSA has handrails located on three sides.

OPERATIONAL COMMENTS

The PSA door has a pivoting handle coupled with a positive locking device which latches the cover in its closed position. The maximum force required to overcome the open or close position pawl spring load is less than 25 lb. The metal door slides open to expose the compartmentalized PSA liner, which stores the EVA equipment. The lower portion of the door is hinged and held open by a spring–loaded roller. A decal diagram located on the door cover shows the positions of the tools stowed in the container. A limited amount of space remains in the PSA for future tools. Only the port PSA is flown on all missions, and it is full of orbiter tools. The STBD PSA is optional for flight–specific items. The PSA is not optimized for easy ground removal or installation, and tool compartment changes are also not easily made. No crew body restraint is provided other than limp tether lines.

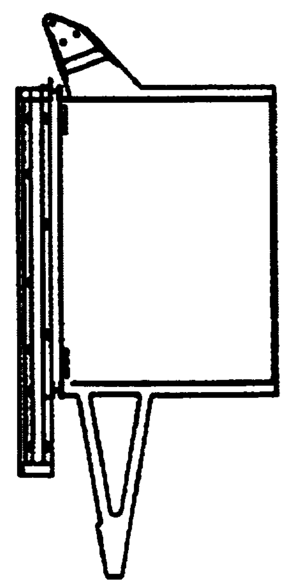
CONTACTS

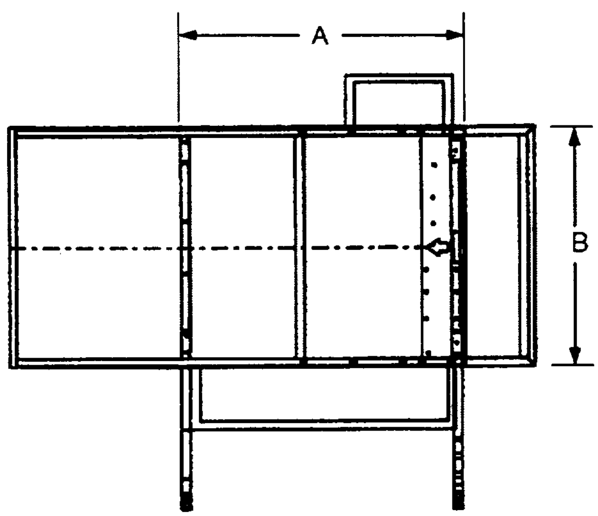
Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

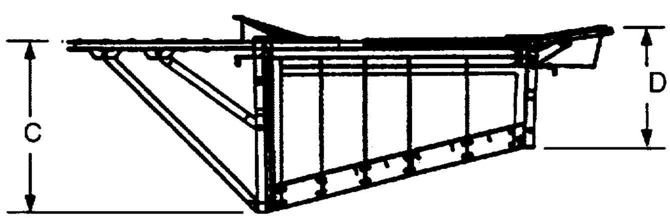
STOWAGE ASSEMBLY, PROVISIONS

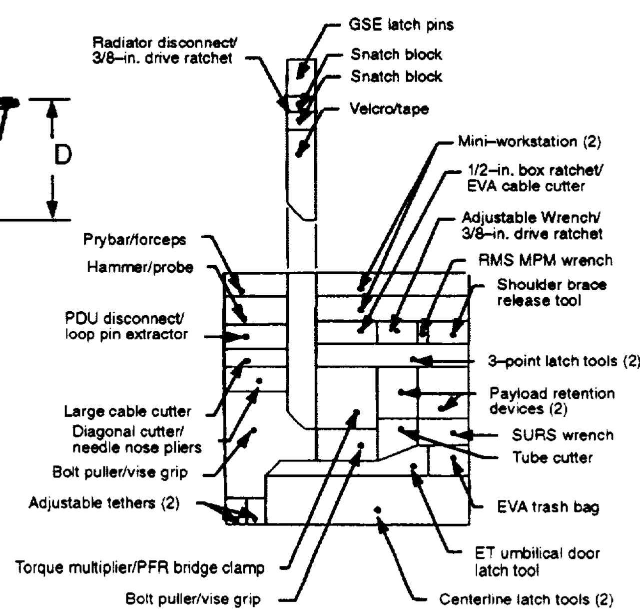
Technical Information	
Part number	V568–340428 (port) V568–340405 (stbd) M072–661633 (PSA tool installation) SDD33103434–301 V669–000977 (tool box decals)
Weight	Total: 270 lb (port including tools) Tools: 150 lb (port)
Material/ construction	Aluminum sheet metal, Teflon door rollers and tracks, honeycomb aluminum outer door
Load rating	
Temperature range	–200° to +250° F (operational), +350° F (storage)
Quantity flown	Port (std), Stbd (as required)
Stowage	Bay 1
Availability	Standard (port only)

Dimensional Data		
	inches	cm
A	31.5	80.01
B	27.5	69.85
C	17.0 (port) 20.0 (stbd)	43.18 (port) 50.8 (stbd)
D	10.0 (stbd) 12.0 (port)	25.4 (stbd) 30.48 (port)



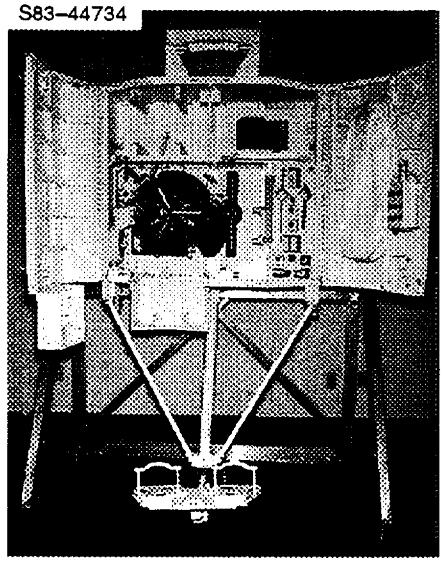






STOWAGE ASSEMBLY, SPECIAL EQUIPMENT

S83-44734



OVERVIEW

The special equipment stowage assembly (SESA) was designed for the stowage of tools and equipment such as the trunnion pin attachment device (TPAD) and hydrazine servicing tools.

OPERATIONAL COMMENTS

The SESA is a modified cargo bay stowage assembly (CBSA) which includes a tripod with a dedicated portable foot restraint. The shelves, foam, and door stowage compartment of the CBSA have been removed; partitions, handholds, mounting hardware, structural stiffeners, and clearance holes have been added. It was used during the STS 41-B practice mission for Solar Maximum satellite repair. A trunnion pin structure was attached to the SESA top for practicing manned maneuvering unit (MMU)/ TPAD operations.

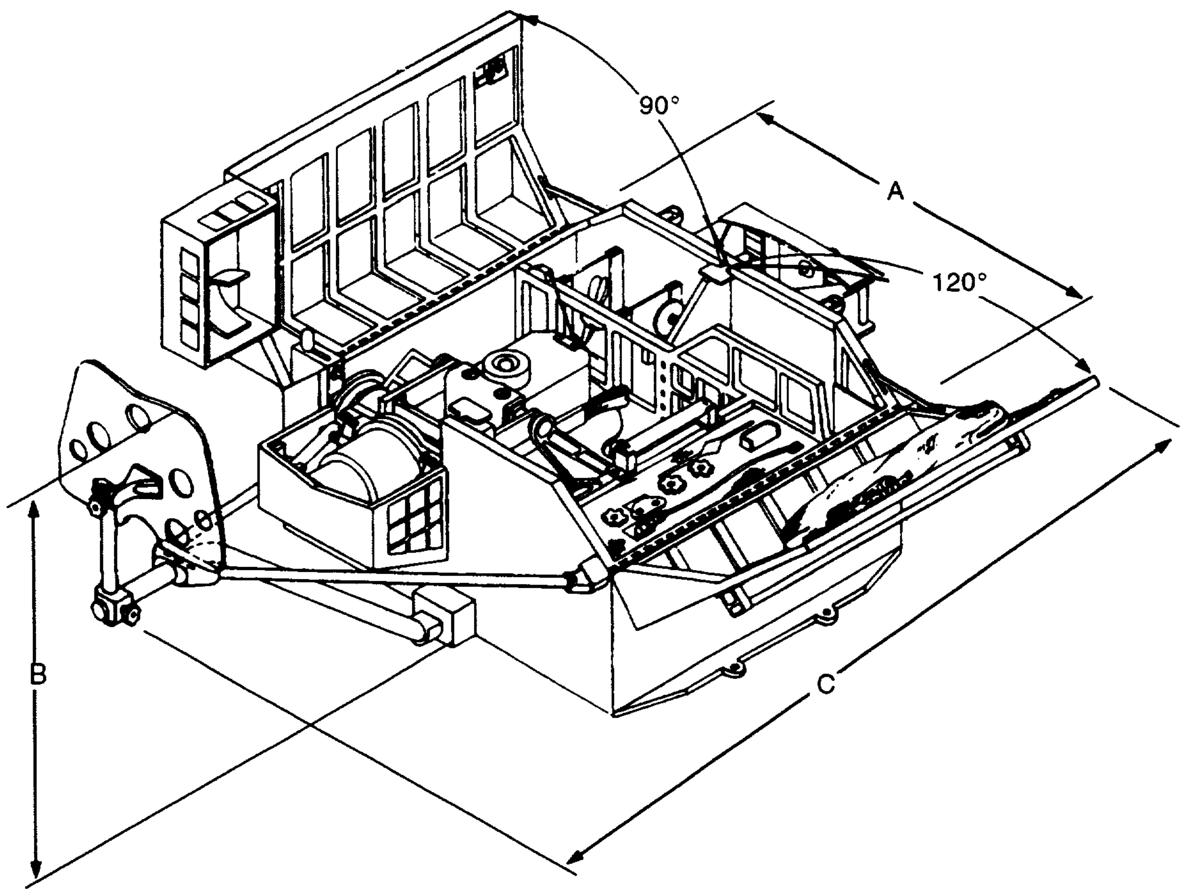
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

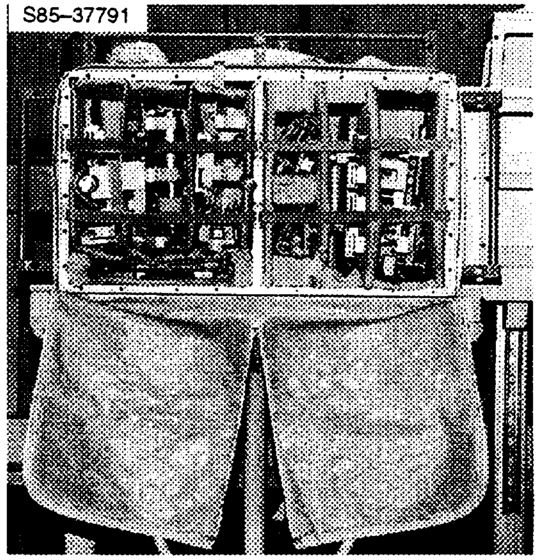
STOWAGE ASSEMBLY, SPECIAL EQUIPMENT

Technical Information	
Part number	10173-20001-01
Weight	246 lb (unloaded) 386 lb (loaded)
Material/ construction	Aluminum
Load rating	
Temperature range	
Quantity flown	One (when needed)
Stowage	Payload bay
Availability	Flight specific

Dimensional Data		
	inches	cm
A	48.10	122.17
B	44.26	112.42
C	92.66	235.36



STOWAGE ASSEMBLY, TOOL CONTAINER



OVERVIEW

The tool container stowage assembly (TCA) provides stowage of tool boards and tool caddies with tools and equipment attached. This item is an integral part of the Leasat equipment stowage assembly (LESA) **and is used with a dedicated foot restraint.**

OPERATIONAL COMMENTS

The TCA has an aluminum top, sides, base, and central wall. Fabric–covered foam partitions are individually sized to enclose each tool board or caddy. Handrails are provided along the edges of the TCA. The front of the TCA has zippered fabric covers that secure the boards and caddies in their positions and allow a suited crewmember one–handed operation in removing or replacing necessary tool boards or caddies. Kevlar retainer straps restrain TCA contents when the fabric cover is open. Devices are provided on the TCA for attachment of the EVA trash bags during entry and of transfer bags during salvage operations. The TCA contained five tool boards and three tool caddies on STS 51–I.

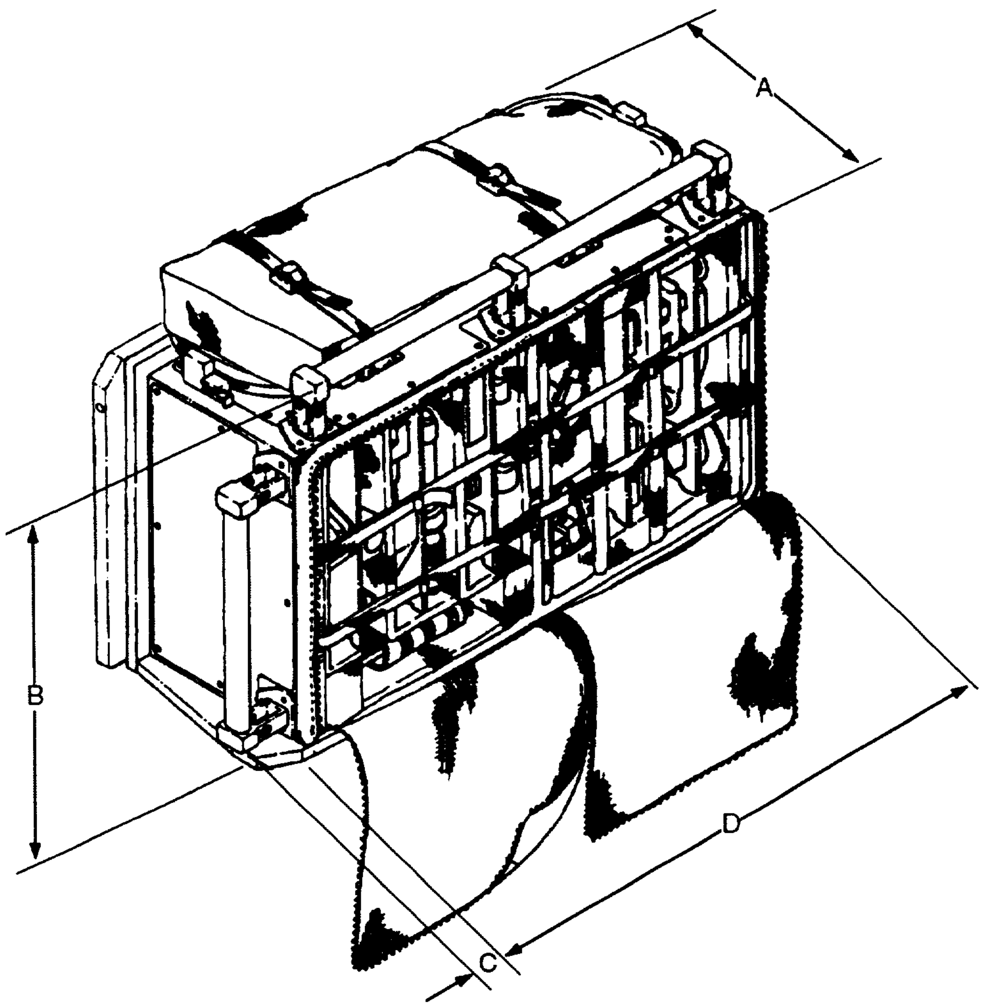
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

STOWAGE ASSEMBLY, TOOL CONTAINER

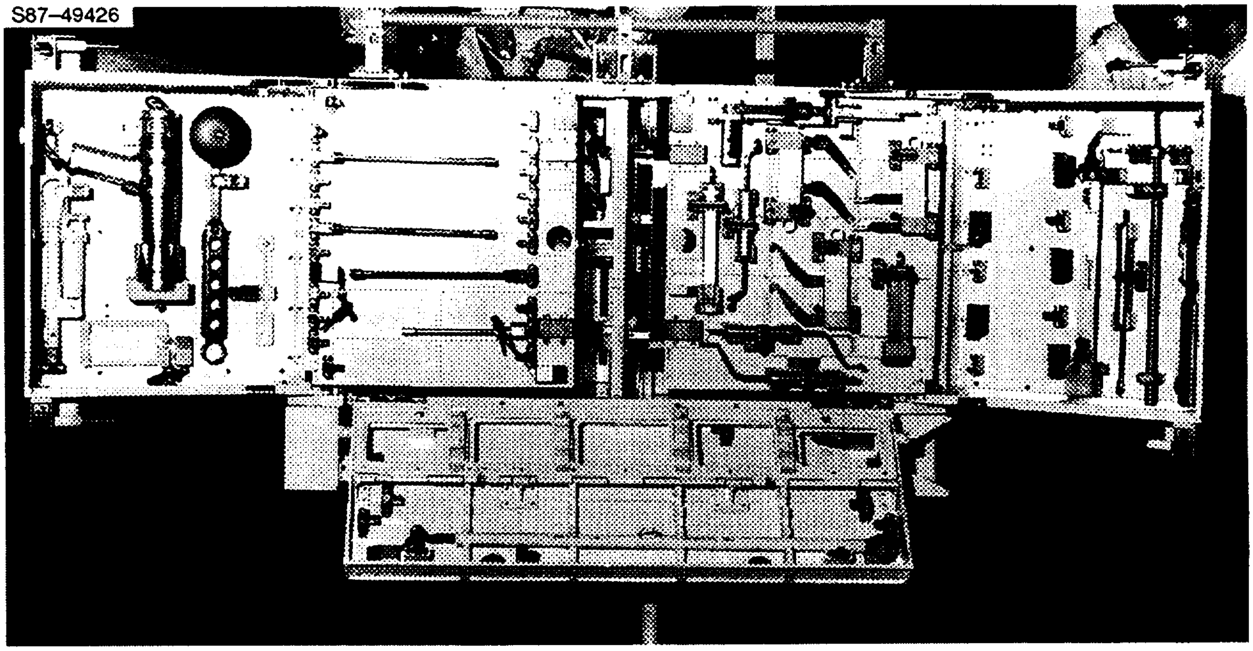
Technical Information	
Part number	10176–20003–01
Weight	99.0 lb
Material/ construction	Aluminum, Solemide foam, Nomex fabric, Armalon
Load rating	
Temperature range	
Quantity flown	**One on STS 51–I**
Stowage	Bay no. 3, starboard on STS 51–I
Availability	Flight specific

Dimensional Data		
	inches	cm
A	15.875	40.32
B	23.600	59.94
C	4.100	10.41
D	34.500	87.63



STOWAGE BOX, HST TOOL

S87–49426



OVERVIEW

The Hubble Space Telescope (HST) stowage tool box provides stowage of individual tools, tool boards, and tool caddies required for the maintenance and repair of the HST. The basic box design was derived from the Leasat equipment stowage container. It can be mounted to **selected baseplates** depending on the mission location requirements. A four–point latching system secured with pip pins is employed to latch the tool box doors for launch. Various other latches are designed into the door panels and tool mounting locations for tool retention.

OPERATIONAL COMMENTS

The HST tool box consists of aluminum sides and base, a dividing wall, and deep doors. There are handrails **along the top and sides** by which EVA crewmembers can translate themselves or brace themselves when stowing and unstowing equipment. The tool box interior accommodates tool boards, tool caddies, and individual tools and equipment. The tool box doors are designed with sufficient depth to allow storage on the front and back of the swing–out door panels. The inside door skins also have provisions for tool mounting. There **is a single door–stop position that holds each door open at 120°. The latest configuration has "dog bone" cross–sectional handholds on the front and sides. The handholds on the doors should not be used as translation aids except when the doors are closed. There are no crew–rated tether points on this box. A foot restraint can be attached to an articulating socket on the base of a quadpod and is launched folded up and pinned against the quadpod. There are 7/16–in. hex contingency release bolts provided to override failed door latches, hinges, and hold–open mechanisms.**

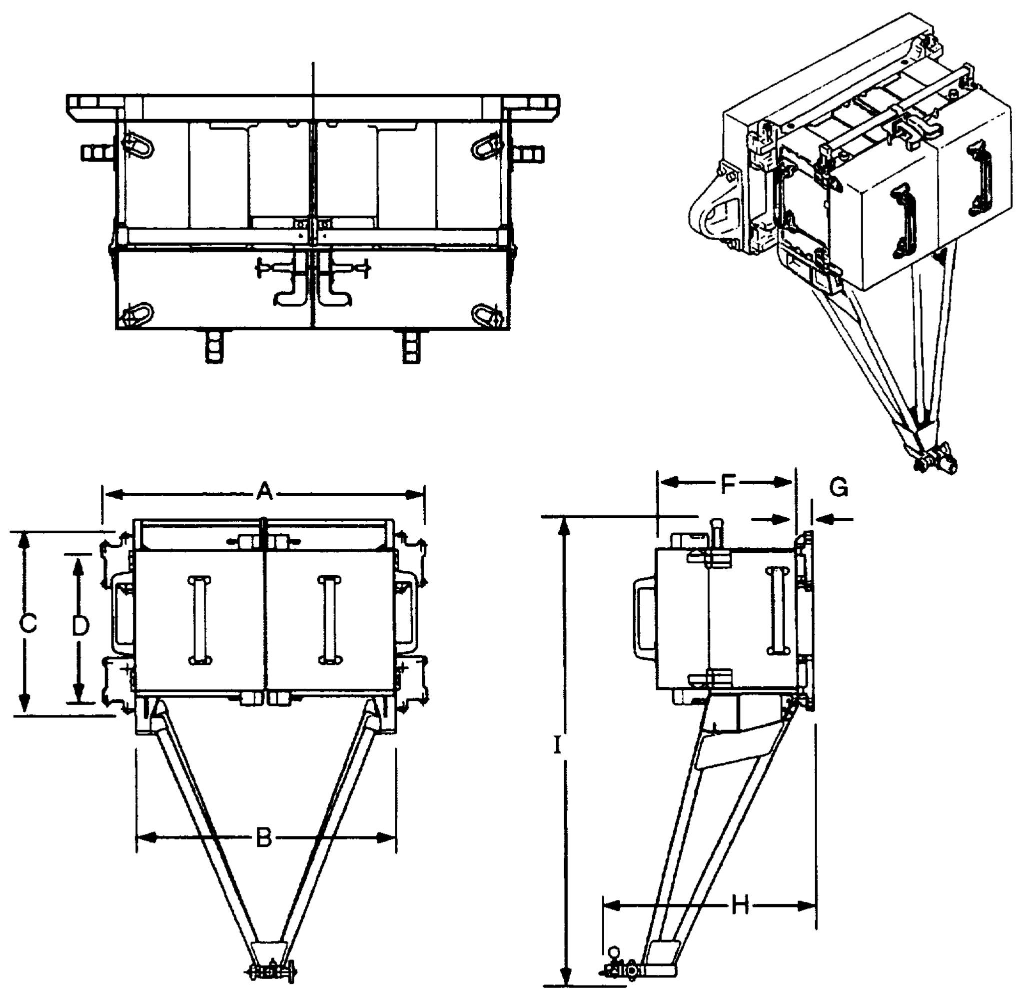
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

STOWAGE BOX, HST TOOL

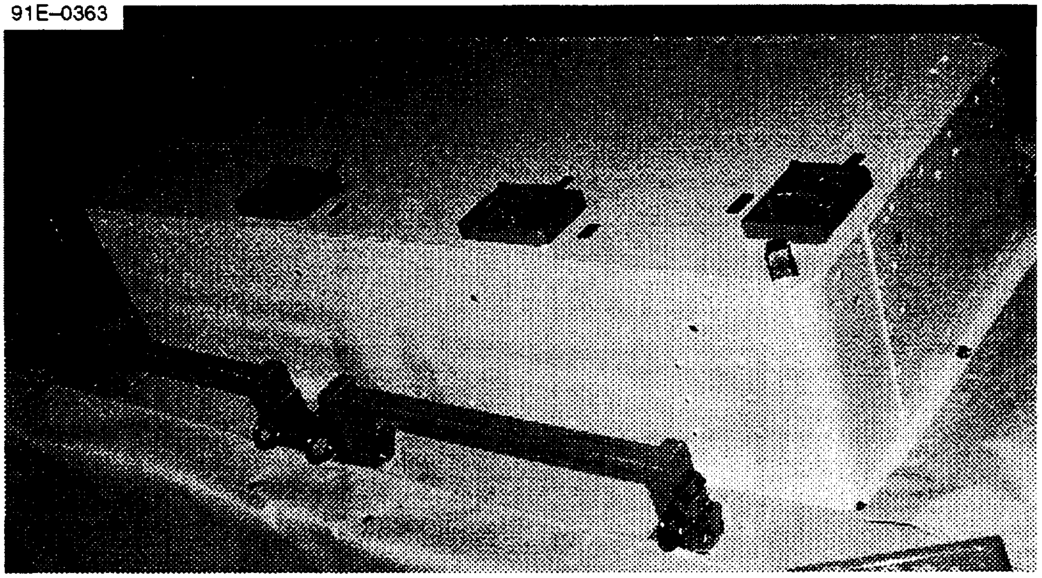
Technical Information	
Part number	10181–10030–01
Weight	**196.4 (empty, without sidewall carrier)**
Material/ construction	Aluminum Stainless steel Aluminum bronze Delrin
Load rating	**25–lb open door limit**
Temperature range	–150° to +250° F (operational)
Quantity flown	
Stowage	
Articulation	**–15° to +75° in seven 15° increments (PFR socket)**
Availability	Flight specific

Dimensional Data		
	inches	cm
A	43.00	109.22
B	**34.50**	**87.63**
C	**23.80**	**60.452**
D	**19.50**	**49.53**
E	**7.04**	**17.89**
F	**18.42**	**46.79**
G	**2.22**	**5.64**
H	**26.00**	**66.04**
I	**61.45**	**156.08**



STOWAGE BOX, UARS TOOL

91E–0363



OVERVIEW

The UARS stowage tool box was used to store upper atmosphere research satellite (UARS) EVA contingency tools during launch and landing. The box is constructed of a 1/8–in. thick aluminum alloy enclosure, in which the tools are stored in blocks of foam and held in place with large 1/4–turn fasteners. The box was attached to the port aft side of the UARS carrier.

OPERATIONAL COMMENTS

The tool box lid is hinged with a hold–open device that limits opening to 90°. To open or close the lid, four folding T–handles rotate 90°. Two of the four latches must be secured to survive launch and landing loads even when all tools are secured. The latches are identical to those used previously for the cargo bay stowage assembly (CBSA), the STS 41–B special equipment stowage assembly (SESA), and the STS 41–C flight support system locker. For STS–48, this box contained a modified rope reel, a foot restraint probe extension, and several UARS solar array release tools.

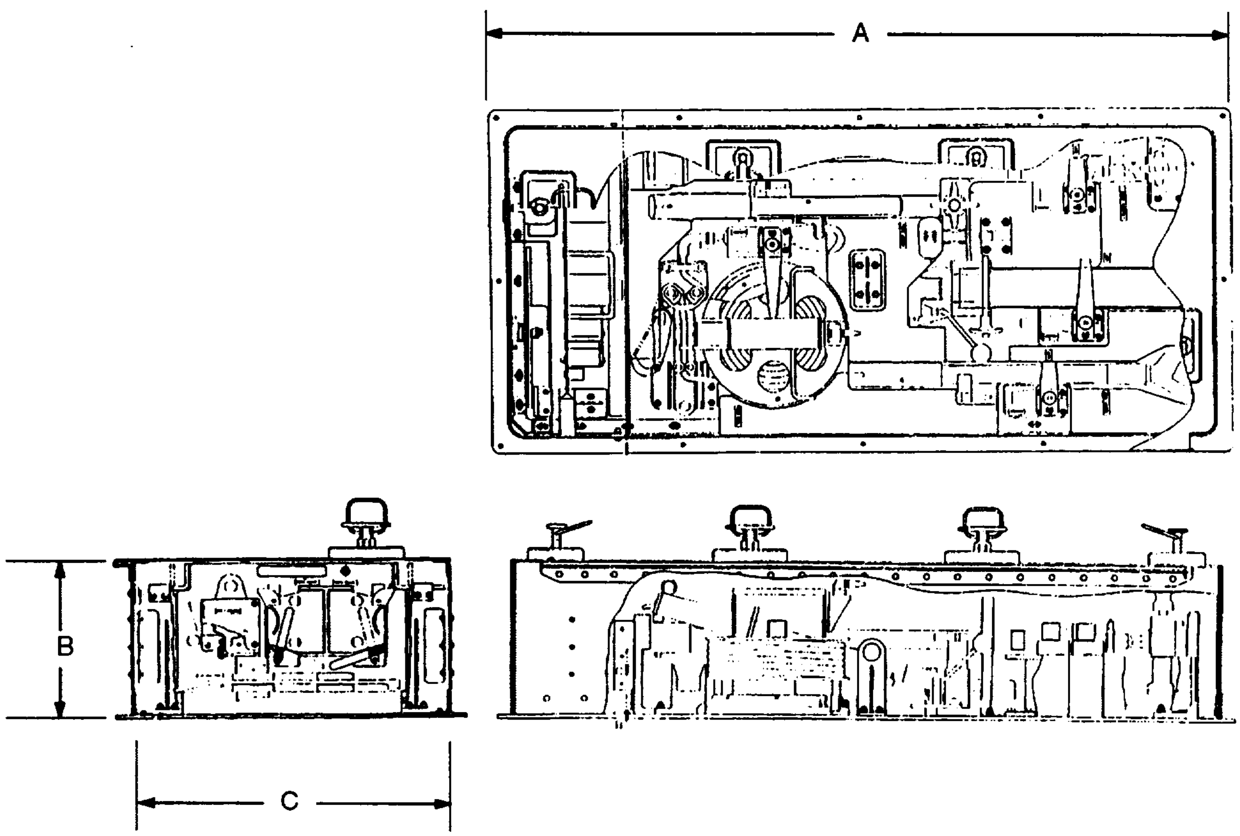
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: R. Rashford, GSFC, (301) 286–7183

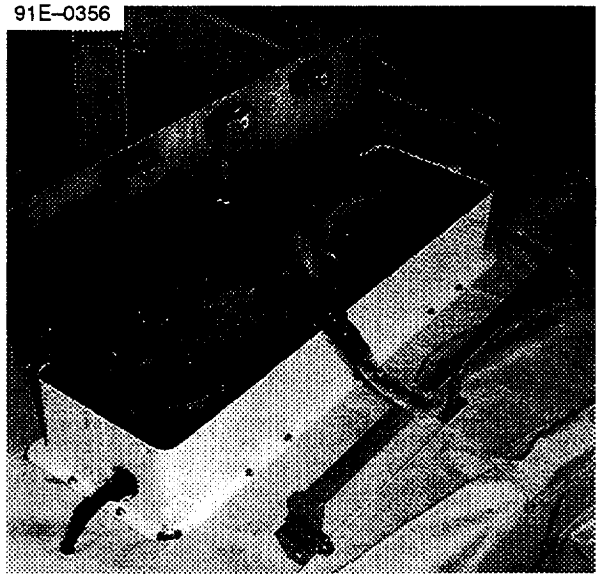
STOWAGE BOX, UARS TOOL

Technical Information	
Part number	47–284552–G1
Weight	
Material/ construction	Aluminum alloy box, stainless steel/cast zinc latches, Nomex–covered solamide foam cushions
Load rating	
Temperature range	
Quantity flown	One for STS–48
Stowage	Port side of UARS carrier
Availability	Flight specific

Dimensional Data		
	inches	cm
A	45.0	114.3
B	9.5	24.1
C	20.0	50.8



STOWAGE BOX, UMBILICAL



OVERVIEW

The UARS umbilical cable, also known informally as the jumper cable, is a 30–ft–long cable designed to provide backup power, hardline command and telemetry, and hardline receiver enable switching between the orbiter and the UARS Observatory. The female connector used for the EVA cable hookup is a circular scoop–proof connector with positive mate locking action. The connector end of the cable has a tether point to facilitate routing by the EVA crew.

The umbilical cable is stowed in the EVA umbilical cable box, which provides easy access and allows rapid removal. The cable is wound in a figure eight around two 5–in.–diameter, 4–7/8–in. high cylinders spaced about 20 in. apart. Cable crossings in the middle of the box are held down by a Velcro strap, and the free end of the cable is secured to the inside of the box lid by mating its connector to a dummy receptacle. The box was attached to the port starboard side of the UARS carrier for STS–48.

OPERATIONAL COMMENTS

Three T–latches secure the box lid. Only one latch must be secured to provide containment during launch and landing. The latches are identical to those used previously for the cargo bay stowage assembly (CBSA), the STS 41–B special equipment stowage assembly (SESA), and the STS 41–C flight support system locker. The lid is hinged with a hold–open device that limits opening to 90°.

The umbilical connector is operated using horizontally opposed wing tabs on the connector shell. All electrical interfaces are deadfaced at the time of the EVA connection. The mating half of the connector is mounted on the aft end of the UARS spacecraft. The Leavy pole provided EVA crew reach access and stability for this umbilical connection task. A red alignment mark on the cable connector is lined up with red and black marks on the spacecraft for initial engagement and final locking.

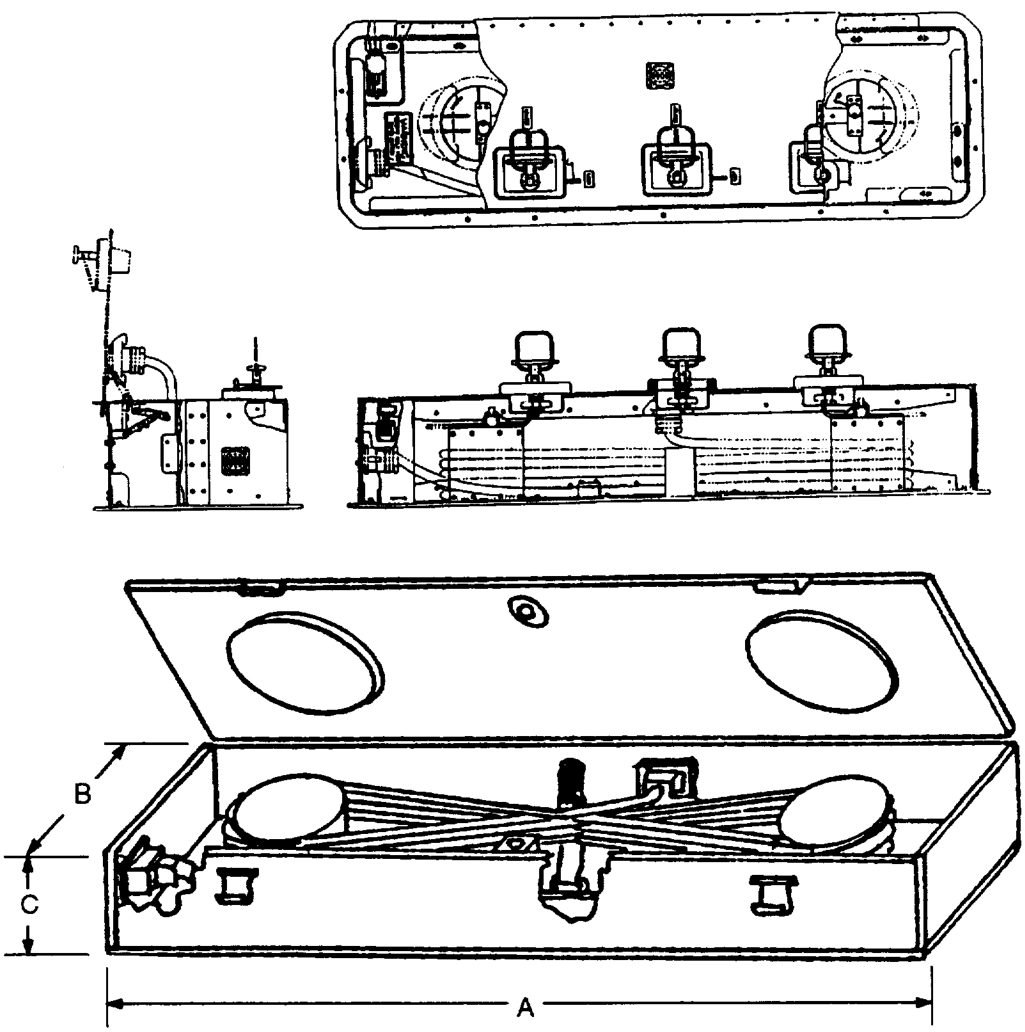
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: R. Rashford, GSFC, (301) 286–7183

STOWAGE BOX, UMBILICAL

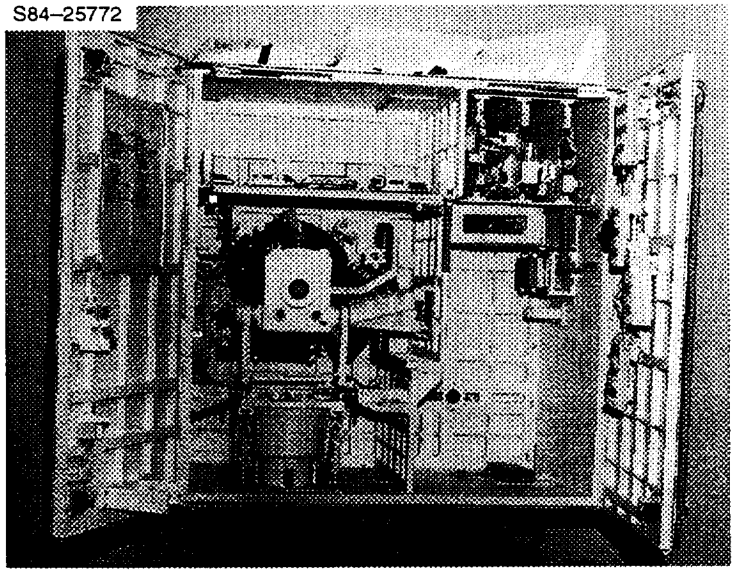
Technical Information	
Part number	Cable – Box –
Weight	
Material/ construction	Aluminum alloy box, stainless steel/cast zinc latches Size 25 Breech Lok umbilical connector
Load rating	
Temperature range	
Quantity flown	One for STS–48
Stowage	Stbd side of UARS carrier
Availability	Flight specific

Dimensional Data		
	inches	cm
A	42	106.68
B	12	30.48
C	7	17.78



STOWAGE LOCKER, FLIGHT SUPPORT SYSTEM

S84-25772



OVERVIEW

The flight support system (FSS) locker stows tools and equipment **and was** used for **Solar Max** satellite repair. The locker mounts on the FSS cradle at station X_{FS} 85.70 (orbiter X_o – 1160.9) for launch and entry.

The FSS locker is designed for crewmember access and use. It includes a portable foot restraint, handholds, and doors for removing and replacing tools. The locker is normally used with a dedicated FSS foot restraint to aid crewmember access.

OPERATIONAL COMMENTS

The FSS locker protects its contents with thermal insulation and by transmitting launch and entry loads through its connection with the cradle. Brackets, latches, and mounting hardware restrain the tools and equipment stowed in the locker. This locker flew on STS 41–C and contained the trunnion pin attachment device (TPAD), main electronics box (MEB) replacement box, two module servicing tools (MST's), an EVA power tool, four tool caddies, and three tool boards.

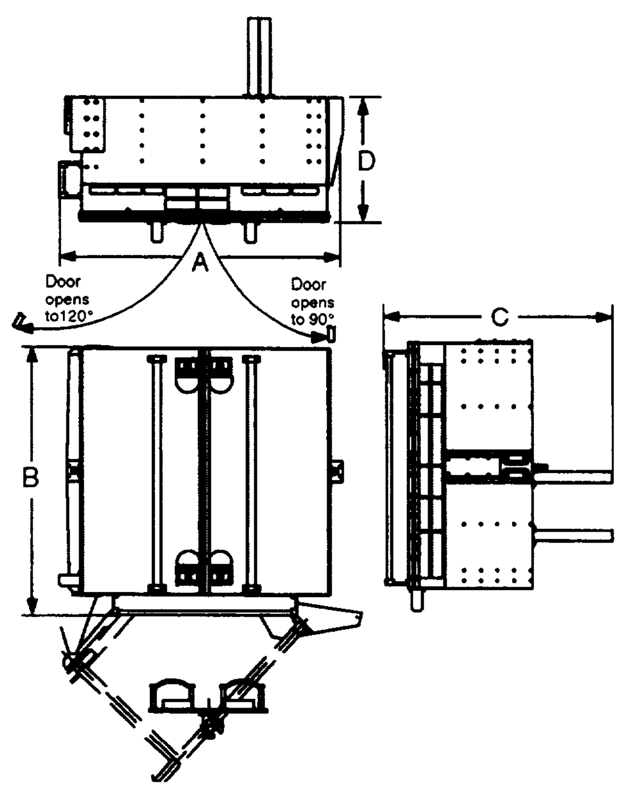
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

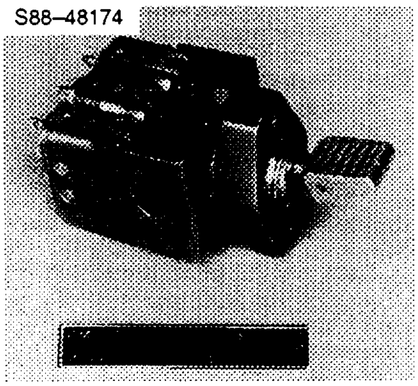
STOWAGE LOCKER, FLIGHT SUPPORT SYSTEM

Technical Information	
Part number	10172–20001–01
Weight	Empty – 442.6 lb Packed – 789.0 lb **Mounting structure – 176.6 lb**
Material/ construction	Aluminum honeycomb
Load rating	
Temperature range	**50°–90°F (MEB control temp)** **14°–104° F (MST control temp)**
STS 41–C contents	TPAD, MST (2), MEB with panel, manipulator foot restraint tool boards (3), tape strips in caddy, EVA scissors, power hand tools (2), shrouded screwdriver extension, hex allen drive extension, crow's foot, pin straightener, MEB panel support bracket, thermal patch, pin connector installation tool, pin connector removal tool, Essex ratchet tool, large trash bag, 7/16–in. socket extension, drill bit, tape caddy, open end wrenches (2)
Quantity flown	One for STS 41–C
Stowage	Cargo bay
Availability	Flight specific

Dimensional Data		
	inches	cm
A	53.86	136.80
B	57.65	146.43
C	43.87	111.43
D	23.00	58.42



SWITCH, EMU

S88–48174


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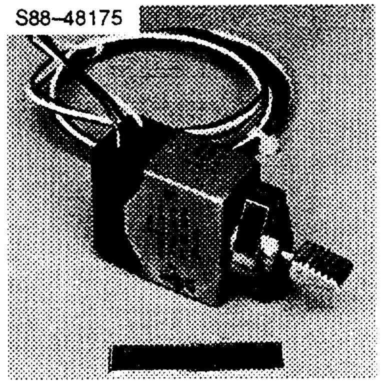

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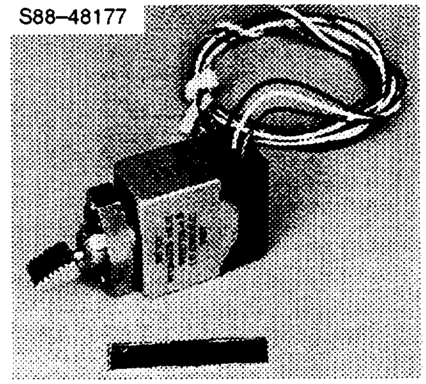


OVERVIEW

The extravehicular mobility unit (EMU) switch is in use as a control device on every shuttle EMU. There are actually several versions of this toggle switch which vary in configuration. Triple pole, double throw; single pole, double throw; and double pole, double throw units are presently extravehicular activity (EVA) certified. Two configurations have momentary on–off positions. Each configuration is rated for 28 V dc. The throw force is 4 lb near the base of the large knob.

Each single and double pole switch is hermetically sealed in a dry–nitrogen–filled case with glass–metal seals at the terminal entry points. Stationary dual redundant contacts are engaged by a roller contact to keep switching force to a minimum. The switches with momentary features are rated for 0.5 amp while the others are rated for 1.0 amp.

The triple pole configuration has three ganged leaf–spring switches. Each of these switches is dry–nitrogen–filled and hermetically sealed with silver plated contacts. This configuration is designed to handle a 10–amp current flow at two poles and a 5–amp current flow at the third pole.

OPERATIONAL COMMENTS

To prevent accidental operation, these switches are protected by switch guards. Like all EVA toggle switches, they are subject to tether snagging if inadequately protected. Where protruding switches are a problem, lower profile pushbutton devices like those on the EMU helmet lights should be considered. The advantages of toggle switches over other designs include positive visual and tactile verification of switch position. Non–EMU applications of these toggle switches have included the portable data acquisition package (PDAP), the simplified aid for EVA rescue (SAFER), and early versions of the electronic cuff checklist.

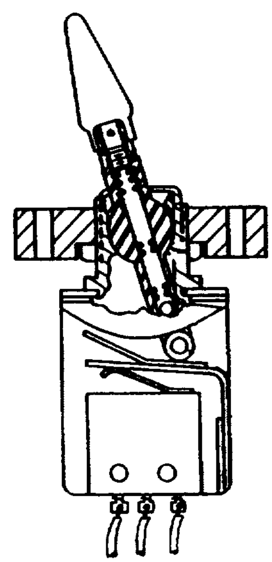
CONTACTS

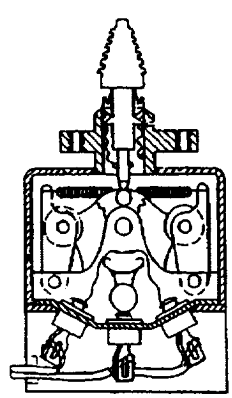
Operational: R. Fullerton, NASA/DF42, (713) 483–2589
Technical: G. Lutz, NASA/EC6, (713) 483–9257

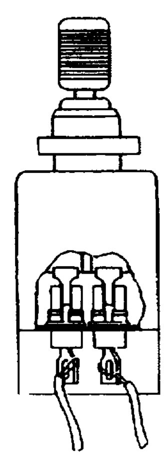
SWITCH, EMU

Technical Information	
Part number	SV778596 (triple pole, double throw) SV767794 (single pole, double throw, mom on) SV771887 (double pole, double throw) SV767795 (single pole, double throw) SV767792 (single pole, double throw, mom on)
Weight	<1 lb
Material/ construction	Stainless steel, aluminum, braycoat grease on toggle pivot
Load rating	4 ± 2 lb (throw force) 28 V dc 5/10 amps (SV778596) 0.5 amp (SV767794, SV767792) 1.0 amp (SV767794, SV767795)
Temperature range	
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A		
B		
C		
D		
E		
F		
G		
H		
Z		

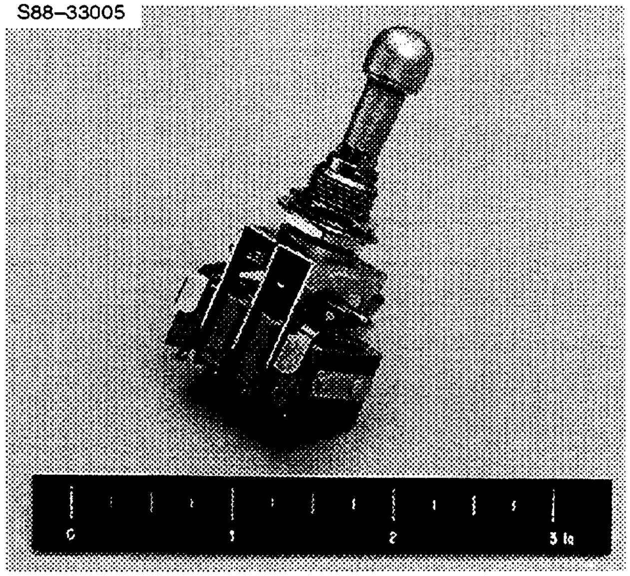






SWITCH, EVA

S88–33005



OVERVIEW

The extravehicular activity (EVA) switch is a commercially manufactured switch modified and certified for EVA use. It consists of a toggle switch lever and frame containing one or more basic microswitches. The switch is a modular assembly available in a variety of configurations, including two– or three–position locking switches and up to four ganged basic switches operated by the same lever.

The basic switches used in the assembly are hermetically sealed with glass–to–metal bead seals at the terminal entry points. They are inert–gas filled, have silver or gold contacts as required, and can switch resistive loads up to five amperes at 28 V dc or 115 V ac, 400 Hz.

OPERATIONAL COMMENTS

To prevent accidental operation, the spring–loaded locking levers must be pulled 0.09 in. upward to change positions. When released, the switch is locked in place. Depending on circuit requirements, various locking patterns can be specified, such as locked–in, locked–out, or unlocked at specific switch positions. Five of these switches are used on the EVA power package.

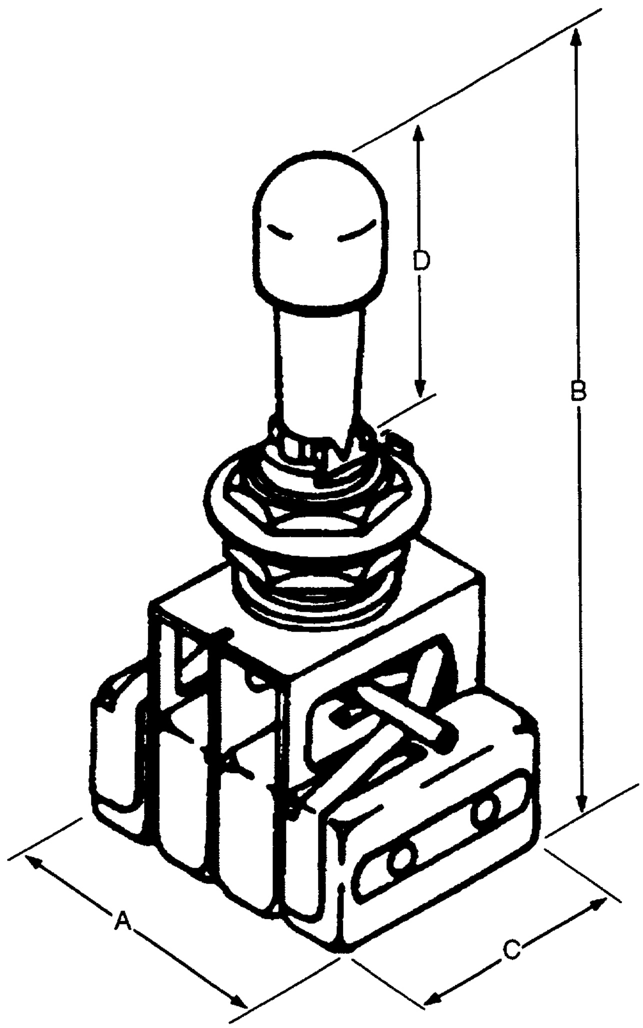
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

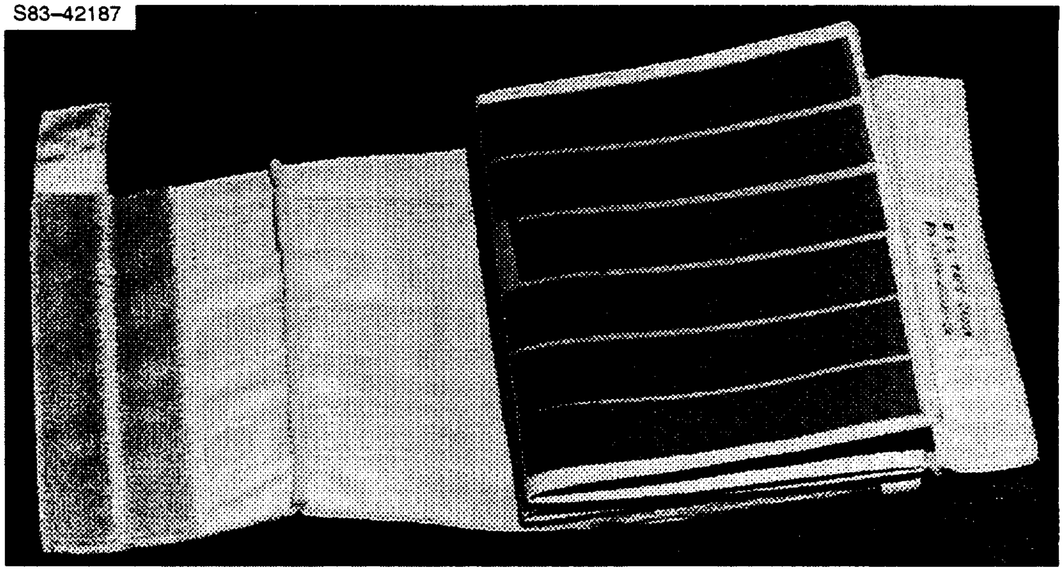
SWITCH, EVA

Technical Information	
Part number	S085MD1738-01
Weight	0.11 lb
Material/ construction	Toggle – Stainless steel
Load rating	
Temperature range	–85° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.31	3.33
B	2.63	6.68
C	0.84	2.13
D	1.00	2.54



TAPE CADDY, KAPTON



OVERVIEW

The Kapton tape caddy, also called the door drive linkage (DDL) tape set, is a foldup fabric tool caddy containing Kapton tape strips which are used for restraining disconnect mechanisms or loose hardware during extravehicular activity (EVA). **It has been replaced by the combined tape/Velcro caddy for standard orbiter EVA manifest.**

OPERATIONAL COMMENTS

The tape strips, which vary in length depending upon the configuration, adhere to both sides of a foldout section of Armalon material. A crewmember can pull off tape with little effort as it is needed. The tape strips are composed of three layers of Kapton to prevent curling. The caddy itself can be secured at work areas by use of the guide strap pull or interface adapter assembly. The –04 assembly is a standard flight item, and the tape is primarily used to hold up the door drive linkage. The –03 assembly was intended for use on the Solar Maximum mission. The holes in the 4–inch tape pieces were positioned over thermal washers.

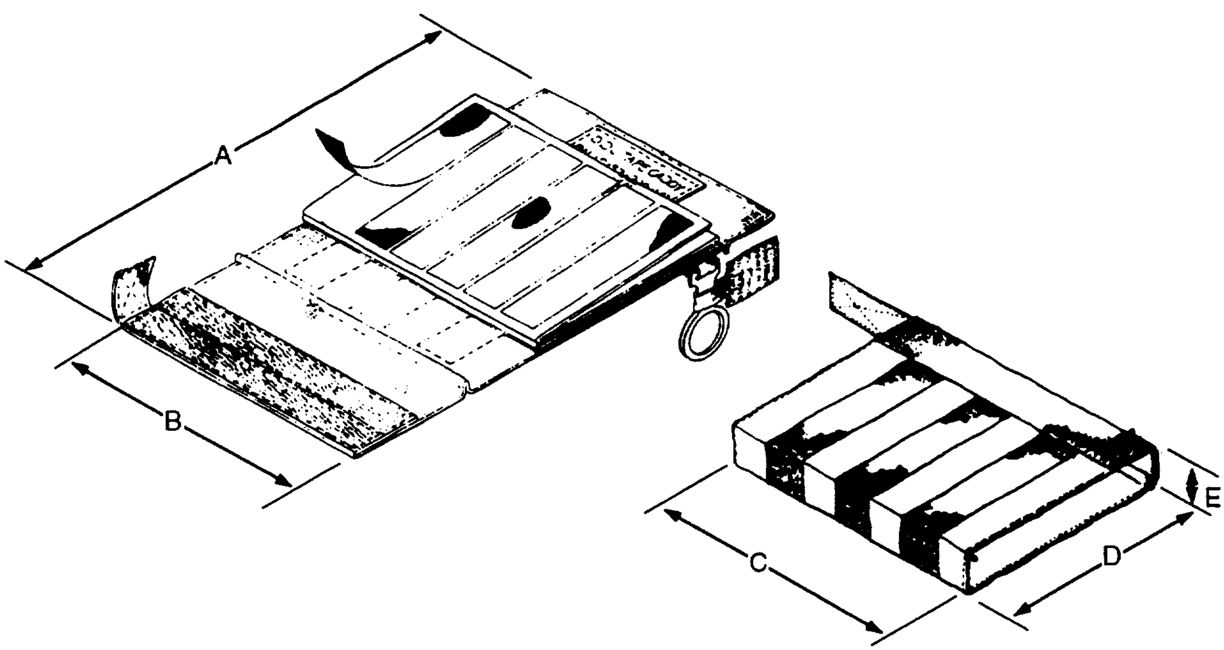
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

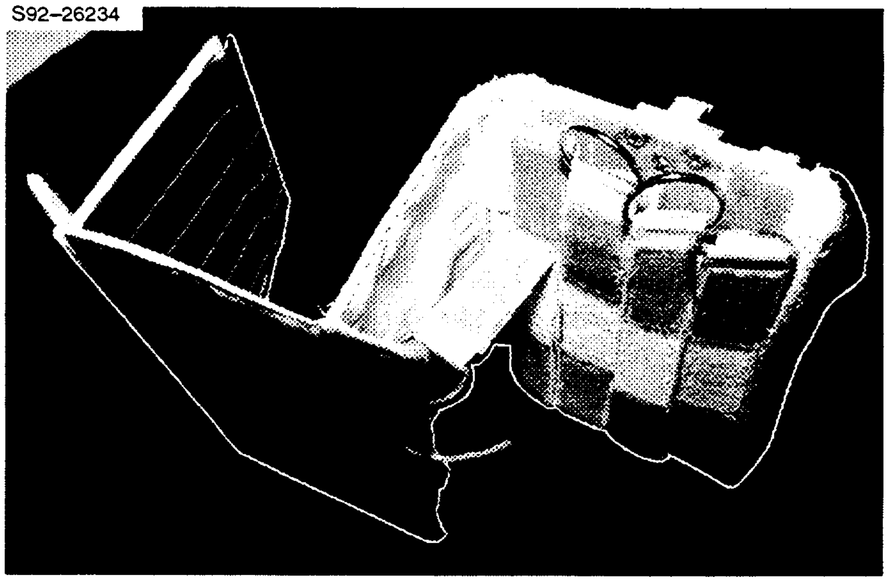
TAPE CADDY, KAPTON

Technical Information	
Part number	10159–20004–03, –04
Weight	0.84 lb
Material/ construction	Caddy – Nomex and Armalon Kapton thermal tape
Load rating	30 in–lb **(tape tensile strength)**
Temperature range	–50° to 150° F (operational)
–03 configuration	20 strips of 1– by 5–in. Kapton 20 strips of 1– by 4–in. Kapton with 1/2–in.– dia hole punched 1–1/2 in. from one edge
–04 configuration	12 strips of 1– by 15–in. Kapton
Quantity flown	
Stowage	
Availability	**Flight specific**

Dimensional Data		
	inches	cm
A	14.5	36.83
B	7.5	19.05
C	7.0	17.78
D	5.5	13.97
E	1.0	2.54



TAPE/VELCRO CADDY



OVERVIEW

The Velcro/tape caddy is a foldup fabric container that holds Velcro and tape strips for restraining disconnected mechanisms or loose equipment during an EVA. The strips are used as a nominal means of securing cut or disconnected payload bay door latch and drive linkages. This combination caddy replaces the previously used individual tape and Velcro caddies as a stowage and weight savings.

OPERATIONAL COMMENTS

The four Velcro tethers are 22–7/8 in. long and fabricated of 1–in. by 2–in. alternating segments of hook and loop Velcro sewn on both sides of Armalon material. A tab on one end and a D–ring on the other assist EVA crewmembers in handling the tethers. The tethers are stowed folded back and forth upon themselves in the caddy. The tape strips, which are 13–1/4 in. long, adhere to both sides of a foldout section of Armalon material. The strips are composed of three layers of Kapton to prevent curling. Manned thermal vacuum testing has proven this to be the best EVA tape available.

The caddy can be transported and secured during use by a tether point ring and a bayonet fitting. It is part of the normally manifested orbiter equipment and is stowed in the port provisions stowage assembly (PSA).

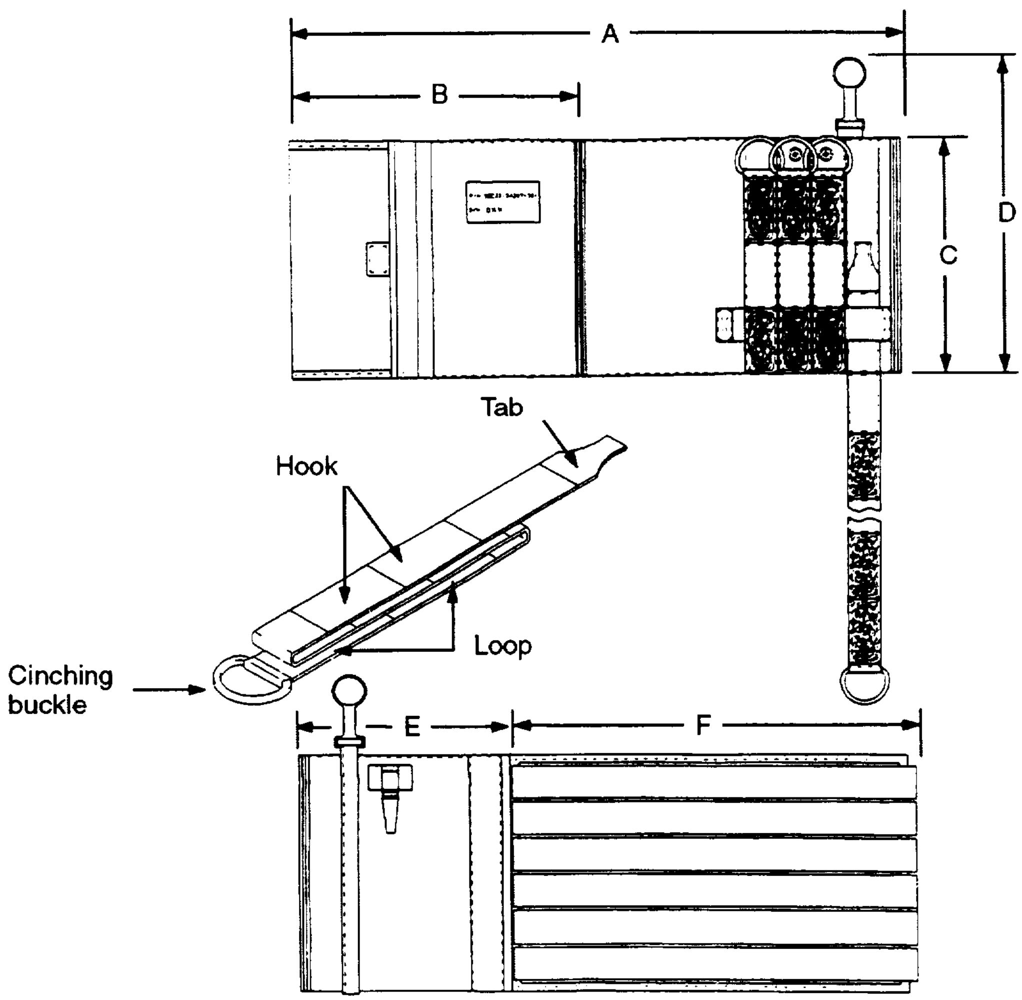
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

TAPE/VELCRO CADDY

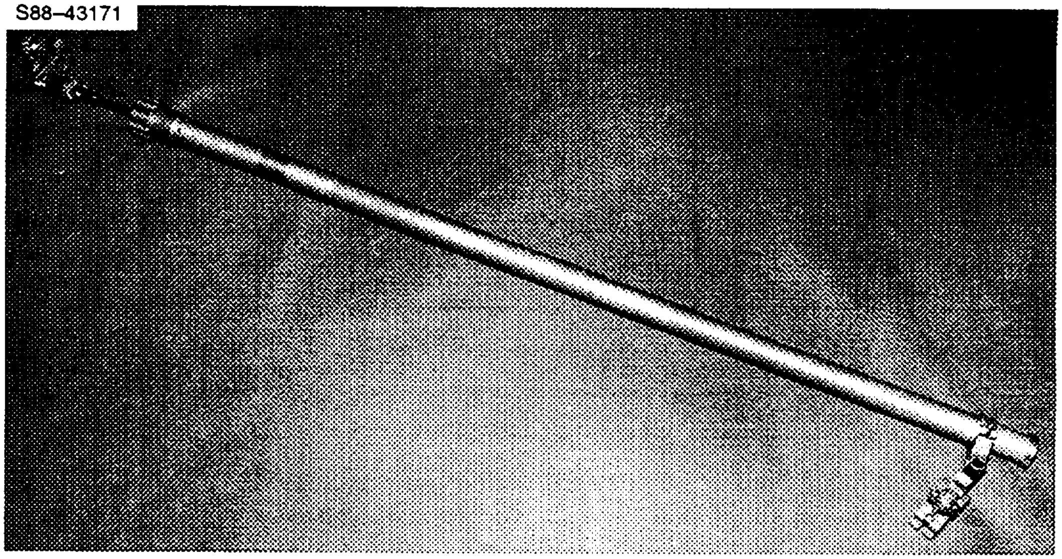
Technical Information	
Part number	SED33104207–301
Weight	2.0 lb
Material/ construction	Ortho fabric, Armalon (caddy) Kapton (tape) Nylon Velcro, Armalon (Velcro straps)
Load rating	
Temperature range	–200° to +250° F
Quantity flown	One
Stowage	Port PSA
Availability	Standard

Dimensional Data		
	inches	cm
A	18.38	46.69
B	8.75	22.23
C	7.25	18.42
D	9.63	24.46
E	6.5	16.51
F	13.25	33.66



TELESCOPING BOOM

S88–43171



OVERVIEW

The telescoping boom assembly is a contingency device, originally designed to provide a mounting location for the portable foot restraint (PFR) at the forward or aft bulkhead for the purposes of repairing or servicing the payload bay door latches. It consists of an inner and an outer tube and is 70.5 in. long from the pivot point to the end of the inner tube, which can be pulled out to extend the boom to 96 in. Incorporated in the boom is a 900 in–lb–rated torque limiter that will slip if the preset torque limit is exceeded. In its original application, the torque limiter was set at 450 in–lb to prevent damage to the bulkhead handholds.

OPERATIONAL COMMENTS

The telescoping boom mounts on the forward or aft bulkhead, clamped to the centerline or perimeter handrails. The boom may be repositioned by loosening the handrail clamp attached to the inner tube and swinging the boom about a pivot point at the other handrail clamp. This item is no longer manifested for every flight, but it is manifested for all inertial upper stage (IUS) flights for use as a **manual AFTA** translation aid **on the orbiter forward stbd bulkhead.** The foot restraint socket has been removed for IUS flights for translation ease.

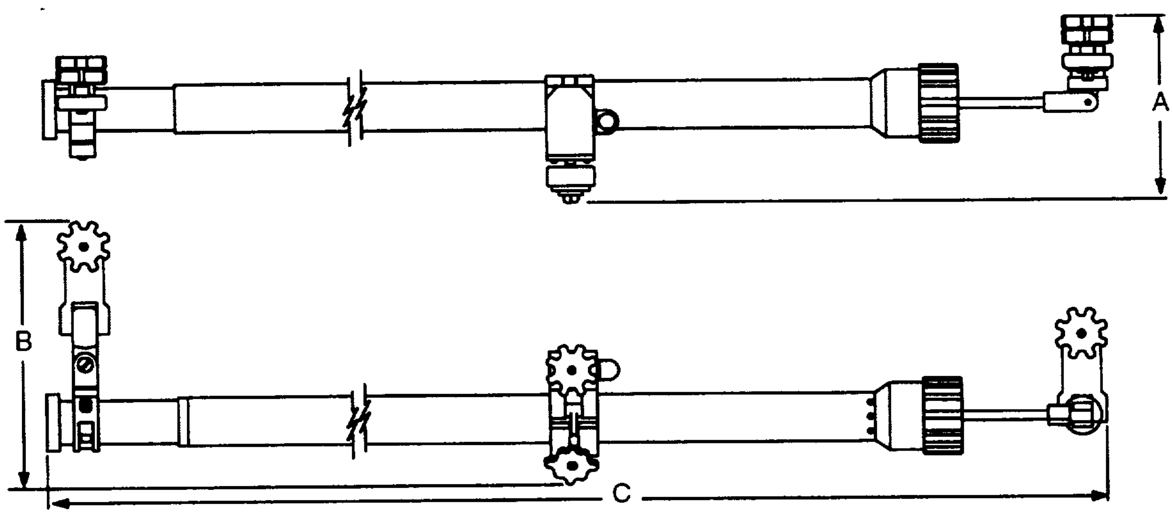
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 488–9247

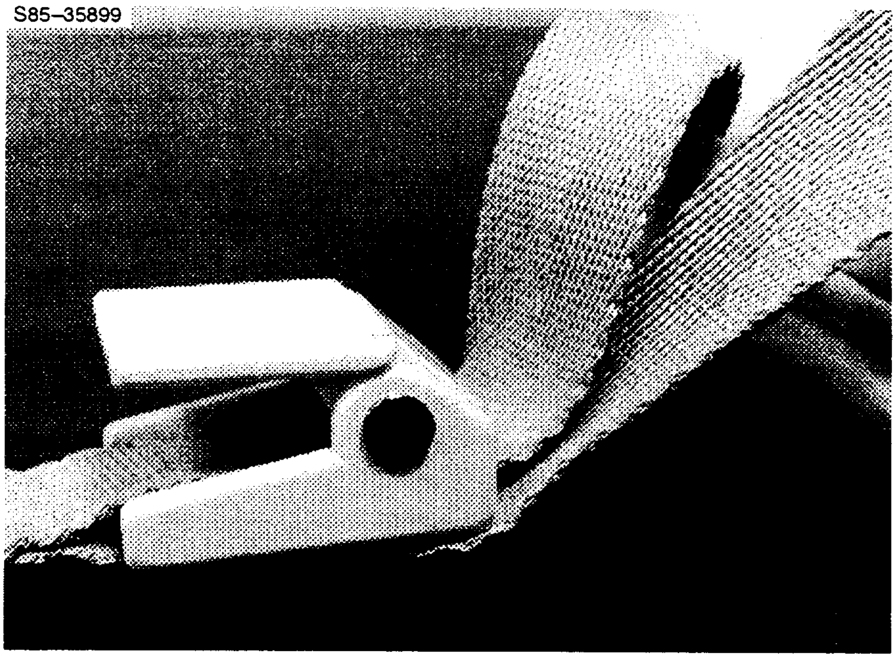
TELESCOPING BOOM

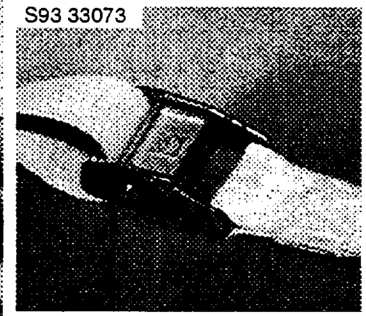
Technical Information	
Part number	10155–20003–02
Weight	9 lb
Material/ construction	Aluminum alloy, stainless steel
Load rating	**200 lb (perpendicular to boom)**
Temperature range	
Quantity flown	**One**
Stowage	**Payload bay bulkhead**
Availability	Flight specific

Dimensional Data		
	inches	cm
A	7.47	18.97
B	10.42	26.47
C	66.5 **(min.)** 112.0 **(max.)**	168.91 284.48



TENSIONING BUCKLE





OVERVIEW

The tensioning buckle, also called a jam cleat **or cam buckle**, is an adjustable connector for webbing straps that are used to secure EVA equipment. **There are two versions of this buckle. Adjustable equipment tethers have recently used the smaller SED33104182. The older design (10174–20079) has been used on the EVA power pack, the 51–A motor nozzle cover, and the STS 51–I transfer bag**.

OPERATIONAL COMMENTS

The tensioning buckle is sewn to one end of a Kevlar strap. In operation, the end of another strap (or the other end of the same strap) is threaded through the buckle and pulled tight to secure equipment. Once the cleat is in place, pulling on the strap tightens the connection. Depressing the cleat lever releases the connection.

CONTACTS

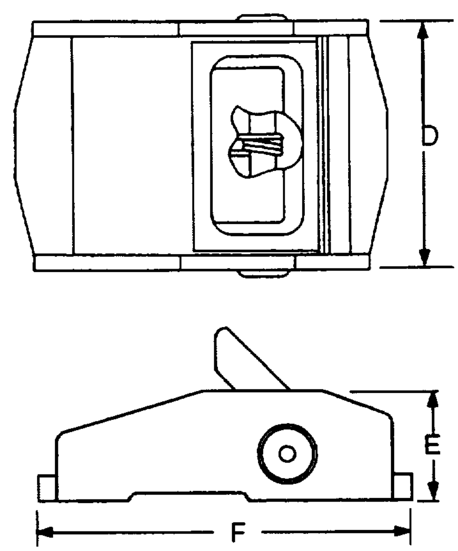
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

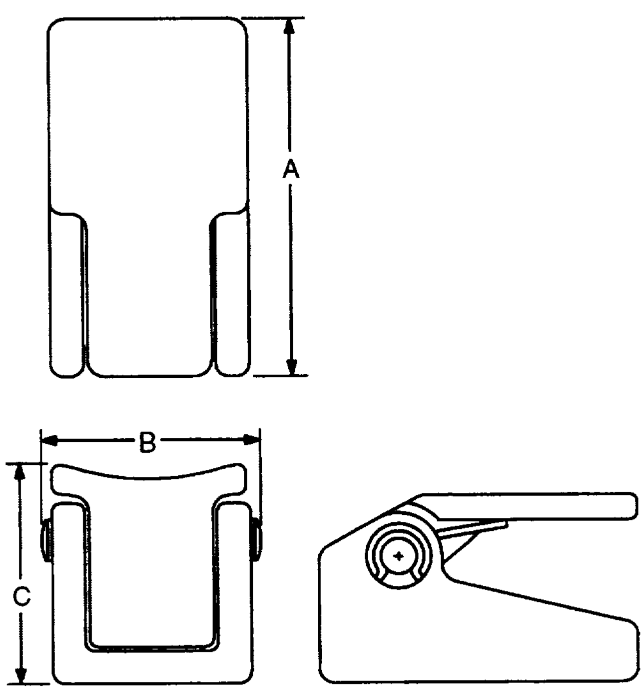
TENSIONING BUCKLE

Technical Information	
Part number	10174–20079–01 SED33104182–301
Weight	0.25 lb
Material/ construction	Aluminum, stainless steel
Load rating	**200** lb (SED33104182) **TBD lb** (10174–20079)
Strap width	1.0 in. **(10174–20079), 0.75 in. (SED33104182)**
Strap thickness	0.06 in.
Temperature range	–200° to +250° F (operational)
Quantity flown	As required
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.940	4.93
B	1.470	3.73
C	1.103	2.80
D	**1.20**	**3.05**
E	**0.53**	**1.35**
F	**1.77**	**4.50**

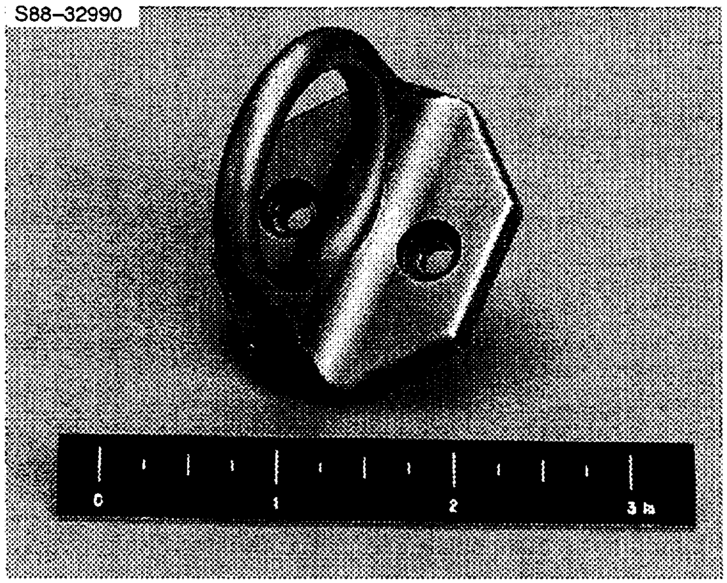
SED 33104182





10174–20079

TETHER POINT



OVERVIEW

The tether point, also known as a restraint eye, is available for use in a variety of extravehhicular activity (EVA) applications where an appropriate tether point is needed. Originally developed for the Solar Maximum Mission, the tether point was incorporated into tool boards no. 1 and no. 2.

The tether point is assembly–dependent in that it is used as a part of another assembly and is not flown as a standalone item.

OPERATIONAL COMMENTS

Each tether point is incorporated into the design of a piece of equipment depending on the need for a restraint point. The 1.25–in. internal diameter of the tether point allows for easy attachment to a large or small french hook or to a large or small universal tether hook.

The strength of the tether point is determined by its intended usage. Tether points incorporated into restraint, mobility, and translation aids and those used at work stations are designed to be as strong as the waist tether and safety tether system (574–lb load limit in any direction).

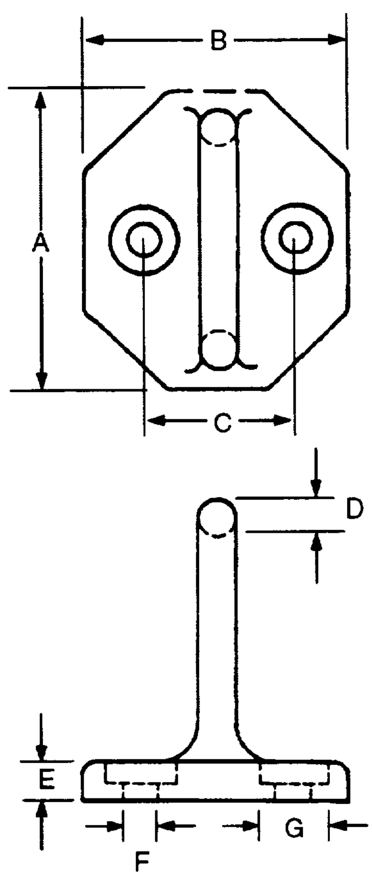
CONTACTS

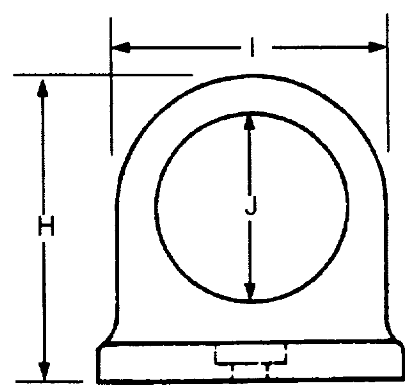
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

TETHER POINT

Technical Information	
Part number	10174–20151–01
Weight	0.049 lb
Material/ construction	Aluminum
Load rating	
Temperature range	–150° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific

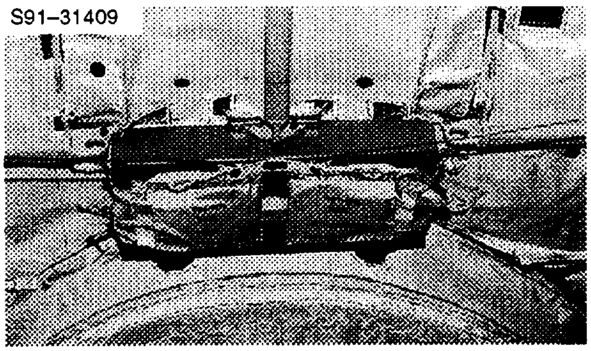
Dimensional Data		
	inches	cm
A	2.000	5.08
B	1.750	4.45
C	1.000	2.54
D	0.250	0.64
E	0.250	0.64
F	0.203	0.52
G	0.406	1.03
H	2.000	5.08
I	1.750	4.45
J	1.250	3.18



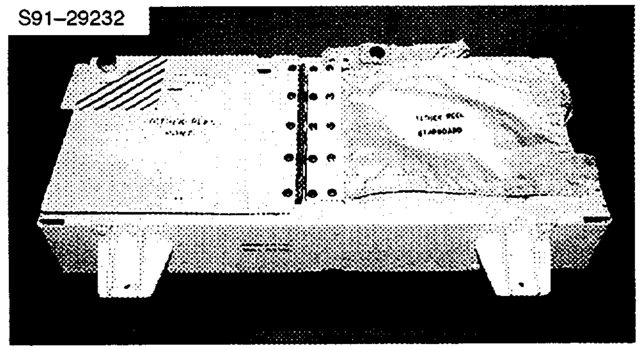


TETHER REEL BOX

S91–31409



S91–29232



OVERVIEW

The crew safety–tether reels are stowed just outside the open airlock hatch so that the crew can connect to the reels while the crew is still attached to the airlock with the relatively short waist tether. A box is mounted on the vehicle to restrain the reels during launch and landing and must be opened to release the reels for use. The reels are held in place by conformal foam cushions and fabric flaps. Tether points for each reel protrude from the box to allow hookup before the reels are removed from the box. A separate fabric strap helps to properly route the tether cable from this box to the sill longeron slidewire.

OPERATIONAL COMMENTS

Since the tether ring of the stowed reel is at an awkward angle for easy hook connection, a larger fabric loop has been added to each reel and is secured to the box by a Velcro patch.

The small 1/4–turn fasteners are not recommended for future applications. Their small size and the difficulty in attaching them to fabric that is not rigidly restrained make them a multihanded operation. At the end of a long extravehicular activity (when fingers tend to be fatigued), using the fasteners is laborious while free floating. The snap of the cable strap is not recommended for similar reasons.

For the above reasons, a rigid door with a pushbutton fastener has been developed as an alternative. To open this door, the button is depressed and the door springs open. The black and white hatched area of the door is pushed to close the door. Before this new design can be implemented, a simple backup release is needed to cover a failure of the more complex pushbutton.

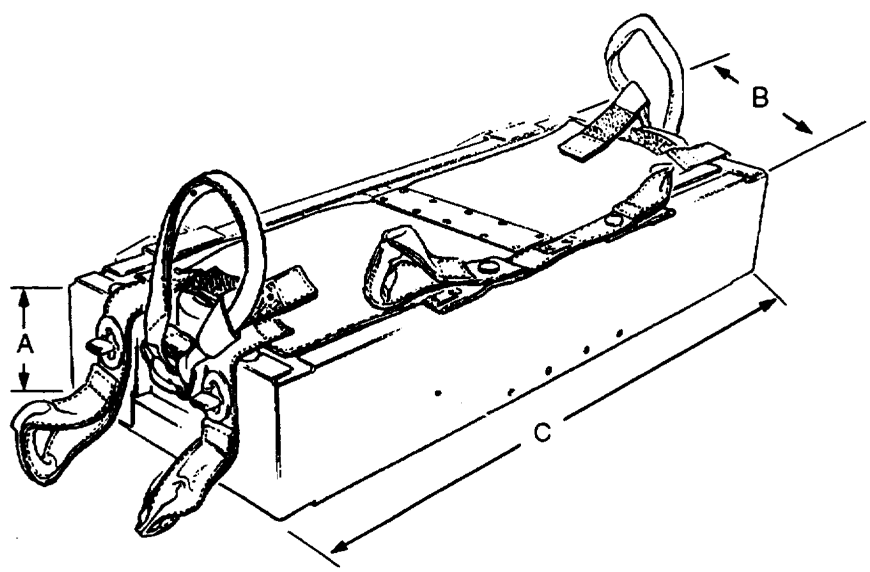
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

TETHER REEL BOX

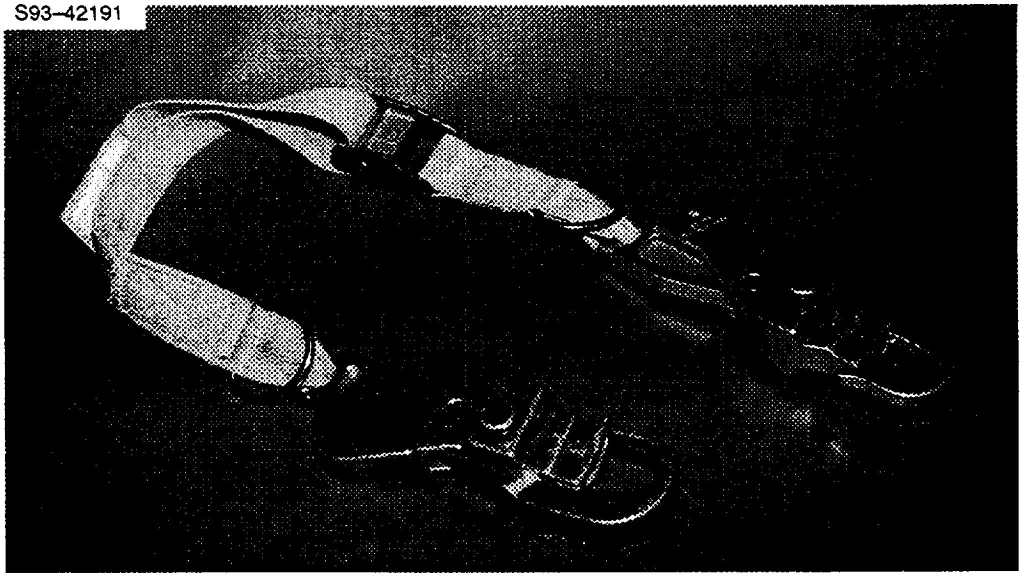
Technical Information	
Part number	V627–650780 (standard box) (prototype box) M072661617 (vehicle installation)
Weight	5.0 lb
Material/ construction	Aluminum housing, Solamide foam cushions, Nomex fabric flaps/straps
Load rating	
Temperature range	–200° to +250° F
Quantity flown	One
Stowage	Forward bulkhead or tunnel adapter
Availability	Standard

Dimensional Data		
	inches	cm
A	3.35	8.5
B	8.08	20.5
C	18.10	46.0



TETHER, ADJUSTABLE EQUIPMENT

S93–42191



OVERVIEW

The adjustable equipment tether, previously known as the adjustable wrist tether, attaches to the extravehicular mobility unit (EMU) glove to secure tools to the suited crewmember or other tether points. The tether length can vary from 28 to 40 in., including a small extravehicular activity (EVA) hook on each end. The tether is made of Nomex webbing with aluminum EVA hooks, an adjustment slide, and D–rings.

OPERATIONAL COMMENTS

Opening of an EVA hook requires that push–to–open buttons on each side be depressed simultaneously while the hook is squeezed. The hook has a maximum opening of 0.59 in. and springs closed as soon as it is released.

The length of the tether is adjusted with an adjustable cam buckle. Velcro fabric on the free end of the tether strap provides a grip for the crewmember and secures the free end to the strap to prevent slippage. Two adjustable wrist tethers are normally manifested and stowed in the port provisions stowage assembly (PSA).

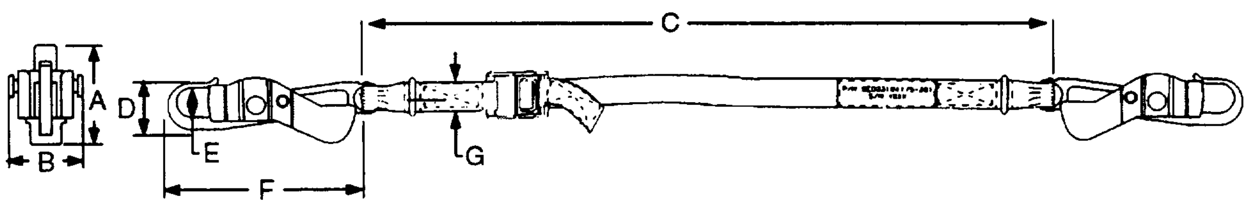
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

TETHER, ADJUSTABLE EQUIPMENT

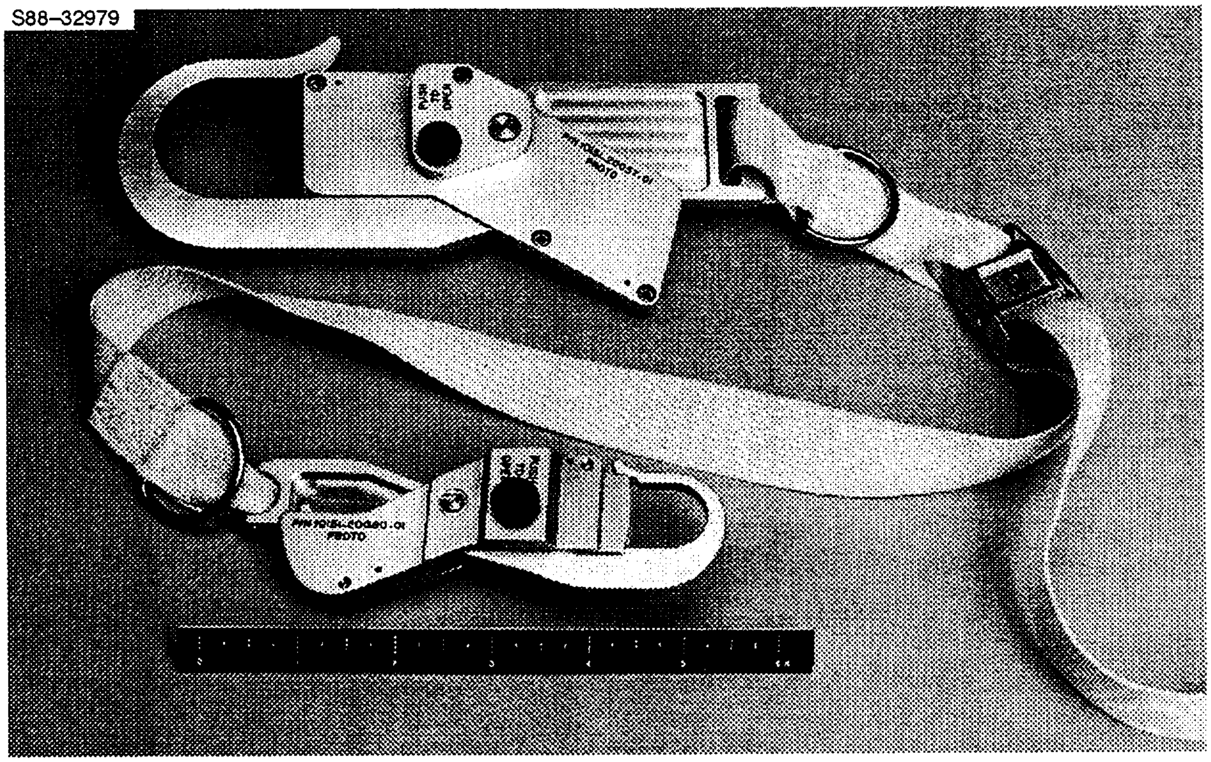
Technical Information	
Part number	SED33104175–301 or 10159–20005–03 (9792–03 or SED39119074–303 hooks)
Weight	0.78 lb
Material/ construction	Hooks – Aluminum Strap – Nomex
Load rating	1400 lb webbing breaking strength 200 lb buckle load limit 50 lb overall limit
Temperature range	–200° to 250° F (operational), +350° F (stowage)
Quantity flown	Two
Stowage	Port PSA
Availability	Standard

Dimensional Data		
	inches	cm
A	2.00	5.08
B	1.31	3.33
C	8.00 18.00	20.32 45.72
D	1.35	3.43
E	0.75	1.91
F	5.00	12.7
G	0.75	1.91



TETHER, ADJUSTABLE EQUIPMENT (HST)

S88–32979



OVERVIEW

The adjustable equipment tethers are Nomex webbing straps with extravehicular activity (EVA) hooks on either end. The tethers are used by the EVA crewmembers to secure tools and equipment. This tether has been designed for use during Hubble Space Telescope (HST) maintenance.

OPERATIONAL COMMENTS

The tethers have one small universal tether hook on one end and one large universal tether hook on the other. The webbing length can be adjusted by using a cam lock buckle. This buckle can withstand a maximum tether load of 200 lb. The hooks cannot be operated by a single, gloved hand without positioning aid from a second hand. These hooks are also fatiguing when used frequently.

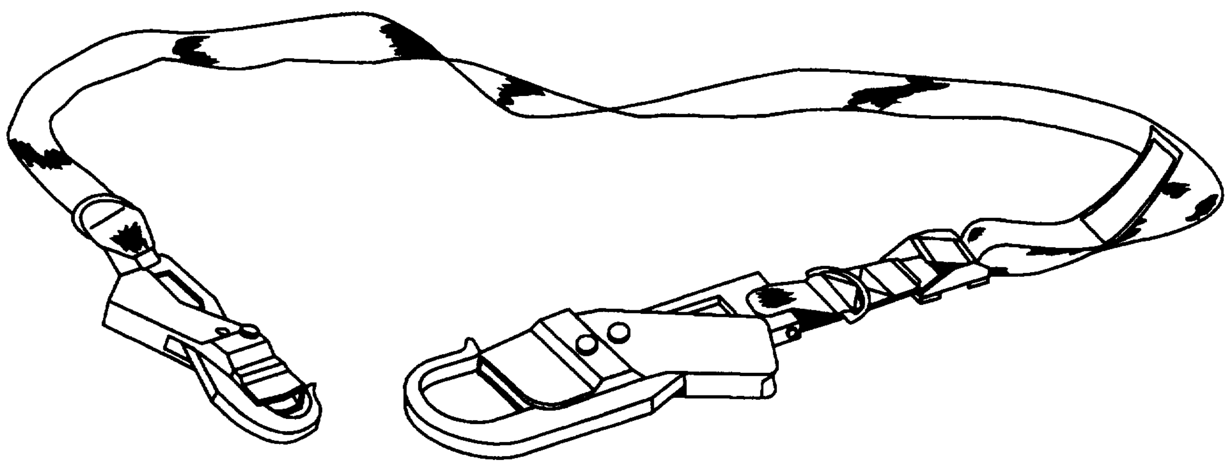
CONTACTS

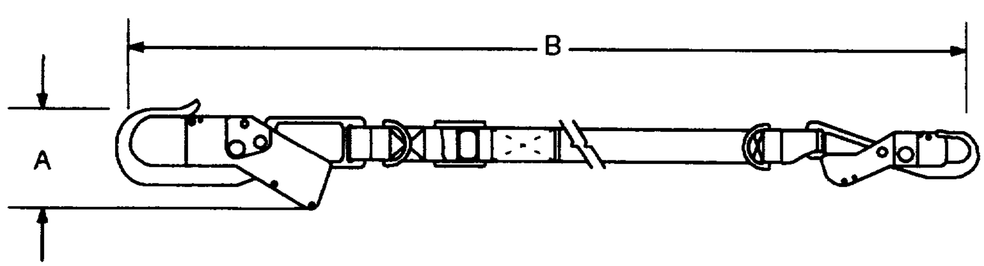
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

TETHER, ADJUSTABLE EQUIPMENT (HST)

Technical Information	
Part number	10181–10016–**03** (34–in. tether) 10181–10016–**04** (80–in. tether)
Weight	**0.79** lb (–01), **0.83** (–**04**)
Material/ construction	Aluminum alloy, Nomex
Load rating	200 lb
Temperature range	
Quantity flown	
Stowage	
Availability	Flight specific

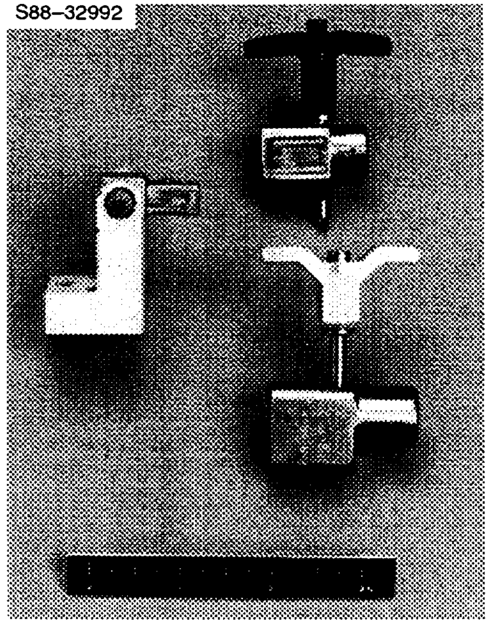
Dimensional Data		
	inches	cm
A	4.12	10.46
B	18.5 – 34.0 (–01) 18.5 – 80.0 (–02)	46.99 – 86.36 46.99 – 203.20





TETHER, DROP–PROOF

S88–32992



OVERVIEW

The drop–proof tether, also called the self–tethering disconnect or the McTether, is a quick–disconnect device installed on many different tools. The drop–proof tether is the safest means existing for connecting tips, sockets, and drives to extravehicular activity (EVA) tools equipped with a modified 3/8–in. square drive fitting. This system assures that sockets and extensions cannot be accidentally untethered and lost.

OPERATIONAL COMMENTS

When two tools are connected by drop–proof tethers, the male and female attachment devices are secured by a spring–loaded ball that can be released only by a pip pin. Installation requires that the pip pin be inserted before pushing the driver and drop–proof tether together. Removal requires insertion of the pip pin prior to pulling the two items apart. **Frequent pip pin operation can be a factor in increased EVA overhead.**

Three drop–proof tether configurations currently exist. The construction of the original (10168–10068–01) has a female socket which is secured to drive tools by the installation of a spring pin. The smaller, lighter mini–McTether (10181–10003–06) is secured with a cryogenically installed capture pin. The third configuration (10181–10003–04) is pinned to a right–angle drive.

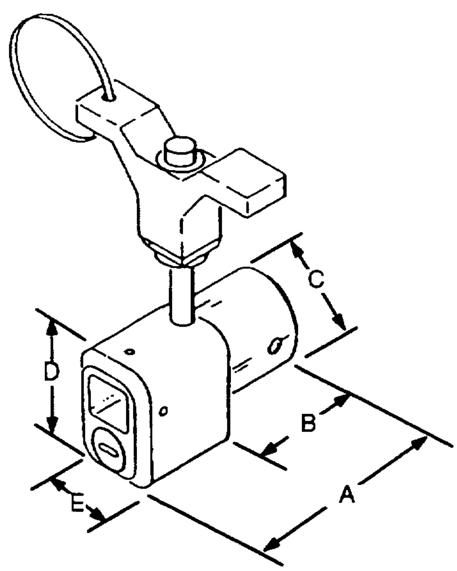
CONTACTS

Operational: R. C. Trevino, NASA/DF4, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

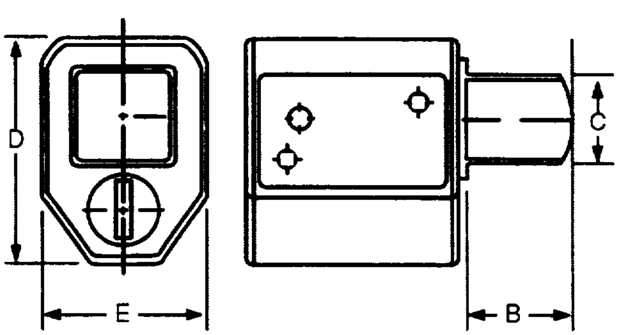
TETHER, DROP–PROOF

Technical Information	
Part number	10168–10068–01 10181–10003–**04/06**
Weight	0.184 lb (10168–) 0.100 lb (10181–)
Material/ construction	Stainless steel
Load rating	
Temperature range	–130° to +150° F
Quantity flown	
Stowage	
Availability	Flight specific

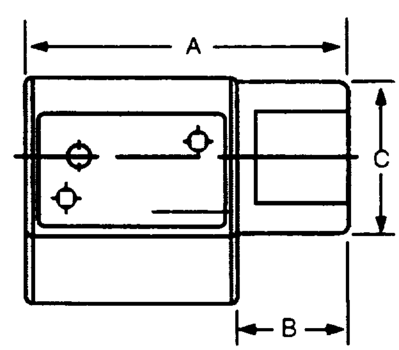
Dimensional Data						
	10168–10068–01		10181–10003			
			–01		–03	
	inches	cm	inches	cm	inches	cm
A	1.70	4.32	1.329	3.38	1.329	3.38
B	0.70	1.78	0.422	1.07	0.454	1.15
C	0.70	1.78	0.372	0.94	0.640	1.63
D	1.01	2.57	0.930	2.36	0.930	2.36
E	0.70	1.78	0.660	1.68	0.660	1.68



10168–10068–01



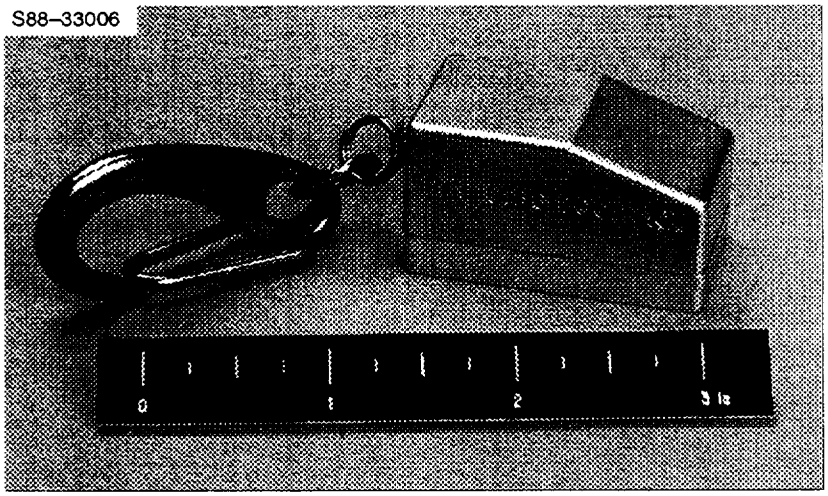
10181–10003–01



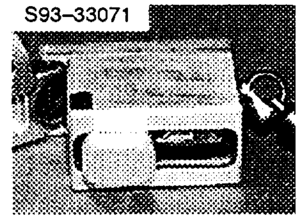
10181–10003–03

TETHER, RETRACTABLE

S88–33006



S93–33071



OVERVIEW

Retractable tethers are used to restrain tools and small equipment stowed on tool boards and tool caddies for use during extravehicular activity. Tethers consist of a takeup reel enclosed in a housing, a 3–foot or 6–foot Kevlar tether line, and a swivel hook or hooks to secure tools and equipment. The 6–foot tether design incorporates a velocity limiting feature.

OPERATIONAL COMMENTS

The retractable tether extends and retracts smoothly, with no more than 0.25 pounds of retracting force. A french hook is sometimes fixed to the swivel hook to permit release of a tool from the retractable tether. **One of these tethers is built into the HST power tool handle. Liberal application of this type of tether can reduce the overhead of crewmember tether operations (e.g., pretethered tools in tool boxes). Improvements under development include a teflon coated stainless steel cord to reduce cord fraying and a lock–off mechanism to allow tool use without having to fight tether tension. One version is being converted to an auto retract wrist tether.**

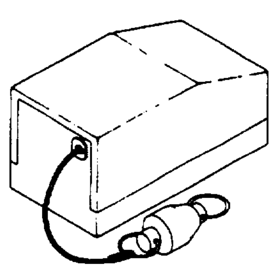
CONTACTS

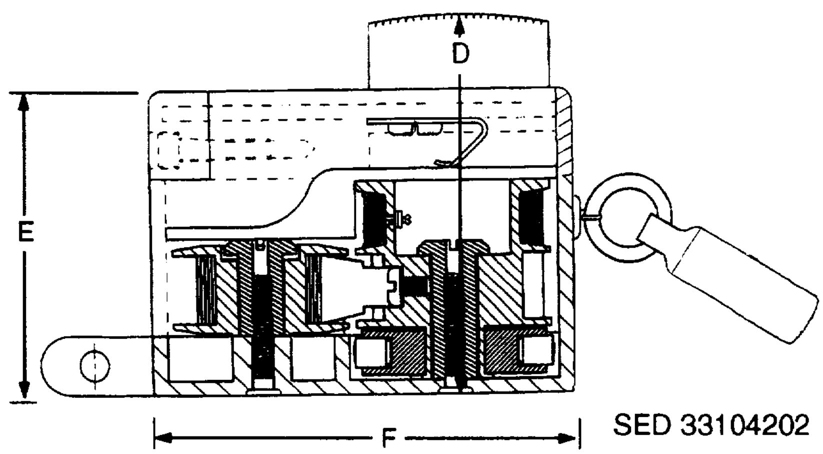
Operational: R. C. Trevino, NASA/DF4, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

TETHER, RETRACTABLE

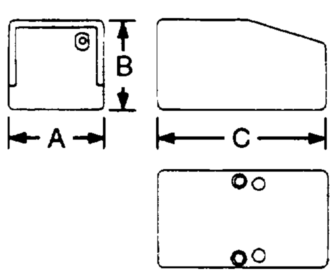
Technical Information	
Part number	10153–20004–01 (Vespel case, **3 ft cord)** 10153–20004–02 (aluminum case, **3 ft cord)** 10156–20027–02 (aluminum case, **6 ft cord)** **SED33104202–301 (side cord exit, 6 foot cord)** **SED33104202–303 (bottom cord exit, 6 foot cord)** **SED33104202–303 (lockable 6 foot cord)**
Weight	0.14 **lb (3 foot), 0.20 lb (6 foot)**
Material/ construction	Case – aluminum alloy or vespel Tether – 400 denier Kevlar **or spectra cord** 1/32 inch diameter, 4% stretch before breakage
Load rating	**0.25 lb retracting force** **120 lb cord breaking strength** **50 lb cord attachment strength (lockable reel)** 5 lb cord attachment strength (std reels)
Temperature range	–200° to 250° F (operational)
Quantity flown	Varies, used on tool caddies or tool boards
Stowage	Assembly dependent
Availability	Flight specific

Dimensional Data				
	10153–		10156–	
	inches	cm	inches	cm
A	1.24	3.15	1.00	2.54
B	0.79	2.01	0.97	2.46
C	2.31	5.87	1.76	4.47
Cord	3 ft	0.9 m	6 ft	1.8 m
	SED 33104202			
D	1.625	4.13		
E	1.25	3.18		
F	1.75	4.45		
Cord	6 ft	1.8 m		

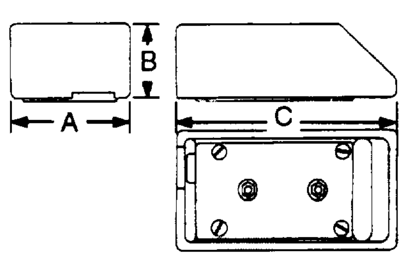




SED 33104202

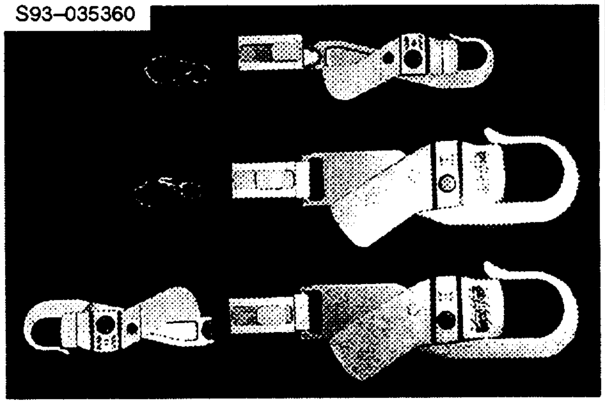


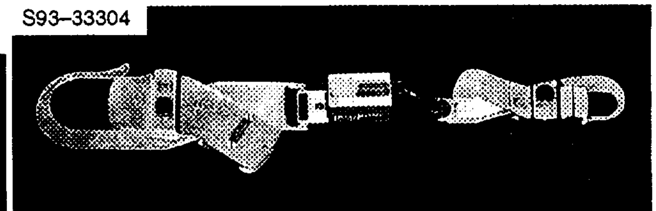
10156–20027

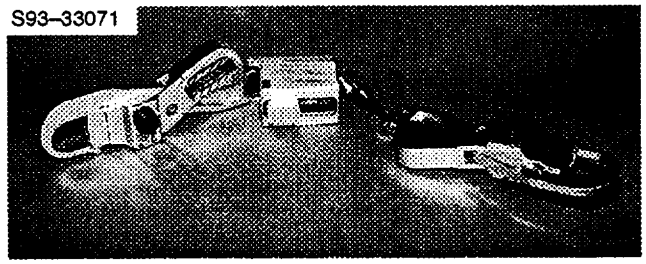


10153–20004

TETHER, RETRACTABLE EQUIPMENT


S93–035360


S93–33304


S93–33071

OVERVIEW

The retractable equipment tether was specifically designed to enable crewmembers to keep both hands free for body control during translation and to preclude small loose objects from damaging nearby structure (or crewmembers). With the elimination of the fixed length associated with most standard wrist and waist tethers, objects can be held closer to the body for easier positioning control. This tether centers around a tool caddy retractable tether reel, to which a selection of hooks can be attached. For current versions, combinations of wrist, waist, and french hooks are being used. Improved hooks can be substituted when they become available. These tethers were developed for on–orbit evaluation as part of an extravehicular–activity–related detailed test objective (DTO).

OPERATIONAL COMMENTS

The self–tending tether reel can be locked while an attached tool is being used or can be released for automatic length adjustment. The lock does not prevent the tether cord from extending, but simply increases the friction for cord extension. Care must be exercised while translating to avoid snagging the tether and pulling out the cord to its full length under tension. While the cord itself has a high load rating, its attachment to the reel case is not as strong, so the tether is limited to 50 lb loads. Except for the lock function, the reel has not been changed from the basic tool caddy design, which has the same use limitation. Future versions can be enhanced to restrain larger equipment. The tether cord of each reel is 6 ft long and is made of a material that should be less prone to fraying and particulate generation than the current Kevlar cord of tool caddies. While the small 2–in. french hooks have no independent lock and are subject to inadvertent release if twisted, they are being used because of their small size to keep the overall tether length as short as possible.

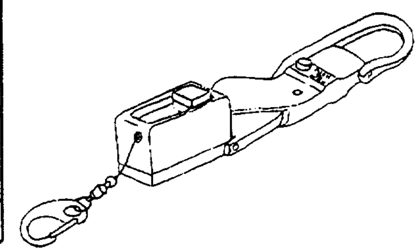
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

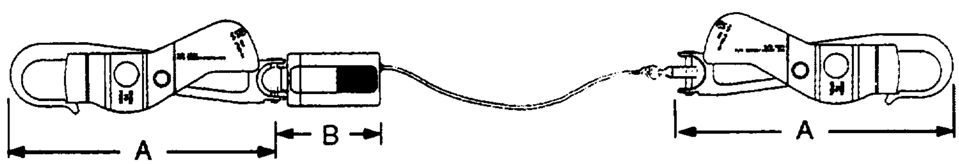
TETHER, RETRACTABLE EQUIPMENT

Technical Information	
Part number	SED3310530 –301 (Two small hooks) –303 (One small hook, one french hook) –305 (One small hook, one large hook) –307 (One french hook, one large hook) –309 (One large hook, one small hook)
Weight	
Material/ construction	Aluminum reel case, spectra cord
Load rating	50–lb tension rating 0.25–lb cord tension, 0.6 lb locked
Temperature range	–150° to +250° F
Quantity flown	Four –301 (STS–57) One each –301, –303, –305, –307 (STS–51) Three each –301, –305, –309 (STS–61)
Stowage	Attached to EMU inside the airlock (STS–51 and 57) Middeck locker (STS–61)
Availability	Flight specific

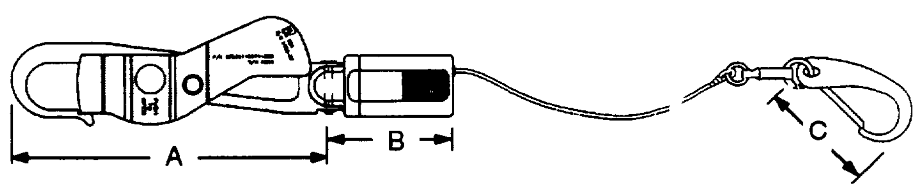
Dimensional Data		
	inches	cm
A	5.25	13.34
B	1.75	4.45
C	2.0	5.08
D	7.5	19.05
Cord	6 ft	1.8 m



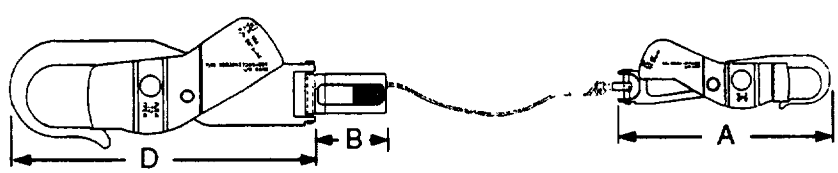
–301



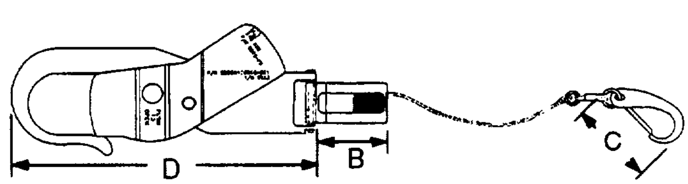
–303



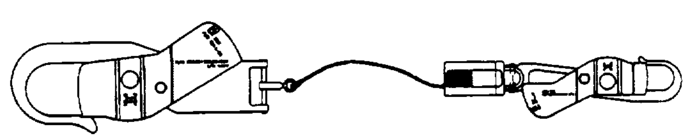
–305



–307

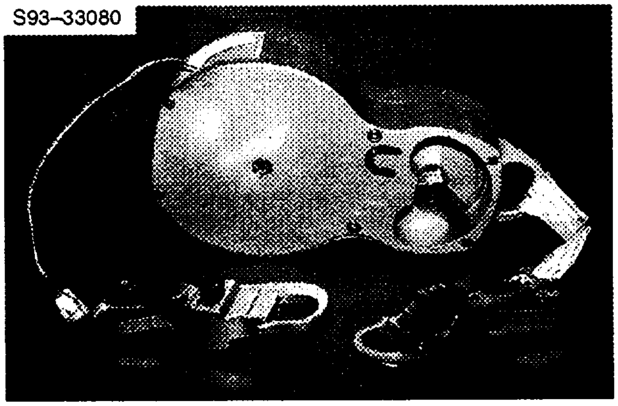


–309

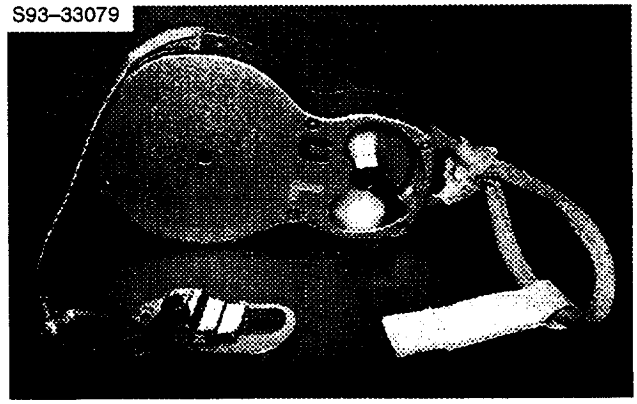


TETHER, SAFETY

S93–33080



S93–33079



OVERVIEW

The safety tether connects the crewmember to a **slidewire** along the cargo bay sill longeron during EVA. The tether consists of a reel case with an integral D–ring, a takeup reel, a **55– or 35–ft** cable, and a locking hook. A selector on the reel case can be used to engage or disengage the auto retracting feature of the tether reel. The locking hook on the tether incorporates a lock–lock feature to prevent accidental opening. **An extension strap has been added to the D–rings of standard slidewire units to make a larger target for tether hookup during airlock egress.**

OPERATIONAL COMMENTS

For launch and entry, the port and starboard safety tethers are stowed in a cloth–covered stowage container **that** is secured to the bulkhead above the airlock in the cargo bay. While still in the airlock, after opening the airlock hatch, a crewmember attaches a waist tether to the **extension strap on the D–ring** of the safety tether. The other end of the waist tether is hooked to a D–ring on the extravehicular mobility unit (EMU) waist bearing. A series of four Velcro straps **secures** the safety tether cable from the **slidewire** to the airlock during launch and entry.

All **35–ft** cable lengths **have been** replaced with a 55–ft cable. This change **was** effective for the Hubble Space Telescope deploy mission. **The 35–ft version can still be requested as a flight–specific option. STS–37 and STS–49 used a modified version with a small wrist tether hook attached via a short strap to the reel case D–ring. This configuration allowed the extendable cable/hook to be used as an equipment tether. This extra strap/hook is certified for crew safety tether loads.**

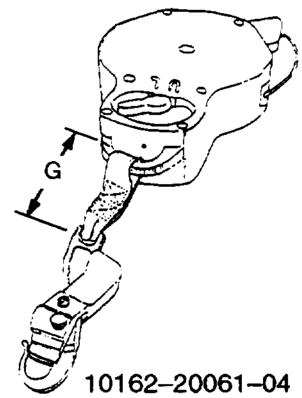
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

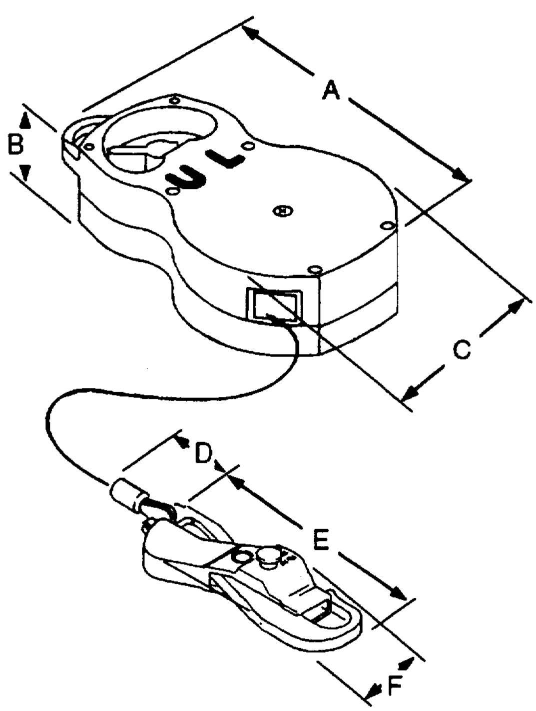
TETHER, SAFETY

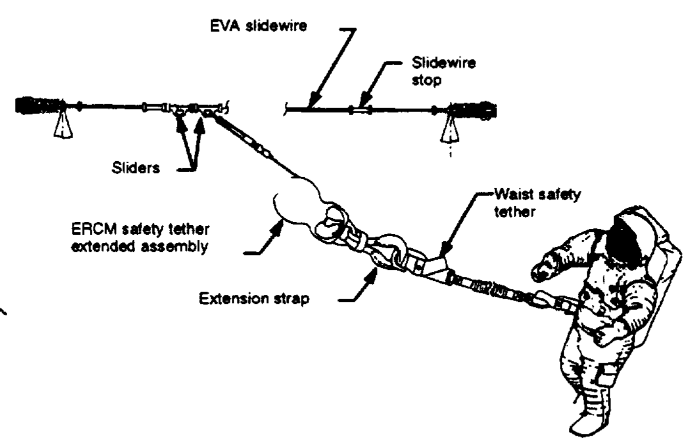
Technical Information	
Part number	10162–10062–04 (35 ft **without extension strap**) 10162–10062–07 (55 ft **without extension strap**) **10162–20061–04 (55 ft with short strap/hook)** **SED33105087–303 (55 ft with short strap/hook)** **10162–20061–03 (55 ft with extension strap)** 9792 (hook only)
Weight	3.48 lb **3.72 lb (10162–20061–04)**
Material/ construction	Housing – Aluminum, stainless steel**, Vespel cable guide** Tether – Stainless steel cable, 3/32–in.–**dia**
Load rating	Cable – 920 lb
Extension force (locked)	1.5 lb
Retraction force (unlocked)	0.5 lb
Free retraction rate	**11 ft/sec max. (after 25–ft extension)** **5 ft/sec max. (after 10–ft extension)**
Temperature range	–200° to 250° F (operational), **+350° F (storage)**
Quantity flown	Two **(10162–20061–03)**
Stowage	Payload bay fwd bulkhead **(std)** **Tunnel adapter (Spacelab module)**
Availability	Standard

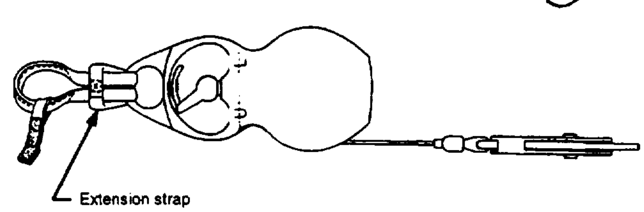
Dimensional Data		
	inches	cm
A	8.360	21.23
B	2.086	5.30
C	4.490	11.40
D	1.500	3.81
E	5.000	12.7
F	1.750	4.45
G	4.0	10.2



10162–20061–04



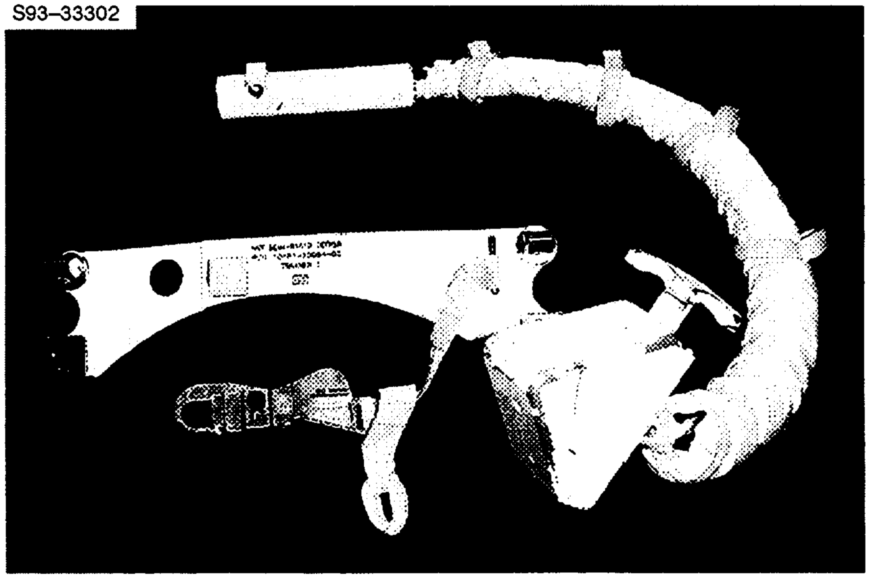




10162–20061–03

TETHER, SEMIRIGID

S93–33302



OVERVIEW

The semirigid tether (SRT) was specifically designed for hands–free manual transport of the large Hubble Space Telescope (HST) portable foot restraint (PFR). It keeps both hands free for body control during translation and precludes large, loose objects damaging nearby structure. It mounts to the mini–workstation attach points on the extravehicular mobility unit (EMU) and can be rigidized to place objects firmly out of the way behind the extravehicular crewmember's back during transport. The rigid section consists of ball/socket segments and a steel tensioning cable that runs through the center of these segments. The friction that exists between these segments creates the resistance to bending when a force is applied to the tether. It is normally stowed inside the crew cabin to allow installation prior to airlock egress.

OPERATIONAL COMMENTS

The SRT can be configured in a right–hand (–01) or left–hand (–02) configuration, depending on mission requirements. Since the mini–workstation can be installed in receptacles provided by the SRT and its pitch adjustment knob is located on the right side, the left–hand configuration of the SRT is preferred to minimize interference with the mini–workstation. Regardless of its location, the tether tensioning housing tends to interfere with access to the EMU waist tethers. Simple adjustment of the hand knob changes the rigidity of the tether from fully relaxed to fully rigid. The tether will withstand a 10–lb force applied at the end of the rigid section when fully tightened. A Nomex cover hides potential pinch points in the rigidizing section; finger loops along its length aid crew positioning of the mechanism. A small wrist tether and loop on a strap lanyard allow the SRT to be restrained if removal becomes necessary during the extravehicular activity (EVA). The current end effector is a PFR socket **and pip pin** but it can be changed to any configuration.

A derivative of this concept is planned for use on space station. Numerous changes are under consideration. The knob might be replaced with a simple lever. Multiple end effectors will be accommodated that can be changed out during EVA. Robotically compatible interfaces and various grasping devices are being studied. The tether may be releasable from its base structure for use as a restraint detached from the EMU. More than one tether unit may be attached to the base to transport additional equipment or tools.

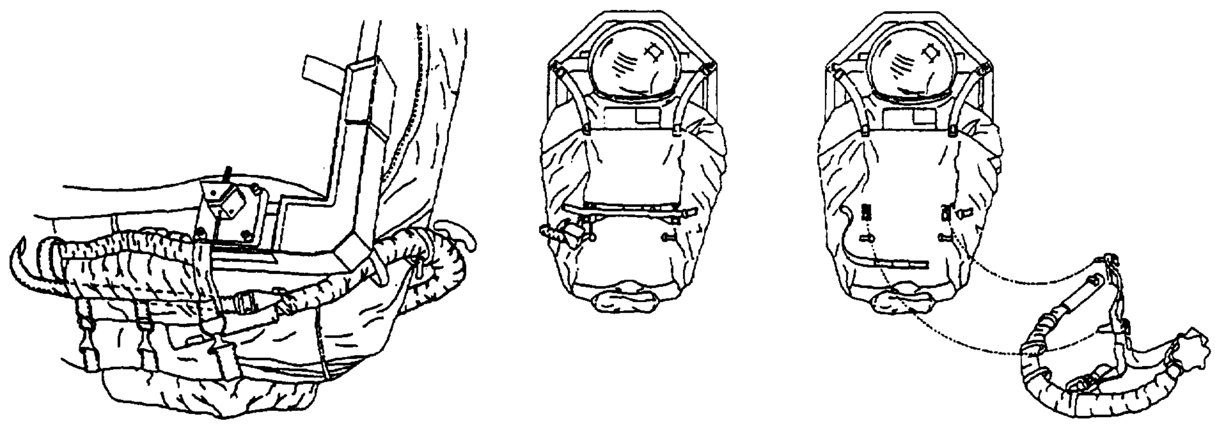
CONTACTS

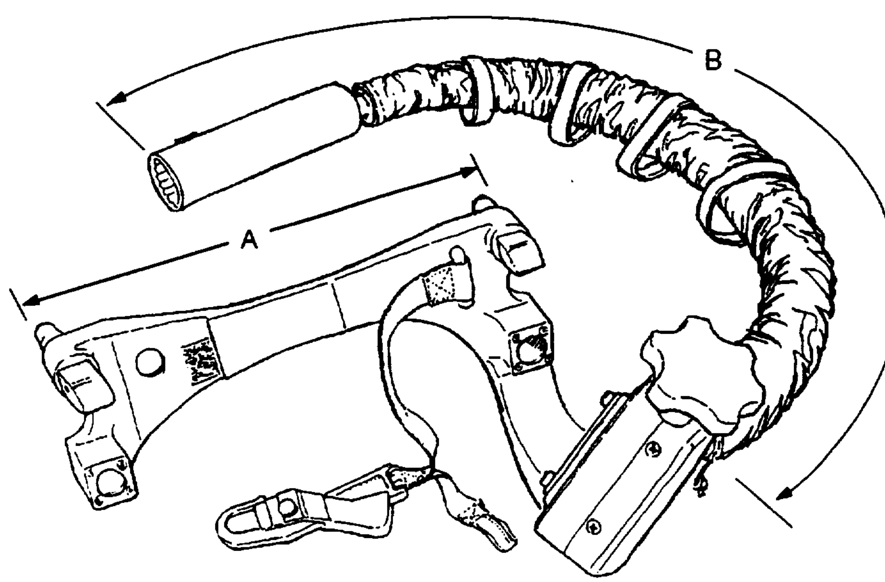
Operational: S. Rainwater, NASA/DF42, (713) 483–2589
Technical: R. Marak, NASA/EC5, (713) 493–9144

TETHER, SEMIRIGID

Technical Information	
Part number	10181–10054–01/02
Weight	8 lb
Material/ construction	Aluminum base plate and housing, Ortho fabric cover
Load rating	10 lb at end effector before rigid section deflects
Temperature range	–120° to +250° F
Quantity flown	Two on STS–31, **one** on STS–51 and STS–61
Stowage	Attached to EMU inside the airlock
Availability	Flight specific

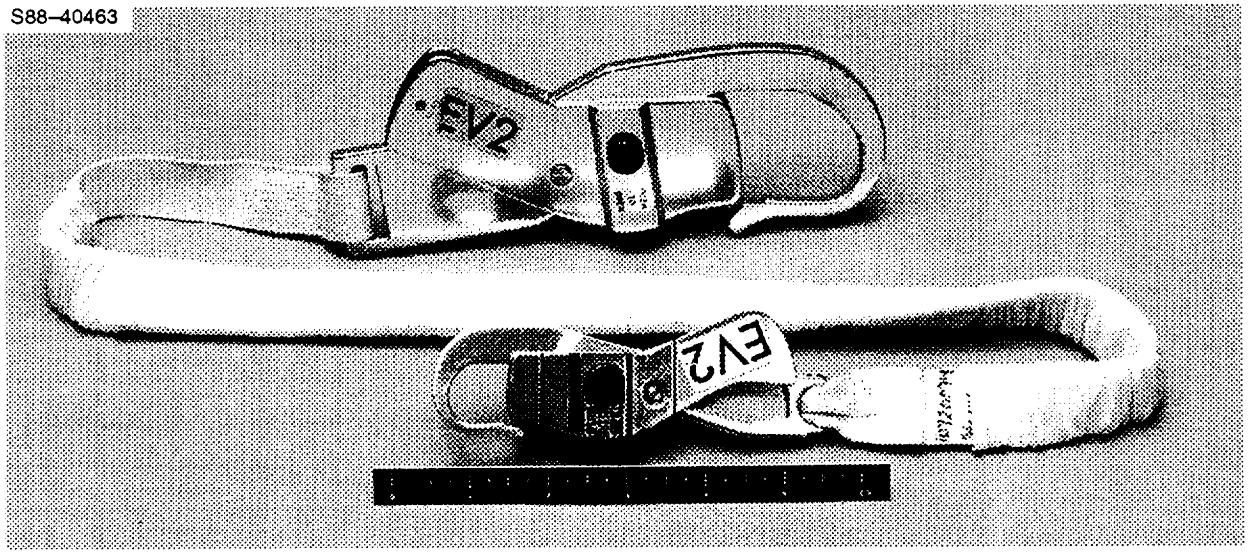
Dimensional Data		
	inches	cm
A	13.53	34.37
B	30.00	76.20





TETHER, WAIST

S88–40463



OVERVIEW

The waist tether consists of a strip of Nomex webbing material with an aluminum extravehicular activity (EVA) hook on each end (one hook is larger than the other). The tether is nominally 37 in. long including the hooks. The tether incorporates a load–limiting feature that allows no more than 75 lb to be imparted to the extravehicular mobility unit (EMU) and safety tether/slidewire system until full extension of the tether occurs. If this load is exceeded, the web stitching will break and absorb kinetic energy to decelerate the crewmember. After all web stitching is broken, the tether will withstand a limit load of 585 lb. A Teflon fabric sleeve retains any broken threads to minimize sources of EVA contamination.

OPERATIONAL COMMENTS

Waist tethers are used to attach the crewmember to the orbiter or to tether a tool to the crewmember. The large hook is attached to handrails, and the small hook is attached to an EMU waist tether ring. Opening of an EVA hook requires that push–to–open buttons on each side be depressed simultaneously while the hook is squeezed. **The hooks cannot be operated by a single, gloved hand without positioning aid from the second hand. These hooks are also fatiguing when used frequently.** The hook will spring closed as soon as it is released. The small hook opens 0.59 in., and the large hook opens 0.91 in. Two waist tethers are normally attached to each primary EMU.

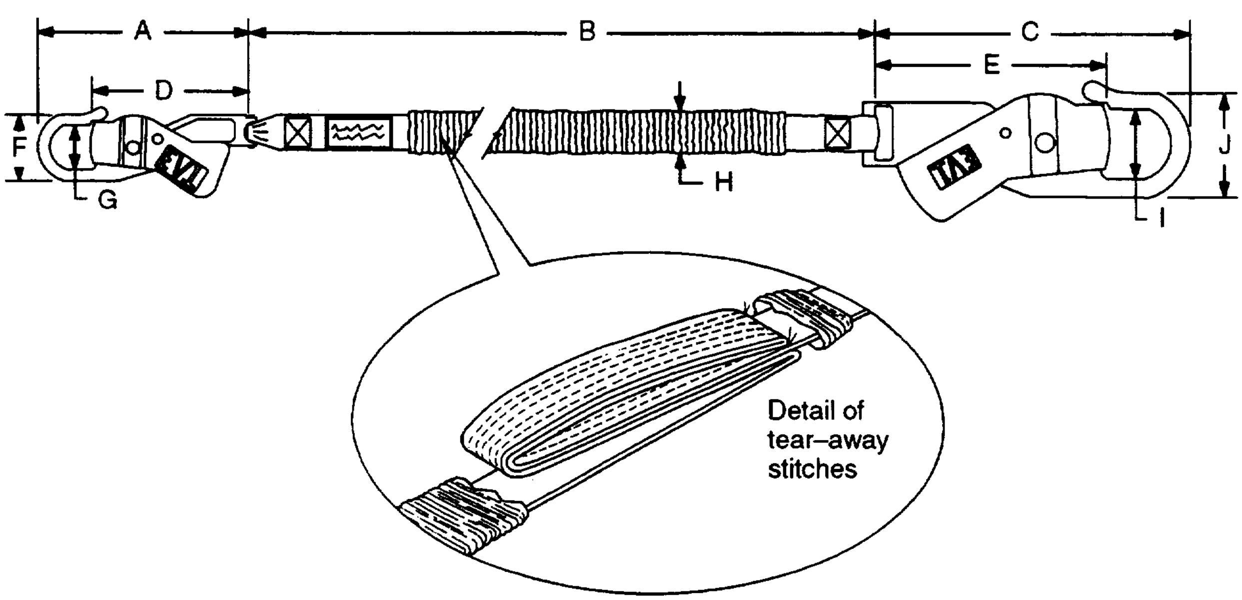
CONTACTS

Operational: **R. K. Fullerton**, NASA/DF42, (713) 483–2589
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

TETHER, WAIST

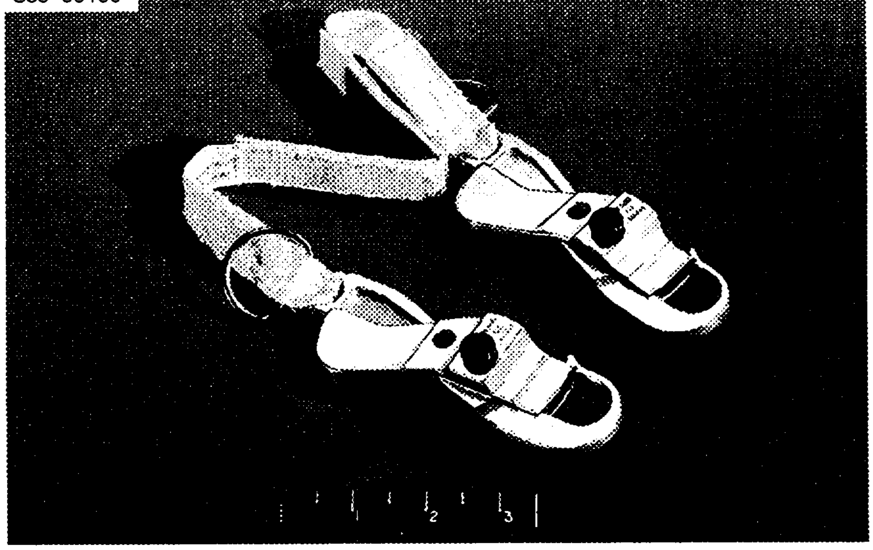
Technical Information	
Part number	SED33104391-301 10151-20040-07 (9792-03 or 10181-10046-01 or SED39119074-303 small hook) (10151-20083-01 or 10181-10047-01 or 9815-03 or SED39121780-301 large hook)
Weight	0.93 lb
Material/ construction	Nomex webbing strap, aluminum hooks
Load rating	1400 lb (webbing breaking strength) 75 lb (load limit before extension) 585 lb (extended tether strength)
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	Two for each **primary** EMU
Stowage	**Attached to EMU**
Availability	Standard

Dimensional Data		
	inches	cm
A	5.00	12.7
B	Normal – 24.50 Breakaway – 84.50	62.23 214.63
C	7.25	18.42
D	4.13	10.49
E	5.25	13.34
F	1.35	3.43
G	0.75	1.91
H	1.00	2.54
I	1.50	3.81
J	2.30	5.84



TETHER, WRIST

S83–35186



OVERVIEW

This type of wrist tether has a fixed–length strap and a small extravehicular activity (EVA) hook on each end. The wrist tether attaches to loops on the extravehicular mobility unit (EMU) gloves. The fixed–length tether is 22.8 in. long, including hooks, and is constructed of a Nomex webbing material with aluminum hooks.

OPERATIONAL COMMENTS

The wrist tether is used to secure tools and hardware to the suited crewmember and tether points. Opening of an EVA hook requires that push–to–open buttons on each side be depressed simultaneously while the hook is squeezed. **The hooks cannot be operated by a single, gloved hand without positioning aid from the second hand. These hooks are also fatiguing when used frequently**. The hook has a maximum opening of 0.59 in. and will spring closed as soon as it is released. One fixed–length wrist tether is normally attached to the right glove of the EMU.

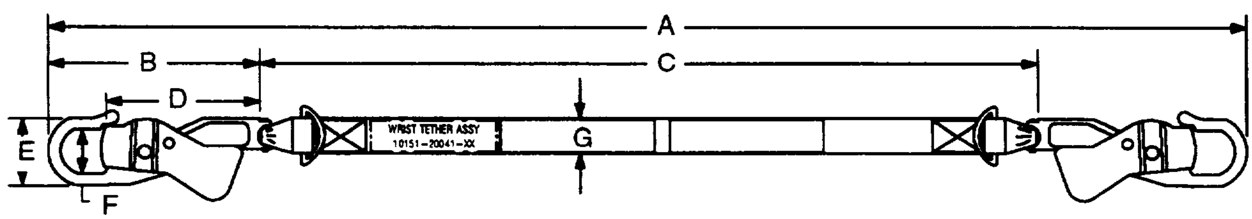
CONTACTS

Operational: **R. McDaniel,** NASA/DF42, (713) 483–2570
Technical: W. B. Wood, NASA EC5, (713) 483–9247

TETHER, WRIST

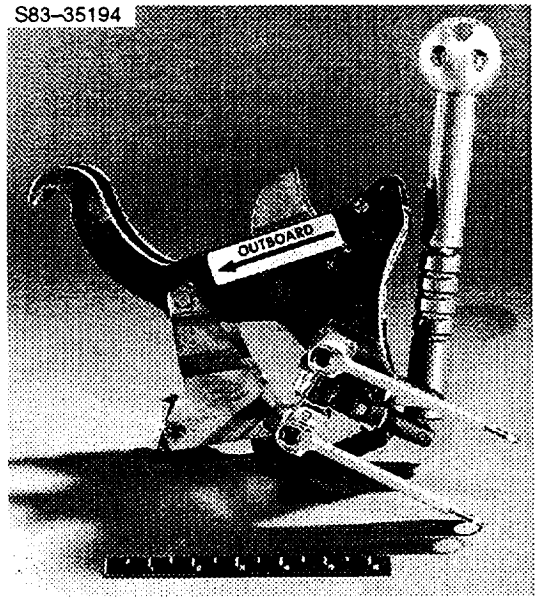
Technical Information	
Part number	**SED33104347–301 or** 10151–20041–**04** (9792–**03 or SED39119074–303** hooks)
Weight	0.52 lb
Material/ construction	Nomex webbing strap, aluminum hooks
Load rating	**1400 lb (webbing breaking strength)** **585 lb (operational load limit)**
Temperature range	**–200° to +250° F (operational), +350° F (stowage)**
Quantity flown	One for each prime EMU
Stowage	Right glove
Availability	Standard

Dimensional Data		
	inches	cm
A	22.80	57.91
B	5.00	12.7
C	12.80	32.51
D	4.13	10.49
E	1.35	3.43
F	0.75	1.91
G	0.70	1.78



THREE–POINT LATCH TOOL

S83–35194



OVERVIEW

The three–point latch tool consists of one spring–loaded and two fixed–load pickup points, a reversible ratchet with stowable handle, two installation handles, and a latch. The tool duplicates the loading on a latch roller produced by a latch hook in nominal condition, transferring loads to the hook pivot, the locking bellcrank, and the latch roller, which secures the forward and aft payload bulkhead latches.

OPERATIONAL COMMENTS

The three–point latch tool is a shuttle–unique device designed to substitute for the payload bay door forward and aft bulkhead latches if a failure occurs there. The tool cannot be installed on a bulkhead latch that has failed with the hook open less than 37° because of interference with the latch hook. Detachable installation handles allow installation of the tool on either side of the bulkhead. **Special handles are available that reduce the grip size for crewmembers with smaller hands; they were last flown on STS–32. Because of structural interference with door components, it is not possible to install any tool on the aft number 4 bulkhead latches.** This tool is part of the normally manifested orbiter equipment. Both three–point latch tools are stowed in the port provisions stowage assembly (PSA) in a transfer bag. **Four tools are manifested after a major payload bay door overhaul or on the first two flights of a new vehicle.**

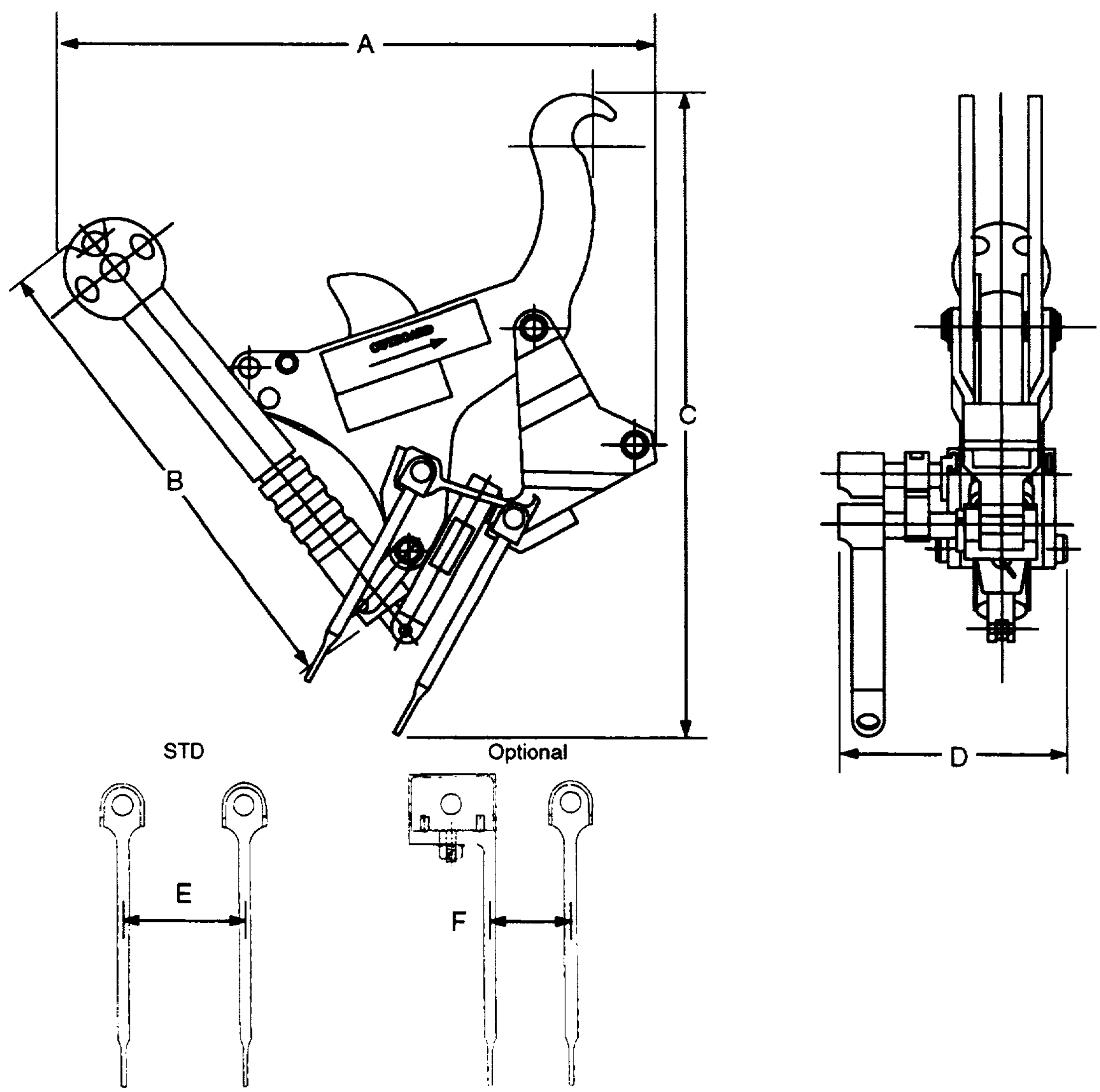
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: **N. Gonzalez**, NASA/ES6, (713) 483–**8944**

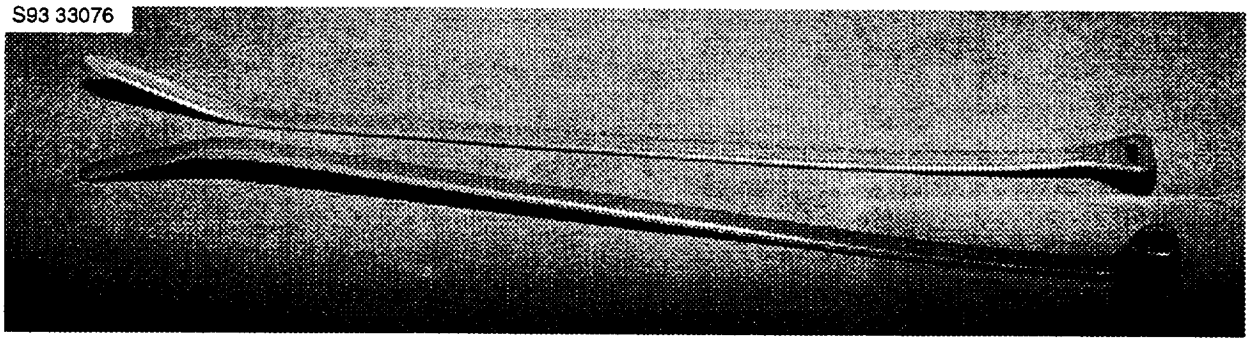
THREE–POINT LATCH TOOL

Technical Information	
Part number	SED33101327–311 (tool) **SED33102886–301 (optional small grip handles)**
Weight	8.8 lb
Material/ construction	Stainless steel
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	Two
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	12.250	31.12
B	9.875	25.08
C	13.375	33.97
D	4.560	11.58
E	**2.10**	**5.33**
F	**1.475**	**3.747**



TIE WRAP



OVERVIEW

These tie wraps are used for a variety of off–nominal extravehicular activity (EVA) purposes as well as for intravehicular activity (IVA) applications. They are standard off–the–shelf tie wraps with a self–locking stainless steel barb in the head. Lengths are available from 3.62 in. to 14.19 in., but the standard orbiter manifest utilizes only units that are 7.31 in. long. Fifty of these are stowed in the in–flight maintenance locker on every flight.

OPERATIONAL COMMENTS

These tie wraps were specifically certified for EVA use to allow the on–orbit pre–EVA fabrication of tether points on equipment not originally designed for EVA (e.g., IVA tools). One tie wrap is assembled into a loop to act as the tether point. A wrap of IVA gray tape prevents this tether loop from tightening with use. A second tie wrap secures the first tie wrap to the body of the equipment. Additional tape can be used with this second tie wrap to rigidly hold it to the equipment or to merely constrain it while allowing it to spin to create a rotating tether point.

Other EVA applications have included restraint of devices which have been partially disassembled by the EVA crew. They can restrain loose drive linkages or cable bundles. Given their small size relative to the gloved hand, these types of EVA applications may be more appropriate for Velcro or tape strips.

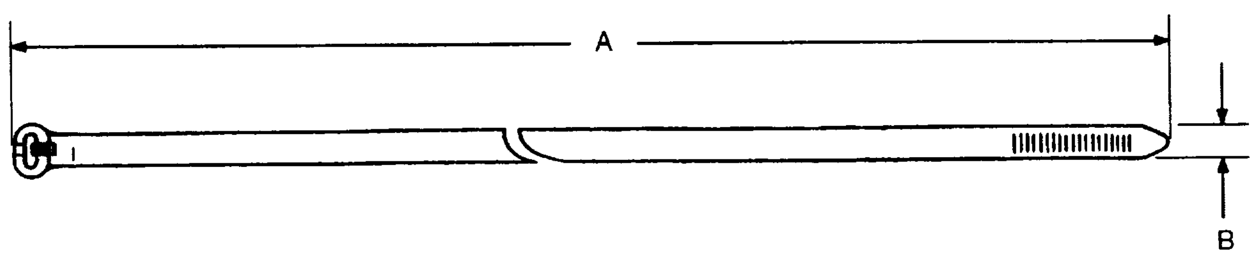
CONTACTS

Operational: B. Adams, JSC DF42, (713) 483–2567
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

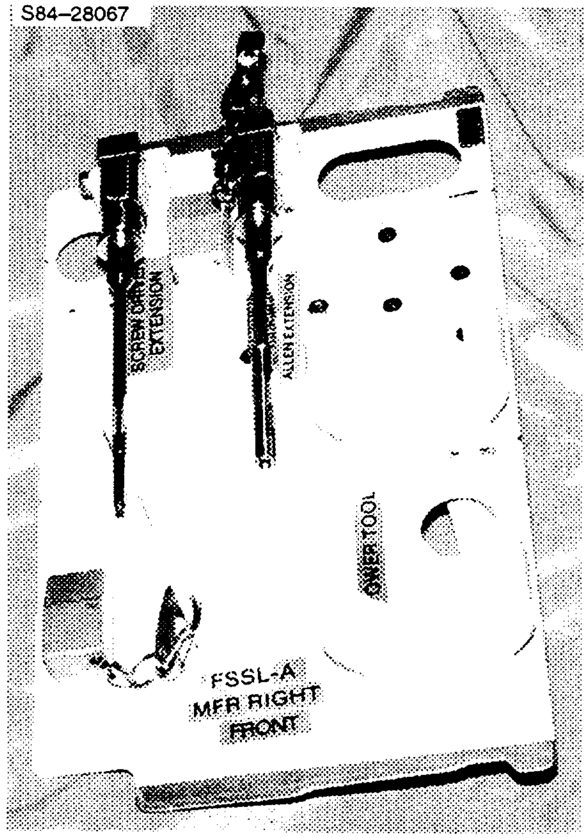
TIE WRAP

Technical Information	
Part number	SDD13101649–302
Weight	1 oz. each
Material/ construction	DuPont Tefzel, stainless steel
Load rating	50 lb (tensile unlocking strength) 1/8 to 1–3/4 in. diameter wire bundle capacity
Temperature range	–200° to +250° F
Quantity flown	50
Stowage	Middeck locker
Availability	Standard

Dimensional Data		
	inches	cm
A	7.310	18.57
B	0.184	3.416



TOOL BOARD



OVERVIEW

The tool board is a device used to restrain tools for stowage; it attaches to a workstation stanchion or to a manipulator foot restraint (MFR) for use. **Due to its large size and lack of rigid restraint, it is not an acceptable means for routine transport of equipment**. The board has a tether point or points and attachments to fit each of the tools or pieces of equipment that it is to restrain. Retractable tethers with swivel hooks are provided for certain tools. Each tool attachment point is labeled.

OPERATIONAL COMMENTS

The tool board is designed to hold tools and equipment on both sides. **For workstation stanchion use like the MFR, only one side of each tool board can be loaded when a pair of tool boards are mounted back–to–back on one side of the stanchion**. Normally, tools can be removed or replaced with one hand using no more than 20 lb of force. Small, similar tools such as screwdriver tips are often interchangeable in their restraint attachments for crewmember convenience. The drawing shown is a typical board layout that was used on the Solar Maximum Satellite Repair Mission. Large, plainly lettered labels are provided to identify the tools.

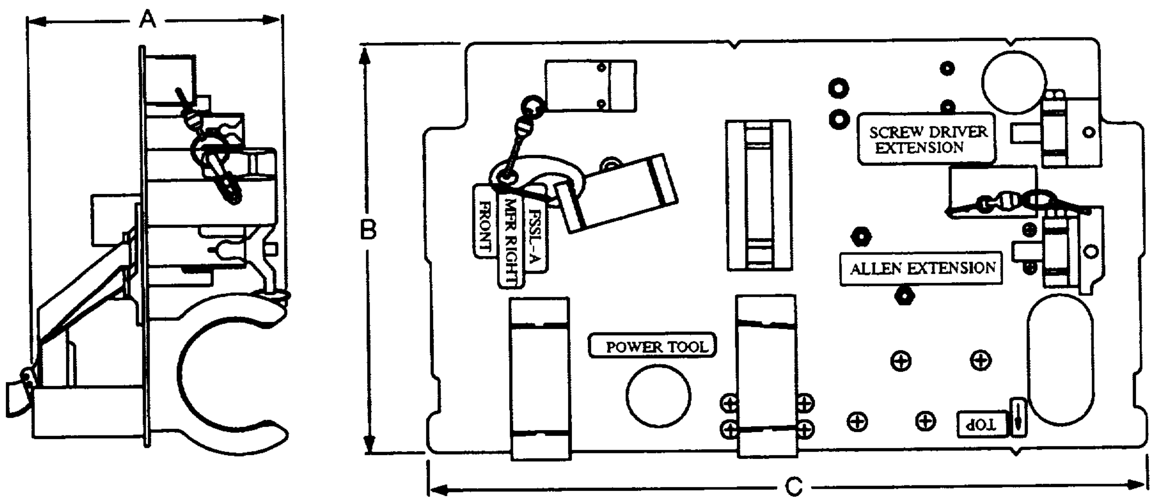
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. Marak**, NASA/**EC5**, (713) 483–**9144**

TOOL BOARD

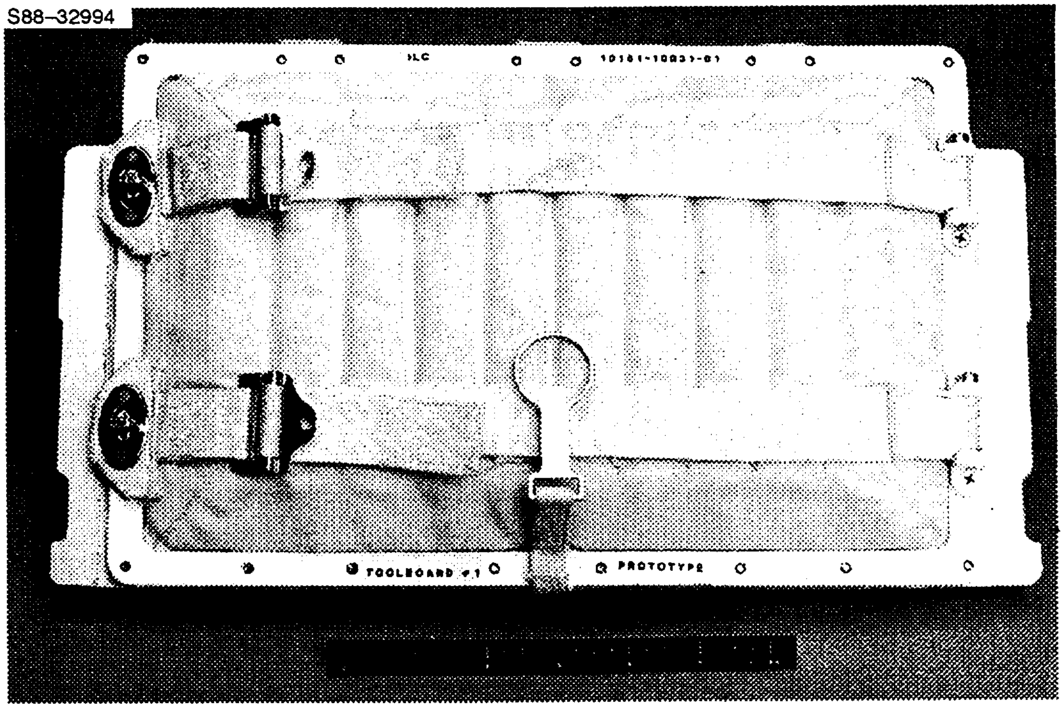
Technical Information	
Part number	(There is no generic tool board. For a typical tool board, see SDD39117837–001)
Weight	1.0 lb (board only, without carriers)
Material/ construction	Aluminum alloy (typical)
Load rating	
Temperature range	
Quantity flown	As needed
Stowage	Varies depending on intended use
Availability	Flight specific

Dimensional Data		
	inches	cm
A	4.900	12.45
B	8.225	20.89
C	14.357	36.47



TOOL BOARD, CUSHIONED

S88-32994



OVERVIEW

The cushioned tool board is designed to restrain Hubble Space Telescope (HST) tools not dedicated to other stowage locations. The tool board consists of two cushioned sides with retention straps to hold the tools against the cushions. A tether ring is provided for transfer of the tool board.

OPERATIONAL COMMENTS

To stow or release tools to/from the toolboard, the 1/4-turn fastener at the end of the straps is used. The straps have adjusters to allow for proper retention of various sizes of tools.

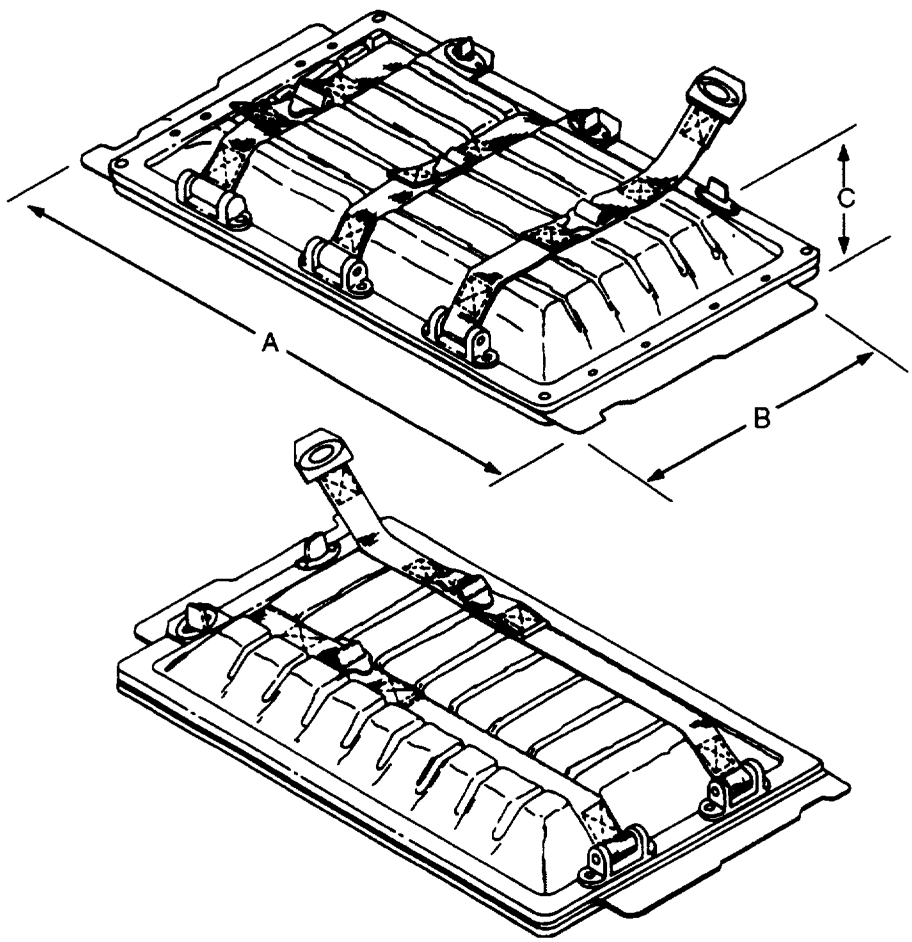
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

TOOL BOARD, CUSHIONED

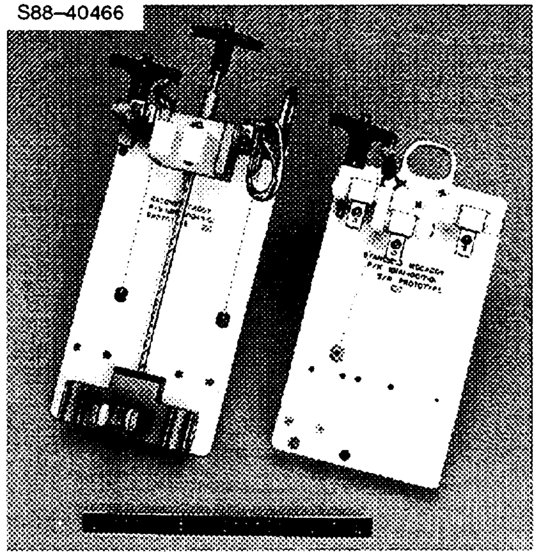
Technical Information	
Part number	10181–10031–01
Weight	2.59 lb
Material/ construction	Aluminum Nomex webbing and fabric Solamide foam 1/4–turn fasteners Adjustments buckles
Load rating	
Temperature range	–150° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	14.32	36.37
B	8.06	20.47
C	2.89	7.34



TOOL CADDY, McCADDY AND RATCHET

S88–40466



OVERVIEW

The McCaddy and ratchet caddy assemblies are similar in design to small tool boards for storing, transporting, and tethering tools for EVA use. They were created for Hubble Space Telescope maintenance applications. The McCaddy is designed to accommodate three drop–proof tether socketed tools. The ratchet caddy accommodates two drop–proof tether tools and one 3/8–in. drive McTether ratchet. The ratchet is secured by two hardpoint locking mechanisms and is tethered by use of a 6–ft retracting tether with a small french hook.

OPERATIONAL COMMENTS

A pip pin attached to a self–retracting tether is included for removal or installation of the tools. The self–retracting tether is positioned on the backside of the caddy, allowing the tether cord to be positioned at an angle minimizing abrasion on the tether cord. **The pip pin for the ratchet is captive and must be pulled out on the latest version to release the ratchet**. A bayonet fitting on each caddy allows for attachment to the mini–workstation **or foot restraint stanchion**. A tether ring provides for safe transfer of the caddy to and from stowage sites.

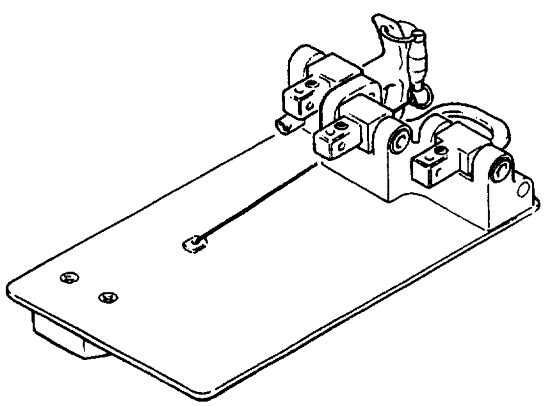
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

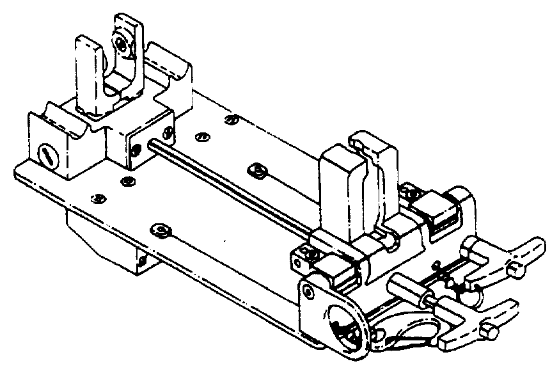
TOOL CADDY, McCADDY AND RATCHET

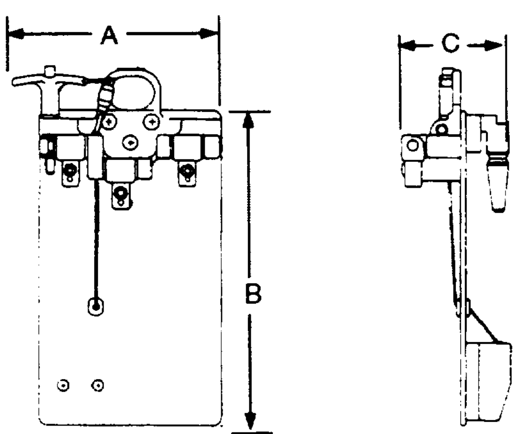
Technical Information	
Part number	10181–10017–01 – Standard McCaddy 10181–10045–**02** – Ratchet caddy
Weight	10181–10017–01 **1.03** lb 10181–10045–02 **1.73** lb
Material/ construction	Aluminum Delrin Stainless steel
Load rating	
Temperature range	–150° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	10045–02	10017–01
	inches	inches
A	4.55	5.20
B	10.20	7.93
C	4.00	2.29

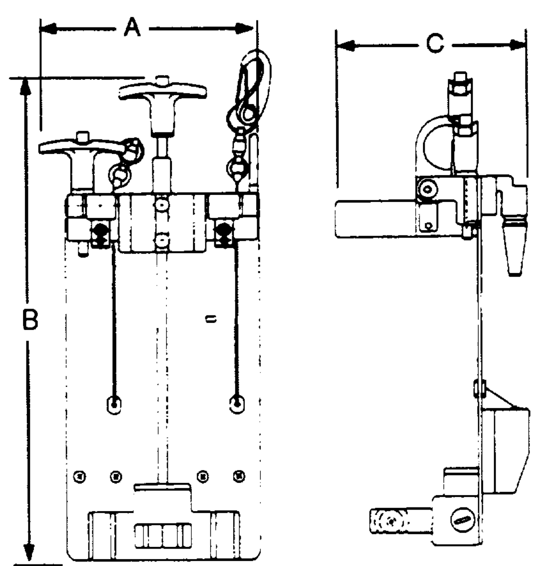


10181–10017





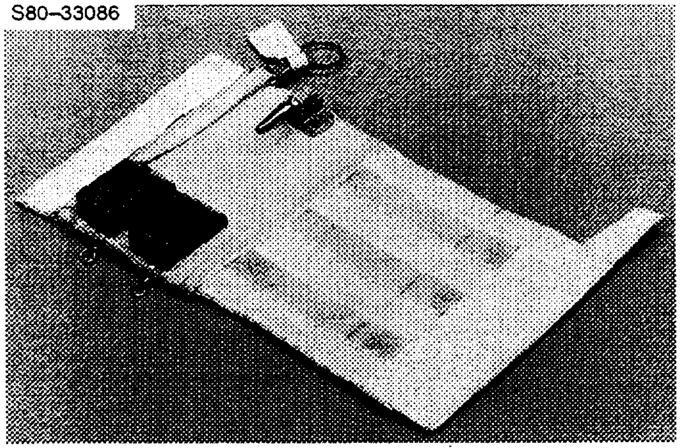
10181–10017



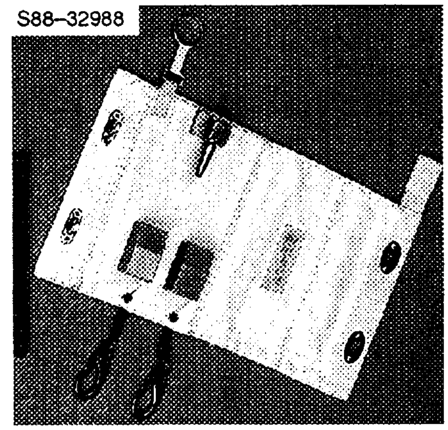
10181–10045

TOOL CADDY, SOFT

S80–33086



S88–32988



OVERVIEW

The soft tool caddy is a stiffened fabric container for **restraining** tools **during** extravehicular activity (EVA). It serves three purposes: the stowage of EVA tools, the transfer of tools to the worksite, and the tethering of tools at the worksite.

OPERATIONAL COMMENTS

The original tool caddies (10153–10053 and 10176–20269) consist of an 8– by 13–in. piece of stiffened fabric that folds over the tools, closes, and seals with Velcro; a tether tab with a 1–inch ring; an interface adapter that attaches to a receptacle on the mini–workstation; and two split–ring–and–swivel attachments on 3– or 6–foot retracting tethers. The split rings and swivels attach a maximum of two tools to each caddy, and four caddies can be attached to one mini–workstation simultaneously **(assuming no tool interference with mini–workstation components). Newer versions of these Velcro caddies use small french hooks instead of swivels and split rings to allow on–orbit tool changeout. One of these (SED33104089) flies in volume H for general use on every flight**. The tools are held in place by mating hook Velcro on the tools with pile Velcro on the caddy surface. When these caddies are folded, they measure 8 by 6.5 inches. Hook Velcro on a tool has proven to be abrasive to the extravehicular mobility unit (EMU) glove palms.

A second style of caddy has been developed that **uses no** Velcro **for** tool retention **to prevent particulate contamination**. These caddies (10181–10044–01/–02) consist of stiffened fabric that folds over the tools, closes, and is sealed with a 1/4–turn fastener; an interface adapter bracket and tether ring for attachment to the mini–workstation or a similar receptacle; and two 2–inch french hooks on individual 6–foot retracting tethers, which are used to tether a maximum of two tools to each caddy. When these caddies are folded, they measure 9 by 4–3/4 inches. **Special larger 1/4–turn fasteners are being incorporated on newer designs to enhance EVA glove compatibility. To preclude loose tools coming out of these caddies without tool restraining Velcro, at least one version has a supplemental internal flap.**

CONTACTS

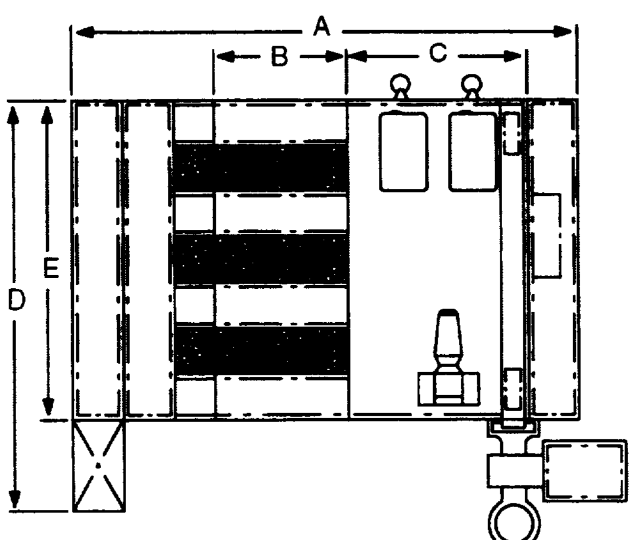
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

C 5

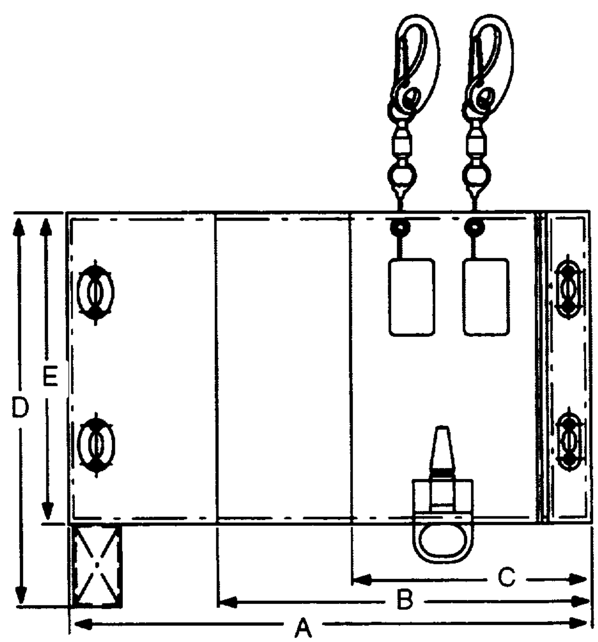
TOOL CADDY, SOFT

Technical Information	
Part number with Velcro	10153–10053–01/–02/–03/–04 **(PSA caddies)** 10176–20269–01/–02 **SED33104394–301 (PSA caddies)** **SED33104089–301 (general purpose caddy)**
Part number without Velcro	10181–10044–01/–02 **(HST caddies)** **SED33104304–301/302/303 (general purpose caddy)**
Weight/	0.77 lb **(Velcro caddies)** 1.8 lb **(Velcroless caddies)**
Material construction	Stiffened fabric 10153–10053 – Pile Velcro 10176–20269 – Pile Velcro 10181–10044 – Stainless steel fastener
Load rating	**120 lb (retracting Kevlar cord strength**
Temperature range	–130° to +150° F **(Velcro caddies)** –150° to +250° F **(Velcroless caddies)**
Quantity flown	As required
Stowage	Varies depending on use
Availability	10153–10053 – Standard SED33104089 – Standard 10176–20269 – Flight specific 10181–10044 – Flight specific

Dimensional Data				
	10153–10053–03		10181–10044	
	inches	cm	inches	cm
A	**11.40**	28.96	**12.10**	30.73
B	**3.80**	9.65	**8.60**	21.84
C	**4.30**	10.92	**5.50**	13.97
D	**8.80**	22.35	**9.10**	23.11
E	**7.00**	17.78	**7.20**	18.29



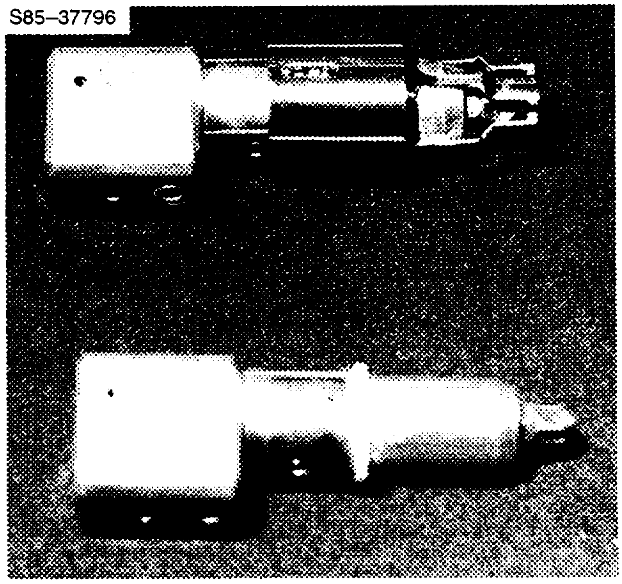
10153–10053



10181–10044

TORQ-SET TIP EXTENSION

S85-37796



OVERVIEW

The Torq-Set tips modified for extravehicular activity use are no. 8 and no. 10 size tips. Both sizes have drop-proof tether attachments and capture devices to hold Torq-Set screws. Another version of the no. 8 tip has no capture device.

OPERATIONAL COMMENTS

Two no. 8 tips without capture devices and two no. 10 tips with capture devices were successfully used on STS 51-I, the Leasat Salvage Mission.

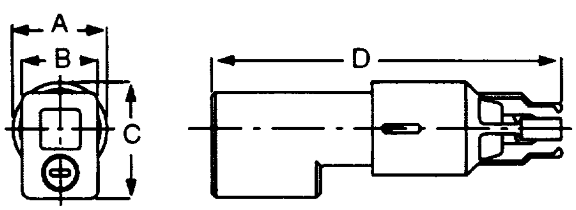
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

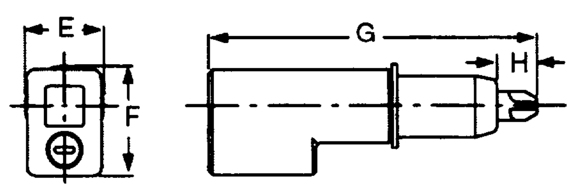
TORQ–SET TIP EXTENSION

Technical Information	
Part number	10176–20132–01 **(no. 8 with capture device)** 10176–20132–02 **(no. 8 without capture device)** 10176–20135–01 **(no. 10 with capture device)**
Weight	
Material/ construction	
Load rating	
Temperature range	**–80° to +180° F (operational)** **–95° to +180° F (stowage)**
Quantity flown	Two each on STS 51–I
Stowage	Tool board
Availability	Flight specific

Dimensional Data		
	inches	cm
A	0.875	2.22
B	0.007	0.02
C	1.100	2.79
D	3.228	8.20
E	0.257	0.65
F	1.025	2.60
G	3.120	7.92
H	0.810	2.06



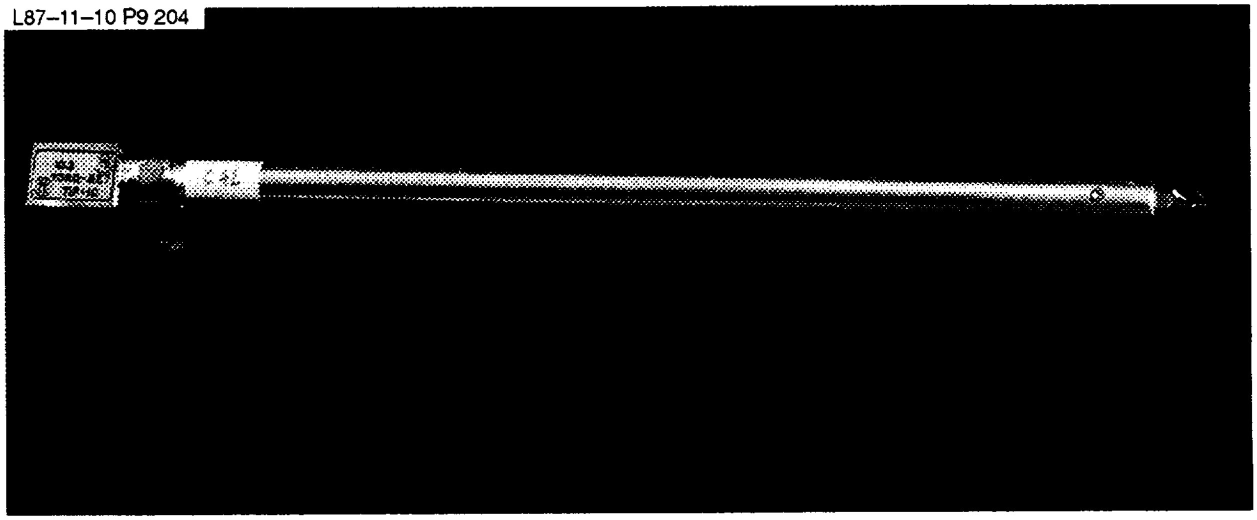
10176–20132–01



10176–20132–02

TORQ-SET TIP EXTENSION (HST)

L87-11-10 P9 204



OVERVIEW

The no. 10 Torq-Set tip tool is sized to fit a no. 10 Torq-Set screw. The tip is extended on a 9-in. shaft with a 3/8-in. drive drop-proof tether.

OPERATIONAL COMMENTS

The Torq-Set tip is used to loosen or tighten Torq-Set screws. It is a contingency tool used as a backup release tool for Hubble Space Telescope (HST) 5/16-in. and 7/16-in. captive hex-head screws or for use where there is insufficient clearance for a socket. **There is a rotation mark on the shaft for counting screw turns.**

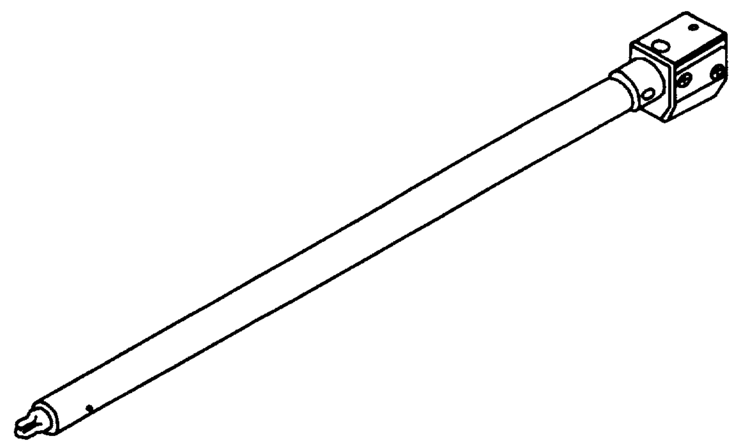
CONTACTS

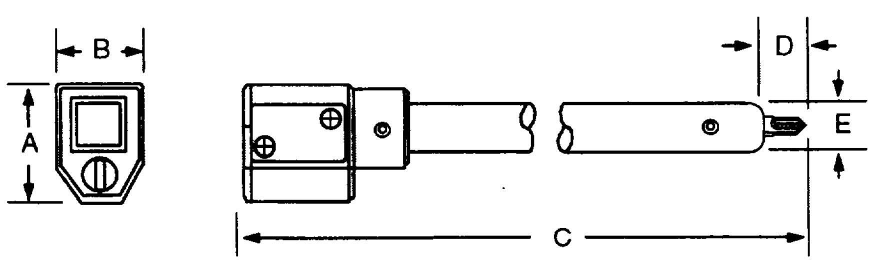
Operational: S. Rainwater, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

TORQ-SET TIP EXTENSION (HST)

Technical Information	
Part number	10181-10021-01
Weight	0.22 lb
Material/ construction	Aluminum Stainless steel
Load rating (**use/proof**)	**52.5/63 in-lb**
Temperature range	-150° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

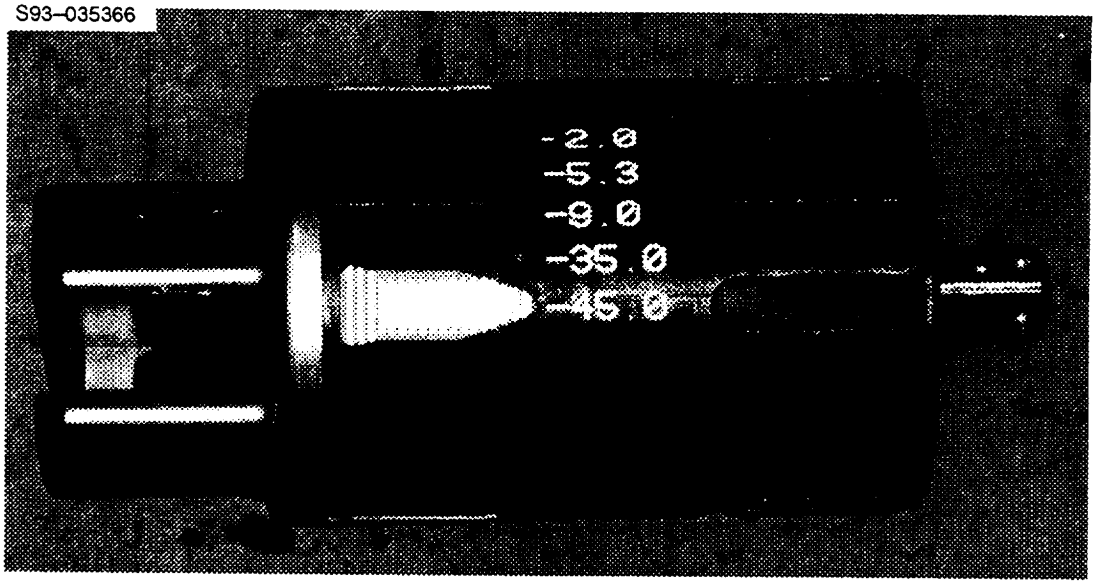
Dimensional Data		
	inches	cm
A	0.930	2.34
B	0.660	1.68
C	10.320	26.21
D	0.600	1.52
E	0.375	0.95





TORQUE LIMITER, MULTISETTING

S93–035366



OVERVIEW

The multisetting torque limiter was created for Hubble Space Telescope (HST) maintenance and incorporates five different torque limit ranges. These five different torque limit ranges are marked as 2.0, 5.0, 10.0, 23.0, and 38.0 ft–lb (photo above is mislabeled). They are designed to limit torque in both clockwise and counterclockwise directions. The removal (counterclockwise) torque is approximately 10 percent higher than the tightening (clockwise) torque. The torque limiter interfaces with any 3/8–in. drive and has a drop–proof tether **with built–in tether point**.

OPERATIONAL COMMENTS

The torque limiter is designed to prevent the overtorquing of fasteners in clockwise and counterclockwise directions. When torque is applied, the limiter will indicate that the torque limit has been reached by a slippage of approximately 30° at the socket drive end without further torque increase. The limiter will reset to deliver torque within 45° from the original start of slippage. A sliding lock button prevents accidental changes in the desired torque setting.

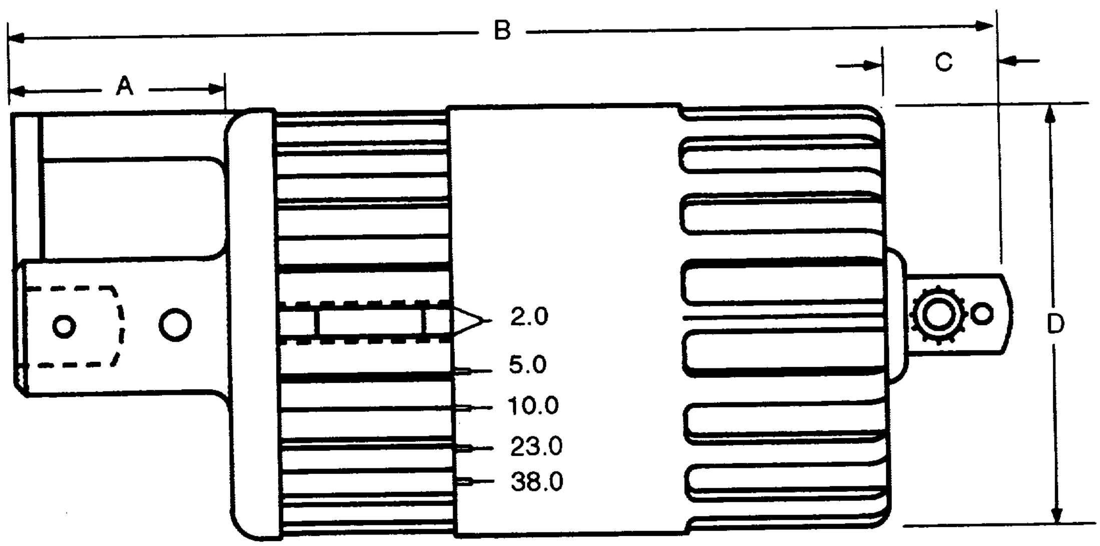
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. Sheffield, LMSC/Dept 64–10, (408) 742–8464

TORQUE LIMITER, MULTISETTING

Technical Information	
Part number	4177657–001, **1525320**
Weight	2.5 lb
Material/ construction	Stainless steel
Load rating	1.7 – 2.3 ft–lb 4.4 – 5.4 ft–lb 9.3 – 10.7 ft–lb 22.0 – 26.2 ft–lb 35.7 – 43.4 ft–lb
Temperature range	–40° to +140° F
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

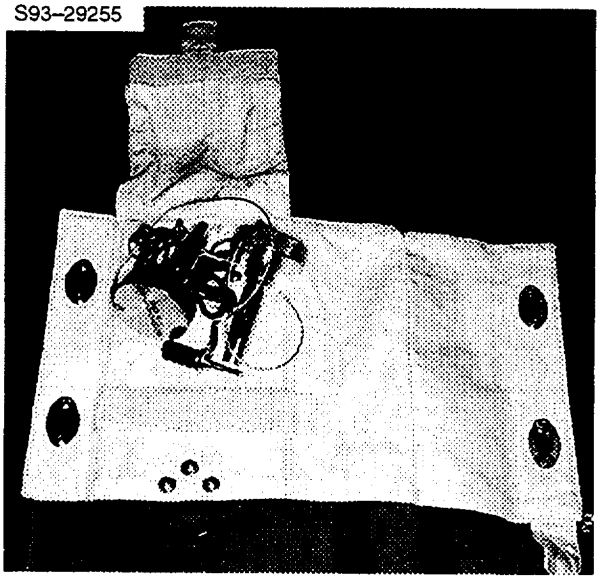
Dimensional Data		
	inches	cm
A	**1.12**	**2.84**
B	5.08	12.90
C	0.66	1.68
D	2.25	5.72



IL_6

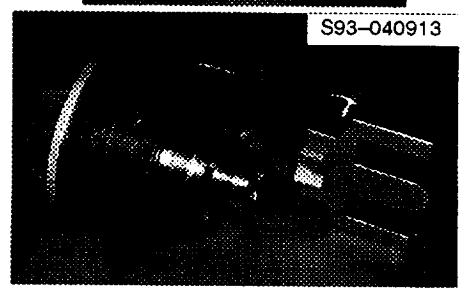
TORQUE MULTIPLIER, MODIFIED

S93–29255



S93–040911

S93–040913



OVERVIEW

This torque multiplier has been developed as a one–piece replacement for the original torque multiplier and reaction fitting. Like the original, this device is used to release the passive latches of orbiter payloads. It is a part of the payload jettison hardware along with the latch pin caddy and the large cable cutter. This version is a modified commercial unit that uses a planetary gear system to tighten and loosen bolts with a continuous 360° rotation in either the clockwise or counterclockwise direction. One unit is flown in the port provisions stowage assembly (PSA) on every flight.

OPERATIONAL COMMENTS

Input is made using a manual ratchet mated to the unit's female 3/8 in. square drive. This female drive has four indentations for the locking ball detents of certain extravehicular activity ratchets. This prevents unsafe tool release during high torque application. The sculpted knob on top can be used for manual operation after the bolt being driven is unloaded. A pushbutton direction selector allows the crew to engage clockwise and counterclockwise anti–backdrive pawls for bolt release and engagement. The neutral center position of this selector has no detent and disengages the backdrive pawls, so it should not be used for high torque application. Output is via a permanently attached 1–1/16 in. 12–point socket. Torque is reacted into the latch by three fingers that passively engage the latch body. A captive knurled knob must be rotated clockwise to rigidly attach the torque multiplier to the latch. The knob has a 3/8 in. square drive input for contingency release. A bayonet fitting is provided to allow attachment to the mini–workstation for two–handed crew translation to each worksite.

Before the latch bolt can be released, lock wire must be removed and stowed (needle nose pliers, small trash bag). 10 full bolt turns are required before the bolt and its washer pull free from its noncaptive nut. After each latch has been released and the payload has been jettisoned, the large pins in the latch pin caddy are used to secure floating latches to their bridge rails for landing. The smaller pin captures the larger pin by acting as a set screw which is threaded into a hole on the latch body.

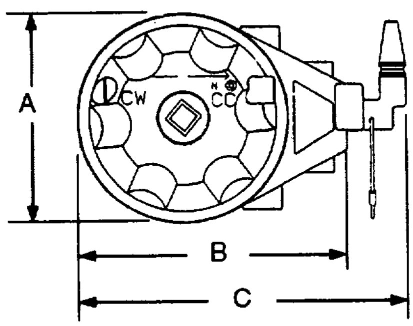
CONTACTS

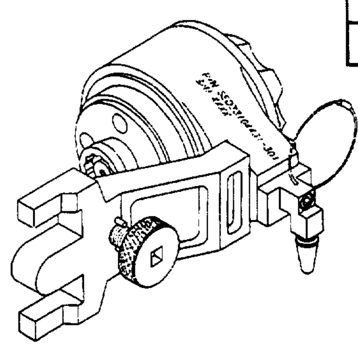
Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

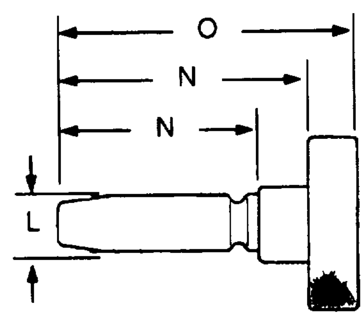
TORQUE MULTIPLIER, MODIFIED

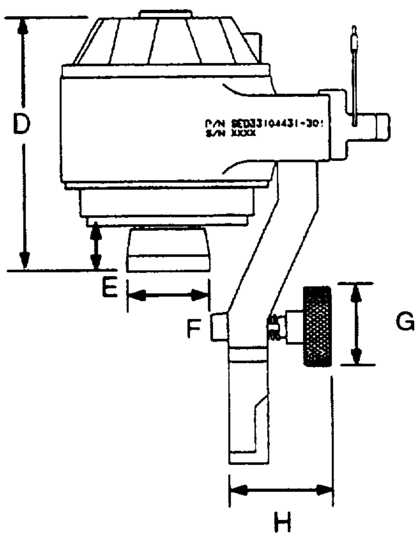
Technical Information	
Part number	SED33104431–301 (torque multiplier) SED33104302–301 (latch pin caddy)
Weight	14 lb (torque multiplier)
Material/ construction	Stainless steel
Load rating	Passive latch breakout torque 660–707 ft–lb 750 ft–lb output torque with 50 ft–lb input 15:1 torque ratio 25 ft–lb to secure bolt/empty latch for landing
Temperature range	–200° to +250° F (operational), +350°F (stowage)
Quantity flown	One
Stowage	Port PSA
Availability	Standard

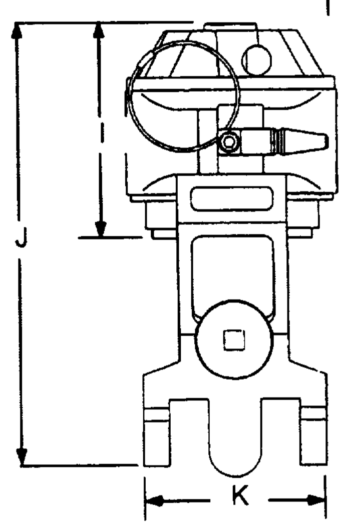
Dimensional Data		
	inches	cm
A	4.03	10.24
B	5.12	13.00
C	6.0	15.24
D	4.76	12.09
E	0.79	2.01
F	1.58	4.01
G	1.5	3.81
H	1.68	4.27
I	3.97	10.08
J	8.7	22.10
K	3.5	8.89
L	0.555	1.41
M	2.000	5.08
N	2.500	6.35
O	3.010	7.65





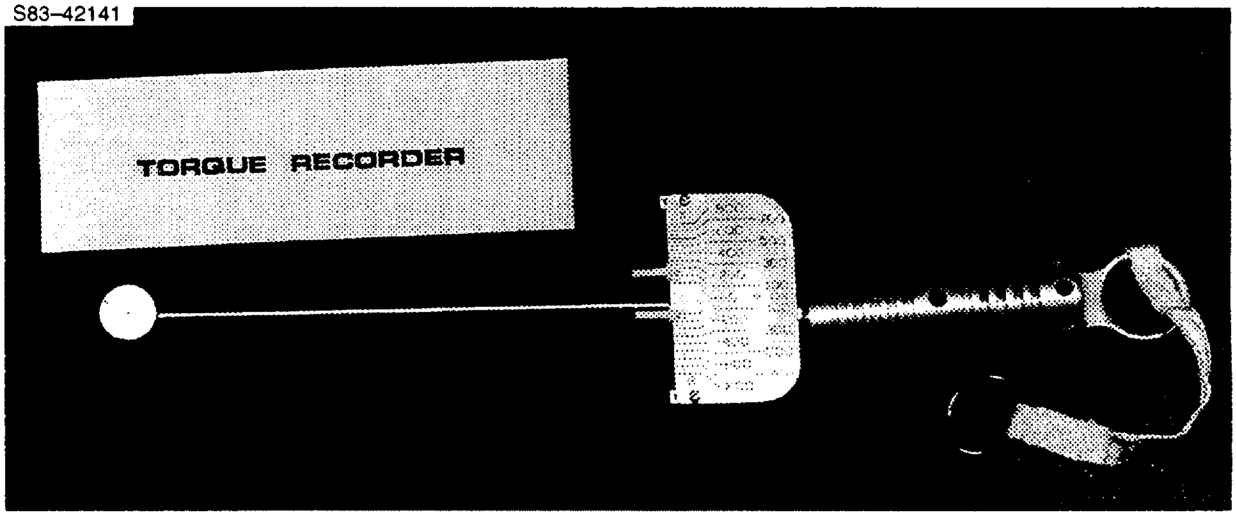






TORQUE RECORDER

S83–42141



OVERVIEW

The torque recorder is a combination of modified common tools. It consists of a modified beam torque wrench **and has an optional pinned on 7/16 socket or drop–proof tether**. A larger, easily readable torque scale and two sliding torque indicators have been added. A larger handle with tether rings has been added for easier gripping.

OPERATIONAL COMMENTS

The torque recorder was originally designed as a task–simulation device to determine the maximum torque an astronaut could apply. The torque recorder records both clockwise and counterclockwise torques.

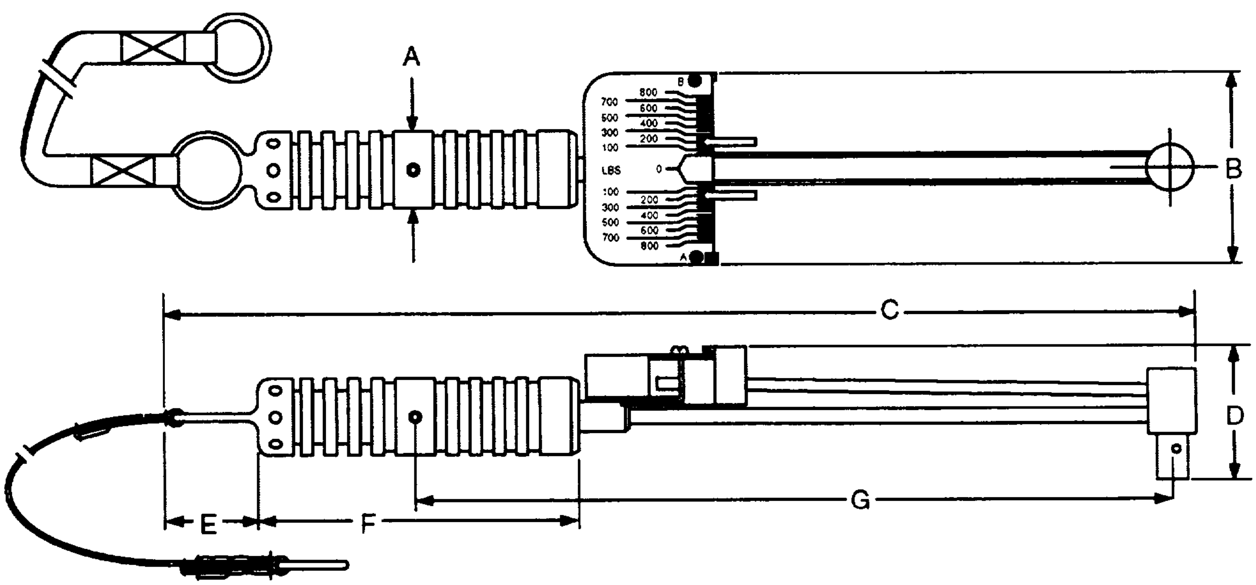
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. J. Marak**, NASA/EC5, (713) 483–**9144**

TORQUE RECORDER

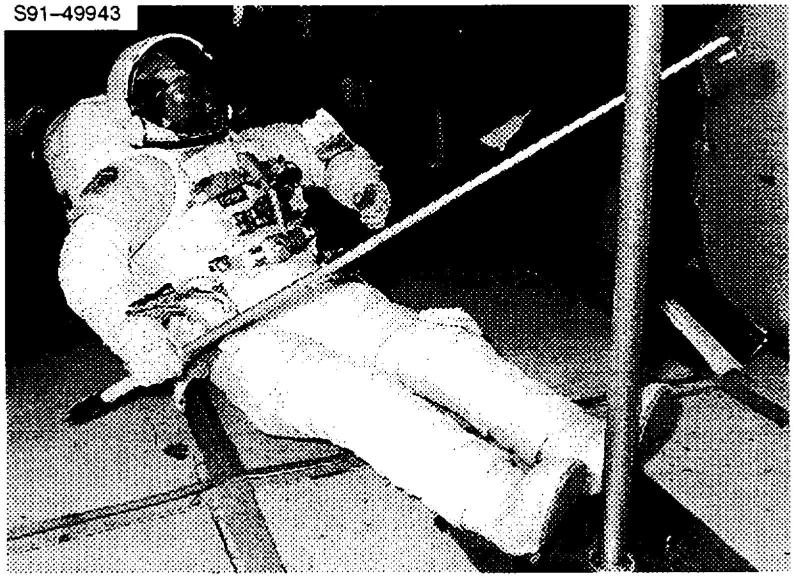
Technical Information	
Part number	10159–10001–01 **(pinned on 7/16 socket)** 10159–10001–**02 (drop–proof tether)**
Weight	1.190 lb
Material/ construction	Torque wrench – Tool steel Handle – Aluminum Torque indicator slides – Teflon
Load rating	
Temperature range	
Torque scale	Reads up to 800 in–lb in either direction
Socket depth	0.5 in.
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.25	3.18
B	3.12	7.92
C	16.21	41.17
D	2.37	6.02
E	1.65	4.19
F	4.25	10.80
G	11.00	27.94



TRANSLATION AID

S91-49943



OVERVIEW

The translation aid (TA) was one of several different crew self-rescue (CSR) concepts for solving the extravehicular activity (EVA) "man overboard" scenario on Space Station Freedom where no shuttle is available to assist. Evaluation of these concepts was conducted as part of the STS-49 Assembly of Station by EVA Methods (ASEM). Each device was intended to cover rescue scenarios including tether mismanagement and tether or hook failure when a fellow EVA crewmember is not available. This device utilizes a modified golf ball retriever that extends to form a rigid pole. All CSR devices were concept evaluations only and did not represent final packaging for quick deployment. "Off-the-shelf" components were used where possible.

OPERATIONAL COMMENTS

The TA is a modified off-the-shelf device comprising an L-shaped hook and seven concentric tubes that compress to approximately 2 ft and extend to 8 ft. The crewmember manually deploys and retracts the pole with the friction-type fittings for desired length. Once the target is grappled, the crewmember uses a manual retraction of the segments to approach the target. An internal Kevlar cord backs up the length of the pole in case there is a failure. The TA could be secured to the extravehicular mobility unit (EMU) by Velcro on a special fabric flap over the suit body seal closure or by a small rigid pocket and Velcro on the suit lower torso. Unlimited grapple exercises can be accomplished with the TA. It was stowed in the middeck for STS-49.

The TA in its 2-ft compressed state is a little too long for easy stowage on the suit throughout an EVA. The grappling device solution obviously does not cover all rescue scenarios since the crewmember must be able to see a regrapple target and have low enough rotation rates to employ such a device. This simple device has considerable potential as an aid for transferring small cargo between crewmembers and worksites. It was even considered as a means to remotely apply small loads for spacecraft stabilization during the Intelsat rescue.

Future self-rescue development is concentrating on a mini manned maneuvering unit known as the simplified aid for EVA rescue (SAFER).

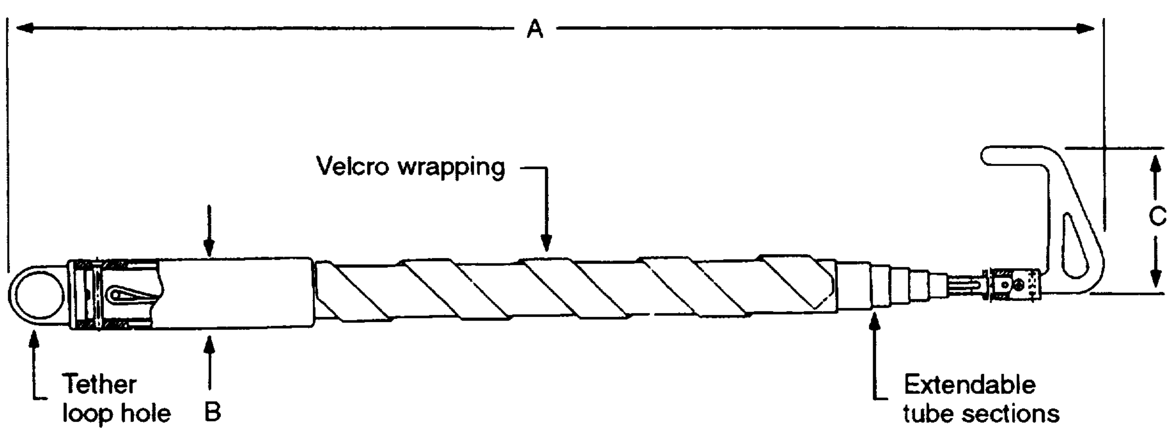
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: R. Schwarz, NASA/EC5, (713) 483-2378

TRANSLATION AID

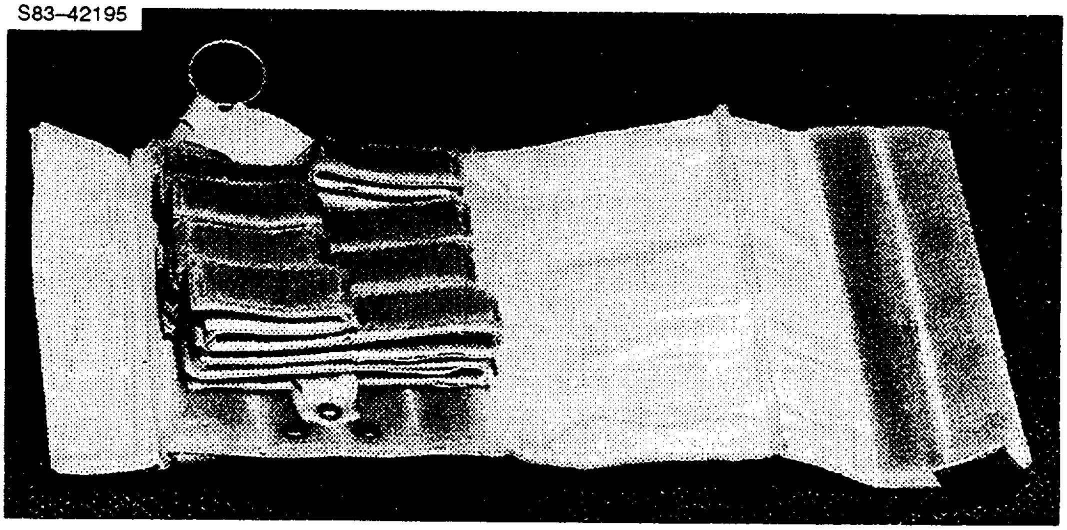
Technical Information	
Part number	SED39122970
Weight	
Material/ construction	Aluminum, Kevlar cord
Load rating	25 lb (tension) 18 lb tether ring
Temperature range	+205° F (operational)
Quantity flown	One on STS–49
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	24–96	61–244
B	1.5	3.8
C	3.0	7.6



VELCRO CADDY

S83–42195



OVERVIEW

The Velcro caddy, also called the door drive linkage (DDL) Velcro set, is a foldup fabric container that holds four Velcro tethers for use in restraining disconnected mechanisms or miscellaneous loose equipment during extravehicular activity (EVA)

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OPERATIONAL COMMENTS

The four Velcro tethers contained in the Velcro caddy are 22–7/8 in. long and are fabricated of 1–in. by 2–in. alternating segments of hook and loop Velcro sewn on both sides of Armalon material. A tab on one end and a D–ring on the other assist in handling by EVA crewmembers. The tethers are stowed folded back and forth upon themselves in the caddy. This assembly is **no longer** a part of the normally manifested EVA hardware **since its replacement with a combined tape/Velcro caddy.**

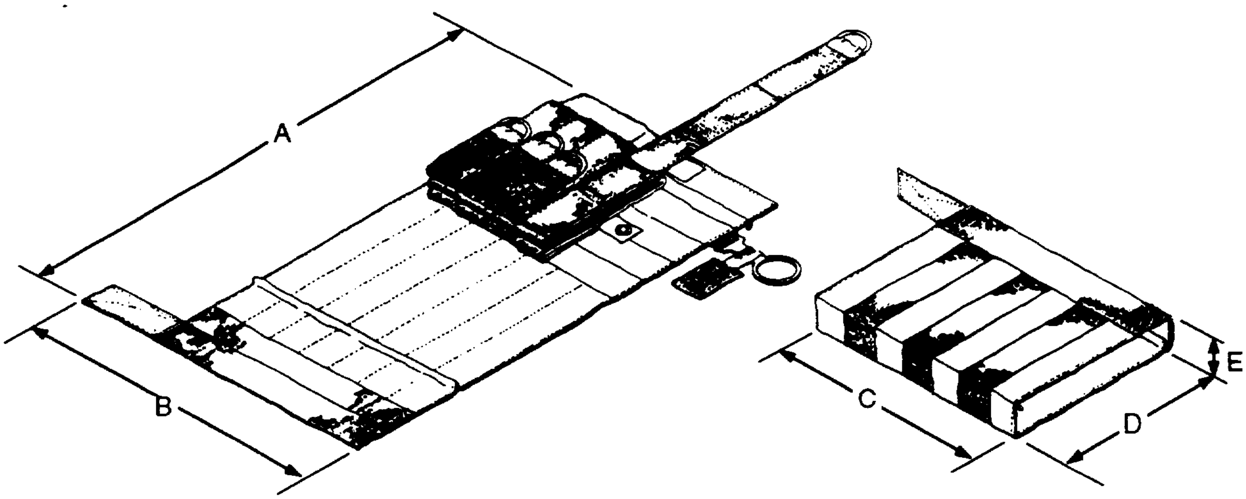
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

VELCRO CADDY

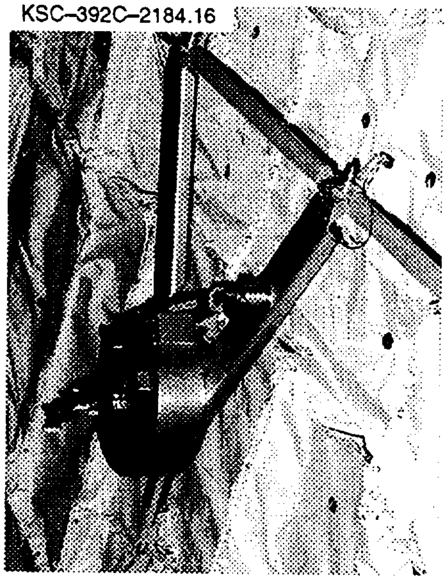
Technical Information	
Part number	10159–20006–02
Weight	1.8 lb
Material/ construction	Caddy – Nomex Strips – Polyester, Velcro, Armalon
Load rating	
Temperature range	–200° to 250° F (operational), **350° F (stowage)**
Strip width	1.0 in.
Strip length	**22 7/8** in.
Quantity flown	
Stowage	
Availability	**Flight specific**

Dimensional Data		
	inches	cm
A	14.5	36.83
B	9.5	24.13
C	7.0	17.78
D	5.5	13.97
E	1.0	2.54

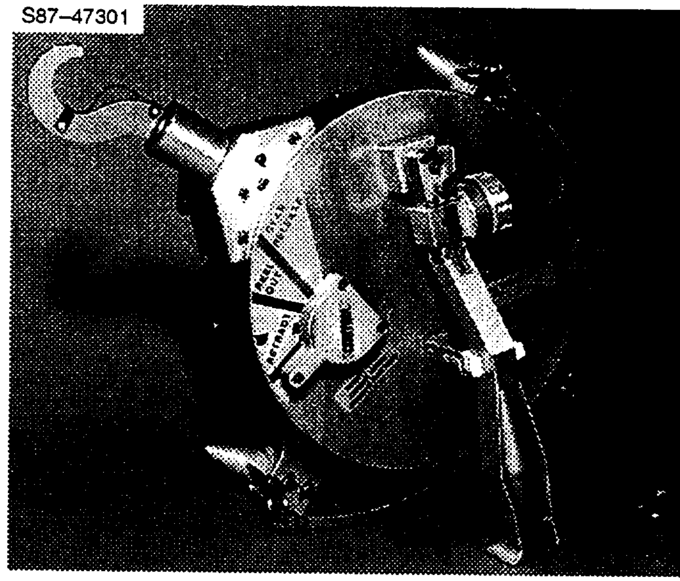


WINCH

KSC–392C–2184.16



S87–47301



OVERVIEW

The extravehicular activity (EVA) winch consists of Kevlar rope, a housing, a reel, a stowable ratchet handle, and a mounting adapter. A rope guide with rollers to prevent fraying is mounted on the housing. A ratchet lever is used to select reverse **(not labeled or used)**, neutral, and engage positions, while the control handle selects ratchet in, retract, reel out, and gear release positions. The winch has 24 ft of 3/8–in.–diameter Kevlar rope with a hook attached to the end. The **spring–loaded** hook fits a 1.25–in.–diameter shaft on the bulkhead latch. The winch has a power ratio of 18.6 to 1.

OPERATIONAL COMMENTS

The winch is used to close the payload bay doors manually in the event the door drive system fails. One winch is mounted on each of the forward and aft cargo bay bulkheads. After all apparent obstructions to door movement have been removed and any necessary disconnect and/or cutting operations are completed, the crewmember routes the rope over the **door latch rollers** and attaches the rope hook to the number 4 latch bellcrank at the tip of the door. The winch may also be used to berth the **remote manipulator system** or to elevate or lower the inertial upper stage tilt table.

A load of 600 lb can be applied on the rope by placing the control to ratchet in and engage and by cranking the ratchet handle. **The control knob should always be cycled through "gear release" when changing modes. If the control knob locks up with the rope under load, simply rocking the engaged drive handle while lightly pushing the control knob toward gear release should free the mechanism.**

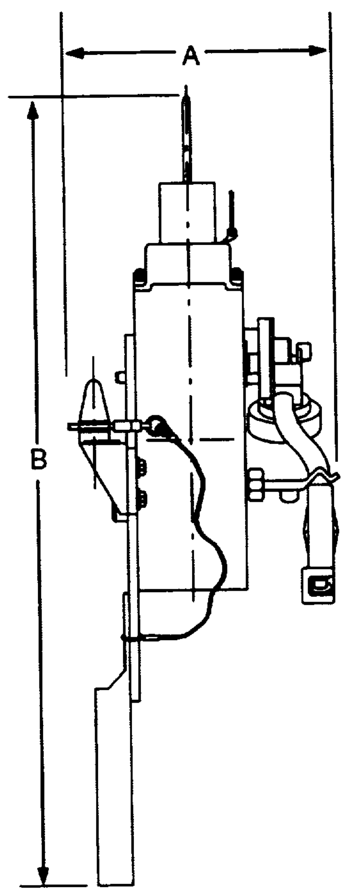
CONTACTS

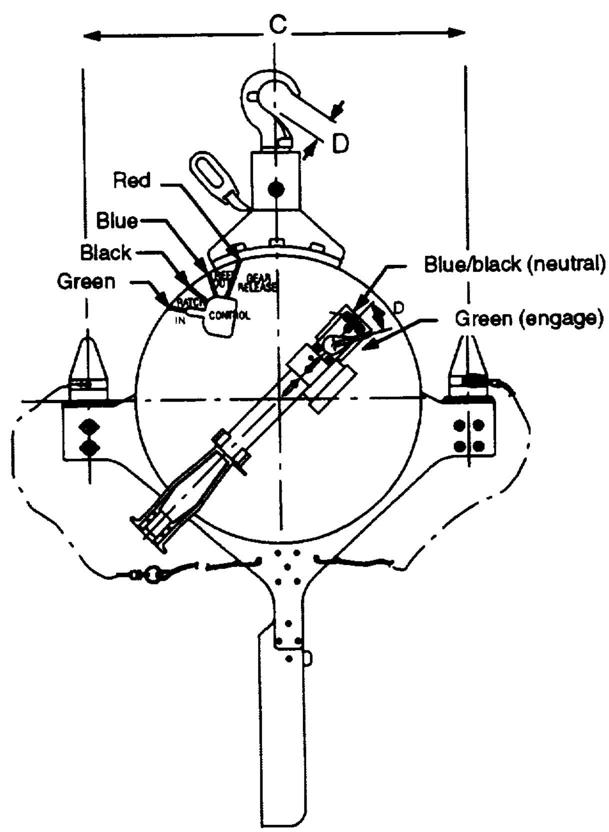
Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: N. Gonzalez, NASA/ES6, (713) 483–8944

WINCH

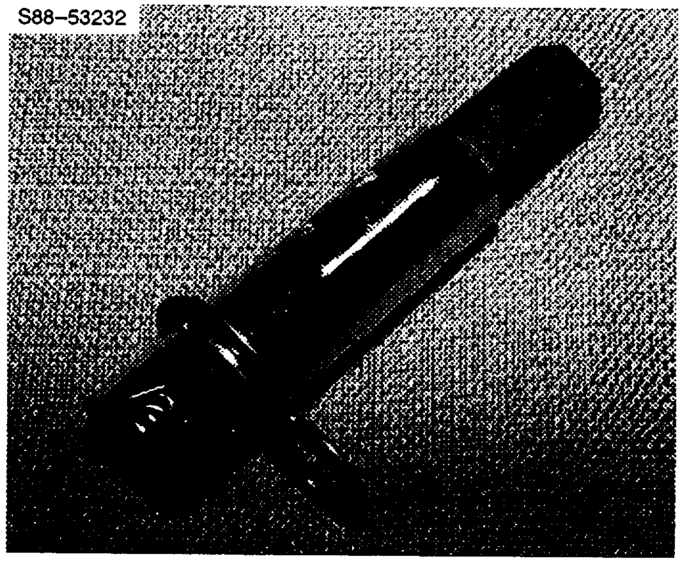
Technical Information	
Part number	SED33101389–313 (winch only) SED33101570–313 (winch and aft mount) SED33101570–315 (winch and fwd mount)
Weight	24 lb forward, 21 lb aft
Material/ construction	Aluminum alloy
Rope length	24 ft
Rope diameter	0.375 in. Kevlar
Hook opening	1.25 in.
Power ratio	18.6 to 1.0
Load rating	**584–lb rope tension limit**
Temperature range	–250° to +275° F **(operational)**
Quantity flown	Two
Stowage	**One fwd bulkhead, one aft bulkhead in cargo bay – In middeck (flight–specific option)**
Availability	Standard

Dimensional Data		
	inches	cm
A	8.50	21.59
B	26.00	66.04
C	13.50	34.29
D	1.25	3.18





WRENCH, 1/2–INCH ALLEN



OVERVIEW

The 1/2–in. allen wrench for 3/8–in. drive is a part of the inertial upper stage (IUS) jettison tools. It consists of a 1/2–in. allen drive attached to a deepwell socket with two spring pins. The deepwell socket is a commercially available socket modified for extravehicular activity (EVA) **contingency** use. A rotating tether ring has been added to the socket for restraint during EVA. Unlike similar items, this tool does not utilize a drop–proof tether interface.

OPERATIONAL COMMENTS

The 1/2–in. allen drive provides an interface between a 3/8–in. drive ratchet and the IUS centering spring bolts. It is designed to remove four bolts at the centering springs should the IUS aft airborne support equipment (ASE) need to be jettisoned. This tool is flown only on IUS flights.

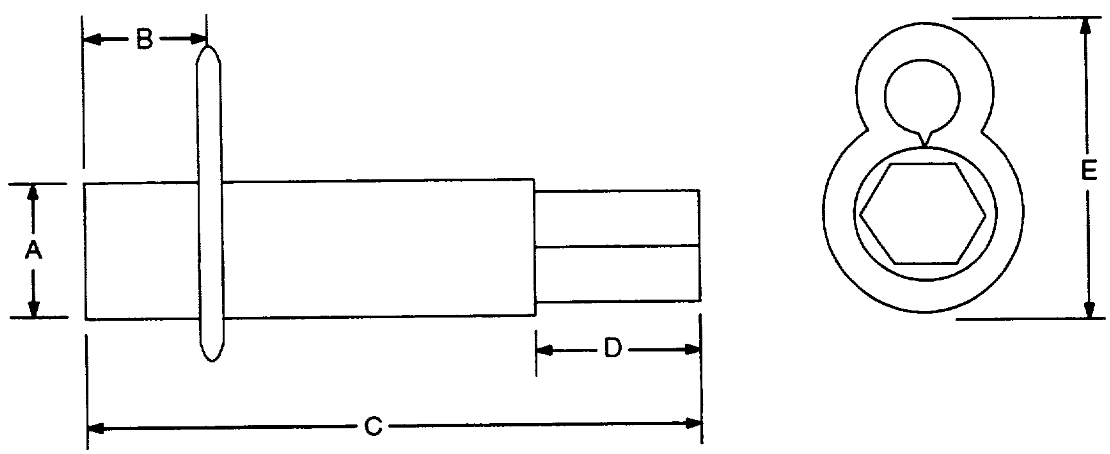
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

WRENCH, 1/2–INCH ALLEN

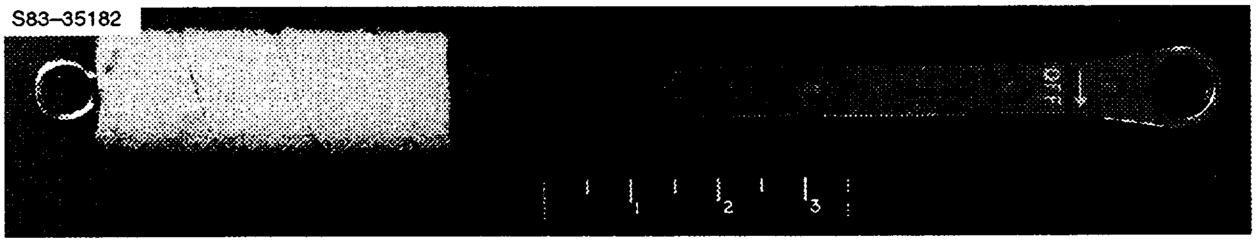
Technical Information	
Part number	10114–20043–01
Weight	4.3 oz
Material/ construction	Tool steel
Load rating	**300 in–lb**
Temperature range	
Quantity flown	Two (IUS flights only)
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	0.75	1.91
B	0.75	1.91
C	3.50	8.89
D	1.00	2.54
E	1.50	3.81



WRENCH, 1/2–INCH RATCHETING BOX END

S83–35182



OVERVIEW

The 1/2–in. ratcheting box end wrench is a common **12–point** wrench modified for extravehicular activity **mission success**. The handle is built up and wrapped with Velcro to provide a positive grip for the gloved hand. A tether ring is mounted on the end of the handle for tethering.

OPERATIONAL COMMENTS

In the event of failure of the RMS to release the payload grapple fixture, the 1/2–in. ratcheting box end wrench is used to disconnect the grapple fixture from the payload. The wrench can also be used to install or disconnect any bolts with 1/2–in. heads. **The payload bay door latch linkage and door drive linkage bolts fit this tool.** A part of the normally manifested orbiter equipment, it is wrapped in a Velcro caddy along with a **set of small** cable cutters and is stowed in the **port** provisions stowage assembly (PSA).

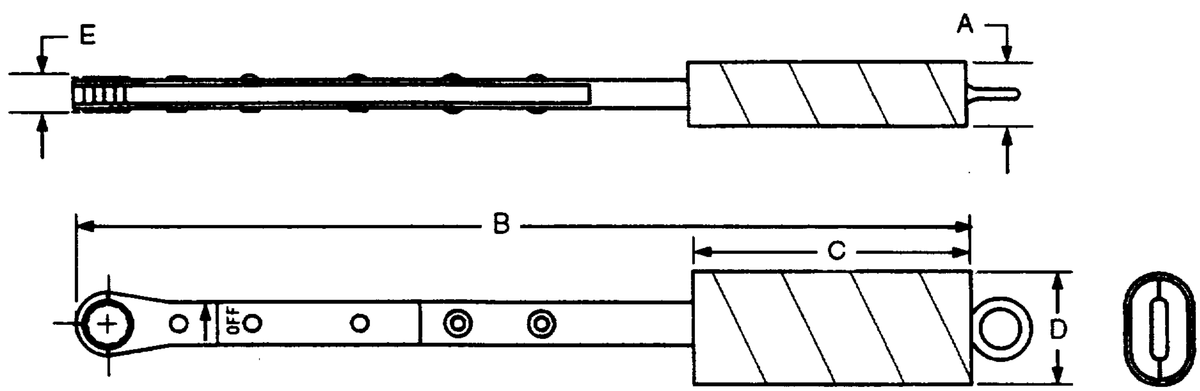
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

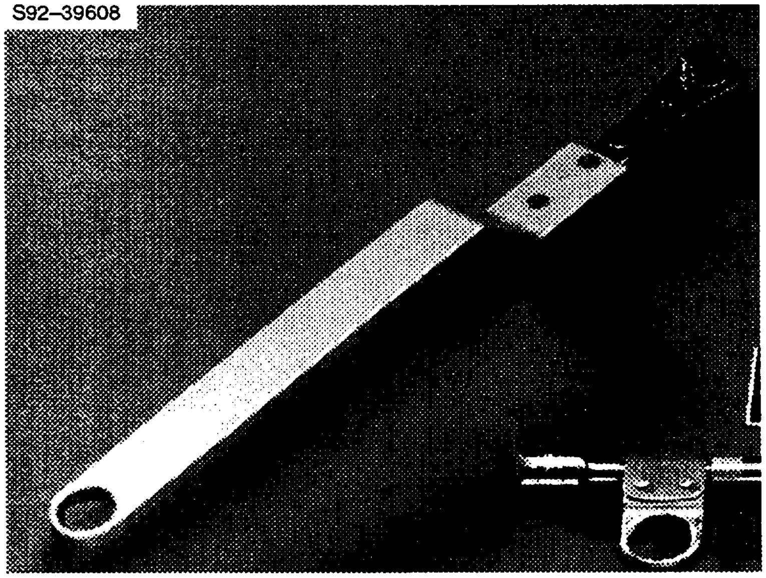
WRENCH, 1/2-INCH RATCHETING BOX END

Technical Information	
Part number	V628-650885-004 or SDD33103441-301
Weight	1.0 lb
Material/ construction	Handle – Polyurethane, flat black, Velcro-wrapped Lubricant – Molykote 321R
Load rating	**30-lb input**
Temperature range	-200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	0.750	1.91
B	12.500	31.75
C	4.000	10.16
D	1.250	3.18
E	0.385	0.95



WRENCH, 5/16–INCH RATCHETING BOX END



OVERVIEW

This box end ratchet is also known as the launch lock release wrench. It was created as a contingency tool to disengage a lock mechanism on the tether reel of the tethered satellite system (TSS) and would be used only after a failure of the automated deployment mechanism. It is a common wrench modified for extravehicular activity (EVA) use with a built–up handle and a tether ring.

OPERATIONAL COMMENTS

This ratchet wrench is actually a 9/16–in. tool that has been fitted with a custom manufactured 5/16–in. insert. Besides size adjustment, the insert acts as a standoff for a set of cap screws on the spacecraft that tend to interfere with ratchet throw. Turning the wrench over allows it to be used both to tighten and to loosen bolts. The dog leg shape of the wrench handle was required because of the tight access for this TSS application. A customized EVA power package can also be used to perform the same latch override task as this tool.

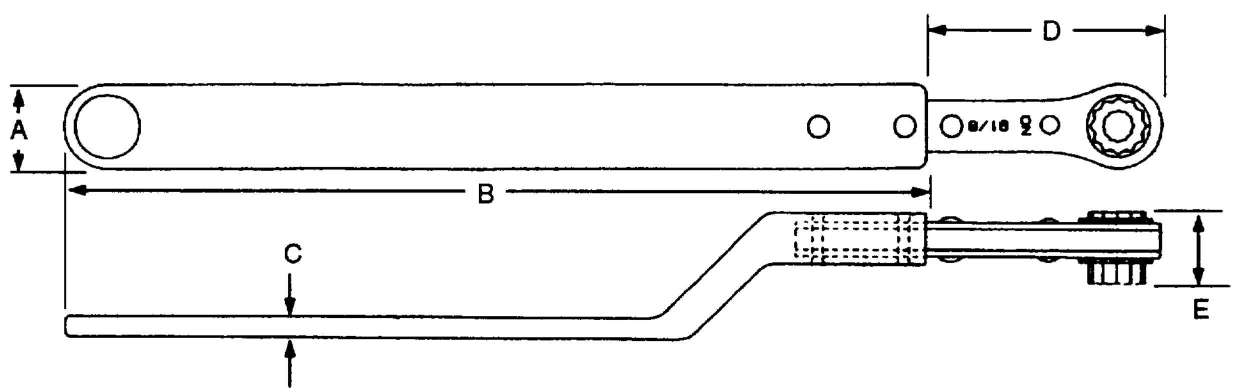
CONTACTS

Operational: L. Thomas, JSC/DF42, (713) 483–2701
Technical: R. Marak, NASA/EC5, (713) 483–9144

WRENCH, 5/16–INCH RATCHETING BOX END

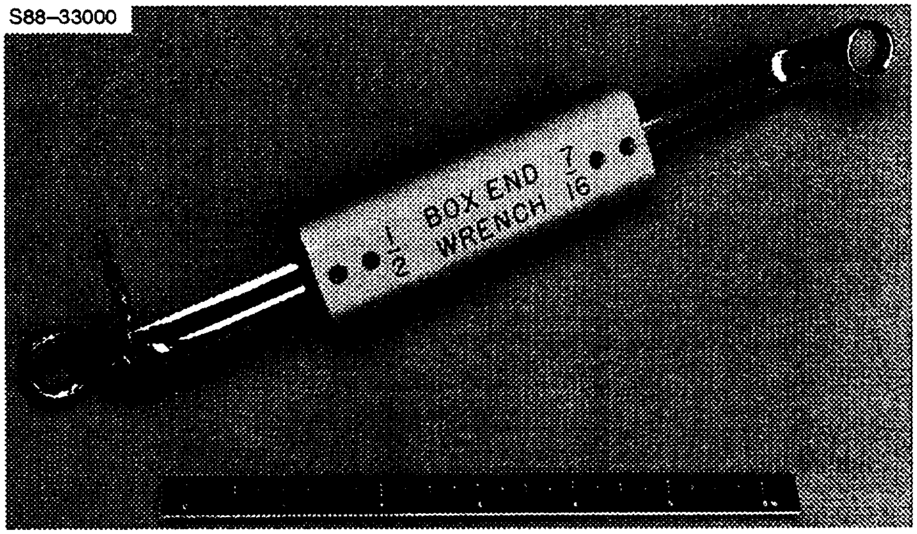
Technical Information	
Part number	SED39123184–301
Weight	0.6 lb
Material/ construction	Aluminum handle
Load rating	250 to 255 in–lb 3 in–lb (backdrive torque)
Temperature range	–15° to +235° F
Quantity flown	One (STS–46)
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.0	2.54
B	9.5	24.13
C	0.25	0.635
D	2.75	6.99
E	0.875	2.22



WRENCH, 7/16-INCH AND 1/2-INCH BOX END

S88-33000



OVERVIEW

The 7/16-in. and 1/2-in. box end wrench has a standard 12-point, 1/2-in. box end wrench and a standard 12-point, 7/16-in. box end wrench combined into one tool.

OPERATIONAL COMMENTS

The 7/16-in. and 1/2-in. box end wrench is designed for backup use on Hubble Space Telescope (HST) maintenance and repair missions. **Its handle has no Velcro for particulate contamination prevention.** It is a standard tool modified with an extravehicular activity (EVA)-glove-compatible handle.

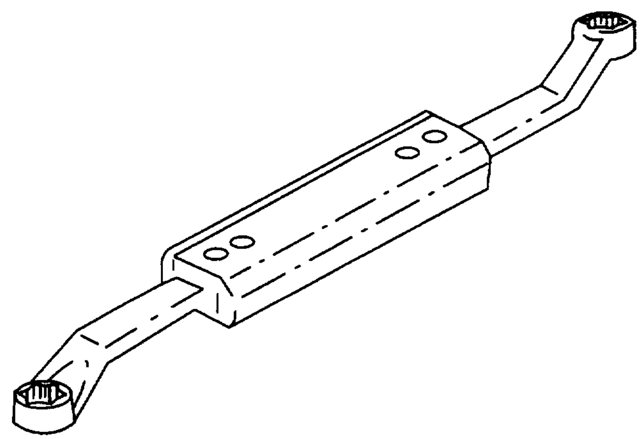
CONTACTS

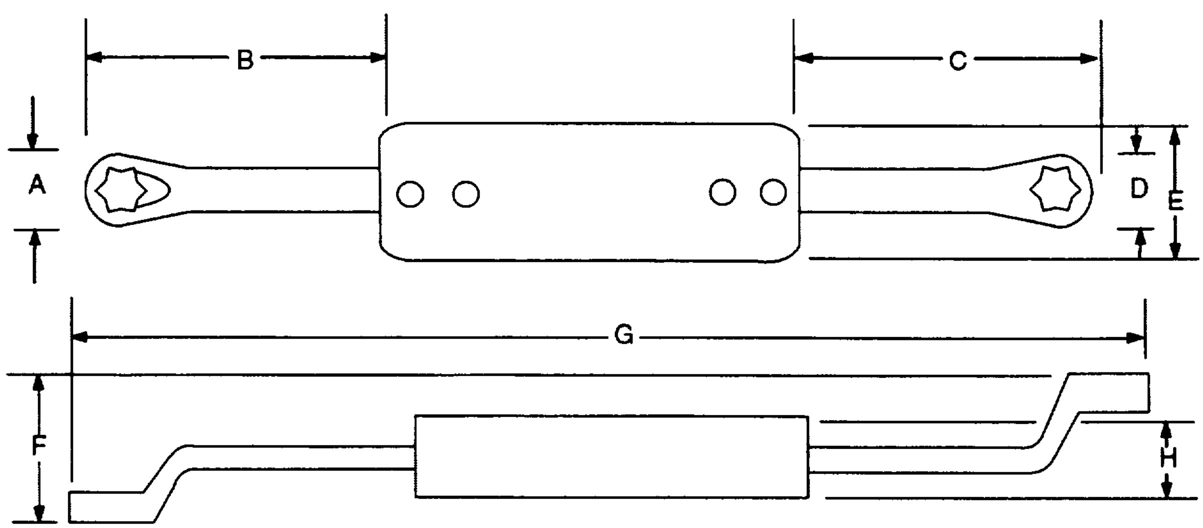
Operational: S. Rainwater, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

WRENCH, 7/16-INCH AND 1/2-INCH BOX END

Technical Information	
Part number	10181-10022-01
Weight	**0.56** lb
Material/ construction	Wrench ends – Stainless steel Handle – Aluminum
Load rating	**336 in-lb (1/2 in. end), 184 in-lb (7/16 in. end)**
Temperature range	-150° to +250° F
Quantity flown	
Stowage	
Availability	Flight specific, **existing units reserved for HST**

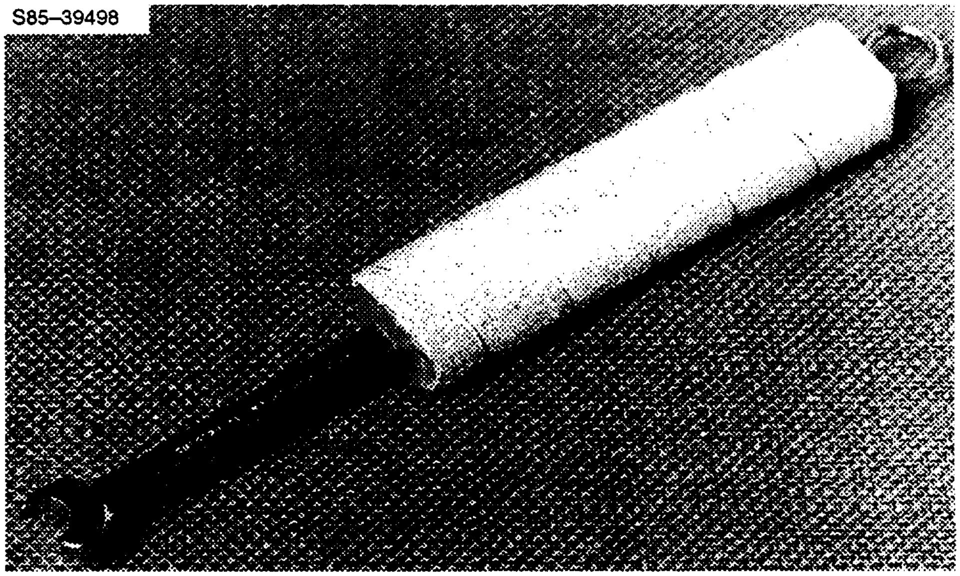
Dimensional Data		
	inches	cm
A	0.75	1.91
B	3.00	7.62
C	3.00	7.62
D	**0.65**	1.65
E	1.38	3.51
F	1.35	3.43
G	10.00	25.40
H	0.75	1.91





WRENCH, 7/16–INCH RATCHETING OPEN END

S85–39498



OVERVIEW

The 7/16–in. ratcheting open end wrench is a commercially available tool modified for **backup** extravehicular activity (EVA) use. The original wrench (10172–20515–01) has a Velcro–wrapped handle attached to the wrench by two dowel pins. A modified version (–02) created for Hubble Space Telescope (HST) use has no Velcro **for particulate contamination prevention** and includes lightening holes in the handle. Each handle includes a tether ring for restraint tethering during EVA.

OPERATIONAL COMMENTS

The ratcheting open end wrench is a contingency tool designed for loosening bolts without removing the wrench. The ratchet–link action allows for speed and easy access when clearance is limited. The head is set at a 15° angle. The –01 wrench was stowed in a tool caddy in the flight support system (FSS) locker for STS 41–C.

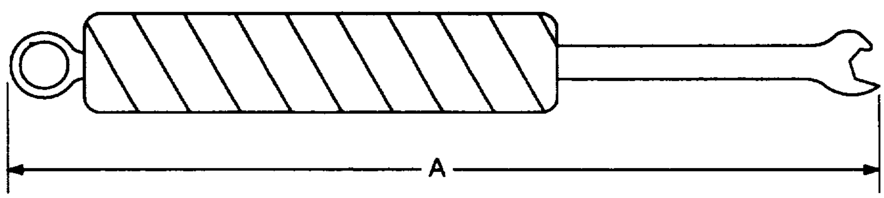
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

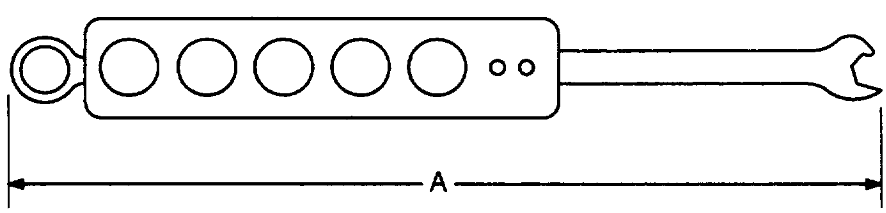
WRENCH, 7/16–INCH RATCHETING OPEN END

Technical Information	
Part number	10172–20515–01/02
Weight	0.51 lb (–01), 0.48 lb (–02)
Material/ construction	Wrench – chrome Handle – aluminum
Load rating	**119 in–lb (–02)**
Temperature range	
Quantity flown	
Stowage	
Availability	Flight specific

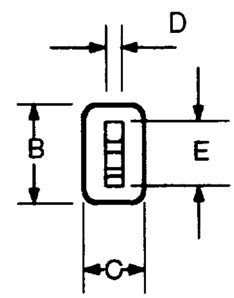
Dimensional Data		
	inches	cm
A	11.00	27.94
B	1.35	3.43
C	0.78	1.98
D	0.22	0.56
E	0.90	2.29



–01

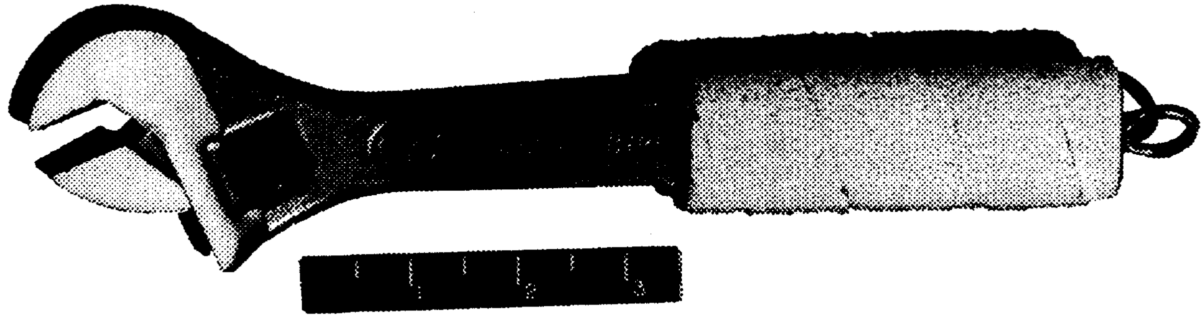


–02



WRENCH, ADJUSTABLE

S83–35192



OVERVIEW

The adjustable wrench is a common crescent wrench modified for **contingency** extravehicular activity (EVA) use. The handle is built up, wrapped with Velcro, and has a ring attached at the end for tethering. The adjustable jaws open to a maximum of 1–1/8 in.

OPERATIONAL COMMENTS

The wrench can be used to hold, tighten, or loosen any square or hex nut or bolt with a head up to 1–1/8 in. across the flats.

It is a contingency tool used to manually force open failed latches on the airlock hatches in case of latch or rotary actuator jamming. The 3/8–in. drive ratchet with 7/16–in. socket is first used to remove the appropriate EVA removable bolt(s). The adjustable wrench is then used to force open the jammed latch and/or any latches disconnected from the rotary actuator. **It may also aid in releasing a stuck airlock depress valve cap by engaging the vent tabs.**

Two separate wrenches are part of the normally manifested orbiter equipment. One is wrapped in a Velcro–lined tool caddy with the 3/8–in. drive ratchet with 7/16–in. hex socket extension and stowed in the **port** provisions stowage assembly (PSA). The second is stowed **in the airlock during EVA** with the 3/8–in. drive ratchet with 7/16–in. hex socket in the EVA bag.

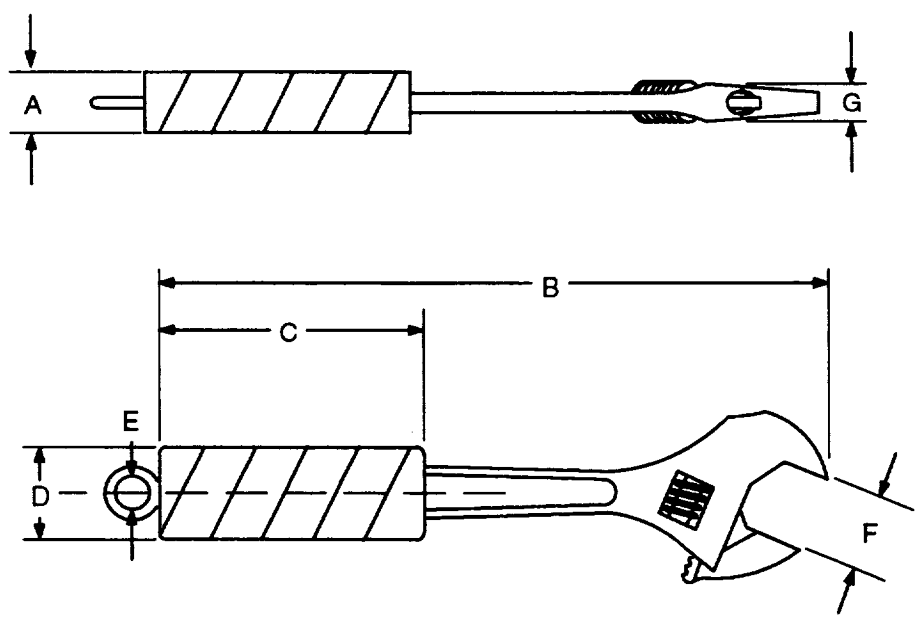
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

WRENCH, ADJUSTABLE

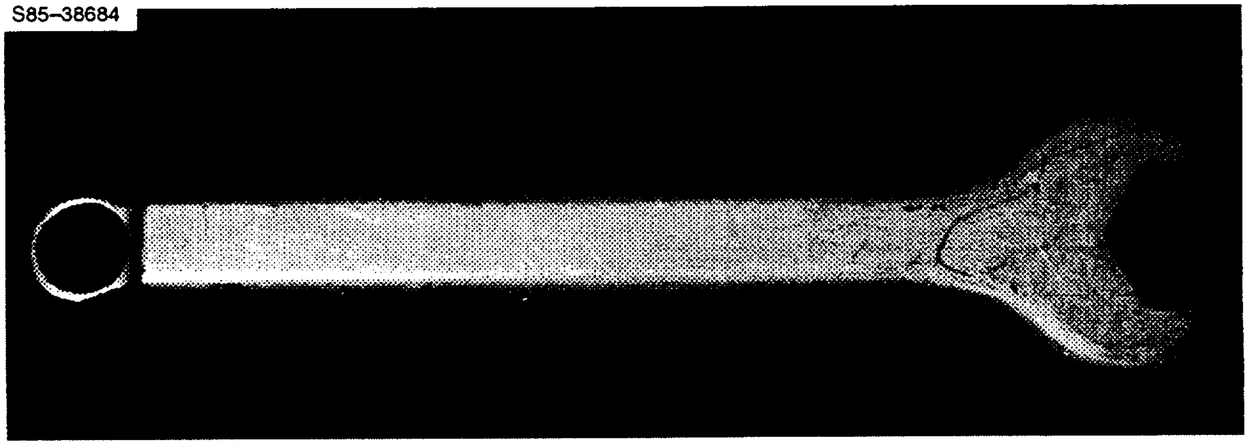
Technical Information	
Part number	V628–650892–004 or SDD33103431–301
Weight	0.99 lb
Material/ construction	Wrench – Chrome moly steel Handle – Polyurethane, flat back, Velcro–wrapped Bonding – MB0130 – 136 adhesive Adj screw – Lubricant – Molykote 321R
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	Two
Stowage	**One in port PSA, one in middeck/airlock**
Availability	Standard

Dimensional Data		
	inches	cm
A	0.750	1.91
B	10.000	25.40
C	4.000	10.16
D	1.250	3.17
E	0.670 max.	1.70
F	1.120	2.84
G	0.563	1.43



WRENCH, CONTINGENCY STRUT

S85–38684



OVERVIEW

The contingency strut wrench is basically a large, open–end wrench. The opening is 2.26 in. The length of the wrench, with a tether ring at the end, is 20.5 in.

OPERATIONAL COMMENTS

The contingency strut wrench was designed to tighten down lock nuts that secure the instrument pointing system (IPS) payload for landing in the event of IPS payload clamp assembly (PCA) failure. The tool is a payload–unique device and is not normally flown.

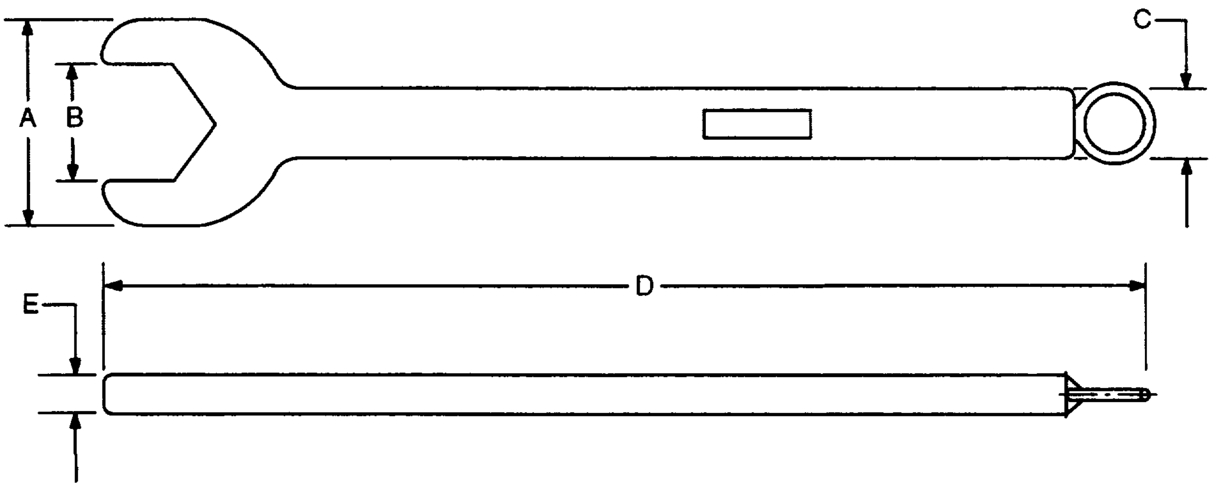
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: **J. Sexton, MSFC, (205) 544–5359**

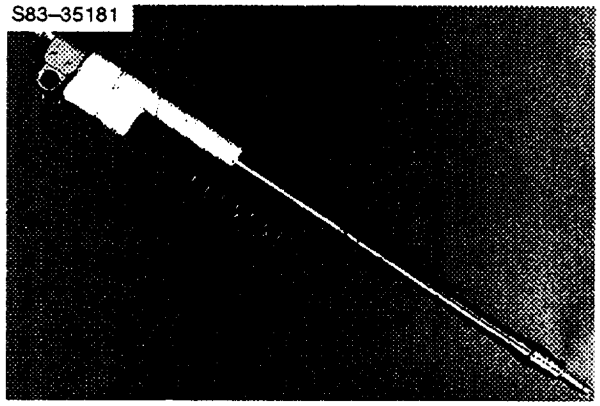
WRENCH, CONTINGENCY STRUT

Technical Information	
Part number	9005043
Weight	2.5lb
Material/ construction	Aluminum, tether ring at end
Load rating	
Temperature range	–150° to 250° F
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	4.40	11.18
B	2.26	5.74
C	1.25	3.18
D	20.60	52.32
E	0.75	1.91



WRENCH, EXTENSION AND 1/4-INCH ALLEN



OVERVIEW

The 1/4-in. allen wrench extension for 3/8-in. drive is a combination of common tools modified for **contingency** extravehicular activity use, a 3/8-in. drive extension with a 1/4-in. allen wrench socket pinned onto the end. The extension has been narrowed near the drive end to allow attachment of a collar with a tool ring for tether attachment. The tool is partially wrapped with Velcro and has Velcro tabs for storage.

OPERATIONAL COMMENTS

In the event of a radiator deployment mechanism failure, this extension is used with the 3/8-in. drive ratchet to disconnect the mechanism manually. The tool is part of the normally manifested orbiter equipment. **It has yellow stripes along the full length of the extension to aid in counting revolutions.** It is wrapped in a Velcro-lined caddy along with a 3/8-in. drive ratchet and stowed in the **port** provisions stowage assembly (PSA). The extension does not use the drop-proof tether system.

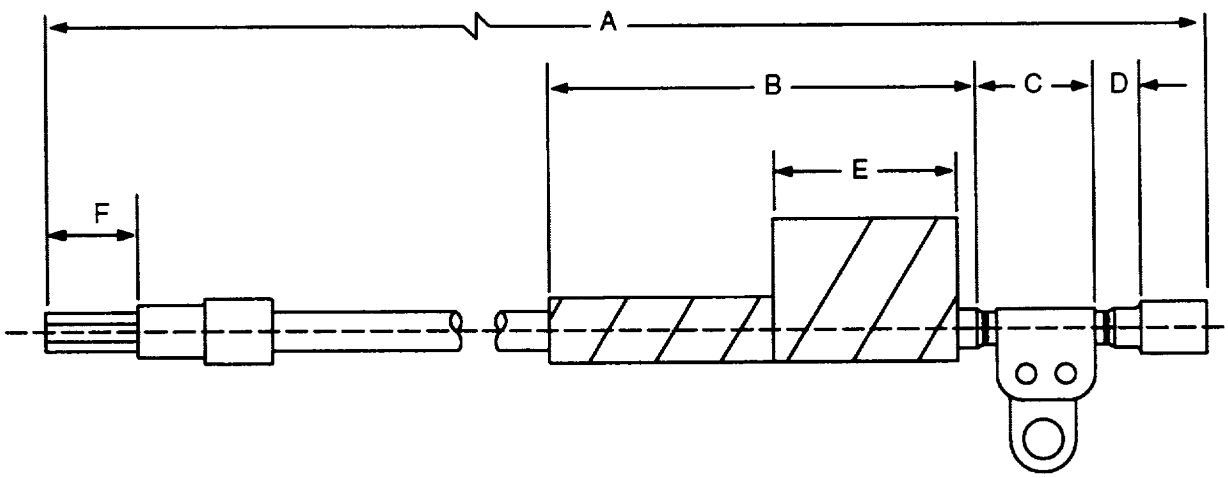
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: W. B. Wood, NASA/EC5, (713) 483-9247

WRENCH, EXTENSION AND 1/4–INCH ALLEN

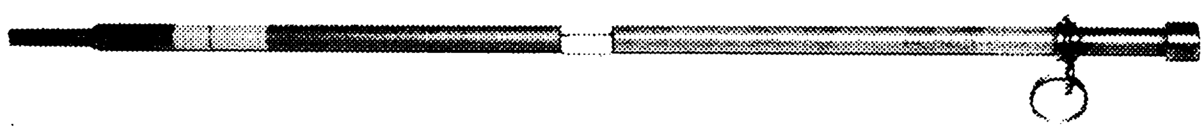
Technical Information	
Part number	V628–650896–004 or SDD33103446–301
Weight	1.0 lb
Material/ construction	Extension – AISI 8640 nickel–plated steel Hex socket – AISI 8640 nickel–plated steel Rivet – NAS 1200–6
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	19.70	50.04
B	5.25	13.34
C	1.06	2.69
D	0.38	0.97
E	2.00	5.08
F	1.00	2.54



WRENCH, EXTENSION AND 1/4–INCH ALLEN (IPS)

S85–34422



OVERVIEW

This 25–in. extension for a 3/8–in. drive **is used for contingency extravehicular activity** (EVA) **and** has a 1/4–in. allen hex **pinned** at the end. It has a rotating tether ring near the top for tethering during use **and lacks a drop–proof tether interface.**

OPERATIONAL COMMENTS

The 1/4–in. allen wrench extension provides an interface between the EVA 3/8–in. drive ratchet and the Spacelab instrument pointing system (IPS) jettison bolts. It is designed to remove four jettison bolts, but could be used on any 1/4–in. allen bolt if a long extension were required.

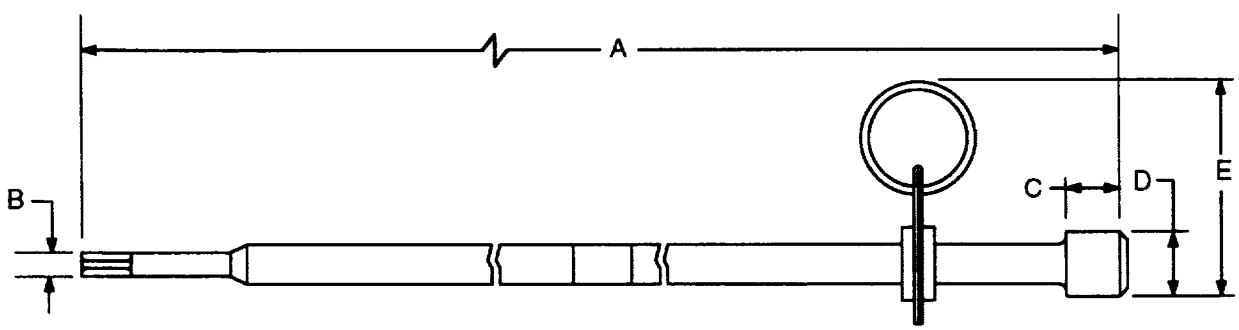
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: **J. Sexton, MSFC**, (205) 544–**5359**

WRENCH, EXTENSION AND 1/4–INCH ALLEN (IPS)

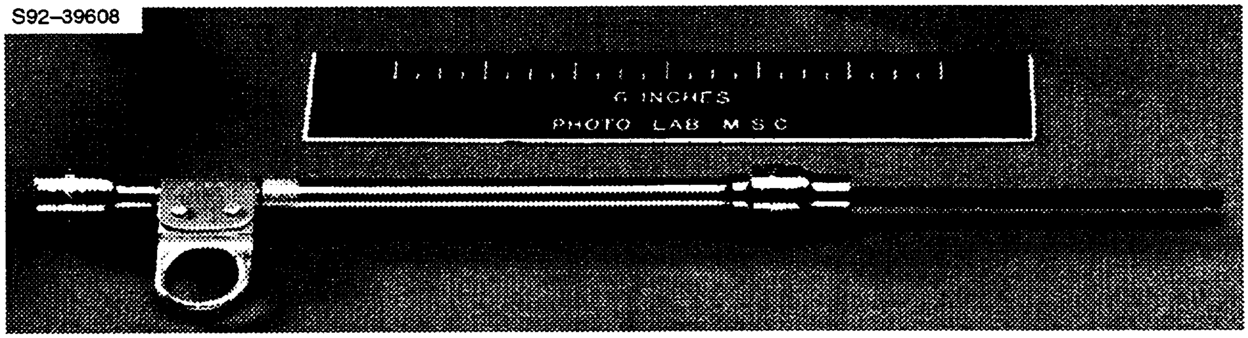
Technical Information	
Part number	883–400310.00.0
Weight	1.9 lb
Material/ construction	Tool steel, rotating tether ring
Load rating	
Temperature range	–150° to 250° F
Quantity flown	One for Spacelab IPS mission
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	24.55	62.36
B	0.36	0.91
C	0.65	1.65
D	0.80	2.03
E	2.65	6.73



WRENCH, EXTENSION WITH 3/16–INCH ALLEN

S92–39608



OVERVIEW

This allen wrench is used to remove the housing on a satellite restraint latch (SRL) of the tethered satellite system (TSS). This is performed as part of an unscheduled EVA to allow backup satellite deployment by contingency latch release. The allen wrench is also used to install a plate that restrains the partially disassembled SRL internal mechansim for reentry. The extension interfaces with any 3/8–in. drive tool. It lacks a drop–proof tether interface and so must be separately tethered during use. This type of extension is commonly transported in a tool caddy.

OPERATIONAL COMMENTS

The allen wrench is a modified commercial item. The ball end allen wrench is pinned to a standard socket extension which has been fitted with a rotating tether point. This tool is used to remove the latch drive housing so that the latch can be driven open or closed by another tool. It is also used to mate the retention screws for a retention cover that replaces the latch drive housing. The long length of this extension and lack of a drop–proof tether make it inappropriate for manual transport attached to a drive tool. There are no engraved/painted rotation marks to assist in counting revolutions. For TSS applications, a customized extravehicular activity power package can also be used to perform the same latch override task as this tool.

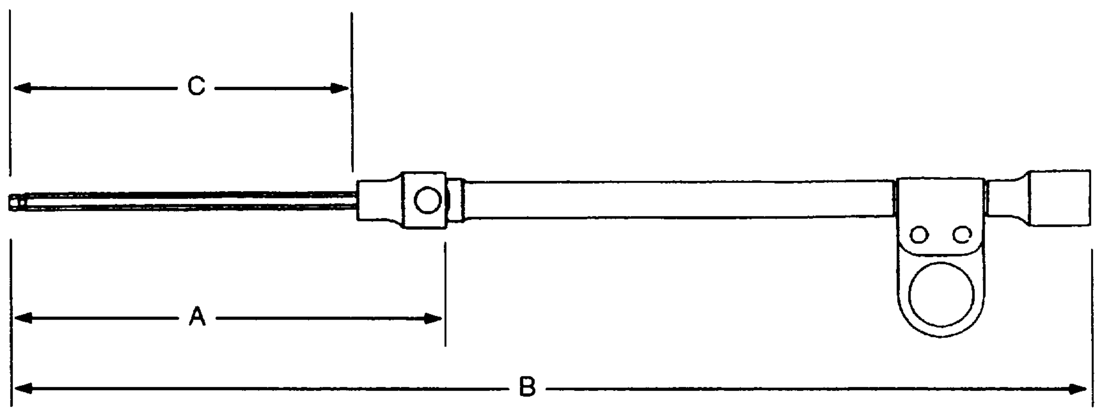
CONTACTS

Operational: L. Thomas, JSC/DF42, (713) 483–2701
Technical: R. Marak, NASA/EC5, (713) 483–9144

WRENCH, EXTENSION WITH 3/16–INCH ALLEN

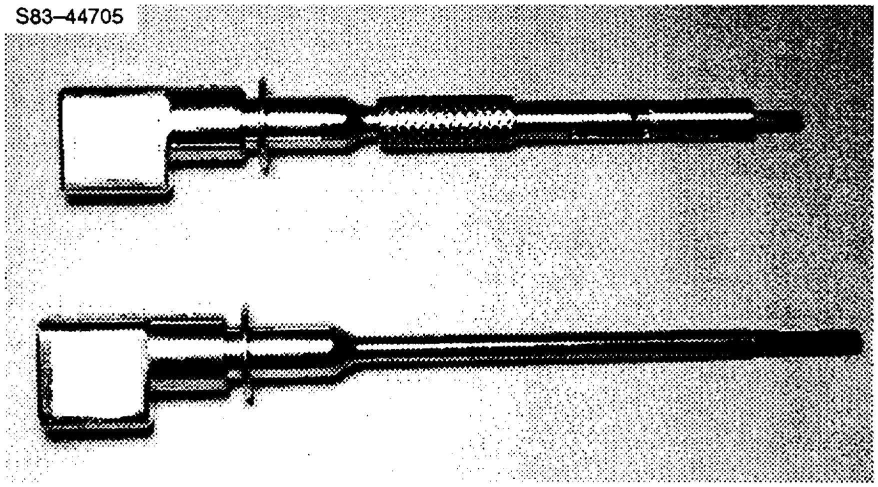
Technical Information	
Part number	SED39123183–301
Weight	0.46 lb
Material/ construction	Tool steel
Load rating	155 in–lb
Temperature range	–15° to +235° F
Quantity flown	One (STS–46)
Stowage	Middeck locker
Availability	Flight specific

Dimensional Data		
	inches	cm
A	5.06	12.85
B	12.6	32.0
C	4.0	10.2



WRENCH, EXTENSION WITH NUMBER 10 ALLEN

S83–44705



OVERVIEW

The number 10 allen wrench extension for 3/8–in. drive, also known as the 5/32–in. allen wrench, has a 5/32–in. allen wrench pinned to one end and a drop–proof tether pinned to the other end. In the –01 configuration, a sliding shroud is spring–loaded to cover the allen wrench and capture the screw being tightened or loosened. The –02 allen wrench extension has a ball–shaped end and no shroud. This design allows 15° off–axis access to the screw.

OPERATIONAL COMMENTS

The number 10 allen wrench extension for 3/8–in. drive was designed for use in disconnecting 5/32–in. cap head screws. A quick–release pin is used to connect the number 10 allen wrench extension to, or disconnect it from, 3/8–in.–drive tools. The allen wrench is usually stored on a tool caddy or on a manipulator foot restraint (MFR) tool board.

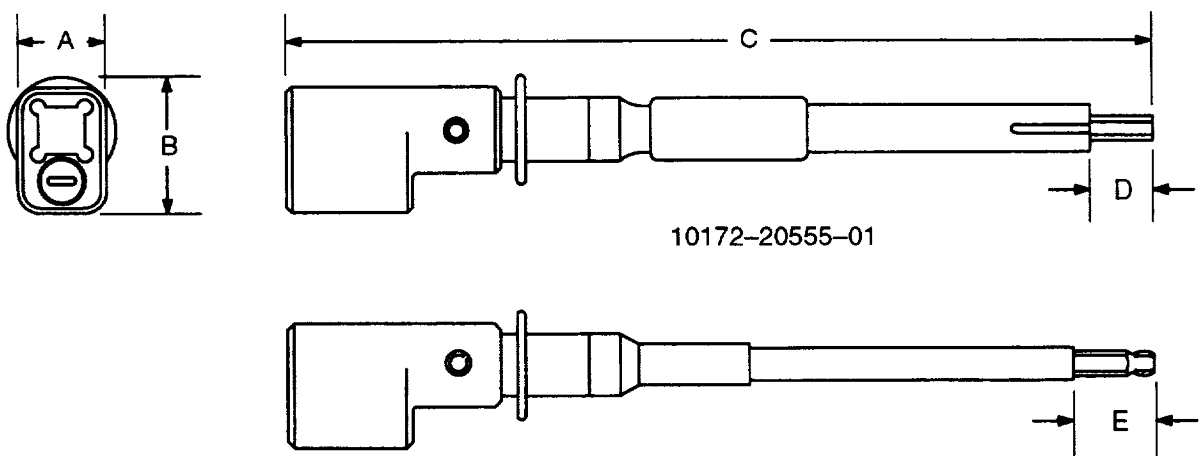
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. J. Marak**, NASA/EC5, (713) 483–**9144**

WRENCH, EXTENSION WITH NUMBER 10 ALLEN

Technical Information	
Part number	10172–20555–01, –02, –03
Weight	0.41 lb
Material/ construction	Stainless steel
Load rating	30/42 in–lb (use/proof)
Temperature range	
Quantity flown	
Stowage	Tool board
Availability	Flight specific

Dimensional Data		
	inches	cm
A	0.70	1.78
B	1.00	2.54
C	6.90	17.53
D	0.60	1.52
E	0.70	1.78

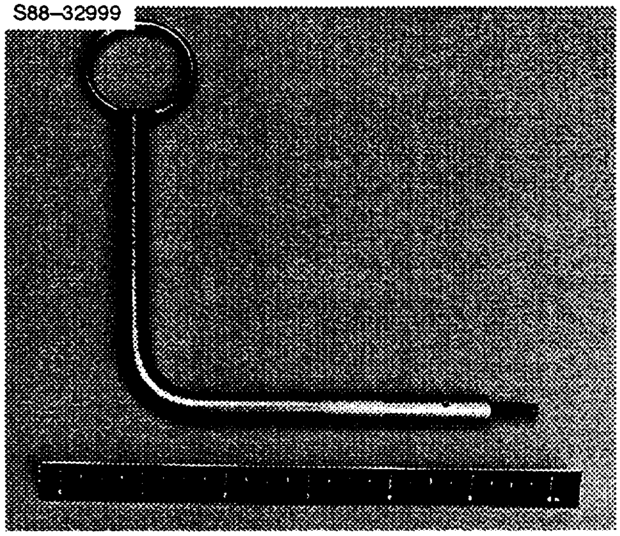


10172–20555–01

10172–20555–02

WRENCH, L–HANDLE WITH NUMBER 10 ALLEN

S88–32999



OVERVIEW

The L–handle number 10 allen wrench, also known as the "L" hex allen wrench, was designed for use on the antenna bridge structure (ABS). The wrench consists of a 5/32–in. hex key installed into a stainless steel L–shaped wrench with a tether ring welded to the end opposite the hex key. After assembly of the hex key into the wrench assembly, the wrench is proof tested to 100 in–lb.

OPERATIONAL COMMENTS

The L–handle number 10 allen wrench was designed for contingency use on the ABS, a major piece of hardware used in the satellite retrieval mission STS 51–A. The wrench was included in the manifest as a contingency tool. In the event of problems with the ABS, the wrench was to be used to dismantle the structure. This tool also served as a contingency tool on STS 51–I.

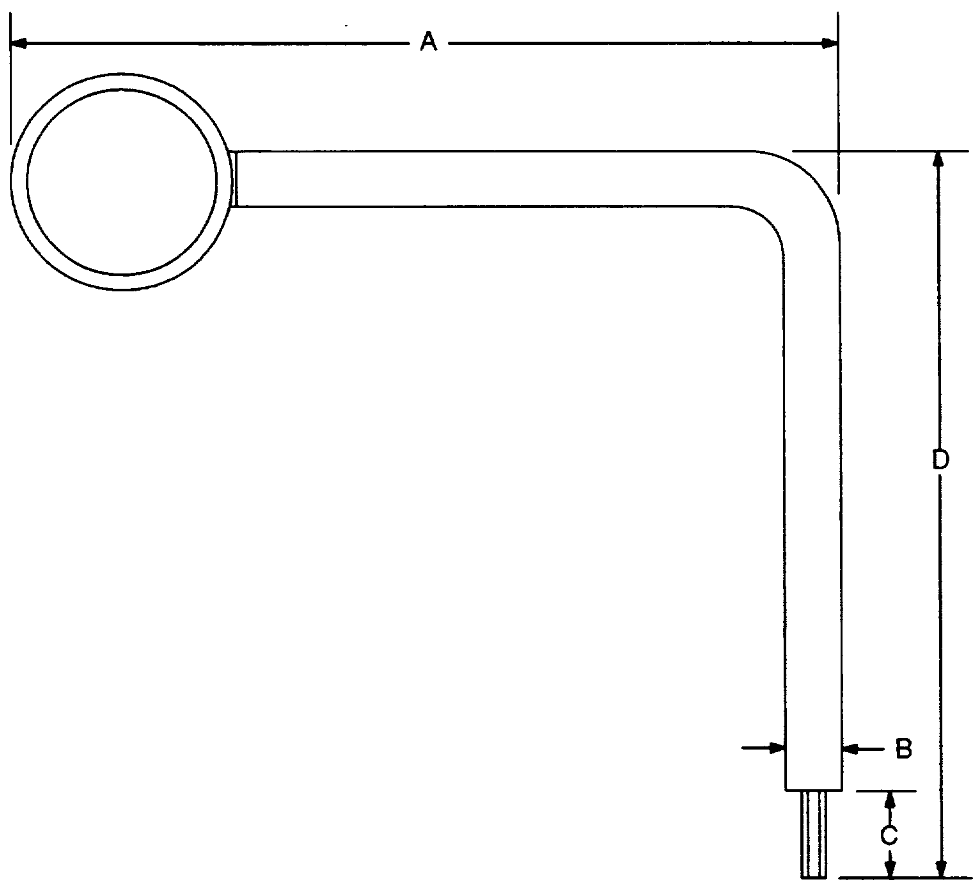
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

WRENCH, L–HANDLE WITH NUMBER 10 ALLEN

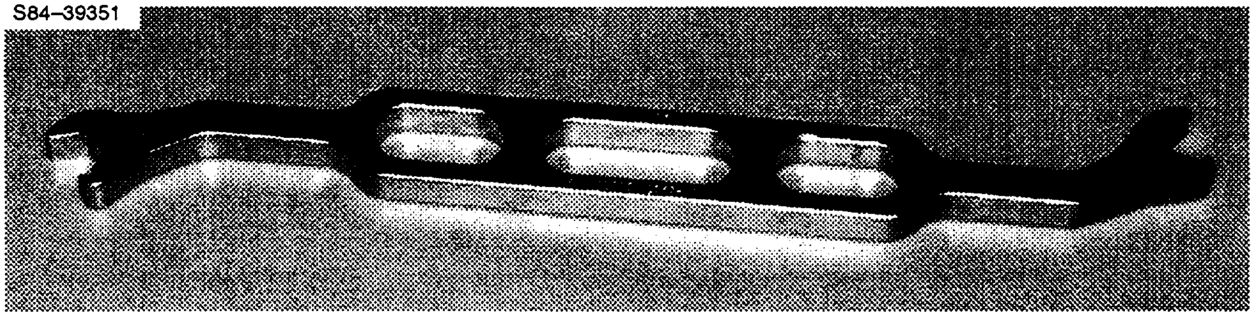
Technical Information	
Part number	10174–20189–01
Weight	0.29 lb
Material/ construction	Hex – High strength steel Handle – Stainless steel
Load rating	100 in–lb
Temperature range	–130° to +150° F (operational)
Quantity flown	**One on STS 51–A and 51–I**
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	5.68	14.43
B	0.38	0.97
C	0.63	1.60
D	5.75	14.61



WRENCH, RMS MPM

S84–39351



OVERVIEW

The remote manipulator system (RMS) manipulator positioning mechanism (MPM) wrench is a double–ended, open–end wrench, with the ends of the wrench angled 30° off center. (One end is 30° up; the other is 30° down.) Both ends have 9/16–in. openings with a large upper jaw and a very small lower jaw, allowing ratcheting motion.

OPERATIONAL COMMENTS

The RMS MPM wrench is used in the event of MPM stow/deploy failure. It is used on a hex section of the MPM drive shaft. Turning the drive shaft rolls the MPM's back into the stowed position, thus allowing the payload bay doors to close. This tool is part of the normally manifested orbiter equipment and is stowed in the port provisions stowage assembly (PSA).

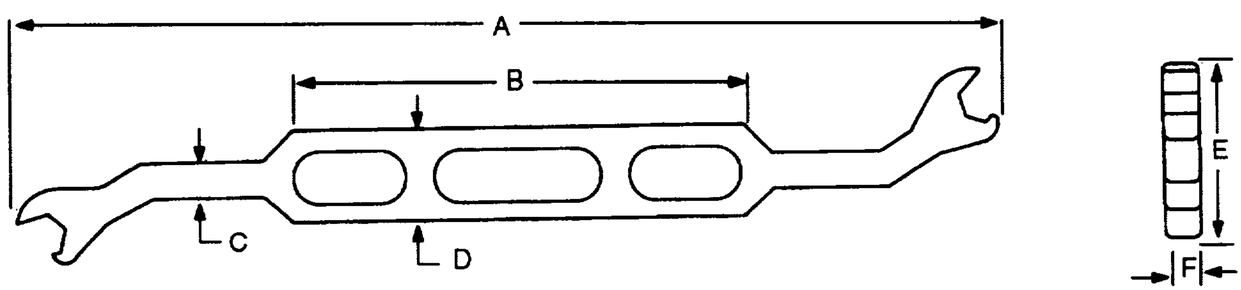
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: **N. Gonzalez,** NASA/ES6, (713) 483–8944

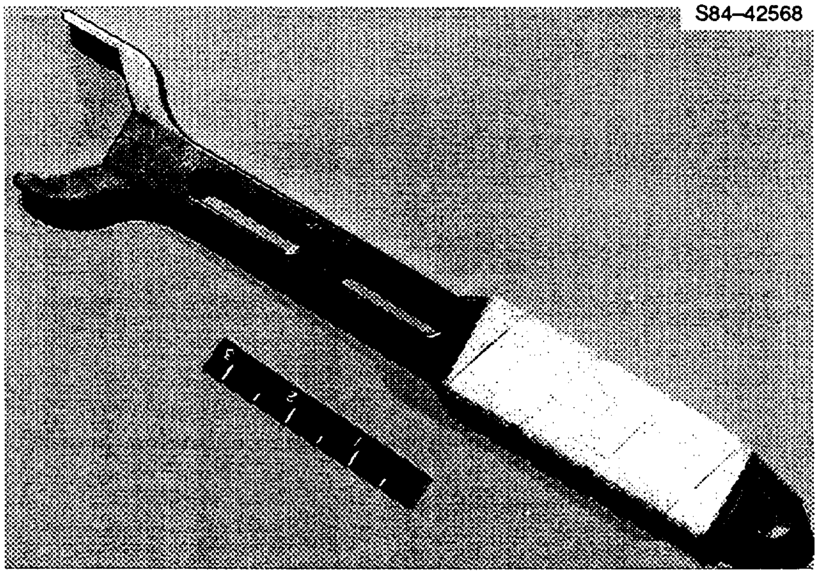
WRENCH, RMS MPM

Technical Information	
Part number	SDD33102355–001
Weight	1.25 lb
Material/ construction	#496 oil–hardened flat stock steel with an electroless nickel plating
Load rating	**100 ft–lb**
Temperature range	**–200° to +250° F (operational), +350° F (stowage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	13.60	34.54
B	6.26	15.90
C	0.50	1.27
D	1.30	3.30
E	2.44	6.20
F	0.50	1.27



WRENCH, SHUTTLE UMBILICAL RETRACTION SYSTEM


S84–42568

OVERVIEW

The shuttle umbilical retraction system (SURS) wrench functions as a spanner wrench. The wrench works only on hex nuts and has a jaw opening of 1–15/16 in. The handle is wrapped with Velcro to provide a sure grip for the gloved hand and has a built–in ring for tethering. This wrench was flown for shuttle pallet satellite (SPAS) and will be used for Gamma Ray Observatory (GRO).

OPERATIONAL COMMENTS

The SURS wrench is a jam removal tool used when the payload umbilical release mechanism jams. It is used to loosen the torque nut and then to pry apart the connector. The tool can also be used to loosen jammed portable foot restraint knobs or to disconnect any 1–15/16–in. hex nut. This tool is part of the normally manifested orbiter equipment and is stowed in the port provisions stowage assembly (PSA).

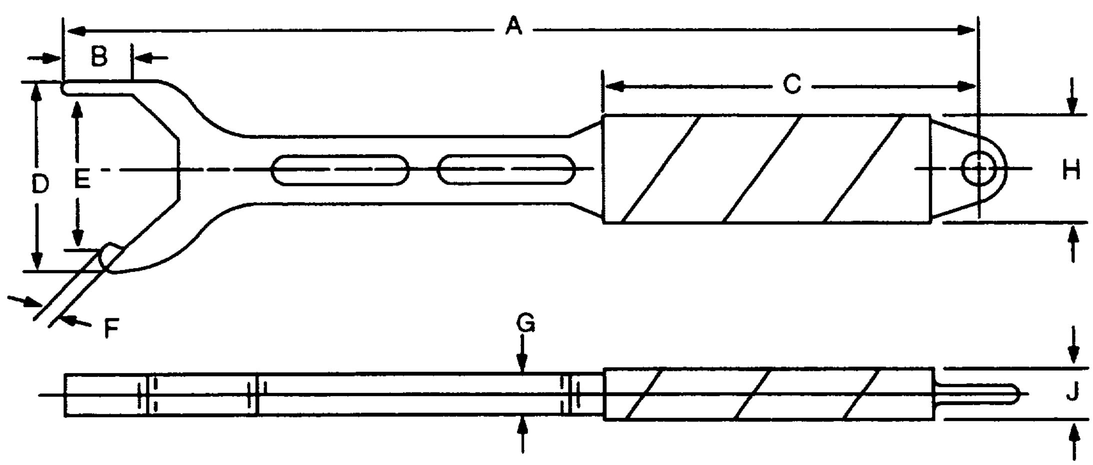
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: **N. Gonzalez,** NASA/**ES6**, (713) 483–**8944**

WRENCH, SHUTTLE UMBILICAL RETRACTION SYSTEM

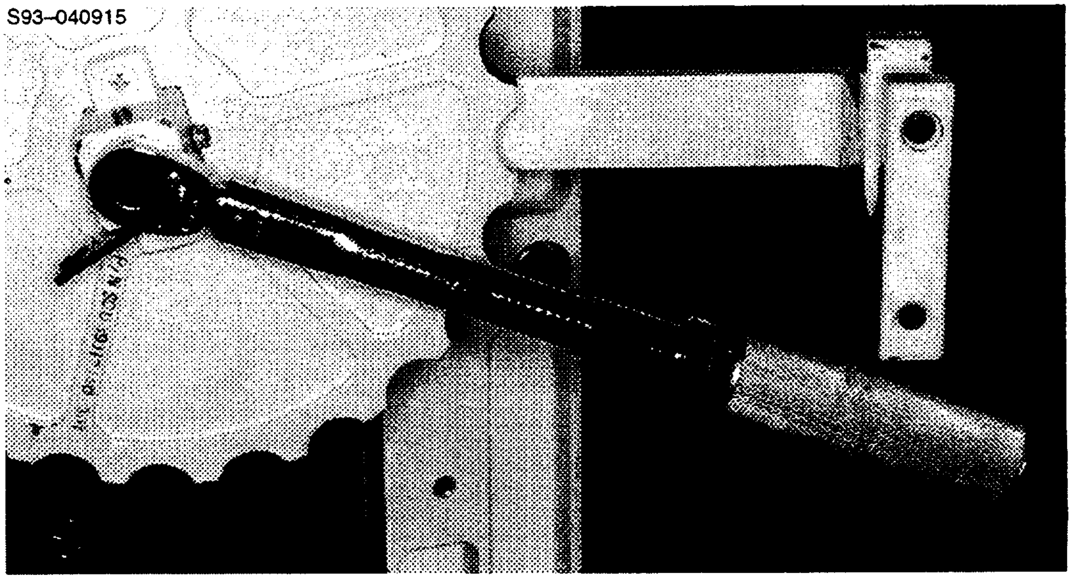
Technical Information	
Part number	SED33103118–301
Weight	2.0 lb
Material/ construction	#496 oil–hardened AISI–01 steel electroless nickle plating
Load rating	240 in–lb (maximum)
Temperature range	**–200° to +250° F (operational), +350° F (stowage)**
Quantity flown	One
Stowage	**Port PSA**
Availability	Standard

Dimensional Data		
	inches	cm
A	11.18	28.40
B	0.81	2.06
C	4.70	11.94
D	2.20	5.59
E	2.00	5.08
F	0.12	0.30
G	0.50	1.27
H	1.38	3.51
J	0.63	1.60



WRENCH, SMALL TORQUE

S93–040915



OVERVIEW

This small torque wrench was a component of the STS 51–A apogee kick motor capture device. It was used to rigidize the docking interface between the WESTAR/PALAPA satellites and the manned maneuvering unit (MMU) during retrieval operations. It is a commercially available tool featuring a 3/8–in. square drive and has been modified with EVA–compatible lubricants and a large direction select lever.

OPERATIONAL COMMENTS

The torque wrench has a fixed length and can apply calibrated torques from 20 to 200 in.–lb in 1 in.–lb increments. The lock ring is turned counterclockwise to lock each torque setting and clockwise for torque adjustment. Torques are indicated by a tactile click feedback. A single fixed setting was used for STS 51–A, since no adjustment was required or easily feasible during EVA. Because it was rigidly attached to the MMU capture device, the wrench currently lacks EVA handling aids like a bayonet fitting or tether point.

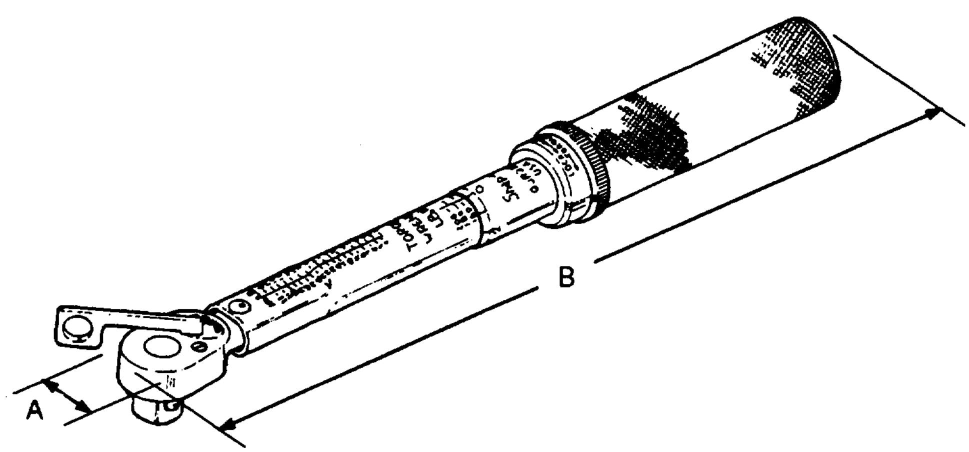
CONTACTS

Operational: R. Trevino, NASA/DF42, (713) 483–2597
Technical: R. Marak, NASA/EC5, (713) 483–9144

WRENCH, SMALL TORQUE

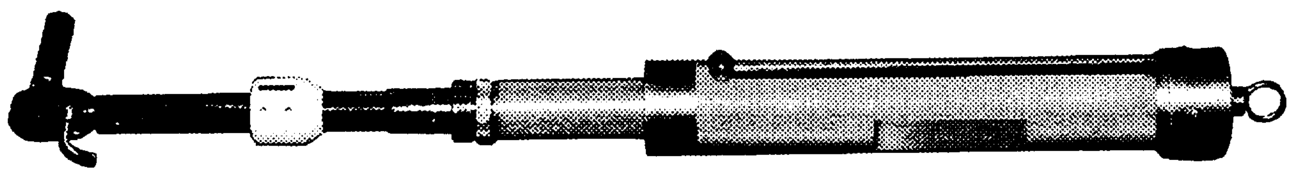
Technical Information	
Part number	10174–20159–01
Weight	1.0 lb
Material/ construction	Limited life items – TBD Lubricants – TBD Metallics – TBD Nonmetallics – TBD
Load rating	20 to 200 in–lb
Temperature range	–130° to +150° F
Quantity flown	Two for STS 51–A
Stowage	Attached to MMU stinger
Availability	Flight specific

Dimensional Data		
	inches	cm
A	1.188	3.016
B	8.75 – 9.50	22.225 – 24.130



WRENCH, TORQUE

S84-43001



OVERVIEW

The torque wrench is a ratchet wrench designed specifically for use during EVA. The head of the -01 wrench has a 3/8-in. square drive with the option of a 7/16-in., 12-point hex, deep-well socket or crow foot attachment. A swivel tether is attached to the opposite end of the handle.

OPERATIONAL COMMENTS

The torque wrench extends from a fully retracted length of 17.5 in. to a fully extended length of 26 in. The torque wrench can apply from 15 to 100 ft-lb of torque. **Torque is set to zero prior to flight to offload stresses from internal Bellville springs and to preserve torque calibration. Torque is set in the cabin prior to EVA.** The lock ring is turned counterclockwise to lock torque setting, clockwise to allow torque adjustment. It was first used on STS 51-A, the Palapa/Westar satellite repair mission, to tighten clamp shoes on the spacecraft adapter. The -02 configuration was used with a crow foot wrench attachment during STS 51-A, but can accept any attachment fitting for a 3/8-in. drive. **The -05 configuration was used for the Intelsat repair activities on STS-49. Drawbacks to this large wrench include lack of a convenient transport means during two-handed manual translation and lack of a drop-proof tether for socket changeout during EVA.**

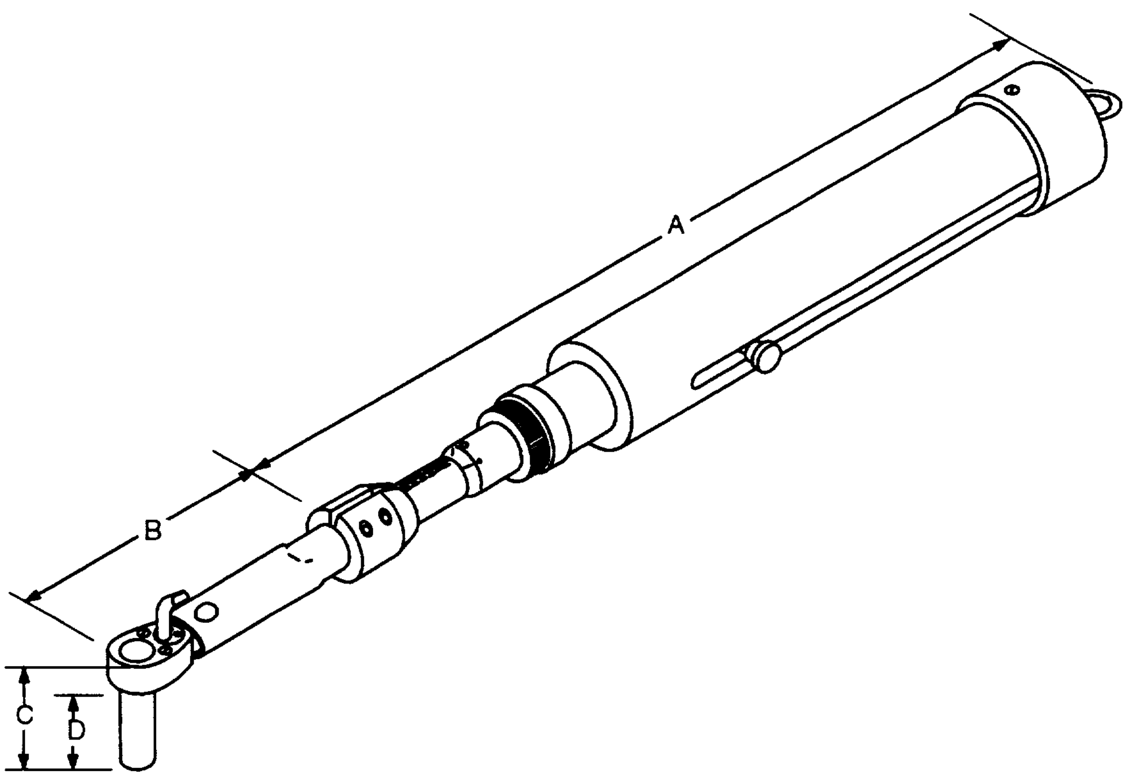
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

WRENCH, TORQUE

Technical Information	
Part number	10174–20100–01 (3/8 inch square drive only) –02 (crow's foot) –05 (7/16 inch socket) –06 (drop proof tether 3/8 inch drive)
Weight	3.25 lb
Material/ construction	
Load rating	15 to 100 ft–lb **(settable torques)**
Temperature range	–130° to +150° F
Quantity flown	One for STS 51–A, **two for STS–49**, one for STS–61
Stowage	Tool board **(STS 51–A), starboard PSA and in cabin (STS–49),** starboard PSA (STS–61)
Availability	Flight specific

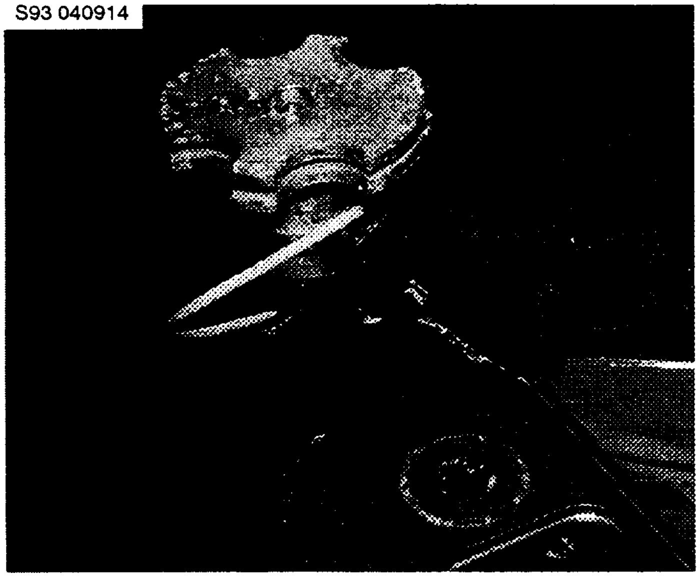
Dimensional Data		
	inches	cm
A	26.00 expanded 17.50 retracted	66.04 44.45
B	5.00	12.7
C	2.63	6.68
D	2.00	5.08

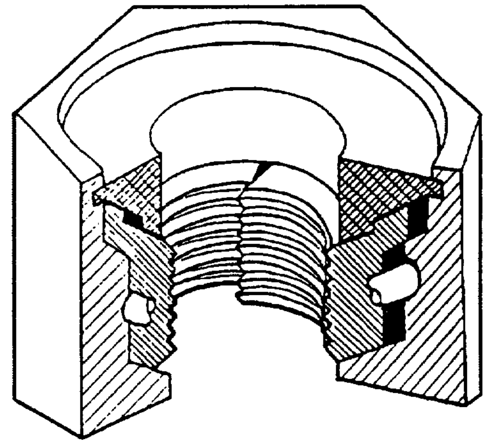


IL_6

ZIP NUT

S93 040914





OVERVIEW

The Zip nut is a patented fastener that eliminates the fine alignment, threading, and repetitive ratcheting associated with standard nut and bolt connections. The Zip nut is essentially a segmented nut encased in a spring–loaded housing or nut plate. It works with any externally threaded bolt by allowing the bolt to slide freely through it in one direction while grasping securely in the opposite direction. It can be designed to allow misalignments exceeding 10° and becomes self–aligning as the bolt enters the nut. It is impossible to cross–thread this fastener, and damaged or contaminated threads are not a problem for bolt insertion. This fastener is highly recommended for any on–orbit EVA bolt/nut application. Its status as a launch and landing restraint is TBD.

OPERATIONAL COMMENTS

The Zip nut consists of three plates that together form the internal threads of the nut. These plates are held in place by a spring that forces them to a minimal diameter. An internal ramp forces the plates together or apart depending on the bolt–force direction. When a bolt is inserted, the plates slide back and away, effectively increasing the diameter of the nut threads and allowing the bolt to slide in without obstruction. When the bolt is pulled in the opposite direction, the plates are pulled inward together. The spring force that holds the plates together is needed only when initially torquing the bolt. Once the bolt is torqued, the springs are no longer needed since the ramp forces keep the threads together. In fact, if the spring were to fail after bolt torquing, the nut would still hold and the bolt could be removed (however, it would not accept a new bolt).

One existing EVA application of this design can be found in the Hubble Space Telescope (HST) program. Four Zip nuts are used to attach a large handhold to one of the on–orbit replaceable units during HST maintenance. The wide field/planetary camera (WFPC) has four threaded studs to which the handhold is connected with Zip nuts. These Zip nuts have been built into a tethered EVA–compatible knob for gloved hand installation and final torquing. Squeezing the upper and lower plates of the knob together releases the nut and allows it to be pulled off as easily as it was installed.

The Zip nut was also a design feature of the STS–29 SHARE stop removal contingency tool.

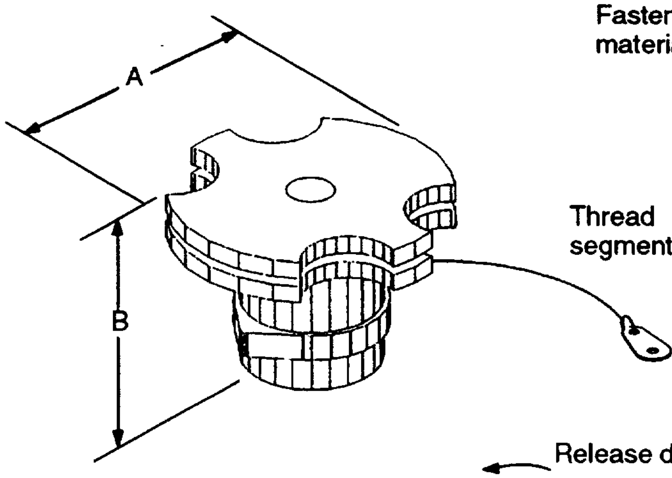
CONTACTS

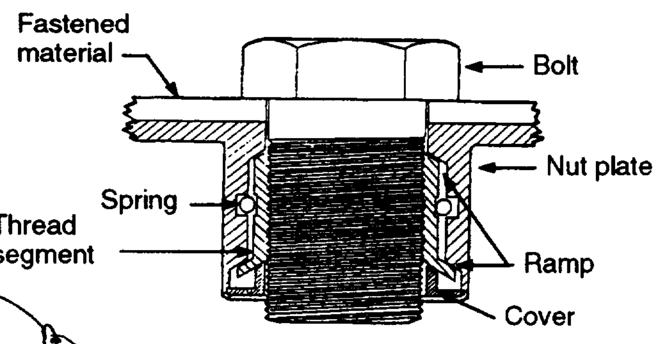
Operational: R. Trevino, NASA/DF42, (713) 483–2597
Technical: R. Marak, NASA/EC5, (713) 483–9144

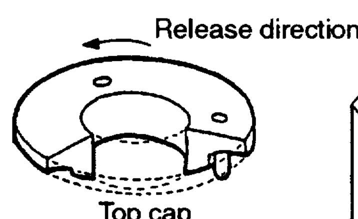
ZIP NUT

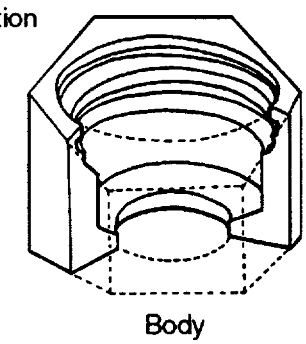
Technical Information	
Part number	SD2040010 (nut with HST knob)
Weight	0.54 lb
Material/ construction	Aluminum, stainless
Load rating	< 2 lb bolt insertion force
Temperature range	
Quantity flown	Eight on STS–61
Stowage	Payload bay
Availability	Flight specific

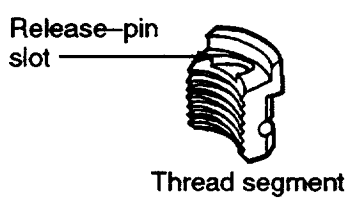
Dimensional Data		
	inches	cm
A	2.5	6.35
B	1.7	4.32











DEVELOPMENTAL/REFERENCE

This section is reserved for items which are not available at the present time. The items are flagged as "reference only" or "developmental" where appropriate.

The "reference only" items are included for future reference as a corporate knowledge repository. These items are not part of the active inventory because of their payload unique utility, because a better design now exists or because they have been found lacking in some way. Since certain features of this hardware may still be valid and because other features should be avoided in the future, this data is deemed important to pass along to future users and designers.

The "developmental" items include new equipment which is anticipated to be useful in the future, but is not yet flight certified and may have only reached the prototype stage. This data gives users a heads–up on which devices may soon be available or could be made available with additional resource expenditure. This will hopefully educate the large EVA community so that redundant costly development efforts are avoided.

Hardware from this section should be used only if the existing "as–is" inventory described earlier is inadequate. New equipment and modifications to existing hardware should be avoided when possible to save on high development or recertification costs.

Since the flight certification and availability cannot be guaranteed for any of this hardware, customers and users must always consult the NASA subsystem manager for each item. The combined expertise of JSC Mission Operations Directorate and Crew and Thermal Systems Division engineers should be relied upon for an exact determination of tool design and use requirements.

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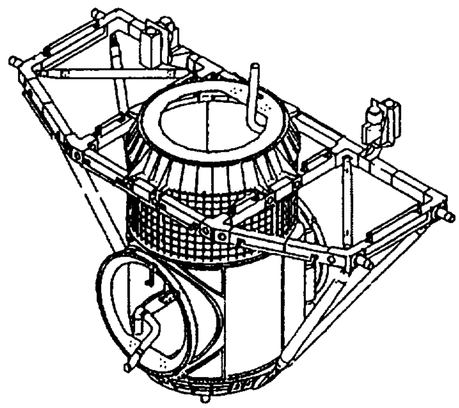
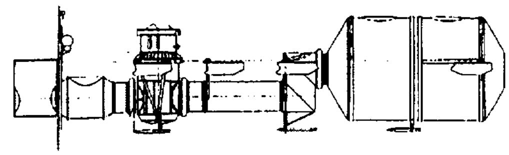
AIRLOCK, EXTERNAL





OVERVIEW

The external airlock, also known as the orbiter docking system, is a derivative of the standard internal shuttle airlock. Like the internal airlock, it provides a volume that can be isolated from the rest of the crew cabin to allow EVA crew egress and ingress for external operations. In addition, the external airlock provides the means to dock with other vehicles (Russian Mir and NASA Space Station Freedom (SSF)) for shirt–sleeved crew and equipment transfer. This airlock replaces the SSF unpressurized berthing adapter starting with MB6. For SSF use, there will be internal utilities for comm, data, power, and water exchange. This airlock can be manifested by itself, in addition to the internal airlock, or connected to a pressurized module like Spacelab in the payload bay.

OPERATIONAL COMMENTS

In terms of EVA support, this external airlock has the following features:

- Mounting provisions for up to three extravehicular mobility units (EMU's), with two on the walls and one on the floor.
- A pair of umbilicals for EMU servicing, including cooling water, high pressure oxygen, battery recharge, hardline communication, and EMU operations power. These umbilicals are not used when the internal airlock is flown.
- Displays and controls for EMU services, airlock depress/repress, and internal lighting.
- Internal and external handrails and standoffs with integral tether points. Tether reel box mounting for either top hatch or aft hatch egress.
- External truss–mounted tool boxes to hold flight–unique equipment and orbiter contingency tools relocated from the provisions stowage assembly (PSA).

For docking support, additional functions are provided:

- Internal and external alignment aid cameras; external laser range finder
- Aft flight deck remote controlled depress valves
- Docking system avionics and air ducted cooling, including a booster fan
- Electric strip heaters for temperature and condensation control

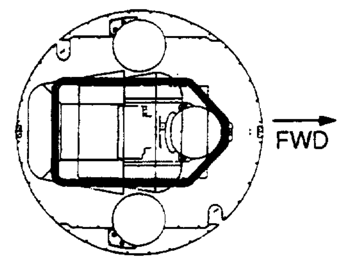
CONTACTS

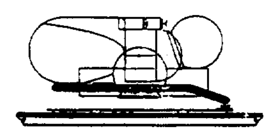
Operational: EVA – R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: ECLSS – H. A. Rotter, NASA/EC6, (713) 483–9249
Structural: K. Edelstein, NASA/ES23, (713) 483–8850
Docking: J. McManamen, NASA/ES64, (713) 483–8958

AIRLOCK, EXTERNAL

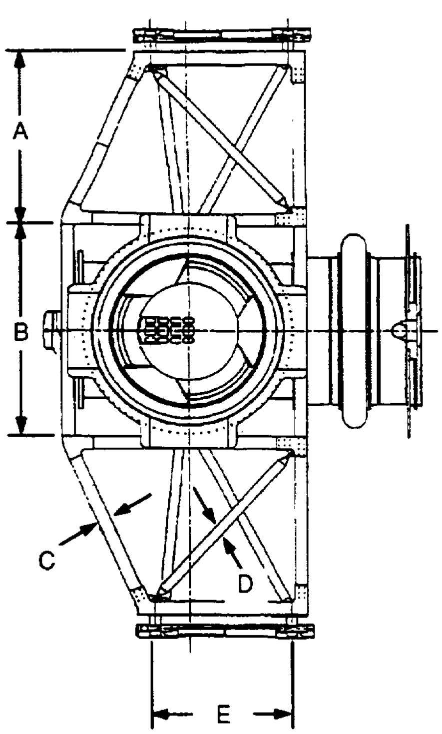
Technical Information	
Part number	SK287–200–92–005 (general arrangement) VL76–34000X (basic structure) L828–652020–22 (pressure vessel handholds) VL28–343017 (truss handholds)
Weight	
Material/ construction	One–piece isogrid aluminum upper cylinder Extruded aluminum handrail tubing Cast aluminum handrail standoffs on truss Machined titanium standoffs on pressure vessel
Load rating	187 lb internal handrail tubes and standoffs 574 lb internal crew safety tether loops 574 lb external handrail standoff tether points
Temperature range	
Internal volume	180 ft^3 (no EMU's, no tunnel adapter) 160 ft^3 (two EMU's, no tunnel adapter) 150 ft^3 (three EMU's, no tunnel adapter)
Quantity flown	One
Stowage	Payload bay
Availability	Developmental, CDR pending

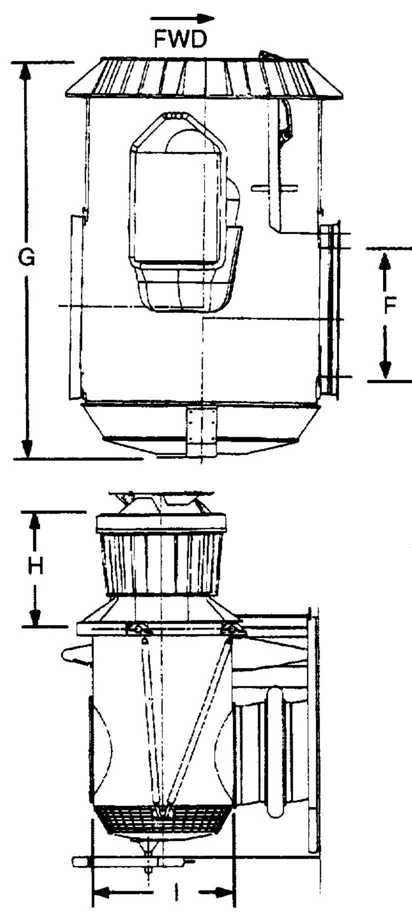
Dimensional Data		
	inches	cm
A	55.75	141.6
B	57.50	146.1
C	4.0	10.2
D	3.0	7.6
E	42.63	108.3
F	36.0	91.4
G	111.0	281.9
H	54.34	138.0
I	67.31	171.0

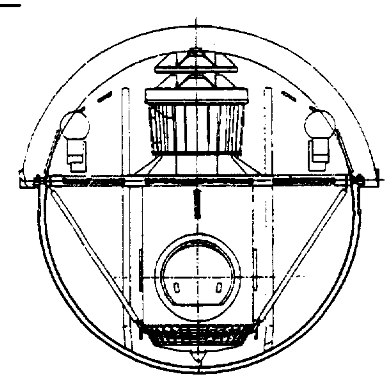




Floor–mounted EMU/helmets

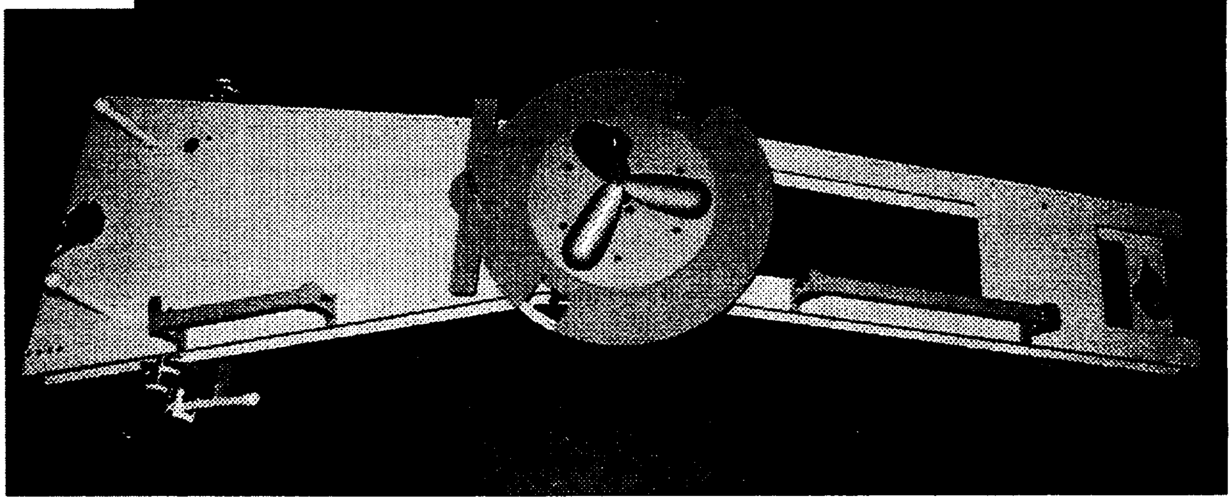






ANTENNA BRIDGE STRUCTURE

S84–39126



OVERVIEW

The antenna bridge structure (ABS) was designed to create a framework which distributes remote manipulator system (RMS)–induced forces on a Hughes satellite (HS376). The structure with brackets is 100 inches by 32 in. by 28 in. The surface of the structure is coated with Chemglaze A276 white paint. It has an RMS grapple fixture and EVA handholds.

OPERATIONAL COMMENTS

The ABS was used on the HS376 retrieval mission **but did not mate to the spacecraft due to a mechanical mismatch**. It was designed to be connected to a common bracket and a bumper bracket, which are attached to the satellite first. Velcro holds the ABS in position while connecting it to the brackets. After the ABS is secured, the RMS can maneuver the satellite. The ABS is a payload–unique device and is not normally manifested. It has mounting locations for the antenna cutter and a cut omnidirectional antenna.

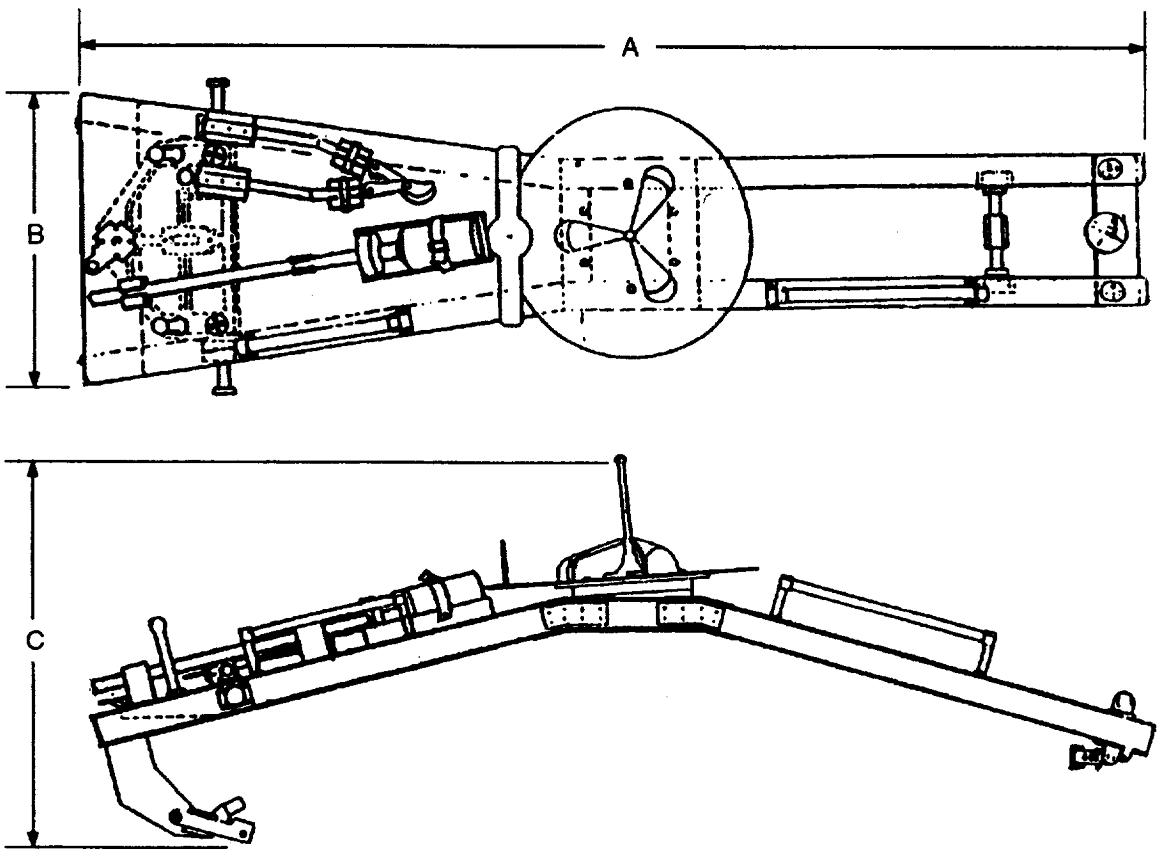
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. J. Marak**, NASA/EC5, (713) 483–9144

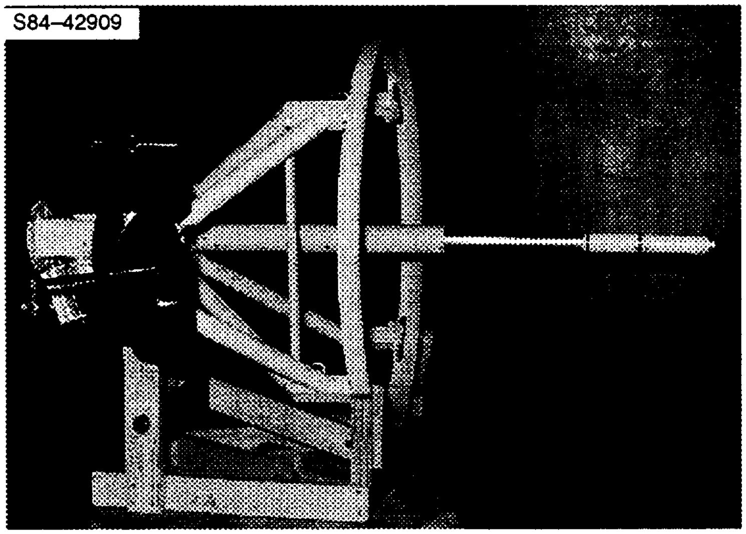
ANTENNA BRIDGE STRUCTURE

Technical Information	
Part number	SED39117098
Weight	116.5 lb
Material/ construction	Aluminum, Chemglaze A276 white paint, EVA handholds, RMS grapple fixture
Load rating	
Temperature range	–130° to 150° F
Quantity flown	**Two on STS 51A**
Stowage	**Modified spacelab pallet**
Availability	Reference only

Dimensional Data		
	inches	cm
A	97.0	246.38
B	26.5	67.31
C	36.0	91.44



APOGEE KICK MOTOR CAPTURE DEVICE



OVERVIEW

The apogee kick motor capture device (ACD) is a mechanical interface between the manned maneuvering unit (MMU) and the apogee kick motor (AKM) of a Hughes HS376 satellite. The ACD includes a grapple fixture for use with the remote manipulator system (RMS). Two pip pins attach the ACD to the arms of the MMU. A toggle assembly with spring–loaded toggle fingers attaches the ACD to the satellite.

OPERATIONAL COMMENTS

The ACD must first be attached to the MMU before the MMU can position the ACD for capture of the satellite. The MMU is used to insert the toggle assembly at the tip of the ACD into the AKM of the satellite. Lines marked on the ACD indicate depth of insertion. Spring–loaded toggle fingers are then released inside the AKM to secure the satellite.

The RMS attaches to the grapple fixture on the ACD and holds the satellite while an antenna bridge structure (ABS) is attached to it. The ACD and MMU are then used to hold the satellite while the RMS moves to the grapple fixture of the ABS. The ACD is then released from the satellite and restowed, using the MMU.

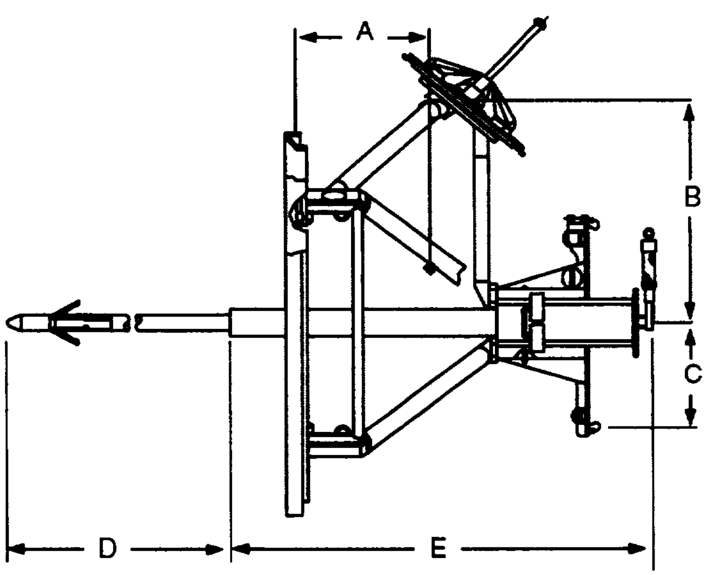
CONTACTS

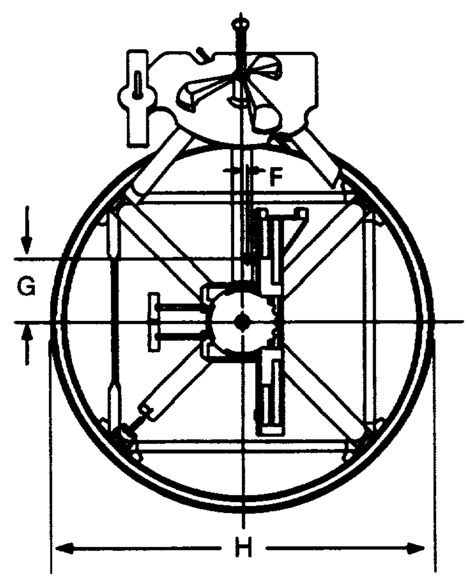
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. J. Marak**, NASA/EC5, (713) 483–9144

APOGEE KICK MOTOR CAPTURE DEVICE

Technical Information	
Part number	SED39117132
Weight	128 lb
Material/ construction	Stainless steel, aluminum alloy
Load rating	
Temperature range	–130° to 150° F **(operational)** **–150° to 230° F (stowage)**
Quantity flown	Two for STS 51–A
Stowage	Spacelab pallet
Availability	Reference only

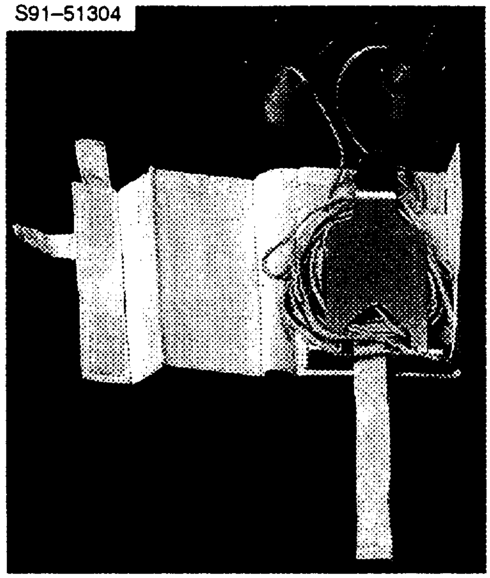
Dimensional Data		
	inches	cm
A	14.28	36.27
B	23.89	60.68
C	11.50	29.21
D	27.00	68.58
E	44.18	112.22
F	0.50	1.27
G	6.00	15.24
H	41.04	104.24





ASTROROPE

S91–51304



OVERVIEW

The astrorope (AR) was one of several different crew self–rescue (CSR) concepts for solving the EVA "man overboard" scenario on Space Station Freedom where no shuttle is available to assist. Evaluation of these concepts was conducted as part of the STS–49 Assembly of Station by EVA Methods (ASEM). Each device was intended to cover rescue scenarios, including tether mismanagement and tether or hook failure, when a fellow EVA crewmember is not available. This device utilizes a hand–thrown bola concept. All CSR devices were concept evaluations only and did not represent final packaging for quick deployment. "Off–the–shelf" components were used where possible.

OPERATIONAL COMMENTS

The AR comprises 20 ft of Kevlar cord with two end effectors or cleats for a bola–type design. It can tolerate a 100–lb tension load. The cord and end effectors are attached and stowed in a standard tool caddy on the EV crewman's mini–workstation. The cord is restrained in the caddy before use by a spring–loaded plate. The cord is deployed by the crewman tossing the two end effectors toward a target and then tightening the cord once they wrap around the structure. A strap with load–alleviating stitches protects the mini–workstation against excessive loads. Redeployment is possible but difficult, as the rope must be recoiled by hand and stowed back in the tool caddy. Two AR's were carried on STS–49 in the starboard PSA.

KC–135 zero–g demonstrations have shown a hand–thrown AR has less than 50 percent accuracy, and redeployment after a miss involves time–consuming hand recoil and, at best, frequent entanglement. Any future rope–type rescue device will need an accurate deployment mechanism and a tangle–free recoil capability. Like all grappling devices, it obviously does not cover all rescue scenarios, since the crewman must be able to see a regrapple target and have low enough rotation rates to employ such a device.

Future self–rescue development is concentrating on a mini manned maneuvering unit known as the simplified aid for EVA rescue (SAFER).

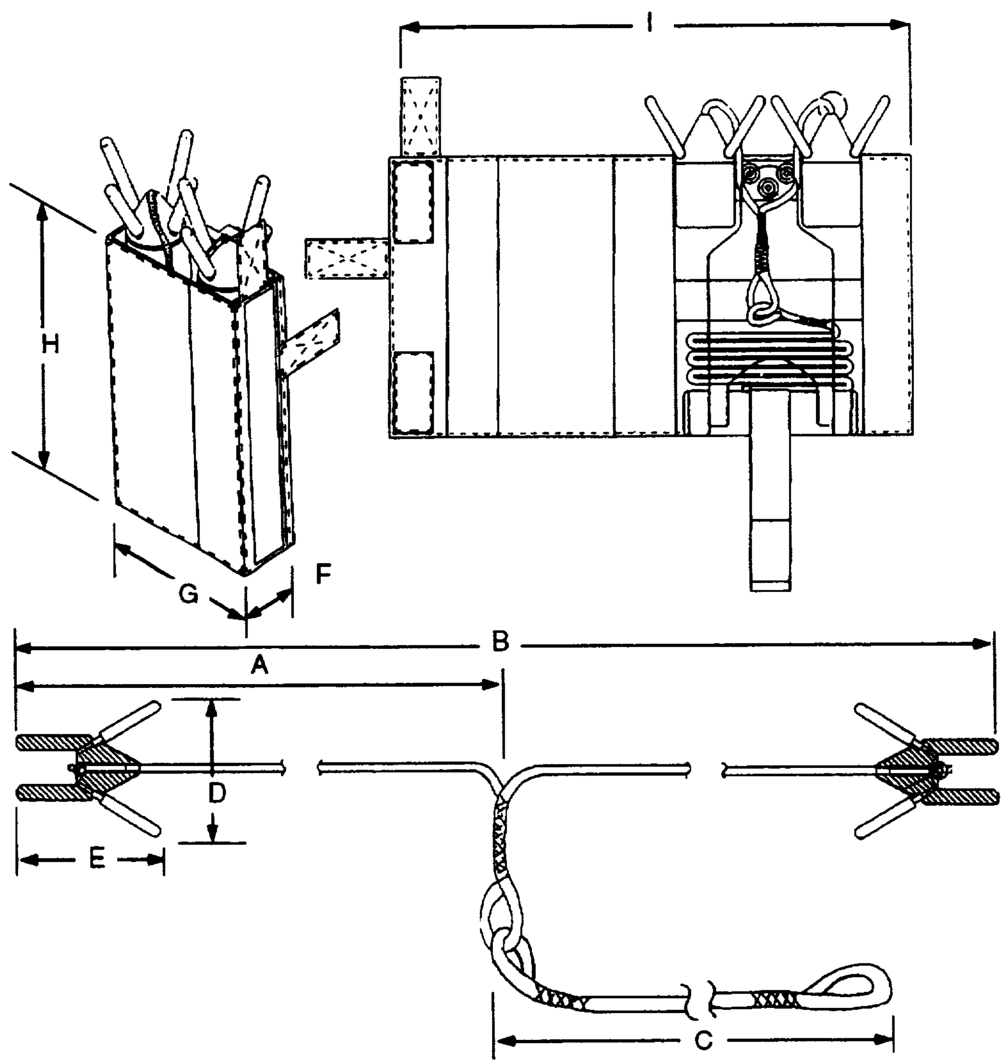
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. Schwarz, NASA/EC5, (713) 483–2378

ASTROROPE

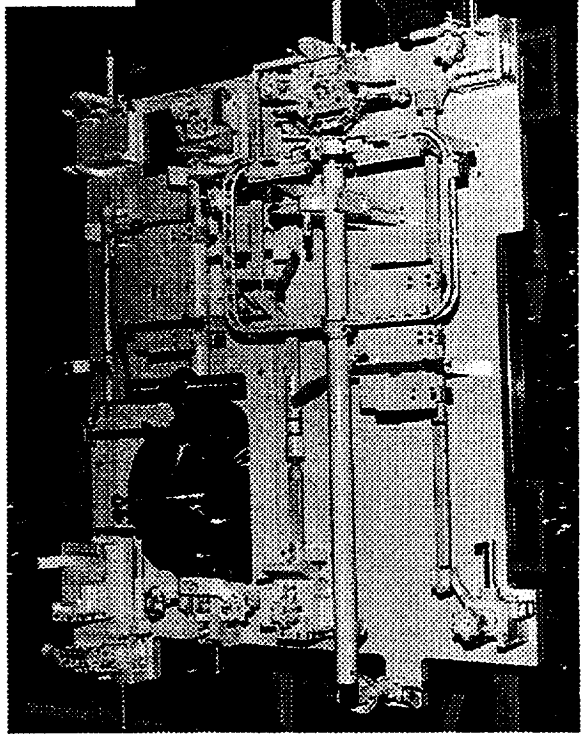
Technical Information	
Part number	SED39122646–302
Weight	1.5 lb
Material/ construction	Kevlar cord Silicone–coated aluminum end effectors
Load rating	100 lb (tension) 15 lb (load–alleviating strap)
Temperature range	
Quantity flown	Two on STS–49
Stowage	STBD PSA
Availability	Reference only

Dimensional Data		
	inches	cm
A	22	55.88
B	44	111.76
C	240	609.6
D	3.03	7.70
E	3.56	9.04
F	1.75	4.45
G	4.75	12.07
H	7.0	17.78
I	14.5	36.83



BAR STOWAGE ASSEMBLY

S85–37785



OVERVIEW

The bar stowage assembly (BSA) was designed as an EVA equipment carrier for the Leasat Salvage Mission. The BSA consists of a mounting plate and attachment devices to secure equipment during launch and landing.

OPERATIONAL COMMENTS

The BSA allows for equipment attachment via a receiver at one end and a spring–loaded latch at the opposite end. Fasteners and center holddowns for tool boards are also a part of the design. The BSA was mounted on a starboard sill longeron get–away special (GAS) beam for STS 51–I. The capture bar, grapple bar, handling bar, spin–up bar, and workstation stanchion were stowed on the BSA.

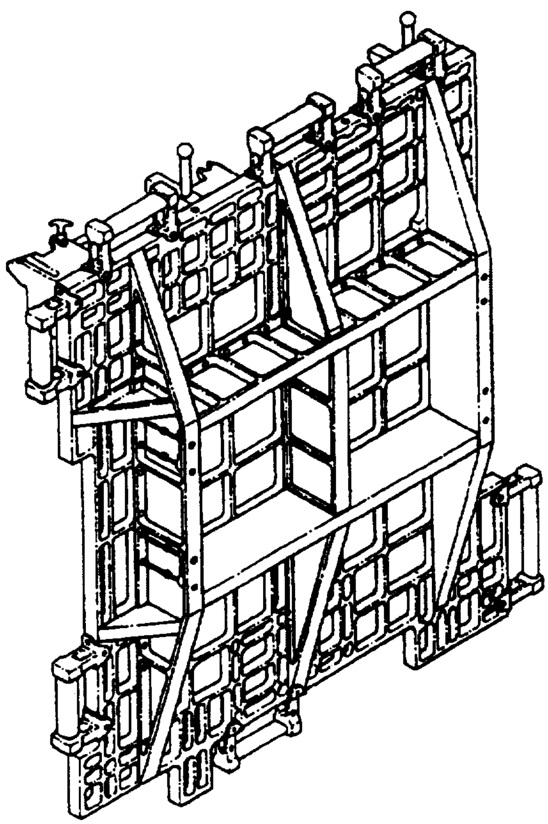
CONTACTS

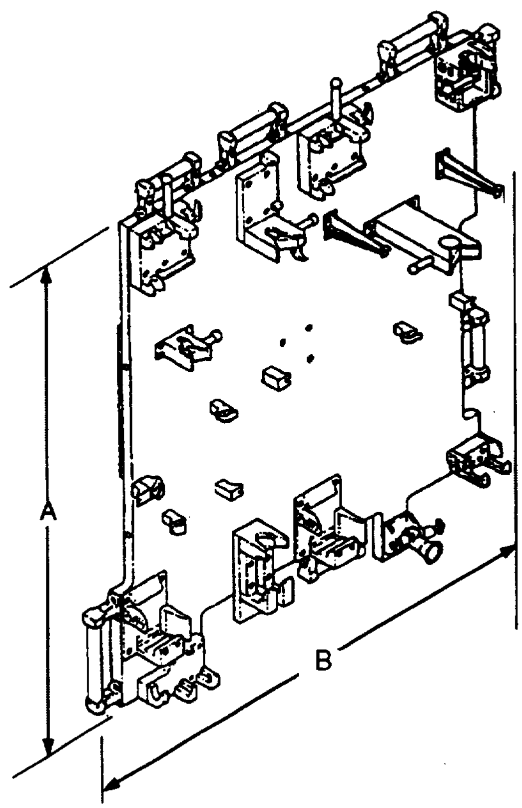
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

BAR STOWAGE ASSEMBLY

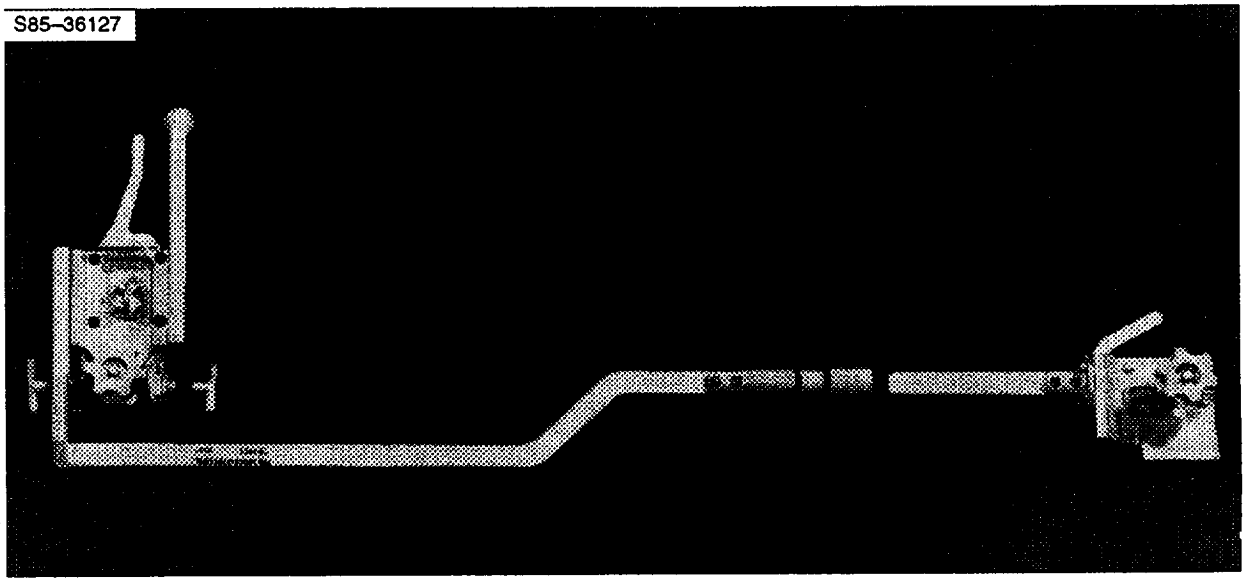
Technical Information	
Part number	10176–20002–01
Weight	266.0 lb (without bars) 415.0 lb (with bars/tool boards) 597.0 lb (with bars/tool boards/GAS beam)
Material/ construction	Aluminum
Load rating	
Temperature range	–130° to +150° F
Quantity flown	One on STS 51–I
Stowage	Payload bay GAS beam
Availability	Reference only

Dimensional Data		
	inches	cm
A	68.88	174.96
B	66.45	168.78





BAR, CAPTURE



OVERVIEW

The capture bar was designed for use during the Leasat Salvage Mission.

OPERATIONAL COMMENTS

The capture bar interfaces with the Leasat forward and aft pushoff side fittings and provides the crewmember with a means of capturing and despinning the satellite. Two capture bars, one prime and one spare, were flown on STS 51–I. Both were stowed on the bar stowage assembly.

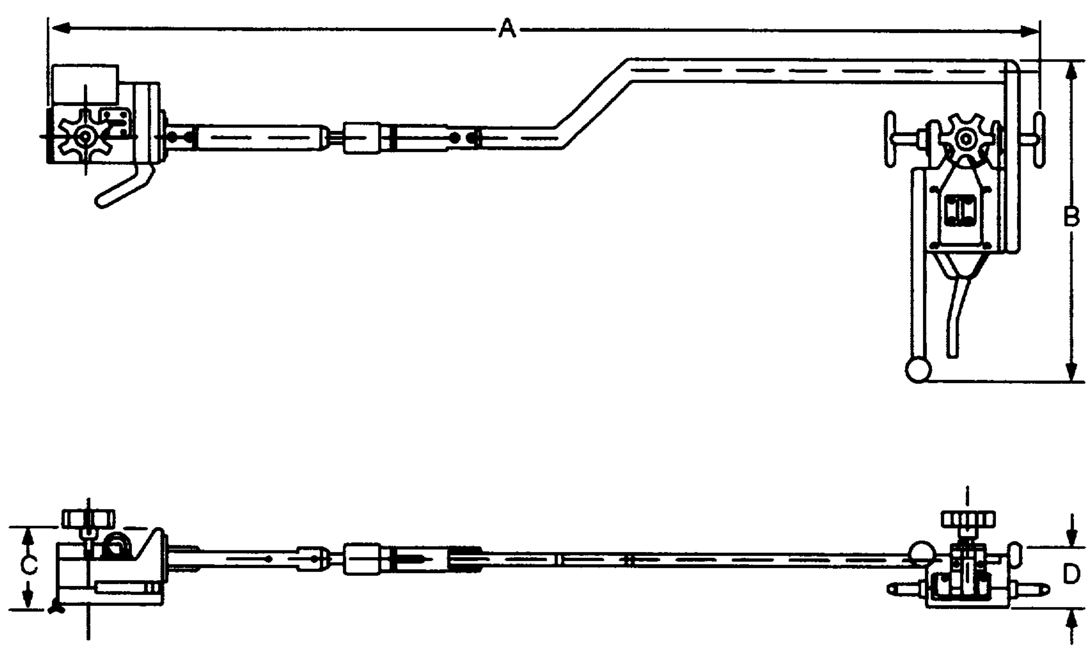
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

BAR, CAPTURE

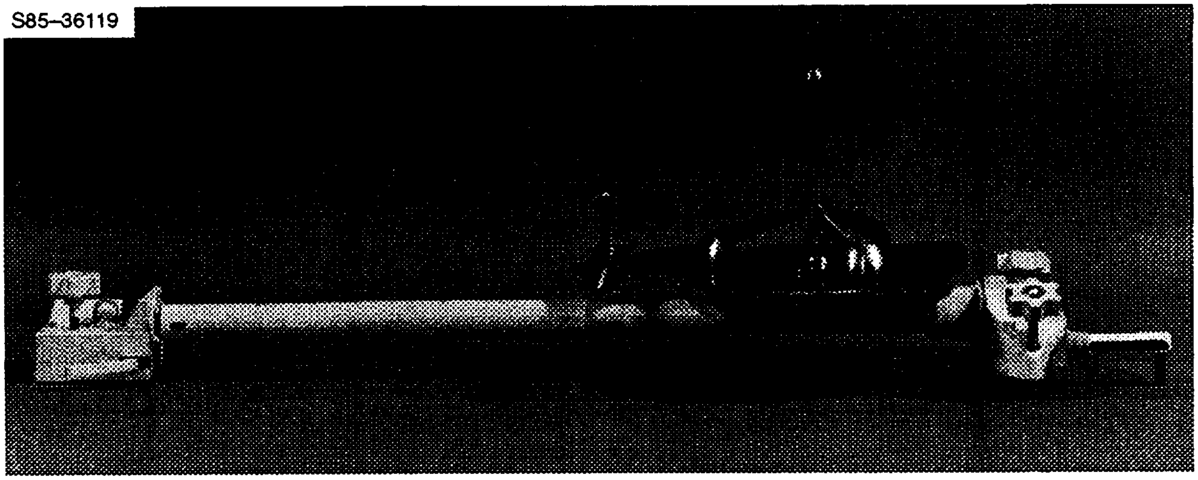
Technical Information	
Part number	SED 39117971–301
Weight	23.5 lb (without tool board) 28.0 lb (with tool board)
Material/ construction	Aluminum
Load rating	**50 lb (tension, compression, shear)** **100 ft–lb (bending)** **20 lb (torsion)**
Temperature range	**–80° to +180° F (operational)** –130° to **+180°** F **(stowage)**
Quantity flown	**Two on STS 51I**
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	57.873	147.00
B	18.938	48.10
C	4.656	11.83
D	3.750	9.53



BAR, GRAPPLE

S85–36119



OVERVIEW

The grapple bar was designed for use during the Leasat Salvage Mission.

OPERATIONAL COMMENTS

The grapple bar was installed on the Leasat forward and aft pushoff side fittings after the capture bar was removed. The grapple bar has a flight standard grapple fixture mounted on it that permitted the remote manipulator system (RMS) to grapple the Leasat. 7/16–in. hex bolts can be used for EVA release of the grapple fixture pin should the RMS end effector fail. One grapple bar was flown on STS 51–I. It was stowed on toolboard no. 3 of the bar stowage assembly (BSA).

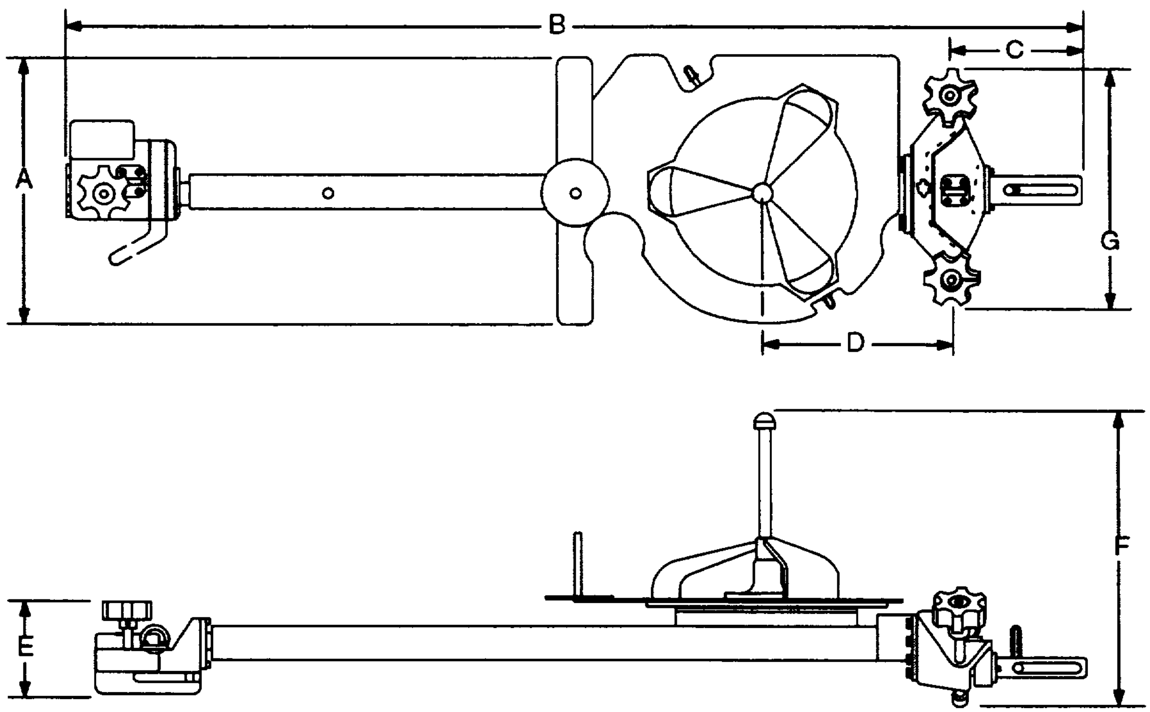
CONTACTS

Operational: R. C. Trevino, NASA/DF2, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

BAR, GRAPPLE

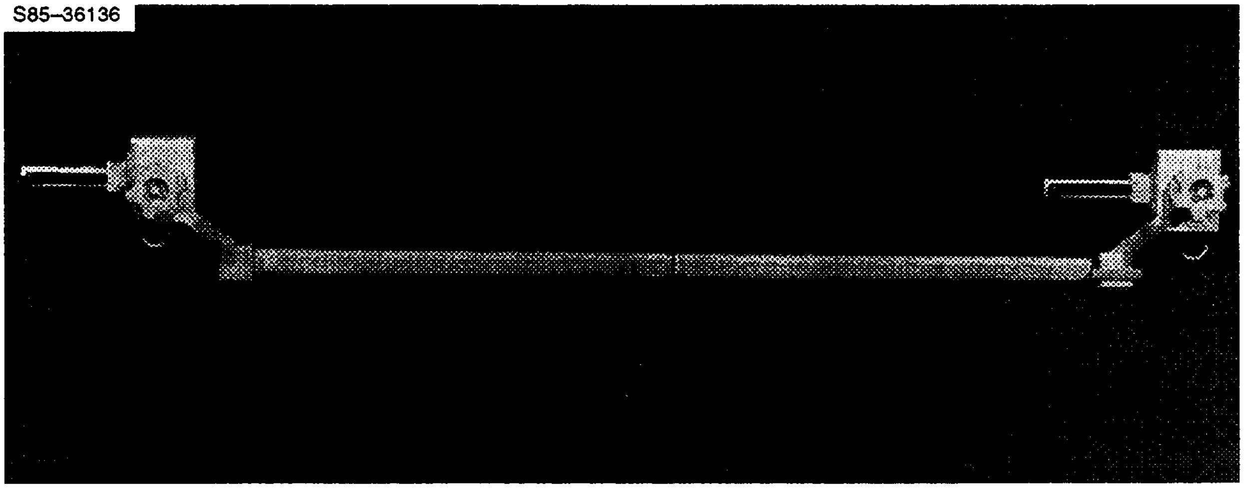
Technical Information	
Part number	SED 39118030–301
Weight	56.6 lb (with tool board)
Material/ construction	Aluminum
Load rating	50 lb (shear) 450 ft–lb (torsion) 1200 ft–lb (bending)
Temperature range	**–80° to +180° F (operational)** –130° to +180° F (stowage)
Quantity flown	One on STS 51I
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	16.000	40.64
B	60.840	154.53
C	7.550	19.18
D	11.000	27.94
E	5.812	14.76
F	17.425	44.26
G	14.000	35.56



BAR, HANDLING

S85–36136



OVERVIEW

The handling bar was designed for use during the Leasat Salvage Mission.

OPERATIONAL COMMENTS

The handling bar was designed to interface with the Leasat forward and aft pushoff side fittings. It was used to provide the crewmember with a means of handling and restraining the satellite while the capture bar was being removed and the grapple bar was being installed. It was stowed on toolboard no. 4 of the bar stowage assembly (BSA).

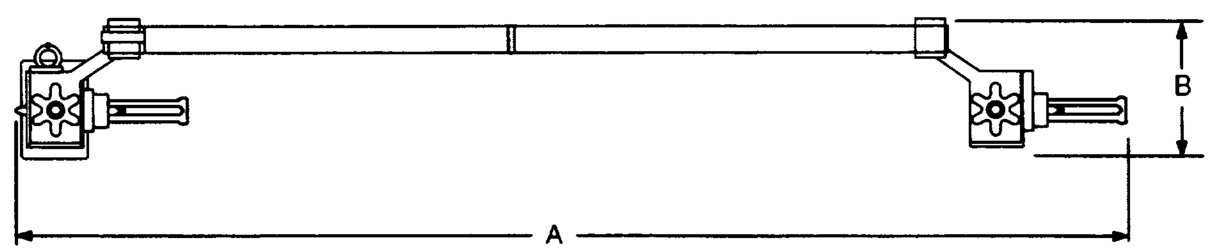
CONTACTS

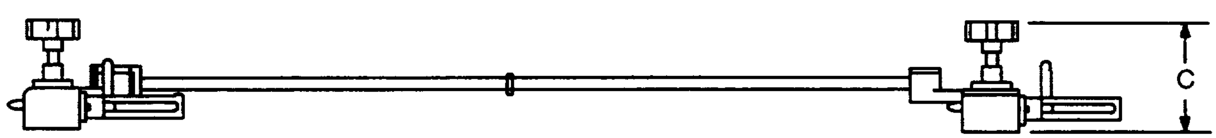
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

BAR, HANDLING

Technical Information	
Part number	SED 3911800–301
Weight	15.5 lb (with tool board)
Material/ construction	Aluminum
Load rating	**200 lb (tension, compression)** **100 lb (shear)** **100 ft–lb (bending)** **20 ft–lb (torsion)**
Temperature range	**–80° to +180° F (operational)** **–130° to +180° F (stowage)**
Quantity flown	One on STS 51–I
Stowage	
Availability	Reference only

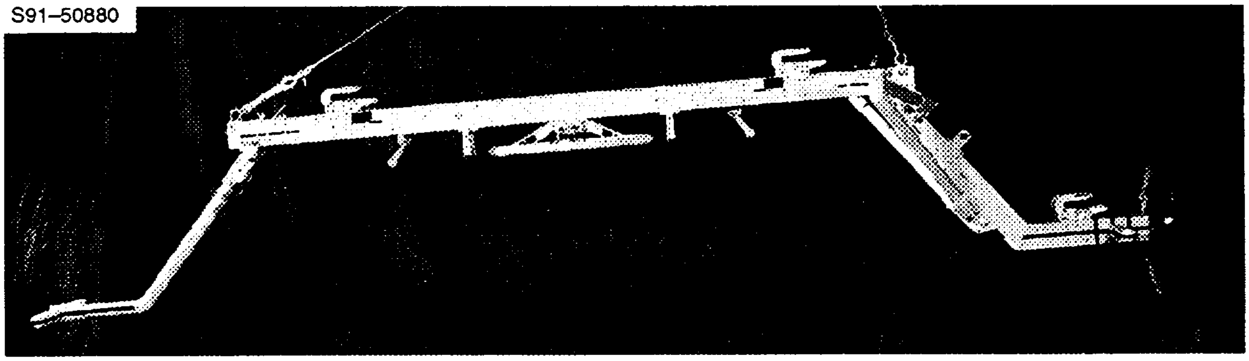
Dimensional Data		
	inches	cm
A	60.73	154.25
B	6.99	17.75
C	5.87	14.91





BAR, INTELSAT CAPTURE

S91-50880



OVERVIEW

The Intelsat capture bar was designed for the STS-49 Intelsat reboost mission as a means of attaching a handling device to a spacecraft that had not been designed for EVA or robotic manipulation. It comprises four major components, the central beam, a right beam extension, a left beam extension, and a steering wheel. The left beam was launched separately from the main and right beams on different stowage brackets of the orbiter sidewall. The bar had features to allow multiple latch attachment attempts. A spare main beam was flown on the booster motor pallet for mission success redundancy.

OPERATIONAL COMMENTS

For the premission-planned manual capture phase, the extravehicular (EV) crewmember was located on a foot restraint attached to the remote manipulator system (RMS) via the portable foot restraint (PFR) attachment device (PAD). After orbiter and RMS maneuvers to present the base of the spacecraft to the EV crewmember, the bar was to be latched to the satellite's booster motor clamp ring. Clocking of the bar relative to the spacecraft was critical to avoid unwanted contact with obstructing structures. The short V-guides surrounding the active latches at both ends of the bar aided with manual alignment and installation. Triggers located below the V-guides activated the capture latches to grip the spacecraft ring with a force of roughly 50 lb on both sides of the ring. A large steering wheel at the center of the bar gave the EV crewmember handles for multiaxis control to despin and halt the residual satellite rotation using brief, light forces. A 7/16-in. EVA bolt could then be driven with a power tool to hard dock the latches. In the event of a latch misfire, the crew could rearm the latches with a pair of arming levers. Latch firing could be initiated either with automatic triggers or with manual triggers. After firm attachment to the spacecraft, the RMS used the grapple fixture of the right beam to maneuver Intelsat into position for the new booster motor. The left and right beams allowed the satellite to be temporarily captured in tall V-guides above the new booster motor during motor attachment work. Both beams were unbolted and stowed prior to satellite redeploy to minimize the impacts to satellite mass properties and reboost propellant. The main beam was relocated to the new booster motor before redeploy so that the original satellite configuration could be preserved after reboost.

The initial capture of Intelsat was not executed as planned because preflight simulation of capture bar attachment used an air bearing simulator that had friction forces equivalent to installation forces. This variation in preflight versus on-orbit dynamics led to a three-EV-crewmember manual capture to maintain spacecraft stability for bar attachment. All other bar operations were nominal.

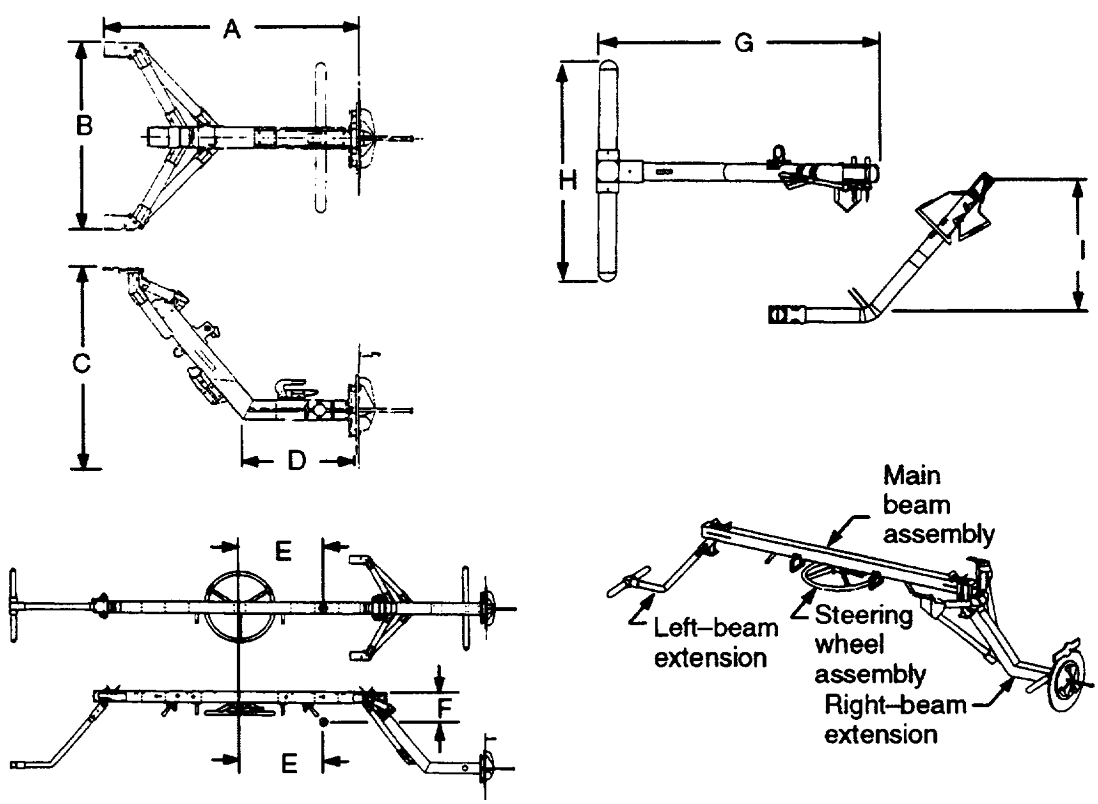
CONTACTS

Operational: W. Wedlake, JSC/DF42, (713) 483-2568
Technical: C. Seaman, NASA/EC5, (713) 483-5843

BAR, INTELSAT CAPTURE

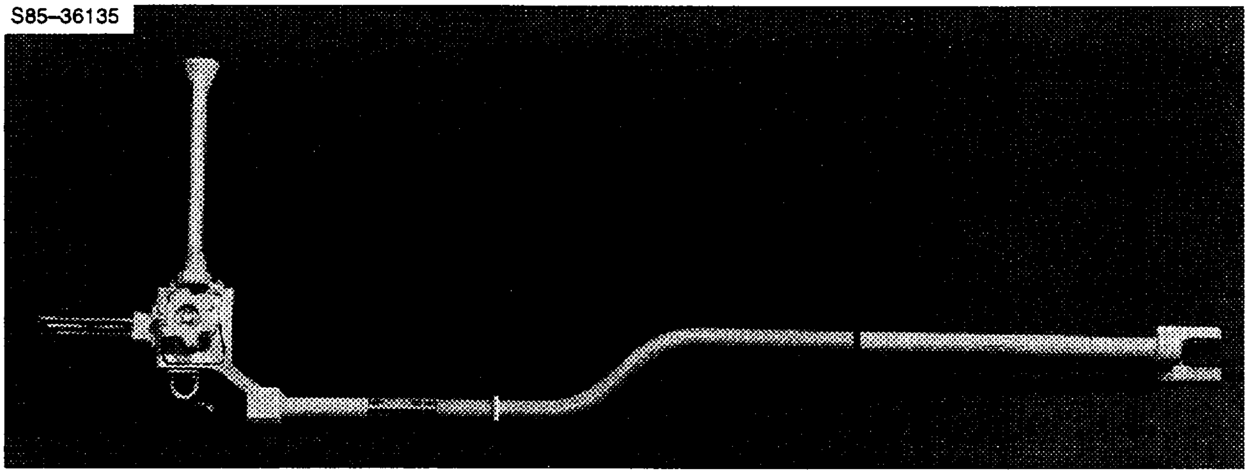
Technical Information	
Part number	SED39122110–302
Weight	136 lb (main and right beams) 7 lb (left beam) 10 lb (steering wheel) 160.8 lb (sidewall carriers)
Material/ construction	Aluminum, stainless steel, CRES
Load rating	2– to 10–lb latch triggers 15–ft–lb–hard–dock bolt 8 to 10 ft–lb left/right beam release bolts
Temperature range	–80° to 150° F
Quantity flown	One prime assembly plus one spare main beam on STS–49
Stowage	Payload bay sidewall carrier (prime assembly) Payload bay pallet (spare main beam)
Availability	Reference only

Dimensional Data		
	inches	cm
A	47.5	120.7
B	37.5	95.3
C	31.75	80.65
D	20.5	52.07
E	30.0	76.2
F	11.8	29.97
G	38.25	97.16
H	26	66.0
I	20.00	50.8



BAR, SPIN-UP

S85-36135



OVERVIEW

The spin-up bar was designed for use during the Leasat Salvage Mission.

OPERATIONAL COMMENTS

The spin-up bar was designed to be installed on the Leasat forward and aft pushoff side fittings. The bar was installed after the grapple bar was removed. It provided the crewmember with a means of spinning up and deploying the satellite. The spin-up bar remains on the Leasat in orbit. It was stowed on toolboard no. 5 of the bar stowage assembly (BSA) for the launch of STS 51-I.

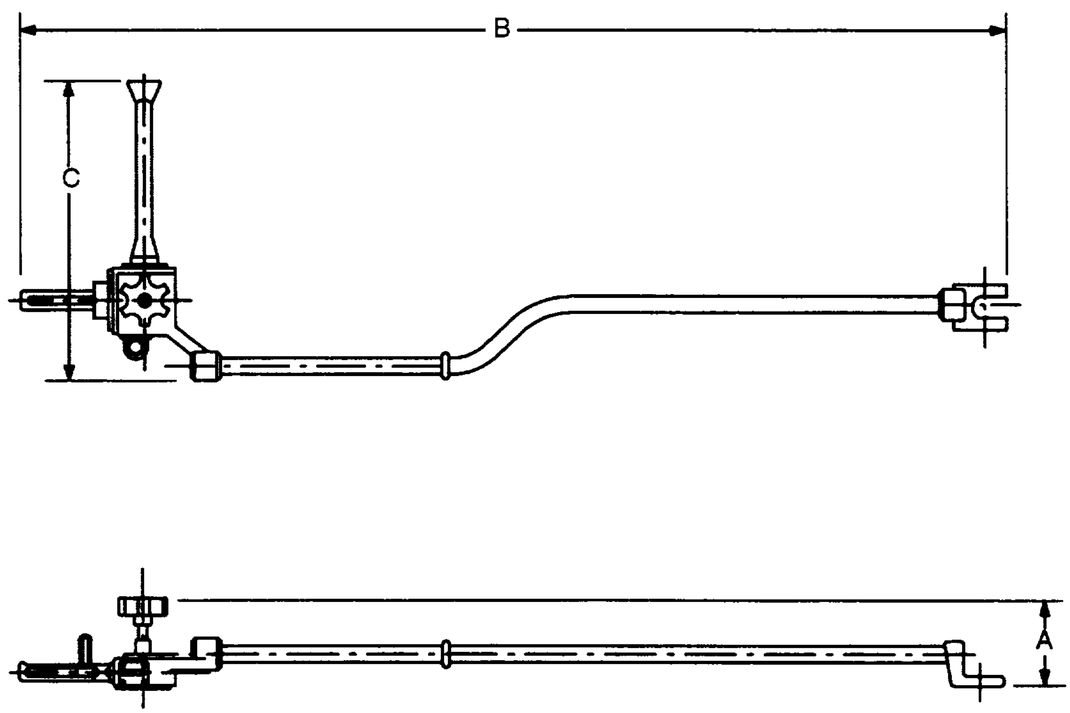
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

BAR, SPIN–UP

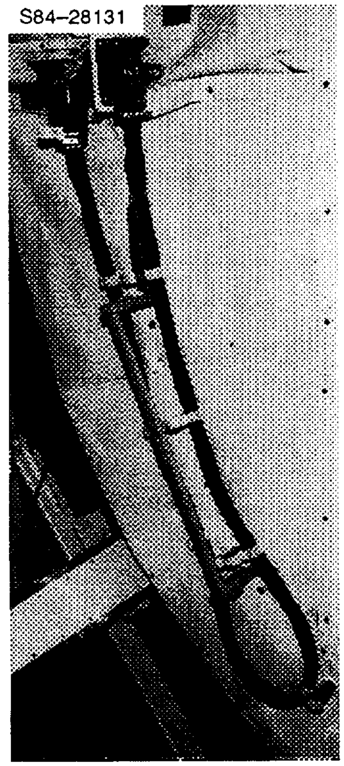
Technical Information	
Part number	SED 39118146–301
Weight	8.0 lb (with tool board)
Material/ construction	Aluminum
Load rating	**50 lb (tension, compression, shear)** **100 ft–lb (bending)** **20 ft–lb (torsion)**
Temperature range	**–80° to +180° F (operational)** **–130° to +180° F (stowage)**
Quantity flown	One on STS 51–I
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	5.60	14.22
B	60.42	153.47
C	15.60	39.62



CABLE, JUMPER

S84-28131



OVERVIEW

The jumper cable is an 11-ft electrical cable with a female electrical connector on one end and a male electrical connector on the other. Each end has two captive bolts used in mating the jumper cable to the desired interface. A tether ring is provided on both sides of the male connector.

OPERATIONAL COMMENTS

The jumper cable was designed to provide a backup electrical interface during the servicing of the Solar Maximum Satellite (Solar Max). The jumper cable is manually mated to the Solar Max connector. The two bolts on the jumper cable connector are tightened by rotating approximately seven full turns clockwise with a tool having a 7/16-in. hex socket. This procedure is then repeated with the other end of the jumper cable at the flight support system (FSS) umbilical connector actuator position. **Use of this jumper was not required for STS 41-C**.

CONTACTS

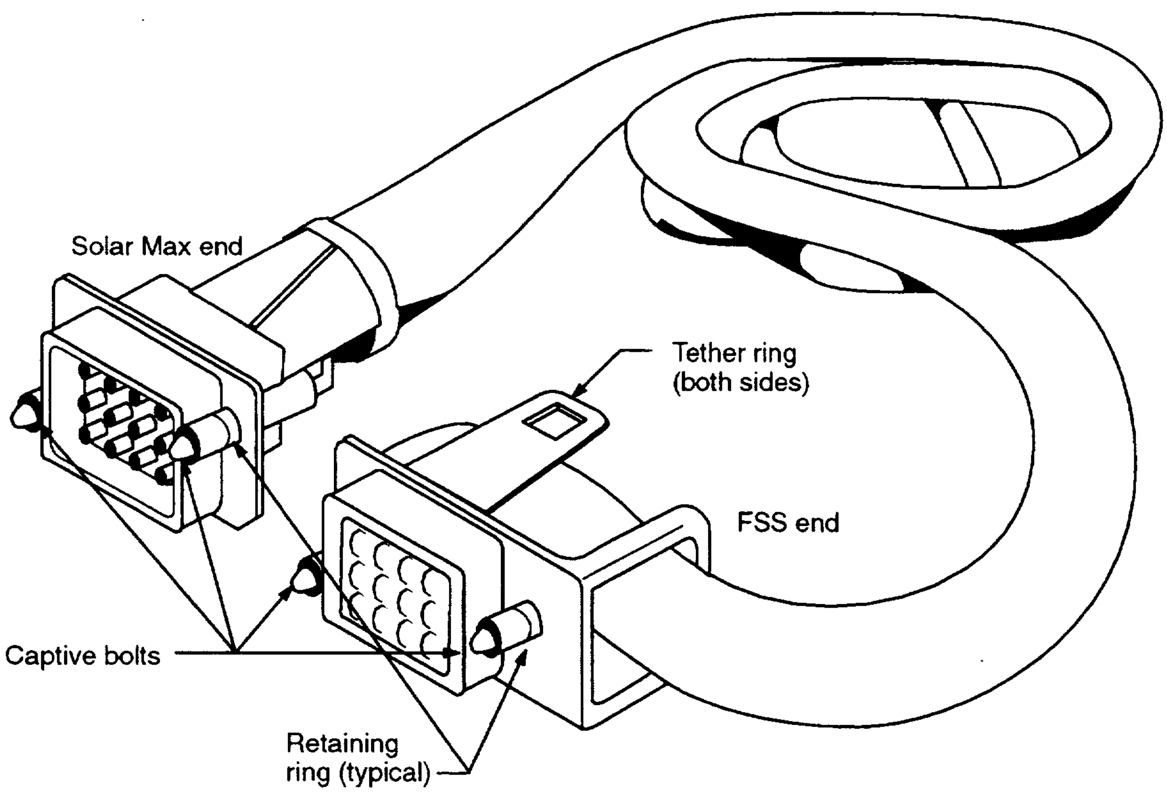
Operational: R. Trevino, NASA/DF42, (713) 483-2597
Technical: K. Olson, NASA/GSFC/442, (205) 772-7660

CABLE, JUMPER

Technical Information	
Part number	9390000608
Weight	17 lb
Material/ construction	Cable – Black Teflon webbing Connector housing – Irradiated aluminum
Load rating	
Temperature range	–94° to +158° F
Quantity flown	**One on STS 41–C**
Stowage	**FSS**
Availability	Referency only

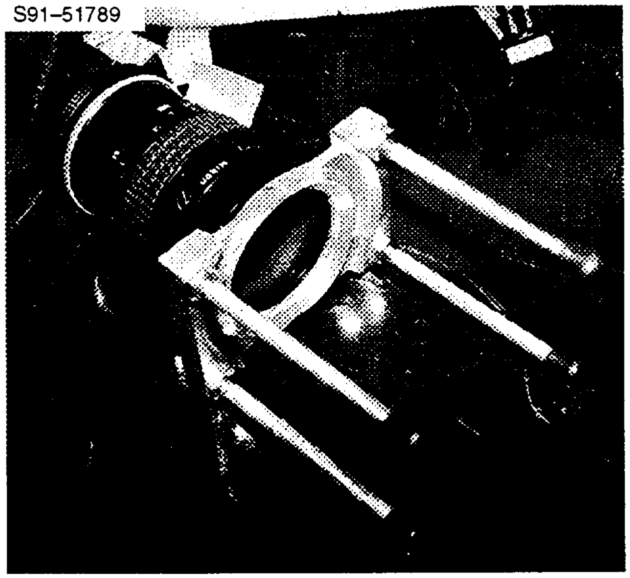
Dimensional Data		
	inches	cm
A		
B		
C		

Length: 11 ft



CAMERA MOUNT, MACRO

S91–51789



OVERVIEW

The macro camera mount was designed for the Intelsat reboost mission to allow closeup photos of the solar array panels. Atomic oxygen degradation of the array components was of concern because of the long unplanned exposure of the satellite in low Earth orbit before rescue. Photos of the array were to help with estimates of the long–term life of the vehicle. Given the difficulty of taking clear, stable pictures with existing EVA cameras in constantly changing lighting conditions while poorly restrained, this device was developed as a stabilization aid. Ultimately, this photo requirement went away and the mount was never fully developed or manifested.

OPERATIONAL COMMENTS

The mount was designed to attach directly to the camera lens so that it could be positioned over the area to be photographed. This was to provide a stable platform with a known focal length to obtain a usable image. The ends of the legs for the mount were to have rubberized fittings to protect the contact surfaces. Since the quality of EVA still photography is largely dependent upon good body and camera restraint, it is difficult to obtain high quality closeup images of hardware. Even wide angle images of large–scale scenes are far from easy, given the nature of the EVA environment and compatibility of the existing camera with gloved hand use.

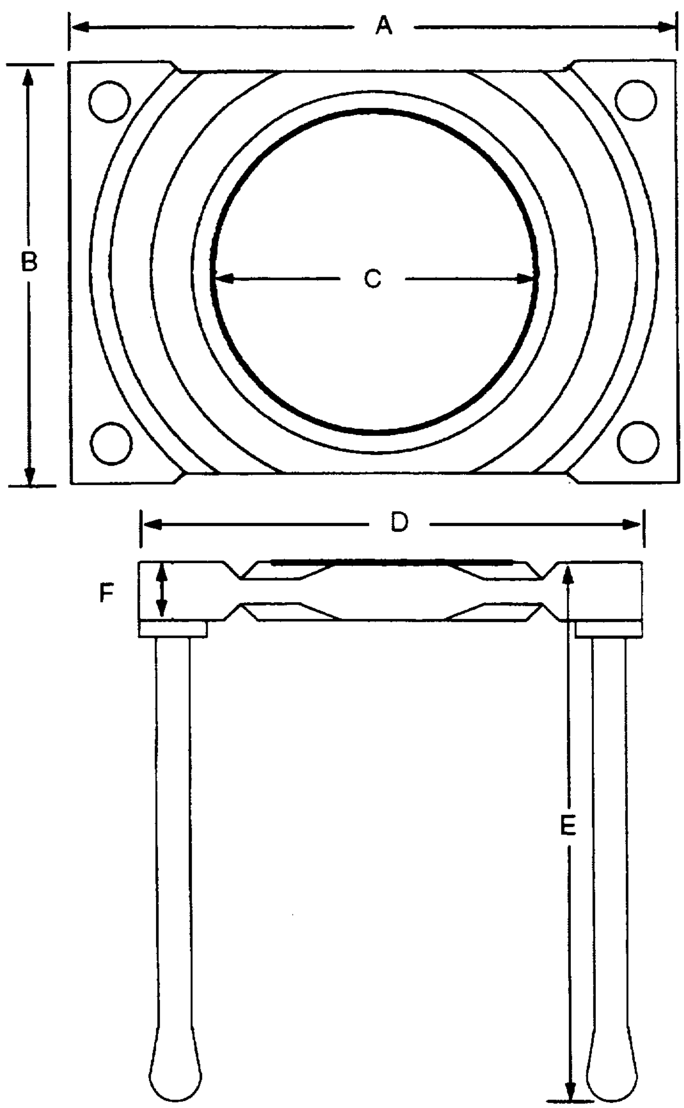
CONTACTS

Operational: W. Wedlake, JSC/DF42, (713) 483–2568
Technical: C. Seaman, NASA/EC5, (713) 483–5843

CAMERA MOUNT, MACRO

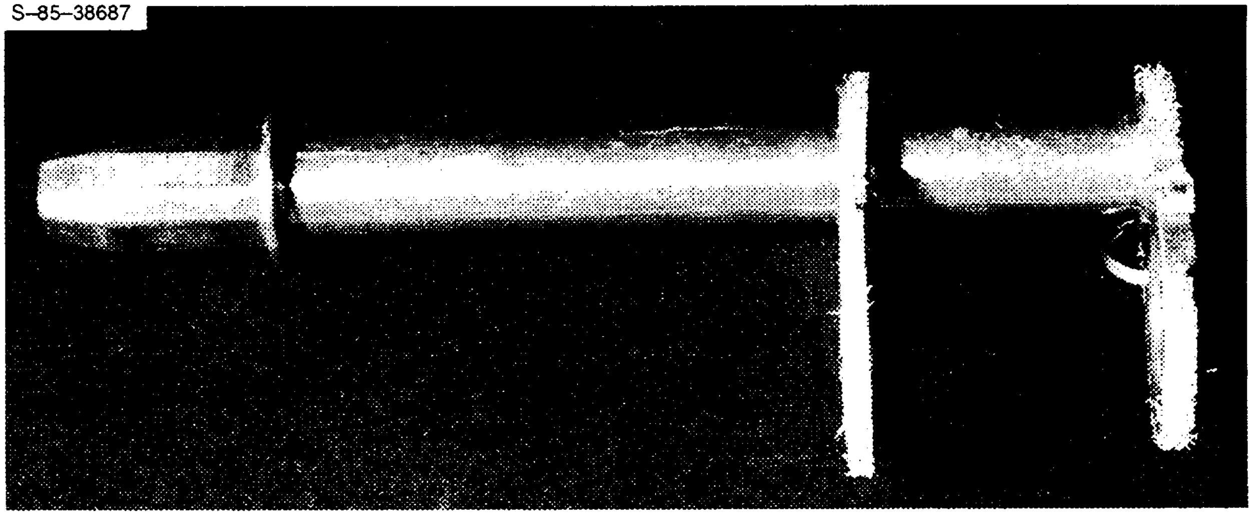
Technical Information	
Part number	None
Weight	<1.0 lb
Material/ construction	Aluminum
Load rating	
Temperature range	
Quantity flown	None
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A	3.81	9.68
B	2.63	5.71
C	1.94	3.48
D	2.73	6.93
E	4.25	10.80
F	0.44	1.11



CARRYOUT BRACKET

S-85-38687



OVERVIEW

The carryout bracket was a support bracket designed specifically for Spacelab scientific airlock (SAL) unscheduled EVA's. It was a metal rod with two circular rings attached on one side and a tether ring attached on the other side.

OPERATIONAL COMMENTS

The carryout bracket was used only during Spacelab flights and only if there was a contingency EVA because of some failure in the retraction of the experiment table and/or closure of the SAL outer hatch. It was installed during the EVA on the experiment table by sliding the two circular rings over the experiment table jettison torque tube and then inserting the bracket base approximately 1 in. into the friction fit hole in the experiment table. The bracket prevents torque tube deflection and allows one-handed ratchet operation for disconnecting the experiment table.

This tool was part of the SAL generic EVA support equipment. It was stowed in the Spacelab tools caddy in Volume H locker of the crew compartment on a flight-specific basis.

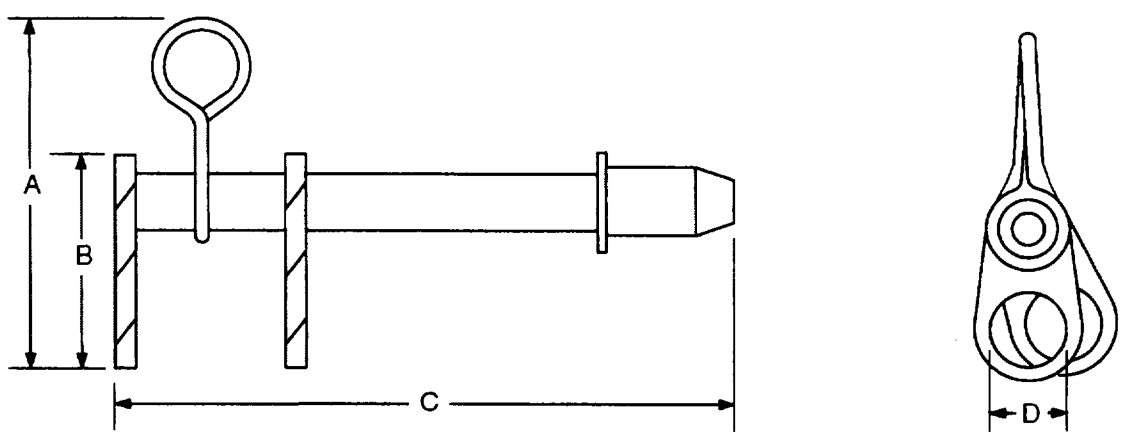
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483-2570
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

CARRYOUT BRACKET

Technical Information	
Part number	10159–20077–01
Weight	0.22 lb
Material/ construction	Aluminum
Load rating	
Temperature range	
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	4.00	10.16
B	2.45	6.22
C	6.65	16.89
D	0.75	1.91



CETA ELECTRICAL CART (EDFE)

S90–33702

S90–5473

OVERVIEW

The electrical cart is a component of the crew and equipment translation aid (CETA) experiment flown on the STS–37 EVA development flight experiment (EDFE). It was one of three candidate carts that were interchangeable with a single rolling truck. Unlike the mechanical and manual carts, this particular design was propelled by a hand–cranked electrical generator. Each cart was evaluated as conceptual technology for Space Station Freedom (SSF) to achieve a means of rapid transport of EVA crew, loose equipment, and tools for SSF assembly and maintenance. The truck provided four wheel roller clusters to engage a track, much like a roller coaster. A portable data acquisition package (PDAP) recorded the instrumented performance of each cart design.

OPERATIONAL COMMENTS

In this EDFE design, a portable foot restraint provides body restraint while translating. While riding the CETA carts, the crew does not use the orbiter safety tether/slidewire but instead uses a fixed tether reel provided by the truck. Artificial illumination was provided by the payload bay floodlights and the extravehicular mobility unit (EMU) helmet lights.

The crew turns a manual crank to power a generator, which in turn powers a pair of small dc motors and the cart spring–loaded, rubber–coated drive wheels. The direction of hand cranking determines forward or reverse motion, as well as providing a braking force. The handles can be locked in place for launch and landing with a sliding tab on top of the handcrank. The generator and handcrank are located on top of a telescoping pole, which is length adjustable with a push/turn knob. The elevation angle of the pole is adjustable with a bracket that has a pushbutton shaft which engages slots on the pole. Smooth, free–spinning handle grips prevent EMU glove abrasion during cranking operations.

This cart has a parking brake controlled from a lever on the boom of the telescoping handcrank. The brake is locked on by pushing on the lever to drive a mechanical linkage and cable system. A handle on the cart platform allows the wheel to be preload engaged or released for cart installation and removal with the truck. Protective covers eliminate pinch points and tether snags related to the wheel rollers. The electrical cart launches and lands installed on a sill longeron cart stowage assembly. This fixture has a dedicated foot restraint to aid in cart handling during stowage and installation.

While the upright body position of this cart gives good translation visibility, it was decided that the SSF CETA cart would be manually propelled as opposed to electrical or mechanical drive systems. Since the EDFE carts were built only as experimental hardware to demonstrate proof of concepts and to aid in final product selection for SSF, its components will not interface with SSF in any manner.

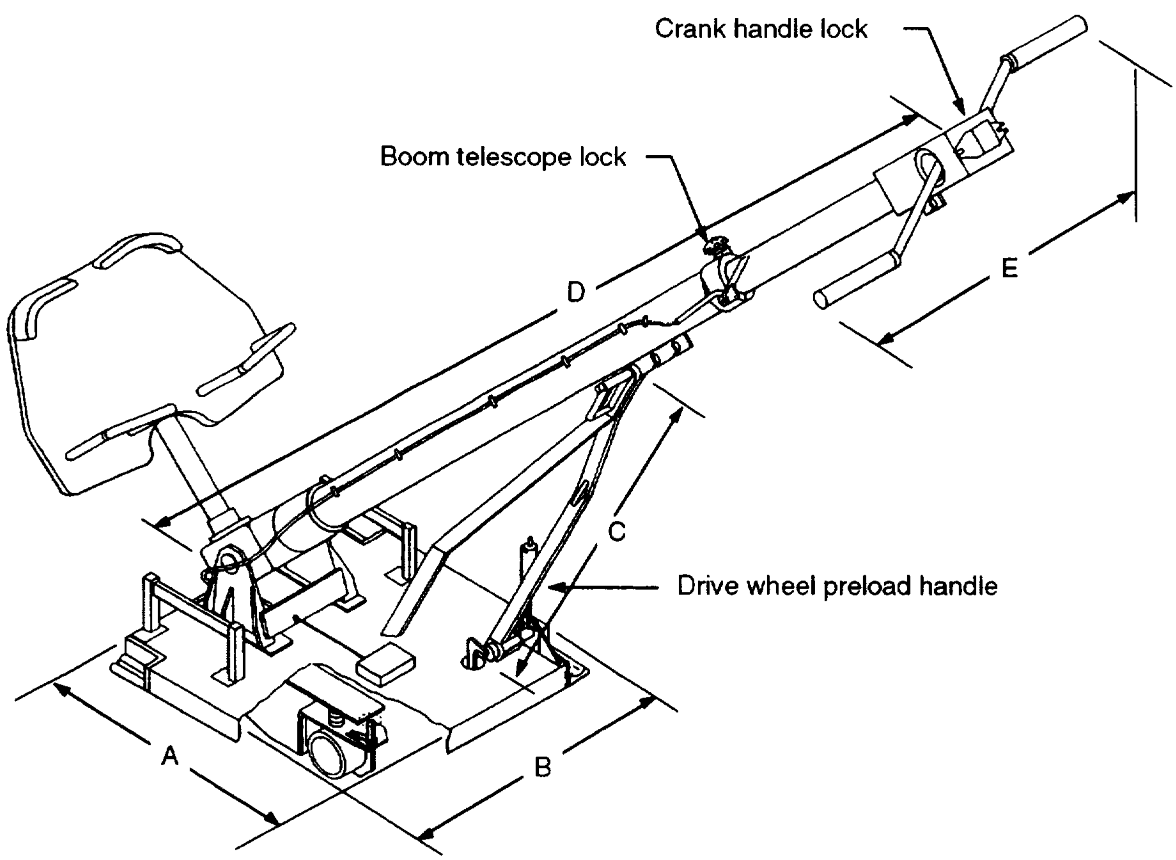
CONTACTS

Operational: B. Adams, JSC/DF42, (713) 483–2567
Technical: J. O'Kane, NASA/EC5, (713) 483–9229

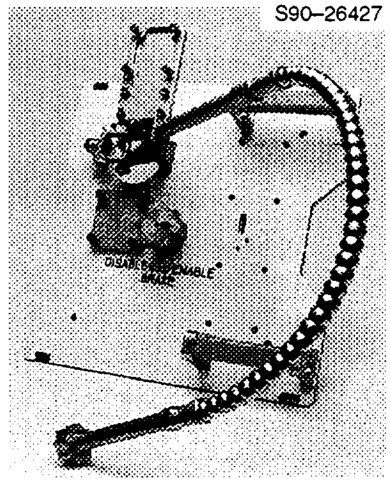
CETA ELECTRICAL CART (EDFE)

Technical Information	
Part number	SED39120974–301
Weight	62 lb (without truck or sidewall carrier)
Material/ construction	Metallics – Aluminum alloys, stainless, CRES Nonmetallics – Raymark brake pads, chemglaze
Load rating	3–**ft/sec** translation and impact rate (nominal) 6–**ft/sec** translation and impact rate (max.) 100–lb foot restraint load (any direction) 200–lb handhold/tether ring strength 9.5–lb handcrank use load 2–lb parking brake hold capacity
Temperature range	–85° to +165° F (operational and stowage)
Quantity flown	One on STS–37
Stowage	Payload bay sidewall carrier
Availability	Reference only

Dimensional Data		
	inches	cm
A	**20.0**	**50.8**
B	**20.0**	**50.8**
C	**24.0**	**61.0**
D	**44.0 to 53.3**	**111.8 to 135.4**
E	**22.0**	**55.9**



CETA MANUAL CART (EDFE)


S90–26427

OVERVIEW

The manual cart is a component of the crew and equipment translation aid (CETA) experiment flown on the STS–37 EVA development flight experiment (EDFE). It was one of three candidate carts that were interchangeable with a single rolling truck. Unlike the electrical and mechanical carts, this particular design was directly manually propelled by grasping the track handrails. Each cart was evaluated as conceptual technology for Space Station Freedom (SSF) to achieve a means of rapid transport of EVA crew, loose equipment, and tools for SSF assembly and maintenance. The truck provided four–wheel roller clusters to engage a track, much like a roller coaster. One truck latch system secured the interchangeable carts. A portable data acquisition package (PDAP) recorded the instrumented performance of each cart design.

OPERATIONAL COMMENTS

A portable foot restraint provided body restraint while translating. While riding the CETA carts, the crew did not use the orbiter safety tether/slidewire but instead used a fixed tether reel provided by the truck. A pair of sockets was mounted on the manual cart base to allow the foot restraint to be attached in more than one location to evaluate single and dual handrail propulsion. Artificial illumination was provided by the payload bay floodlights and the extravehicular mobility unit (EMU) helmet lights.

The manual cart has a single brake handle and set of brake pads that could be actuated as a parking brake (to prevent inadvertent movement when not in use) or as a dynamic brake to decelerate a moving crewmember. The brake handle was mounted on a flexible shaft to aid individual crew access. A short tether strap and hook on the brake handle could be attached to the crewmember's suit to ensure easy and repeatable brake reach. This brake was actuated by pulling on the handle knob to drive a mechanical linkage and cable system. A knob on the cart platform allowed the brake to be enabled or disabled for cart installation and removal with the truck. Protective covers eliminated pinch points and tether snags related to the wheel rollers.

The manual cart was launched and landed installed on the truck to simplify its immediate use. The manual cart brake handle was restrained by the tether shuttle for launch and landing.

Based on the STS–37 evaluations, the SSF CETA cart was selected to be propelled manually rather than by electrical or mechanical drive systems. Since the EDFE carts were built only as experimental hardware to demonstrate proof of concepts and to aid in final product selection for SSF, its components will not interface with SSF in any manner.

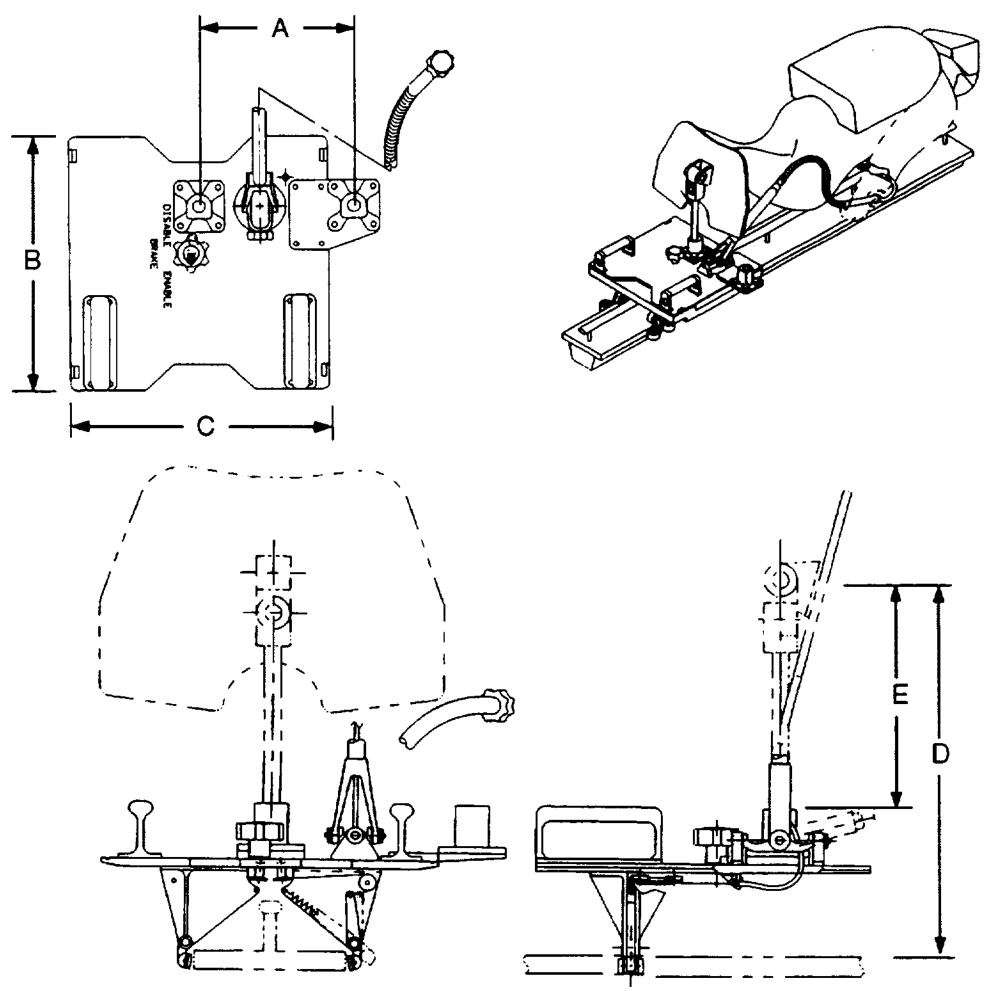
CONTACTS

Operational: B. Adams, JSC/DF42, (713) 483–2567
Technical: J. O'Kane, NASA/EC5, (713) 483–9229

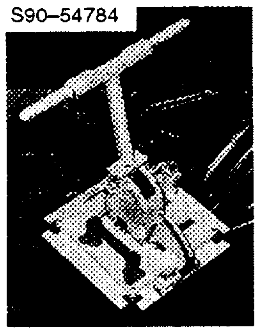
CETA MANUAL CART (EDFE)

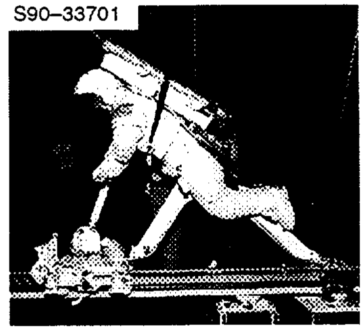
Technical Information	
Part number	LE1011003
Weight	25 lb (without truck)
Material/ construction	Metallics – Aluminum alloys, stainless, CRES Nonmetallics – Raymark brake pads, chemglaze
Load rating	3 ft/sec translation and impact rate (nominal) 6 ft/sec translation and impact rate (max.) 0.25 ft/sec^2 acceleration/deceleration (max.) 100–lb foot restraint load (any direction) 187–lb handrail/knob strength 50–lb brake handle limit load 100–lb brake hold capacity
Temperature range	150° to +140° F (operational and stowage)
Quantity flown	One on STS–37
Stowage	Payload bay CETA rail
Availability	Reference only

Dimensional Data		
	inches	cm
A	12.00	30.48
B	20.0	50.8
C	20.0	50.8
D	22.2	56.388
E	13.3	33.78



CETA MECHANICAL CART (EDFE)


S90–54784


S90–33701

OVERVIEW

The mechanical cart is a component of the crew and equipment translation aid (CETA) experiment flown on the STS–37 EVA development flight experiment (EDFE). It was one of three candidate carts that were interchangeable with a single rolling truck. Unlike the manual and electrical carts, this particular design was propelled by a handcranked ratchet to drive geared wheels. Each cart was evaluated as conceptual technology for Space Station Freedom (SSF) to achieve a means of rapid transport of EVA crew, loose equipment and tools for SSF assembly, and maintenance. The truck provided four–wheel roller clusters to engage a track much like a roller coaster. A portable data acquisition package (PDAP) recorded the instrumented performance of each cart design.

OPERATIONAL COMMENTS

In this EDFE design, a leg restraint or saddle with three sets of pegs was used as an alternative to the standard portable foot restraint . With the pegs placed at the front of the upper thighs, behind the knees, and in front of the ankles, this restraint was to provide greater body stability and allow greater working forces with the upper body. This restraint was secured at one end by the mechanical cart and at the other end by the tether shuttle. While riding the CETA carts, the crew did not use the orbiter safety tether/slidewire but instead used a fixed tether reel provided by the truck. Artificial illumination for this evaluation was provided by the payload bay floodlights and the extravehicular mobility unit (EMU) helmet lights.

With this cart, the crew pushes and pulls against a T–handle to power gears and the cart's spring–loaded, rubber–coated drive wheels. The drive includes a shift mechanism to select park, forward, neutral, or reverse gears and has a variable drive wheel preload for varying traction levels. Extending the T–handle beyond the normal push/pull range while pulling up on the inner portion of the T–handle engages a coaster brake. Smooth, free–spinning handle grips prevent EMU glove abrasion during cranking operations. Protective covers eliminate pinch points and tether snags related to the wheel rollers.

The mechanical cart launched and landed installed on a sill longeron cart stowage assembly. This fixture had a dedicated foot restraint to aid in cart handling during stowage and installation. Two passive and two active latches secured each cart to the single truck. A set of two arrestors on the truck provided a controlled stop in the event the track energy absorbers were contacted after brake failure. The wheel clusters and truck–cart latches were removable for emergency jettisoning if the truck or cart could not be secured for landing.

Based on the STS–37 evaluation, it was decided that the SSF CETA cart would be propelled manually as opposed to using electrical or mechanical drive systems. Since the EDFE carts were built only as experimental hardware to demonstrate proof of concepts and to aid in final product selection for SSF, its components will not interface with SSF in any manner.

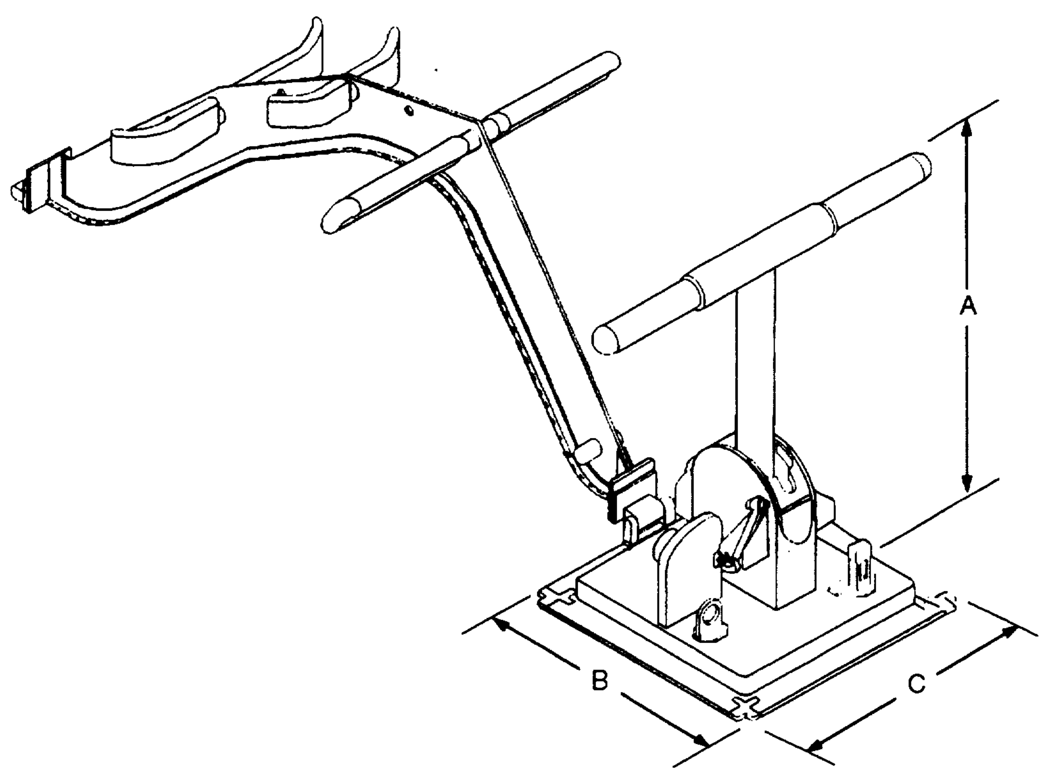
CONTACTS

Operational: B. Adams, JSC/DF42, (713) 483–2567
Technical: J. O'Kane, NASA/EC5, (713) 483–9229

CETA MECHANICAL CART (EDFE)

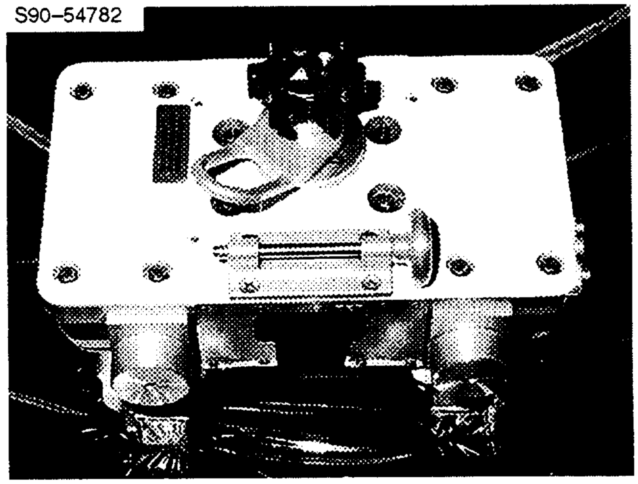
Technical Information	
Part number	SED39121323–301 (cart) SED39121247–301 (leg restraint)
Weight	50 lb (without truck or sidewall carrier)
Material/ construction	Metallics – Aluminum alloys, stainless, CRES Nonmetallics – Raymark brake pads, chemglaze
Load rating	3 ft/sec translation and impact rate (nominal) 6 ft/sec translation and impact rate (max.) 200 lb handhold/tether ring strength
Temperature range	
Quantity flown	One on STS–37
Stowage	Payload bay sidewall carrier
Availability	Reference only

Dimensional Data		
	inches	cm
A	36.0	91.44
B	20.0	50.8
C	20.0	50.8



CETA TETHER SHUTTLE (EDFE)

S90-54782



OVERVIEW

The tether shuttle was a component of the crew and equipment translation aid (CETA) experiment flown as part of the STS-37 EVA development flight experiment (EDFE). The shuttle served as a manually powered translation aid, body restraint, and safety tether attachment while rolling along a stationary track. Like the slidewire, it allows continuous translation without having to incrementally relocate the safety tether. It has four wheel roller clusters that engage a track much like a roller coaster. A design descendant of this unit has been baselined for Space Station Freedom (SSF).

OPERATIONAL COMMENTS

In this EDFE design, a large knob provided crew body restraint while translating. While riding the shuttle, the crew did not use the orbiter safety tether/slidewire but instead connected their waist safety tether reels to a rotating tether point on the shuttle. The shuttle has a parking brake that prevents inadvertent movement when not in use but was not intended for deceleration of a moving crewmember. This brake was actuated by a sliding tab on top of the body restraint knob. The crewmember's gloved hand served as the brake during translations. Protective covers eliminated pinch points and tether snags related to the wheel rollers. Payload bay floodlights and EMU helmet lights provided artificial illumination during translation.

The tether shuttle was installed on the track prior to launch and was held in place by shims and four captive 7/16–in. hex–head bolts. The shuttle was attached to the truck and manual cart for launch via its pip pin and a hinged bracket on the truck. The manual cart brake handle was restrained by the shuttle for launch and landing. Eight noncaptive 7/16–in. hex–head bolts allowed contingency removal from the track in the event that any of the rollers became jammed or the restraint bolts could not be resecured for landing. The shuttle could be mated to the EDFE truck/carts and was an integral component of the mechanical cart evaluation where it held one end of a leg restraint assembly.

This tether shuttle was specifically built as prototype experimental hardware to demonstrate proof of concepts and to aid in selection of a final product for SSF. SSF design is based on these early CETA concepts, but it has since evolved with its own unique hardware. Therefore, these STS-37 components will not interface with SSF in any manner.

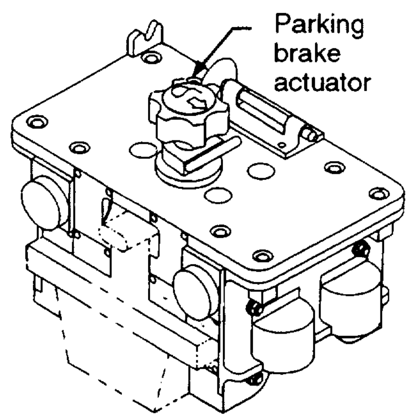
CONTACTS

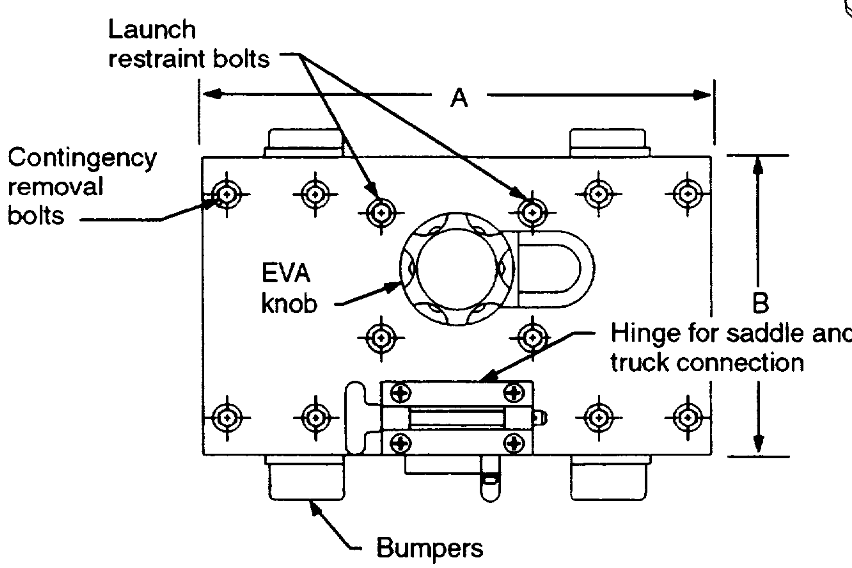
Operational: B. Adams, JSC/DF42, (713) 483–2567
Technical: J. O'Kane, NASA/EC5, (713) 483–9229

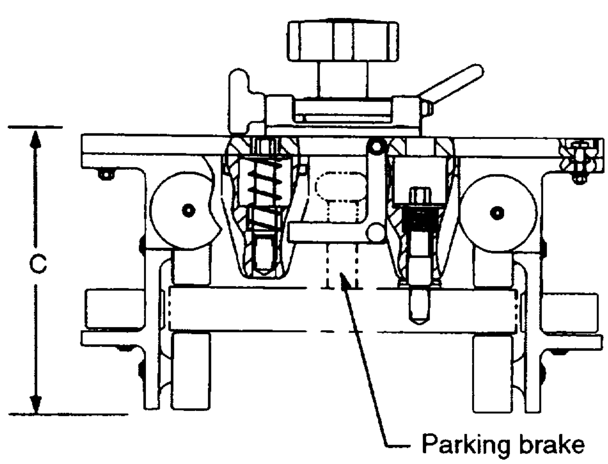
CETA TETHER SHUTTLE (EDFE)

Technical Information	
Part number	LE1011004
Weight	21 lb
Material/ construction	Aluminum alloys, CRES
Load rating	3 ft/sec translation and impact rate 187 lb knob strength 587 lb tether point
Temperature range	–70° to +165° F
Quantity flown	One on STS–37
Stowage	Mated to payload bay CETA track
Availability	Reference only

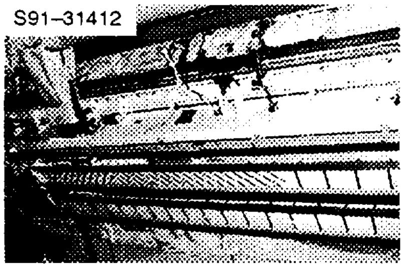
Dimensional Data		
	inches	cm
A	13.4	34.04
B	8.0	20.32
C	7.0	17.8

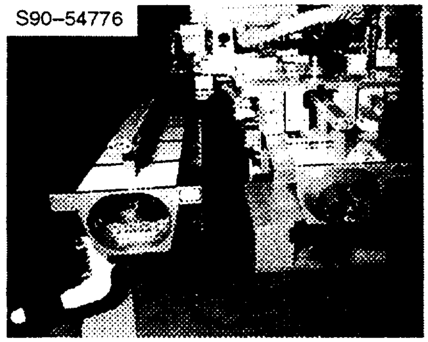


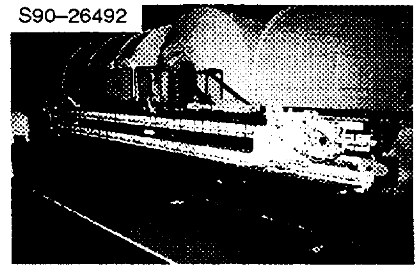




CETA TRACK (EDFE)


S91–31412


S90–54776


S90–26492

OVERVIEW

The crew and equipment translation aid (CETA) track or rails are components of an experiment flown on the STS–37 EVA development flight experiment (EDFE). The rails allowed the evaluation of four different translation devices (three carts and one tether shuttle). Two separate rails were assembled on orbit to create a 47–ft. long translation path. One rail was fixed in place, while the other was relocatable by two EV crewmembers to latch to the aft end of the first rail. The handrail of each track was instrumented with magnets that were used in conjunction with the CETA truck's Hall–effect sensors to determine cart velocity as recorded by a portable data acquisition package.

OPERATIONAL COMMENTS

Each rail was approximately 23.5–ft. long. Sidewall carriers secured the two sections during launch and on–orbit use. Adjustable latches ensured compliance for structural and thermal deflections to ensure that the deployable rail could be installed and stowed properly. The stationary rail also served as the launch location for the truck/manual cart and the tether shuttle. Contingency release bolts were provided as an override in case the track–to–track latch failed to release. The deployable rail was not certified to land in other than the launch configuration.

Continuous handrails along the center of each rail provided the primary means of propulsion for the manual cart and the tether shuttle. A 22–ft. long outrigger handrail allowed the evaluation of parallel manual aids to accelerate or decelerate these translation devices. This outrigger handrail had a dog–bone–shaped cross section and was evaluated as an improved means of maintaining body control during free–floating manual translations. The rails were marked with red, yellow, and black stripes to inform crewmembers of their location relative to the end of travel. The end of each rail had a load–absorbing arrestor to handle CETA truck/cart impacts. It was made up of a honeycomb material that collapsed upon impact and was not designed to be reset for subsequent uses.

All EDFE CETA components were specifically built as prototype experimental hardware to demonstrate proof of concepts and to aid in selection of a final product for Space Station Freedom (SSF). SSF design is based on these early CETA concepts but has since evolved with its own unique hardware. Therefore, these STS–37 components will not interface with SSF in any manner.

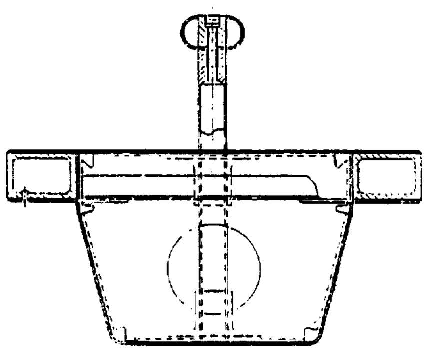
CONTACTS

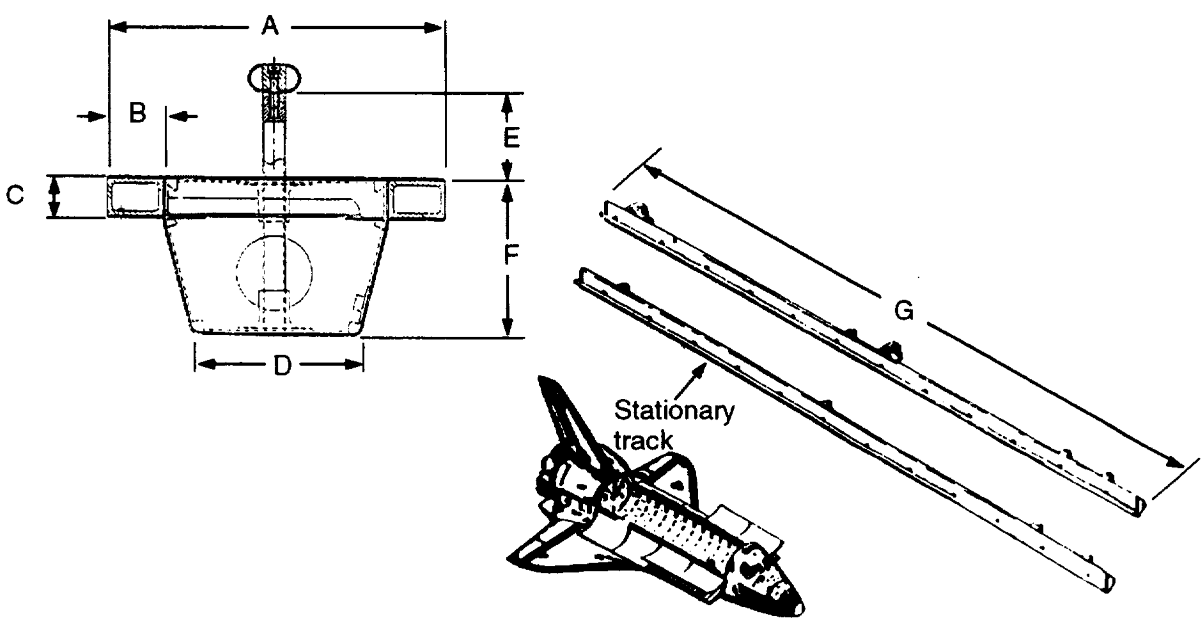
Operational: B. Adams, JSC/DF42, (713) 483–2567
Technical: J. O'Kane, NASA/EC5, (713) 483–9229

CETA TRACK (EDFE)

Technical Information	
Part number	158322 (stationary track) 158323 (deployable track)
Weight	159 lb (stationary track with FSE) 195 lb (deployable track with FSE)
Material/ construction	Aluminum
Load rating	200 ft–lb
Temperature range	–110° to +165° F
Quantity flown	One each on STS–37
Stowage	Payload bay port sill longeron
Availability	Reference only

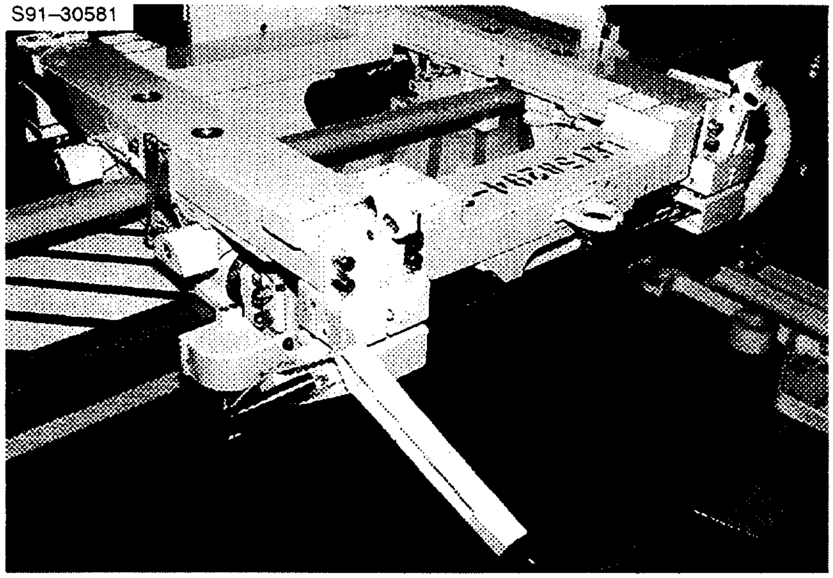
Dimensional Data		
	inches	cm
A	9.00	22.86
B	1.50	3.81
C	1.13	2.87
D	4.50	11.43
E	2.25	5.72
F	4.25	10.80
G	**23.5 ft**	**7.05 m**





CETA TRUCK (EDFE)

S91–30581



OVERVIEW

The crew and equipment translation aid (CETA) truck is a component of the CETA experiment flown as part of the STS–37 EVA development flight experiment (EDFE). The truck served as the common carrier for three candidate carts and a data recorder. It has four–wheel roller clusters that engage a track, much like a roller coaster. One latch system secures the interchangeable carts while a second holds the portable data acquisition package (PDAP).

OPERATIONAL COMMENTS

Two passive and two active latches secured each cart to the single truck. A set of two arrestors provided a controlled stop in the event that the track energy absorbers were contacted after brake failure. The wheel clusters were removable for emergency jettisoning if the truck could not be secured for landing. Brackets and four captive spring–loaded bolts held the truck in place for launch and landing. Instrumentation on the truck consisted of strain gauges, temperature sensors, and Hall–effect velocity sensors. The separate tether shuttle mated with the truck with a simple pip pin arrangement. While riding the CETA carts, the crewmember did not use the orbiter safety tether/slidewire; instead, a fixed tether reel provided by the truck was used.

The truck and its carts were specifically built as prototype experimental hardware to demonstrate proof of concepts and to aid in selection of a final product for Space Station Freedom (SSF). SSF design is based on these early CETA concepts but has since evolved with its own unique hardware. Therefore, these STS–37 components will not interface with SSF in any manner.

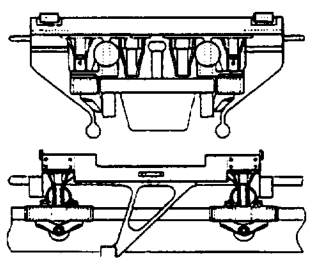
CONTACTS

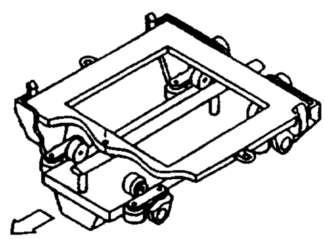
Operational: B. Adams, JSC/DF42, (713) 483–2567
Technical: J. O'Kane, NASA/EC5, (713) 483–9229

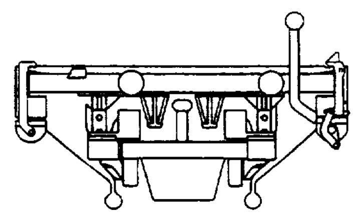
CETA TRUCK (EDFE)

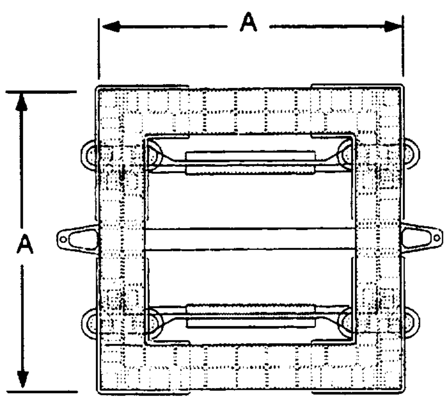
Technical Information	
Part number	158294
Weight	60 lb
Material/ construction	Aluminum
Load rating	200 lb any direction 200 ft–lb bending moment 200 lb tether point
Temperature range	–70° to +165° F
Quantity flown	One on STS–37
Stowage	Payload bay CETA rail
Availability	Reference only

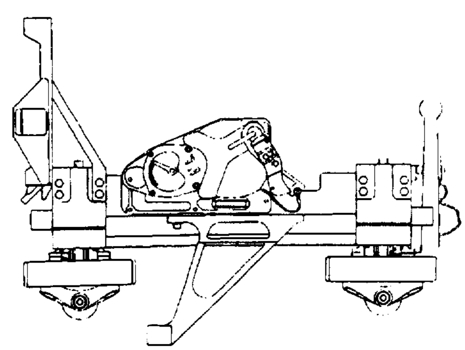
Dimensional Data		
	inches	cm
A	20.5	52.1
B		
C		
D		
E		
F		
G		
H		
Z		





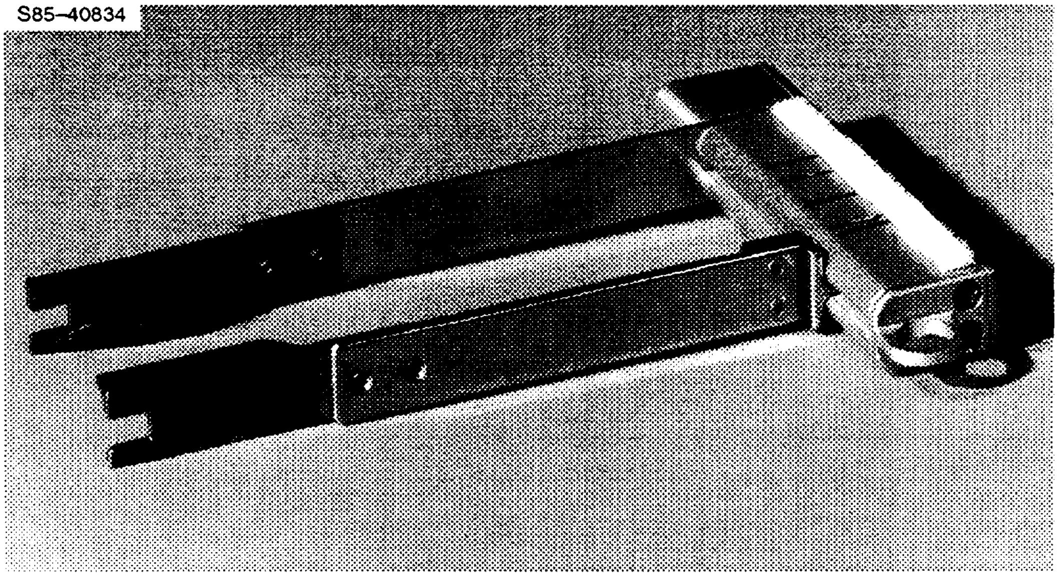






CONNECTOR INSTALLATION TOOL, D

S85–40834



OVERVIEW

The electrical D–connector installation tool, also known as the electrical connector mating tool, is used for replacement of D–style electrical connectors on satellites.

OPERATIONAL COMMENTS

The electrical D–connector installation tool is suitable for one–handed operation by a suited crewmember. The tool consists of a handle and two prongs that extend from the handle. One of the prongs is movable to five positions laterally along the handle to enable use of the tool for various size connectors. Connector holders are attached at the ends of each prong and are machined to accommodate the trapezoidal shape of the D–connector. The holders are positioned over the connector while the crewmember pushes the connector into place before releasing the holders. A tether ring is integral to the tool handle. Velcro on both sides of the handle provides grips for the crewmembers as well as further attachment points. Tooled marks on the handle define movable prong positions.

The tool was used successfully on the Solar Maximum Repair Mission (SMRM).

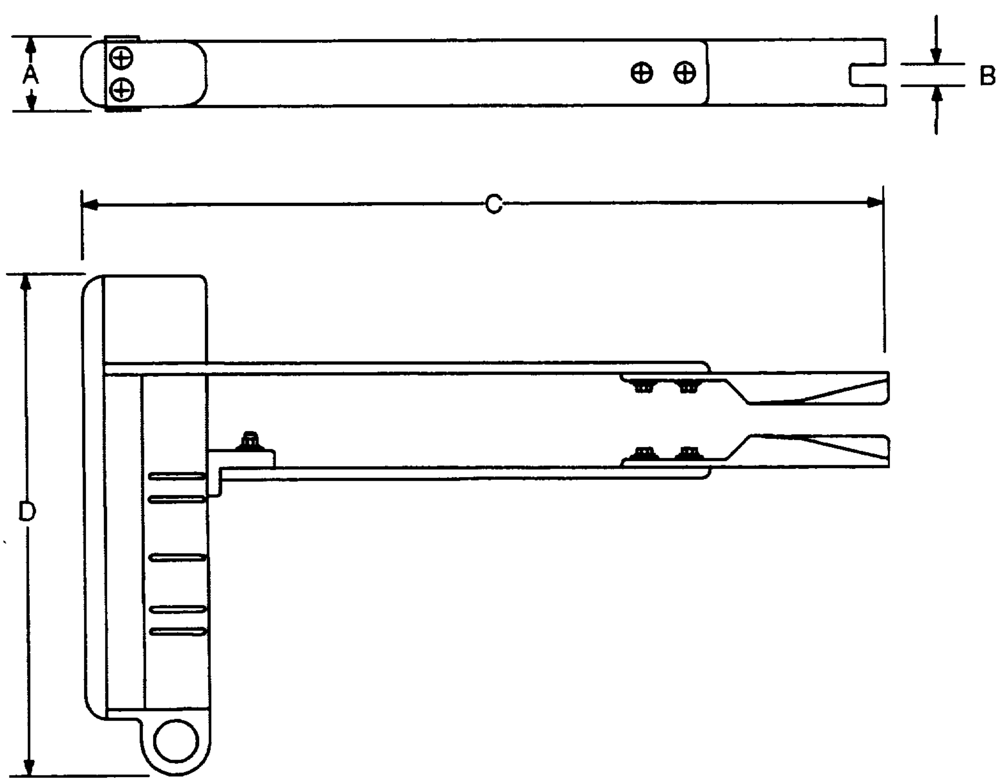
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

CONNECTOR INSTALLATION TOOL, D

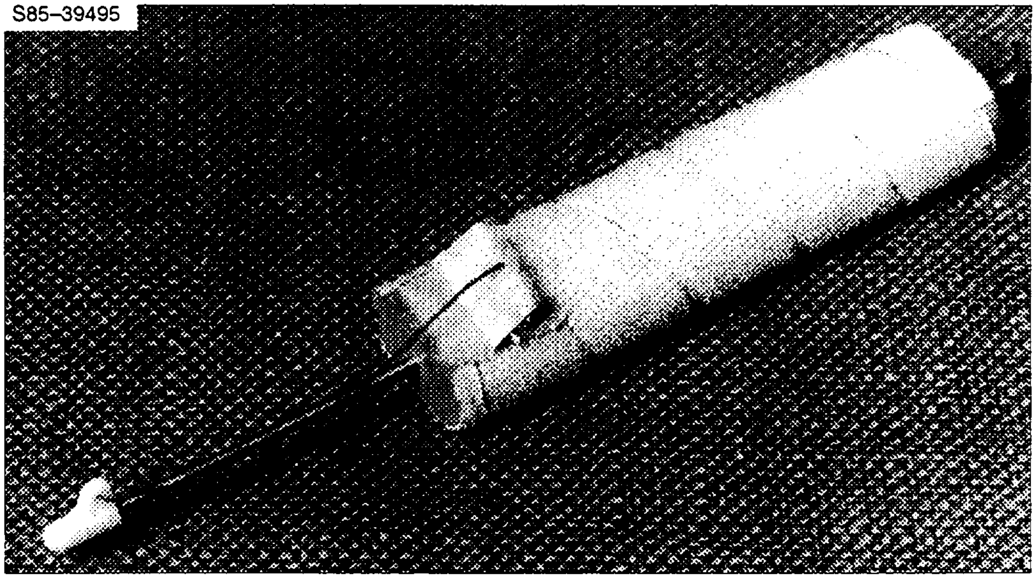
Technical Information	
Part number	SED33102630–303
Weight	0.98 lb
Material/ construction	Prongs – stainless steel Handle – aluminum
Distance between connector holders (at widest point)	Position 1 5.6 cm 2 5.3 cm 3 4.0 cm 4 2.7 cm 5 1.8 cm
Load rating	
Temperature range	
Quantity flown	
Stowage	One on a tool board in the flight support system locker and one on a tool board in the special equipment stowage assembly for STS 41–B
Availability	Reference only

Dimensional Data		
	inches	cm
A	0.85	2.16
B	0.25	0.64
C	8.00	20.32
D	5.70	14.48



CONNECTOR PIN STRAIGHTENER

S85-39495



OVERVIEW

The electrical connector pin straightener is a simple tool for straightening bent pins in electrical connectors during an EVA. It consists of a small-diameter metal tube with a Velcro-wrapped handle with tether ring attached. A safety guard permanently tethered to the handle covers the tip of the straightener before and after use. It will straighten pins attached to 20-gauge or smaller wires.

OPERATIONAL COMMENTS

The pin straightener tube is open at the tip so that it can be slipped onto the end of a bent electrical connector pin and manipulated until the pin is straight enough to function properly. It can be stowed by itself or in a tool caddy.

This tool has flown on STS 41-C, Solar Maximum repair mission, and STS 51-I, Leasat Salvage Mission, but has never been used on orbit.

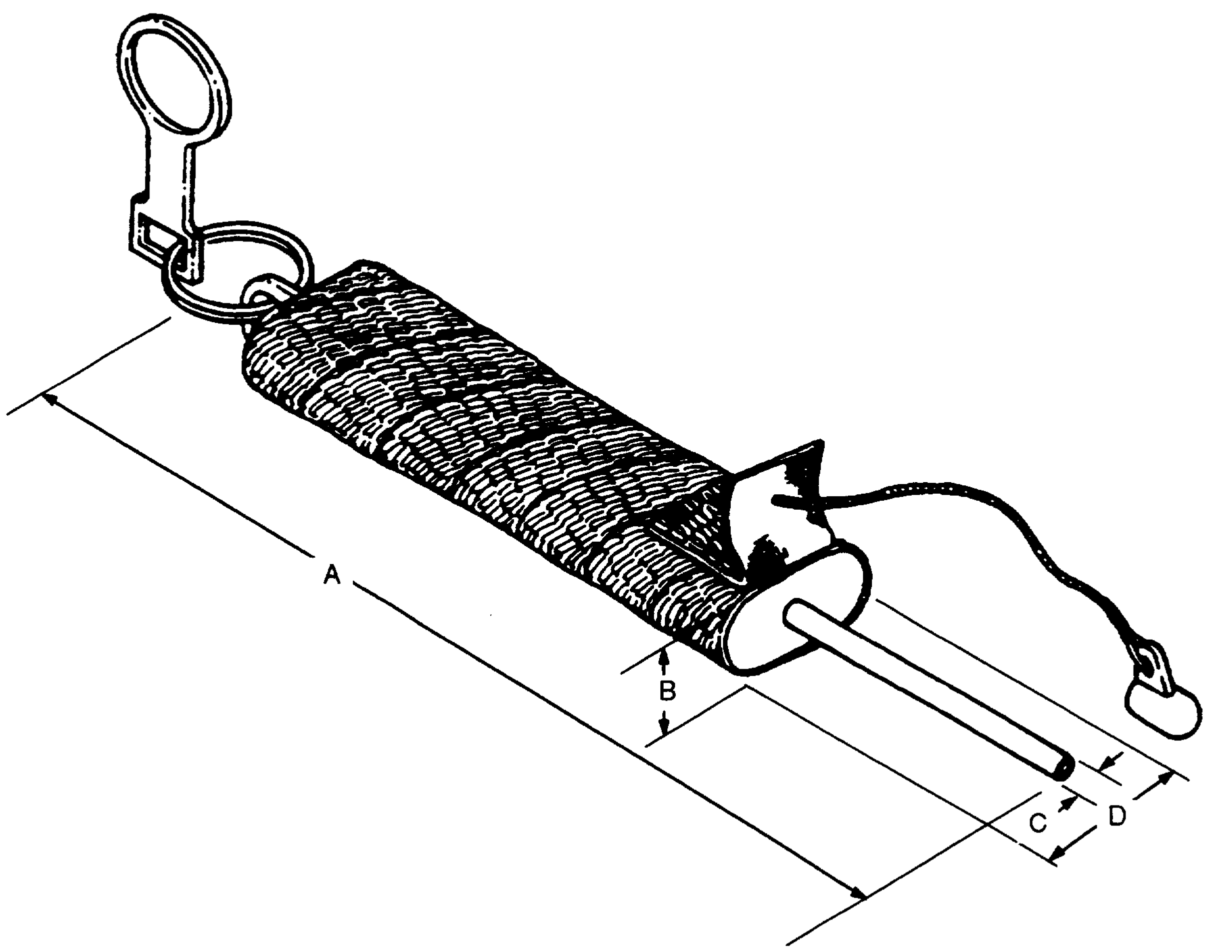
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

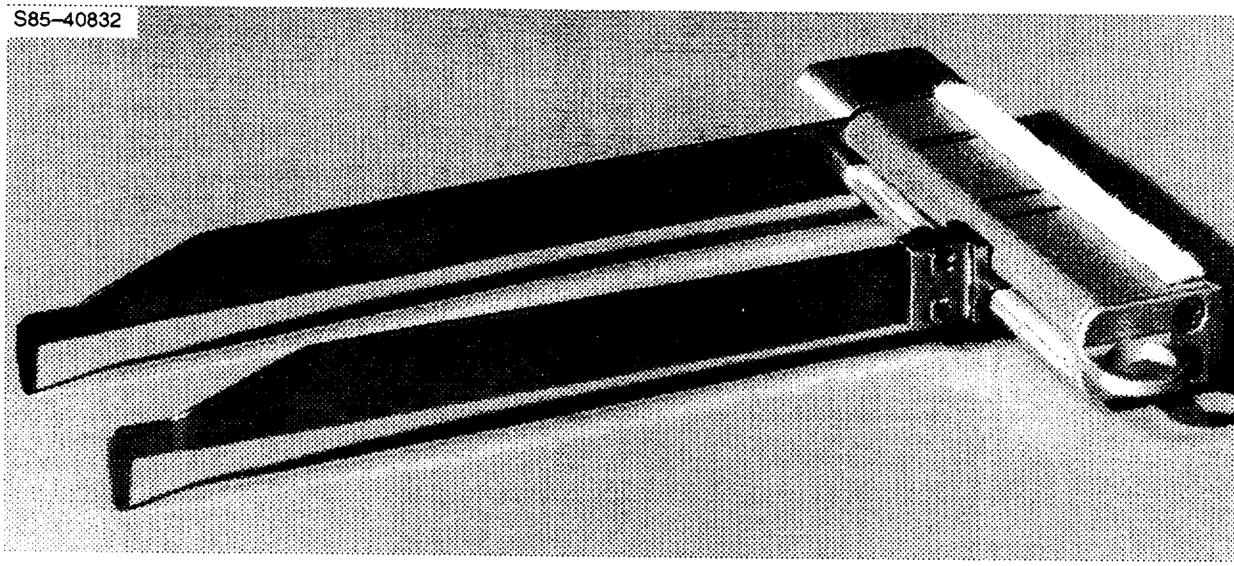
CONNECTOR PIN STRAIGHTENER

Technical Information	
Part number	10176–20147–01
Weight	0.4 lb
Material/ construction	Handle and straightener – Aluminum Tip – Teflon
Load rating	
Temperature range	
Quantity flown	One on STS 41–C and STS 51–I
Stowage	Transfer bag on STS 51–I
Availability	Reference only

Dimensional Data		
	inches	cm
A	9.340	23.72
B	0.750	1.91
C	1.375	3.49
D	0.042 (ID) 0.125 (OD)	0.11 0.32



CONNECTOR REMOVAL TOOL, D



OVERVIEW

The electrical D–connector removal tool is used for removal of D–style electrical connectors on satellites.

OPERATIONAL COMMENTS

The electrical D–connector removal tool is suitable for one–handed operation by a suited crewmember. The tool consists of a handle and two prongs with hooked ends that extend from the handle. One of the prongs can be moved along a slide in the handle to four positions. The ends of each prong form an L–shaped hook 9 mm deep. These hooks are positioned under the connector flange in order to pry the connector loose when the handle is pulled down. A tether ring is integral to the tool handle. Velcro strips on each side of the handle provide gripping power for the crewmember. Tooled marks on the handle define the positions for the movable prong.

The tool was successfully used during the repair of the Solar Maximum Satellite (STS 41–C).

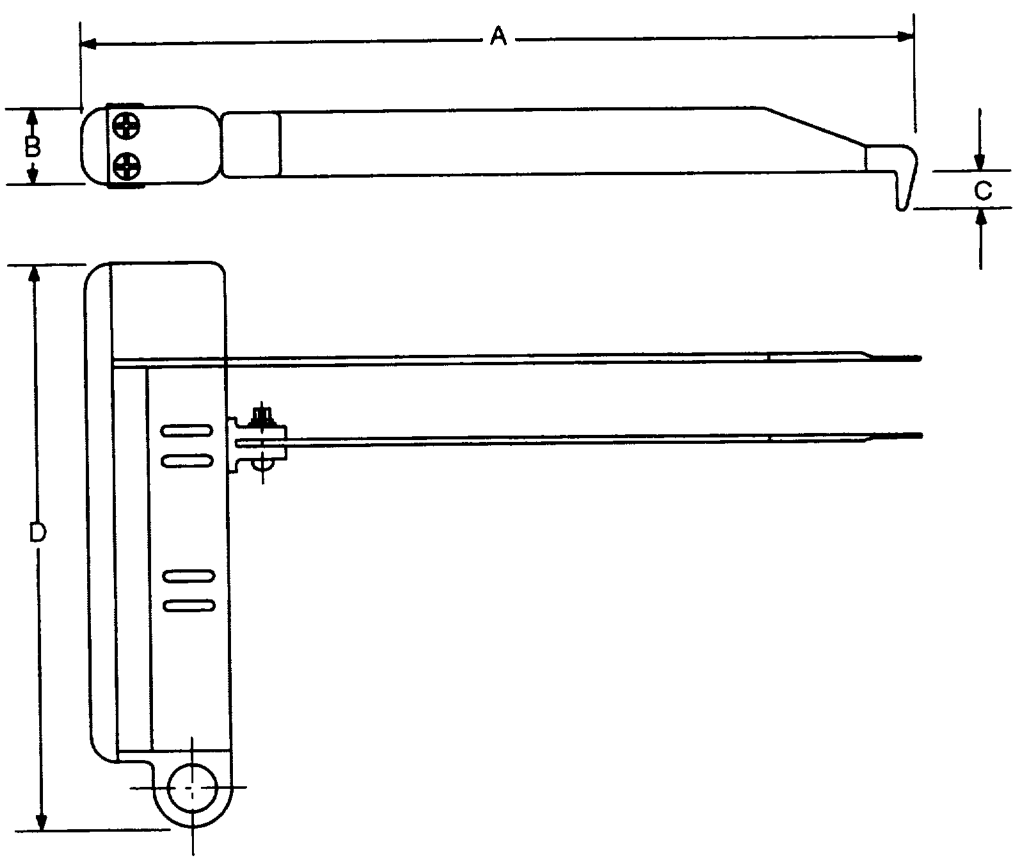
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

CONNECTOR REMOVAL TOOL, D

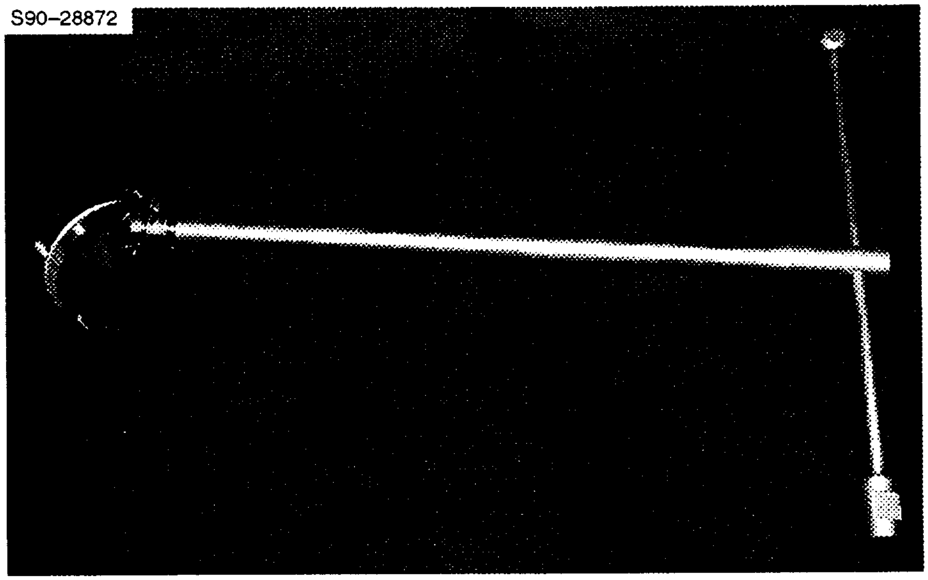
Technical Information	
Part number	SED33102623–303
Weight	0.71 lb
Material/ construction	Prongs – Stainless steel Handle – Aluminum
Distance between prong hooks	Position 1 5.2 cm 2 4.9 cm 3 1.6 cm 4 1.3 cm
Hook depth	9 mm
Load rating	
Temperature range	
Quantity flown	One on STS 41–B and STS 41–C
Stowage	One on a tool board in the flight support system locker and one on a tool board in the special equipment stowage assembly for STS 41–C
Availability	Reference only

Dimensional Data		
	inches	cm
A	8.375	21.27
B	0.850	2.16
C	0.350	0.89
D	5.700	14.48



CONNECTOR TOOL, BASIN WRENCH ELECTRICAL

S90–28872



OVERVIEW

This electrical connector tool is designed to remove and install bayonet–style circular electrical connectors. It was developed for STS–32 as a contingency aid to disconnect difficult–to–reach connectors on a standard interface panel (SIP) on the payload bay sill longeron. This off–nominal task was developed to reapply power for deployment of the Syncom–IV satellite by demating a connector from a failed receptacle and switching to a backup power outlet receptacle. A commercial plumber's basin wrench was modified to create this design. This provides a means to demate connectors that are closely spaced together and deeply recessed out of reach. An integral T–handle is used to apply mate/demate torque.

OPERATIONAL COMMENTS

The connectors to be operated by this tool were never intended for EVA operation and lack wing tabs or similar EVA aids. The spring–loaded jaws grip the knurled surface of the connector and tighten as torque is applied. The tool swivel detented jaws can rotate 180° to provide greater articulation in tight quarters. The jaws will accommodate connectors ranging from a 1.25 to 2.5–in. diameter. Since the jaws do not lock onto the connector, it is relatively difficult to keep the tool mated during use. This tool and the connectors for which it was designed should not be baselined for future nominal applications.

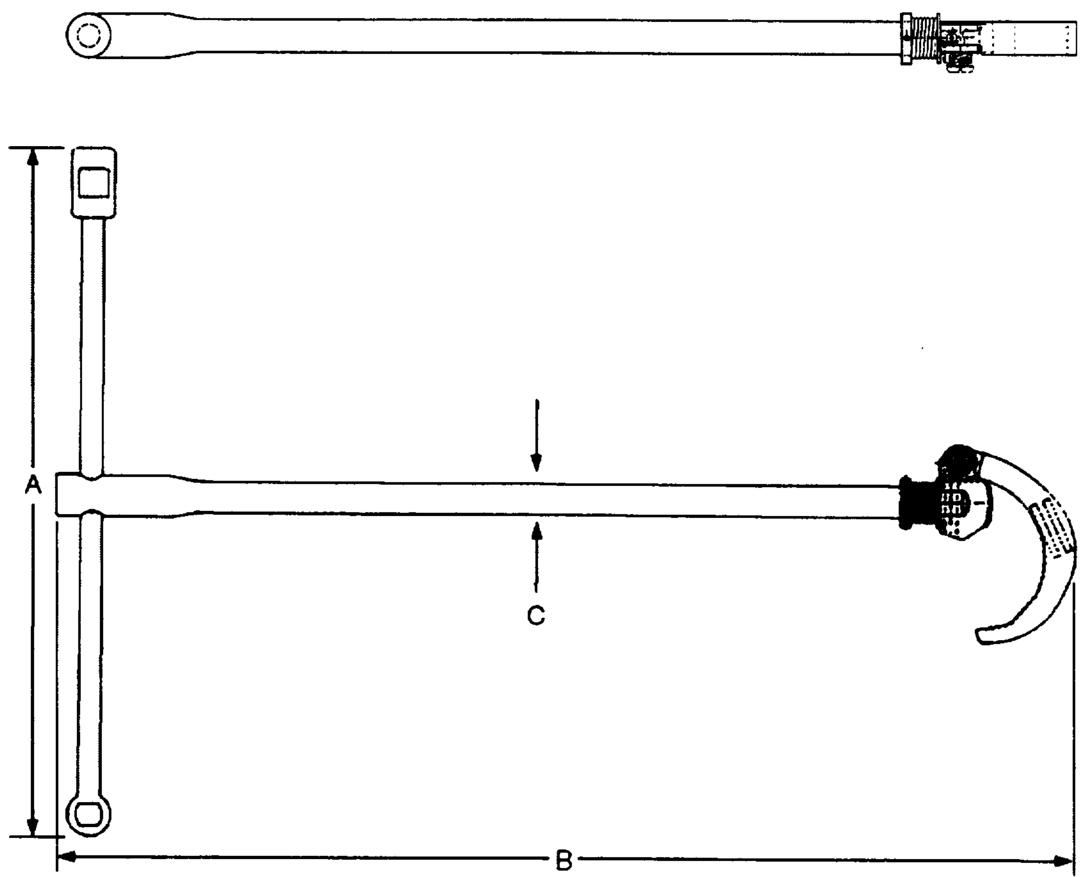
CONTACTS

Operational: W. Wedlake, JSC/DF42, (713) 483–2568
Technical: R. Marak, NASA/EC5, (713) 483–9144

CONNECTOR TOOL, BASIN WRENCH ELECTRICAL

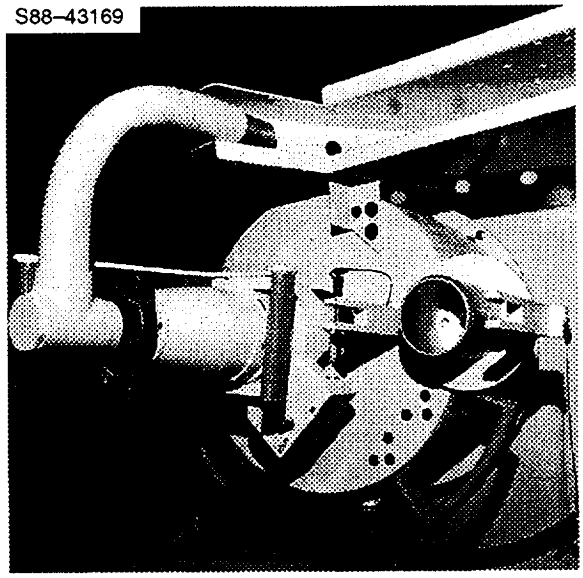
Technical Information	
Part number	SED39121560–301
Weight	
Material/ construction	Stainless steel
Load rating	11 ft–lb
Temperature range	
Quantity flown	One (STS–32)
Stowage	Middeck locker
Availability	Reference only

Dimensional Data		
	inches	cm
A	12.25	31.12
B	18.0	45.72
C	0.56	1.43



CONNECTOR, HELIUM II RESUPPLY

S88–43169



OVERVIEW

The Helium II Resupply Coupling has been designed to allow the resupplying of cyrogenic superfluid helium (He II) tanks. This capability will extend the life of scientific instruments on future satellites. This coupling will be the EVA fluid connection between a He II supply tanker and a receiving spacecraft for the transfer of superfluid helium at temperatures less than 18° K. The coupling is currently being developed to support the superfluid helium on–orbit transfer (SHOOT) flight experiment as a technology demonstration mission.

OPERATIONAL COMMENTS

This coupling consists of a tanker half (type 1) and a spacecraft half (type 2). For manual EVA engagement, the EVA crewmember initially connects the two halves in a "soft dock" position. A 7/16–in. drive hex is then used to fully engage the coupling halves. An electrical switch provides engagement status to the ground and orbiter aft flight deck. When the two halves are engaged, fluid transfer is possible. This procedure is reversed to disengage the coupling.

The coupling will initially be used for manual EVA mate and demate on orbit, but shall be readily modifiable for automatic operation when used with a carrier plate. For the SHOOT flight experiment and the initial superfluid helium tanker resupply missions, a power tool will be used to drive a 7/16–in. hex which controls the mate/demate drive screw. Type 2 couplings will be installed on the advanced X–ray astronomical facility (AXAF) and the shuttle infrared telescope facility (SIRTF).

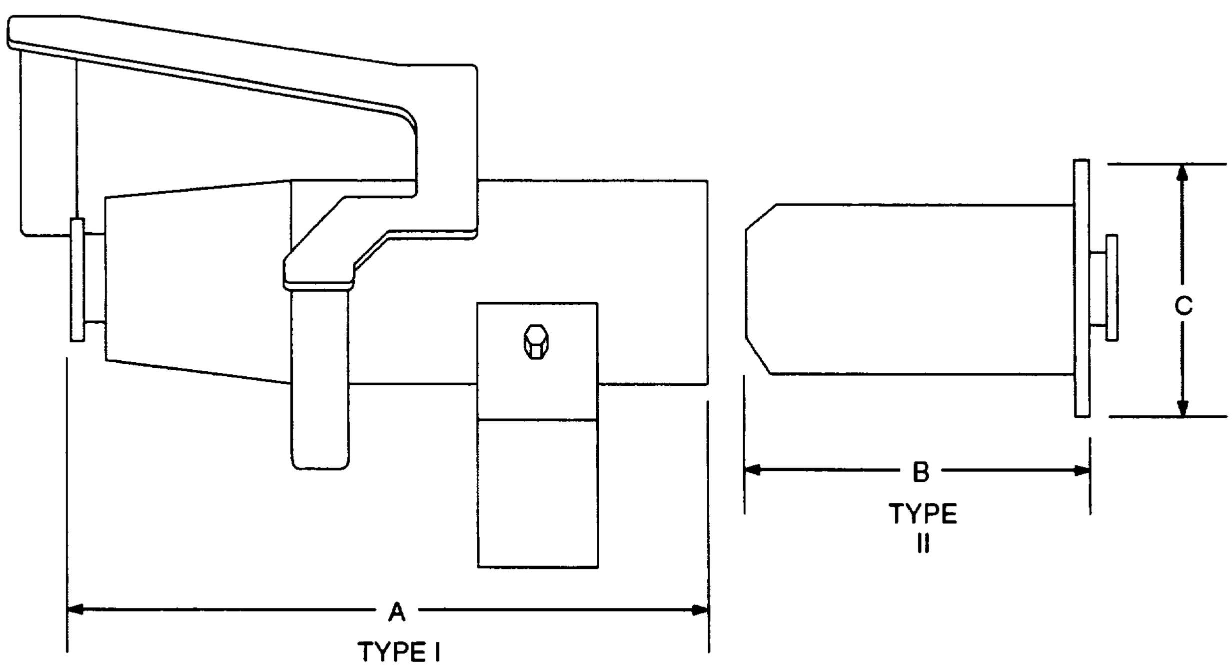
CONTACTS

Operational: R. C. Trevino, NASA/DF4, (713) 483–2597
Technical: W. C. Boyd, NASA/EP4, (713) 483–9020

CONNECTOR, HELIUM II RESUPPLY

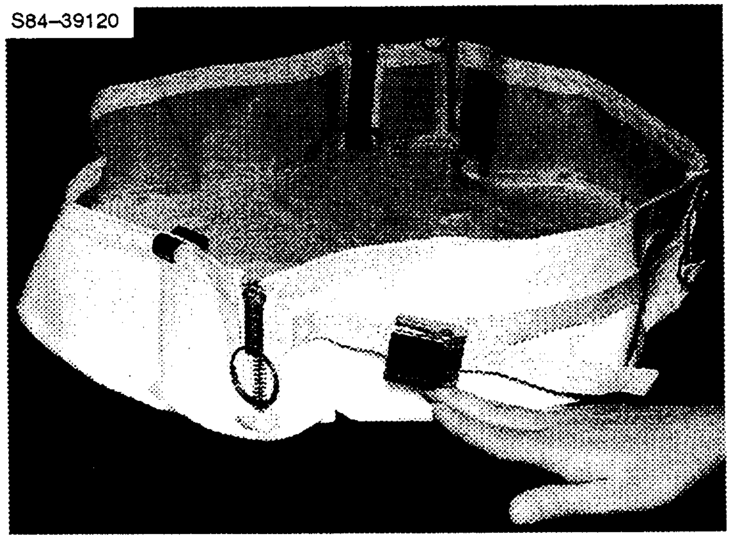
Technical Information	
Part number	None
Weight	31 lb (estimate)
Material/ construction	Stainless steel
Drive torque	~25 in–lb
Drive turns	24.2 in.
Load rating	
Temperature range	–258° to +170° F
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A	13.91	35.33
B	10.02	25.45
C	6.91	17.55



COVER, APOGEE KICK MOTOR NOZZLE

S84–39120



OVERVIEW

The apogee kick motor (AKM) nozzle cover assembly is a fabric cover which fits over Palapa/Westar type satellite nozzles to prevent contamination of the payload bay area by burned residue lining the nozzle interior.

OPERATIONAL COMMENTS

The AKM nozzle cover is constructed of Ortho fabric with Armalon reinforcement along the sides. The cover is installed onto the nozzle by EVA crewmembers prior to soft docking the satellite into the payload bay. Installation is facilitated by zippers at three side positions. Two nozzle clips and a pull strap assure a secure fit of the cover over the nozzle. Two of these covers were successfully used on STS 51–A.

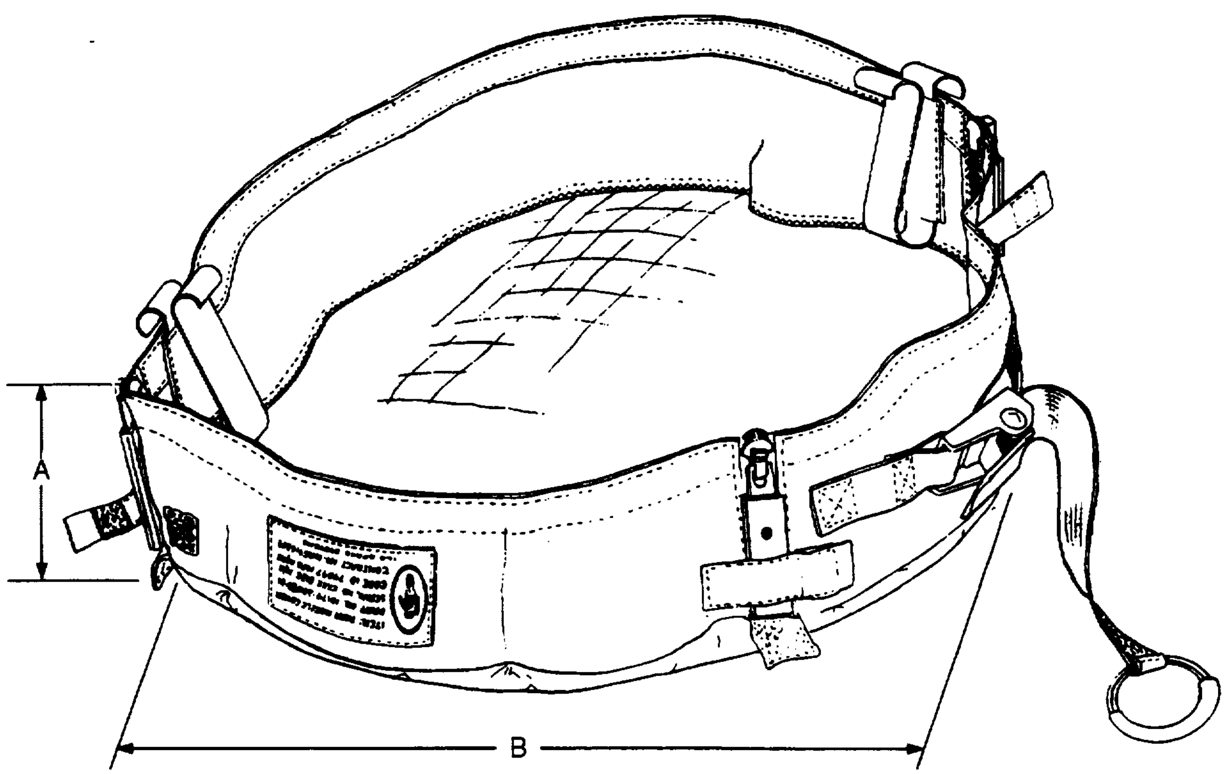
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

COVER, APOGEE KICK MOTOR NOZZLE

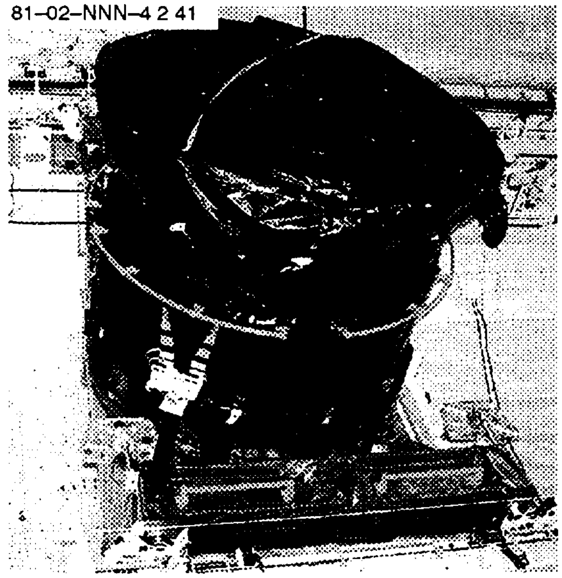
Technical Information	
Part number	10174-20090-01
Weight	2.2 lb
Material/ construction	Ortho and Armalon fabrics
Load rating	
Temperature range	
Quantity flown	**Two on STS 51-A**
Stowage	Spacelab pallet tool stowage bag on tool board #2
Availability	Reference only

Dimensional Data		
	inches	cm
A	4.5	11.43
B	25.5	64.77



COVER, LARGE SOFT ENVIRONMENTAL

81–02–NNN–4 2 41



OVERVIEW

This cover, commonly known as the shower cap, was designed for the STS–49 Intelsat reboost mission to protect sensitive mechanisms from thermal extremes and contamination. It covered the docking latches, umbilicals, and deployment electronics of the replacement booster motor until the Intelsat spacecraft was ready for installation. This large, soft cover was intended for single–flight use and was secured with Velcro. The removal and stowage of this cover was designed for simplicity and minimal overhead; it was to be completed by a single crewmember.

OPERATIONAL COMMENTS

To start the stowage process, the free floating crew released and stowed the segmented edges of the cover by folding them up like the petals of a flower. Velcro held each petal in the launch and stowed configuration. Fabric pull straps provided finger grips for petal handling. From a fixed foot restraint, a single crewmember then folded the entire cover into a modified petal that served as the shower cap's own stowage bag. A long strap across the shower cap diameter aided retraction of the cover. Finally, the cover was stowed out of the way near the worksite with a set of pip pins. Grounding wires protected against static charge buildup; pressure vent patches allowed atmospheric pressure to escape on orbit. The simplicity and the user friendliness associated with the design and use of this cover are recommended for future large, soft covers that must be handled by an EVA crew.

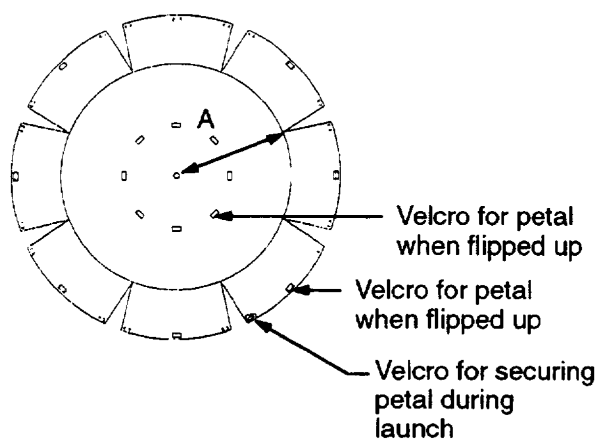
CONTACTS

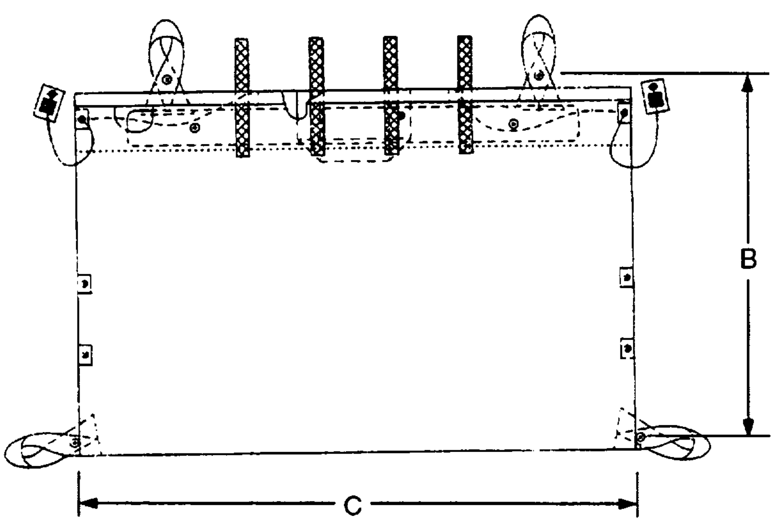
Operational: W. Wedlake, JSC/DF42, (713) 483–2568
Technical: C. Seaman, NASA/EC5, (713) 483–5843

COVER, LARGE SOFT ENVIRONMENTAL

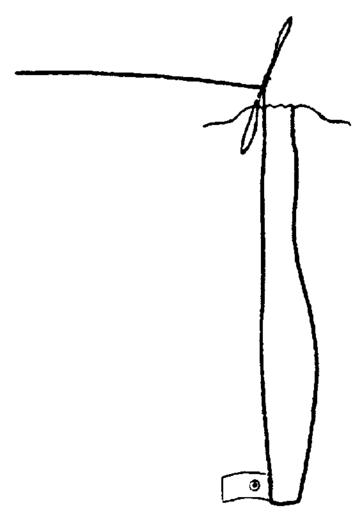
Technical Information	
Part number	7757094
Weight	
Material/ construction	Multilayer Kapton and Mylar blanket
Load rating	0.92 absorbtivity 0.85 emissivity
Temperature range	–22° to 176° F (predicted **temperature** of passive underlying components for STS–49 vehicle attitude)
Quantity flown	One on STS–49
Stowage	Payload bay pallet
Availability	Reference only

Dimensional Data		
	inches	cm
A	53.50	135.89
B	28.0	71.12
C	43.25	109.86



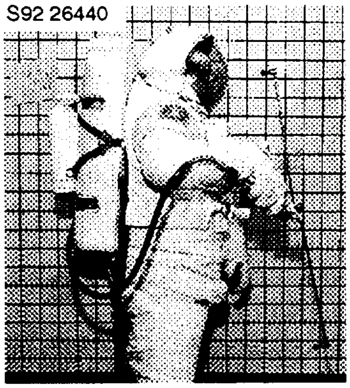


Petal bag

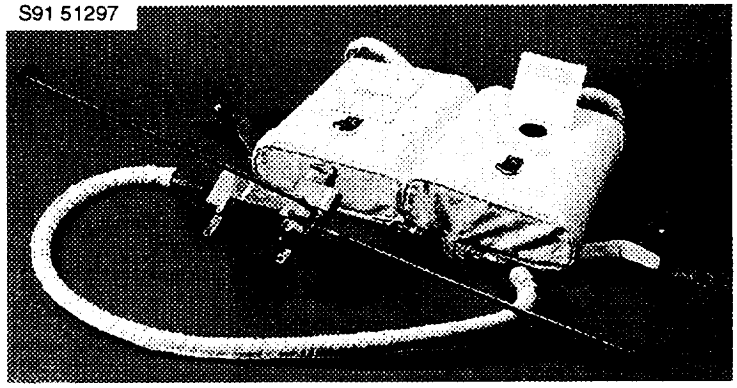


CREW PROPULSIVE DEVICE

S92 26440



S91 51297



OVERVIEW

The crew propulsive device (CPD) was one of several different crew self–rescue (CSR) concepts for solving the EVA "man overboard" scenario on Space Station Freedom where no shuttle is available to assist. Evaluation of these concepts was conducted as part of the STS–49 Assembly of Station by EVA Methods (ASEM). Each device was intended to cover rescue scenarios including tether mismanagement and tether or hook failure when a fellow EVA crewmember is not available. This particular device provides the capability for the EV crewman to "fly" herself/himself back to the station structure. All CSR devices were concept evaluations only and did not represent final packaging for quick deployment. "Off–the–shelf" components were used where possible.

OPERATIONAL COMMENTS

The CPD is a modified version of the Gemini and Skylab handheld maneuvering unit (HHMU). This device requires accurate interpretation of rotation rates and correct hand positioning of the unit by the crewman to stop rotations and induce translation rates. It comprises a four–bottle pack of compressed nitrogen and a hand unit with two tractor nozzles and one pusher nozzle. The bottle pack is secured to the back of the EV crewman's suit (at the manned maneuvering unit (MMU) latch plates) and the hand unit can be attached to the mini–workstation. Each pair of bottle packs has a pressure gauge to indicate state of N2 charge, a relief valve, and a shutoff valve. The handgrip and nozzle location are designed for optimum translation control. The two puller nozzles are located at the outer end of the hand unit wand and are activated by the main handgrip trigger. The pusher nozzle is located in the center of the wand and is activated by depressing first the pusher button with the index finger and then the main trigger, holding both down for the desired duration. All three nozzles have a small Kevlar string attached for the crewman to visually confirm gas flow during operation. In case of a stuck on thruster, the wands can be folded to cut off gas flow. For STS–49, the hand unit and one bottle pack were stowed in the starboard PSA and two additional bottle packs were stowed in a middeck locker.

The CPD has only enough propellant for approximately 40–50 seconds of short propulsive bursts. The hand unit is too large to carry full time on the mini–workstation. The gas supply should be inside the PLSS to avoid interferences beyond the existing EMU backpack. The CPD was required to handle a 1 ft/sec separation rate and up to 10 deg/sec rotation rate. However, a realistic tether failure scenario very likely would have higher rates. The purely manual rotational stabilization system of the CPD makes it difficult to recover from a multiaxis tumble.

Future self–rescue development is concentrating on a mini–MMU known as the simplified aid for EVA rescue (SAFER).

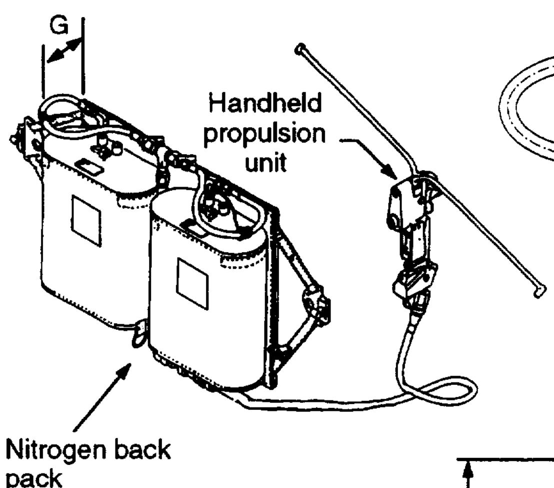
CONTACTS

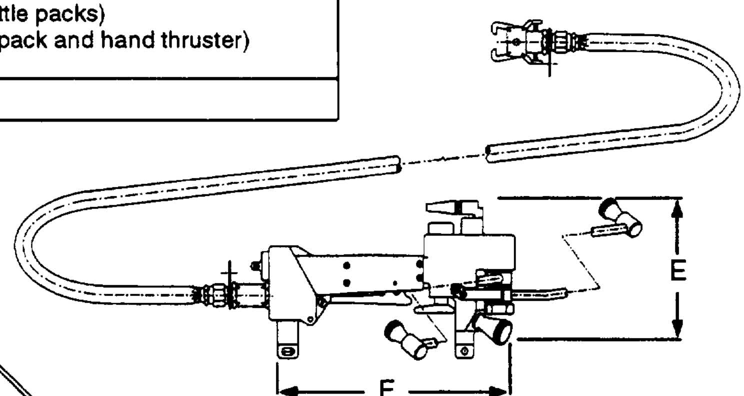
Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. Schwarz, NASA/EC5, (713) 483–2378

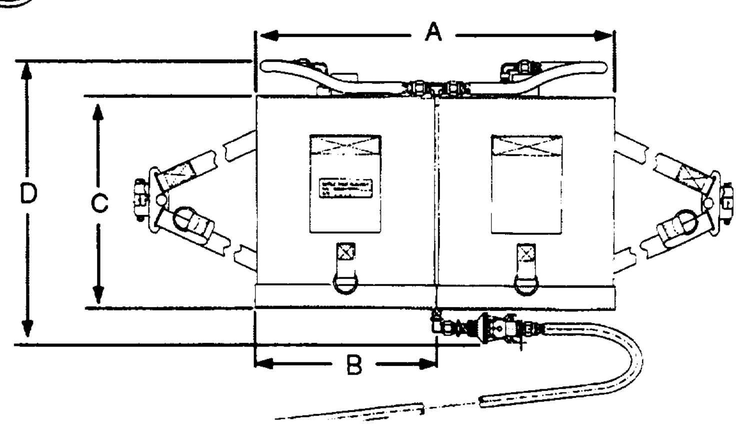
CREW PROPULSIVE DEVICE

Technical Information	
Part number	SED39122612–30X
Weight	30.0 lb (bottle pack) 5.0 lb (hand unit and umbilical)
Material/ construction	Ortho fabric thermal garment, Cres fluid fittings, aluminum housing, Vespel bearing, Braycote lubricant, Loctite
Load rating	6.1 ft/sec (delta V) 1.15 lb (max. thrust) 1.43 lb nitrogen per bottle pack (114 in^3) 2200–psi N_2 supply tank (nominal) 4500–psi N_2 supply tank (leak before burst) 85 psi (regulation to thrusters) 130–psi hand unit (max. operating) 100/90–psi relief valve (crack open/reseat)
Temperature range	–110° to +150° F (stowage) –30° F (min. operational)
Quantity flown	One hand thruster and three bottle packs on STS–49
Stowage	Middeck locker (two bottle packs) STBD PSA (one bottle pack and hand thruster)
Availability	Reference only

Dimensional Data		
	inches	cm
A	20.25	51.44
B	10.25	26.04
C	14.0	35.56
D	15.0	38.1
E	6.8	17.27
F	7.8	19.81
G	4.0	10.16

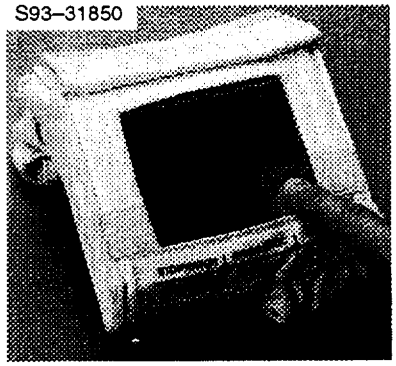






CUFF CHECKLIST, ELECTRONIC

S93–31850



OVERVIEW

Because of the high number of Space Station Freedom (SSF) assembly and maintenance interfaces, EVA crew training may not be as comprehensive as it has been in the past. There will be more reliance upon generic preflight skills training that is supplemented by worksite–unique procedure and data access. The existing paper cuff checklist (in use since the Apollo missions) is inadequate for this high EVA utilization era due to limited data capacity, short useful life of materials, and difficult ground and on–orbit update capability.

To correct the paper cuff checklist deficiencies and to make the extravehicular (EV) crew more independent of intravehicular (IV) and ground support, an electronic cuff checklist is being developed. The data it contains will eventually be updatable prior to EVA via uplink from flight controllers. In the long term, it will be able to transmit data to the the EVA crew at the worksite during EVA. For now, ground–loaded data has been pursued with the capability for future on–orbit data modification. A wrist–band–mounted device has been the focal point for development, but a work–stanchion–mounted unit with larger display, greater memory, and higher resolution graphics is being considered as well. This entire concept is envisioned as a transitional solution leading up to eventual use of a helmet–mounted display.

OPERATIONAL COMMENTS

Detailed features of the basic design include:

- Rugged, reliable, and cost effective
- Fully independent of all extravehicular mobility unit (EMU) systems
- Small and lightweight for minimal interference
- Operable in both flight and training environments
- EEPROM memory storage with 500 plus page display capability for text and simple line drawings
- Flat Screen technology with screen size similar to paper cuff checklist (liquid crystal display selected for minimal power use and and packaging volume, 320 by 240 pixel resolution)
- Automatic brightness control (not available in detailed test objective (DTO) unit)
- Controlled via touch screen with sextant format for software reassignable function keys
- RS232C serial data input port to load data preflight and during flight from existing computers
- Fused internal alkaline battery pack for EVA use, IVA–replaceable without tools
- External dc power port for ground use (not available in DTO unit)
- 11–hour continuous operation
- Automatic power conservation mode (not available in DTO unit)
- EV operable ON/OFF switch (may require a tool for DTO unit)
- Built–in time display and stopwatch

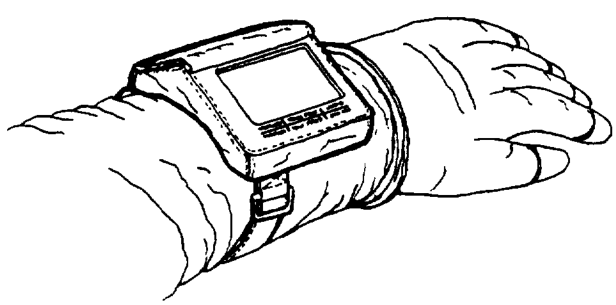
CONTACTS

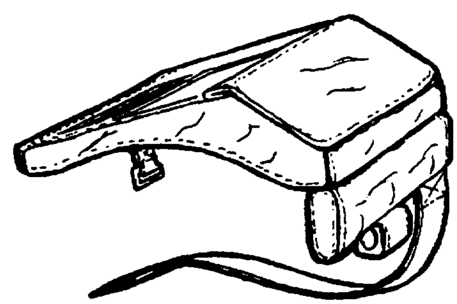
Operational: D. S. Schuck, NASA JSC/DF42, (713) 483–4442
Technical: J. Marmolejo, NASA JSC/EC5, (713) 483–9233

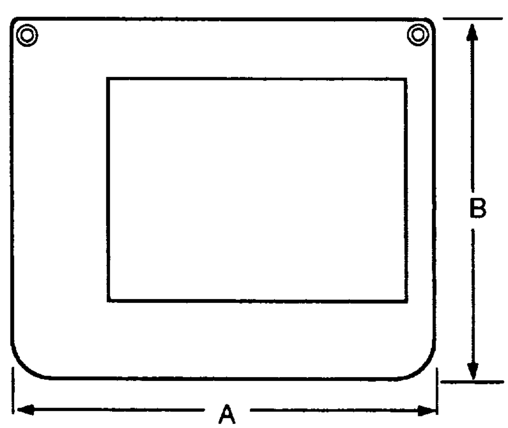
CUFF CHECKLIST, ELECTRONIC

Technical Information	
Part number	SK–ECC–50 top assembly SK–ECC–10 display module SK–ECC–01 battery pack SK–ECC–20 thermal garment
Weight	≤3.0 lb
Material/ construction	Aluminum housing covered with Ortho fabric
Load rating	60° viewing angle 5.4 W–hr using 10 AA alkaline batteries
Temperature range	+32° to +113° F (LCD w/o heaters) 60° F heater control temperature
Quantity flown	Two (Paper cuff checklist flown as backup until electronic unit has proven reliability)
Stowage	Crew cabin
Availability	Developmental (CDR pending)

Dimensional Data		
	inches	cm
A	5.664	14.387
B	4.744	12.050

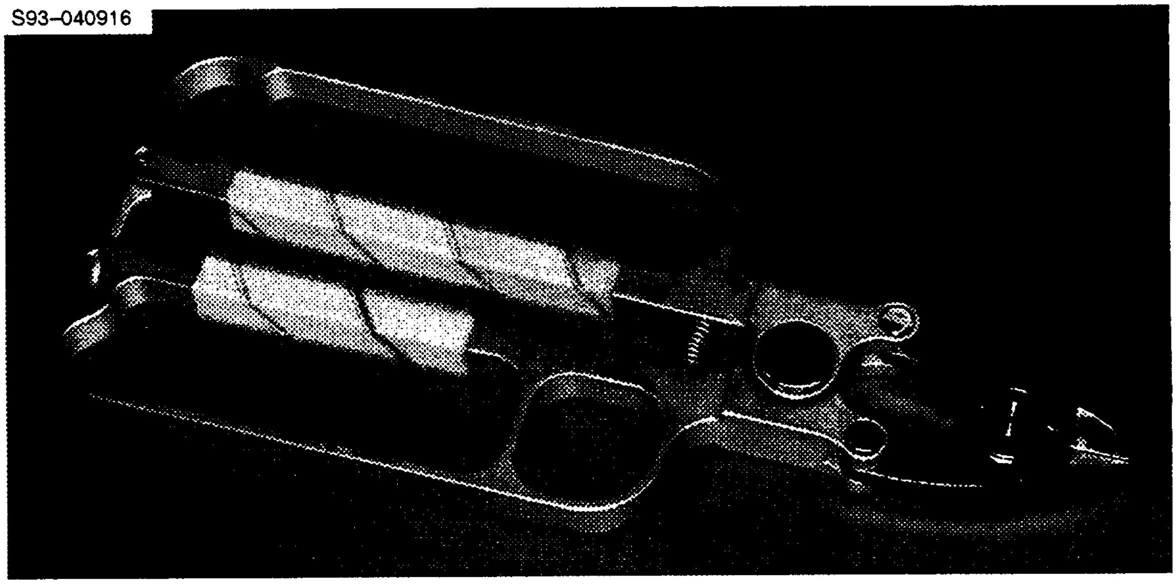






CUTTER, COMPOUND CABLE

S93–040916



OVERVIEW

The compound cable cutter is designed to cut small cables and wire harnesses up to 0.19 in. in diameter. **Currently in development, it is intended to replace the diagonal cutters and parrot–beaked small EVA cable cutters now flown on every mission in the provisions stowage assembly (PSA).**

OPERATIONAL COMMENTS

The compound cable cutter is equipped with large handles to fit the EVA gloved hand and is designed for one–hand operation. The cutter jaw opening measures 9/16 in. wide and 7/8 in. deep when fully opened. **It has pointed jaw tips for cutting in tight access areas.**

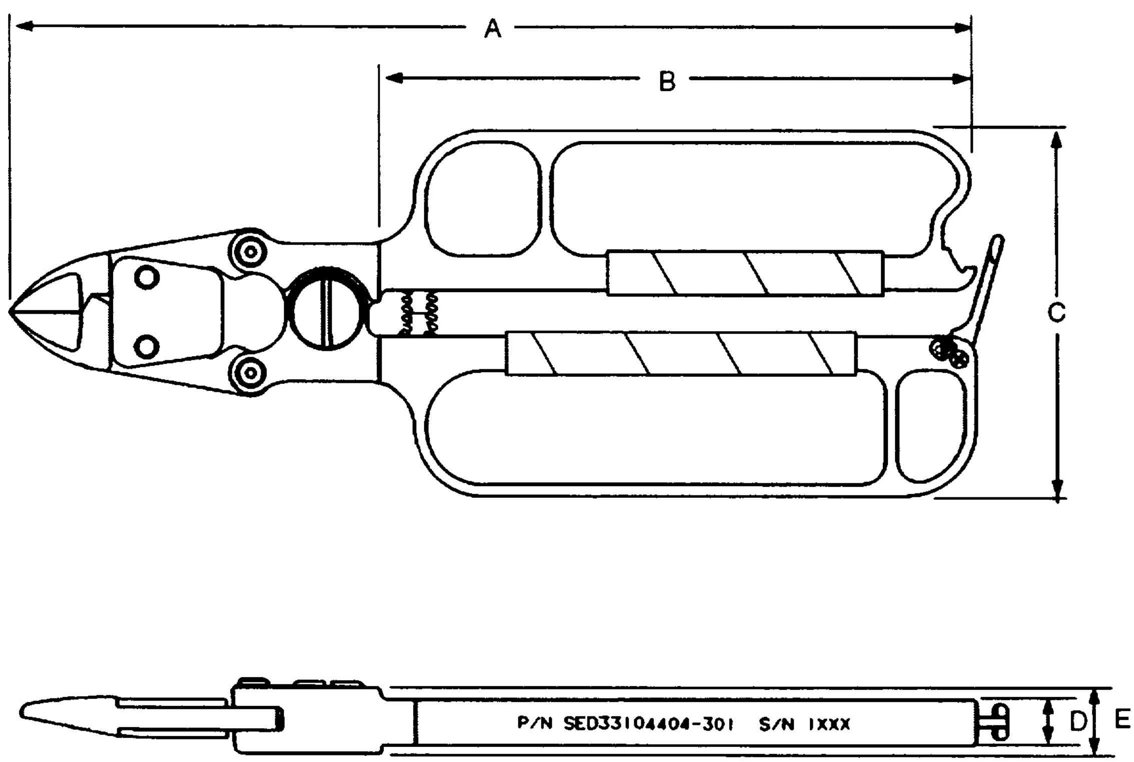
CONTACTS:

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

CUTTER, COMPOUND CABLE

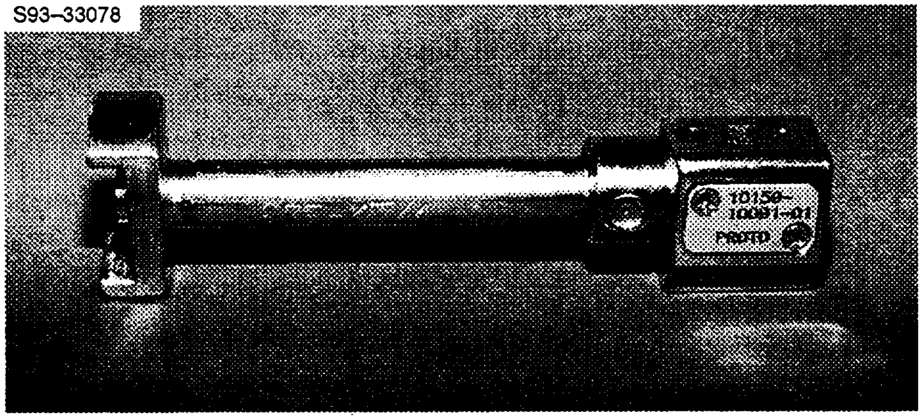
Technical Information	
Part number	SED33104404–301
Weight	0.8 lb
Material/ construction	Jaws – Carbon steel Handles – Aluminum
Load rating	0.19–in. diameter (max. cut)
Temperature rating	–200° to +250° F (operational), +350° F (stowage)
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A	**8.0**	**20.32**
B	**5.0**	**12.70**
C	**3.125**	**7.94**
D	**.375**	**0.95**
E	**0.625**	**1.59**



DOOR LATCH TOOL

S93–33078



OVERVIEW

The ORFEUS telescope has a door that provides contamination protection during ground, launch, and on–orbit periods. This same door also acts as a sunshade when open to stop direct solar radiation from shining inside the sensitive telescope. The door has redundant drive mechanisms for its open/close functions, but a single latch is driven by cables from the same drive mechanisms. These cables are pulled by a pair of lever arms driven by the drive motor shaft. One lever opens the door latch and the other assists in locking the latch. This tool gives the EVA crew the capability to override the drive motor lever arms to open or close the door latch.

OPERATIONAL COMMENTS

The latch assembly consists of one latch body, two closure locks, and a safety lock. With the tool attached to a drive ratchet, the left lever arm can be rotated 34° clockwise to open the latch. Care must be taken to avoid overloading the payload hardware more than 14.7 ft–lb. Drive torque should take only 2.2 ft–lb. The right lever arm is driven clockwise to close the secondary latch lock. For this operation, no more than 29.5 ft–lb should be input to protect the payload hardware. Microswitches and visual flags provide feedback on door position and latch engagement.

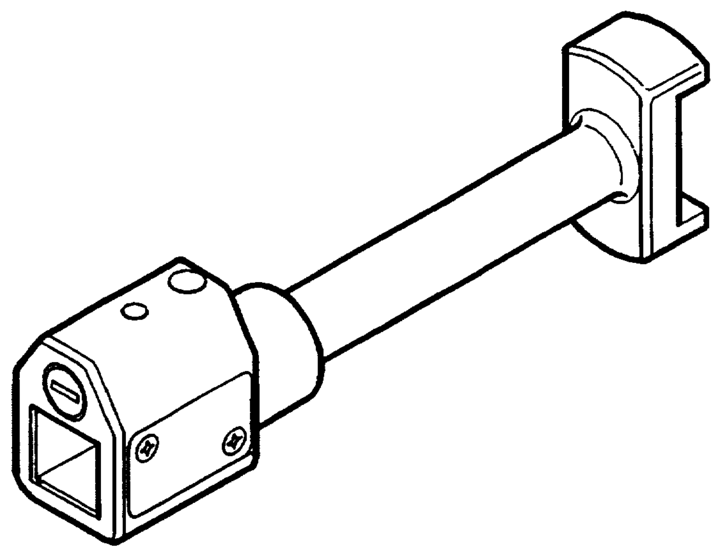
CONTACTS

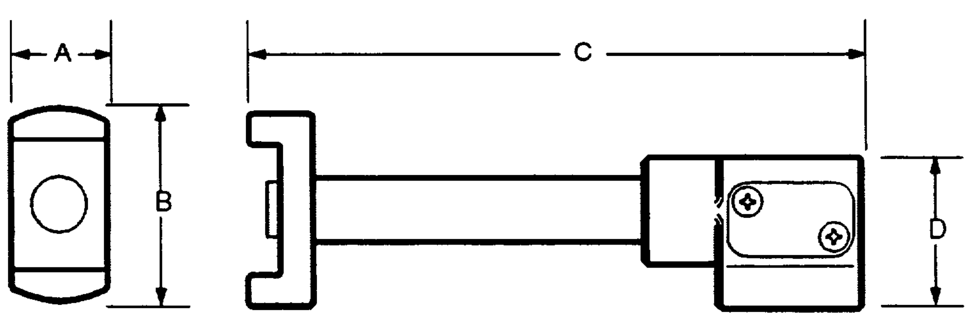
Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: R. Marak, NASA/EC5, (713) 483–9144

DOOR LATCH TOOL

Technical Information	
Part number	10159–10091–01
Weight	0.14 lb
Material/ construction	**Stainless steel, aluminum**
Load rating	29 ft–lb
Temperature range	
Quantity flown	Two on STS–51
Stowage	Middeck locker
Availability	Reference only

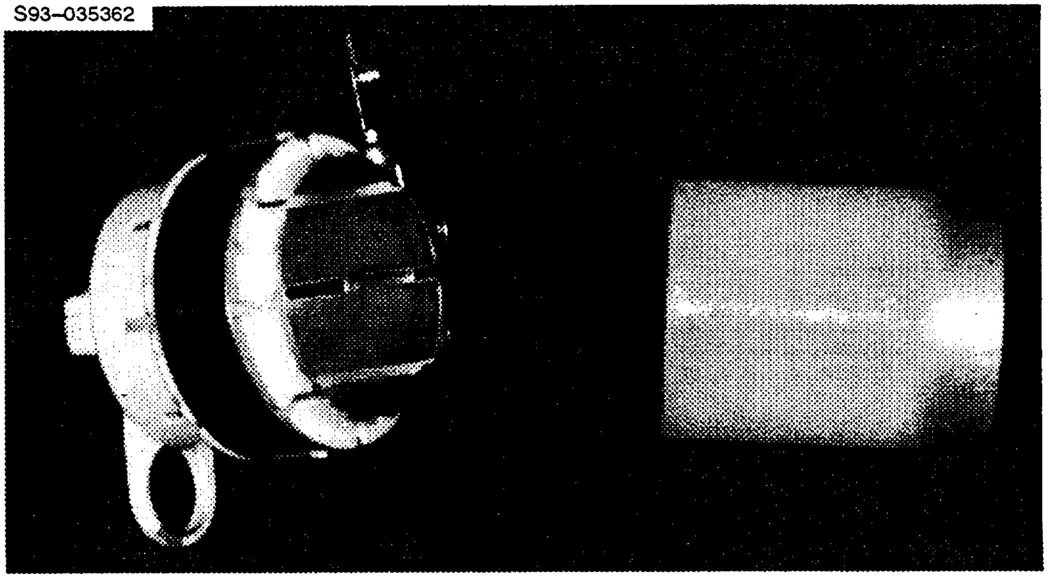
Dimensional Data		
	inches	cm
A	**0.593**	**1.51**
B	**1.180**	**3.00**
C	**3.680**	**9.35**
D	**0.932**	**2.37**





DUST CAP REMOVAL TOOL

S93–035362



OVERVIEW

The dust cap removal tool is a contingency tool specifically developed to assist with actuating and safing the forward and aft restraint structures of the ACTS/TOS spacecraft. If the primary and secondary electromechanical actuators that support spacecraft deployment and landing restraint were to fail, they would have to be isolated by pin puller assemblies. The primary actuator has a pyro puller, but the secondary puller only has a manually operated puller. The pyro pin puller may also require manual actuation if it fails. Each pin puller offers an EVA interface that is protected from contamination by a dust cap that is just a screw–on aluminum lid. The dust cap itself has no EVA interface and is removable only with this device, which functions much like a common automobile oil filter wrench.

OPERATIONAL COMMENTS

This tool was developed from a similar ground support tool. It provides a band clamp mechanism for tightening itself onto the dust cap. A 1/2–in. hex turned clockwise tightens the clamp to secure the tool to the dust cap. A 7/16–in. hex interface is then turned counterclockwise with a manual or powered EVA wrench to remove the tool/dust cap assembly. Tethering of the combined tool/dust cap is provided by the removal tool. A separate tool actuates the pin puller. Multilayer insulation (MLI) and safety wire, which protects certain pin pullers, must be removed before using this tool. Should the preflight–sized band clamp be too tight, it can be loosened by the EVA crew.

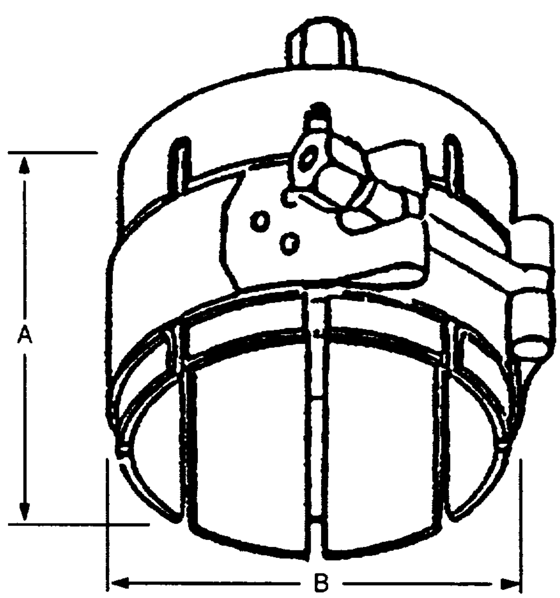
CONTACTS

Operational: O.Koehler, JSC/DF42, (713) 483–4363
Technical: F. Sanders, NASA MSFC/EE43, (205) 544–0164

DUST CAP REMOVAL TOOL

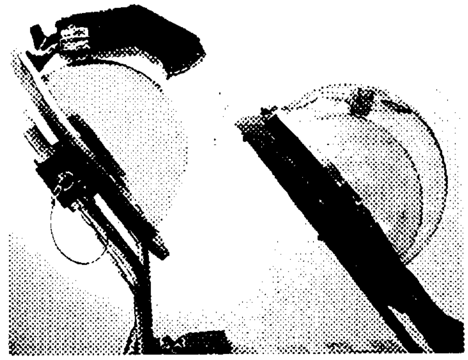
Technical Information	
Part number	**97M52700–1**
Weight	0.84 lb
Material/ construction	Aluminum, stainless steel
Load rating	140 in–lb dust cap removal torque (max.)
Temperature range	
Quantity flown	Three
Stowage	Middeck
Availability	Reference only

Dimensional Data		
	inches	cm
A	3.15	8.0
B	2.95	7.5



EMU HELMET–MOUNTED DISPLAY

S91–39140



OVERVIEW

Looking ahead to the long–term needs of intense Space Station Freedom (SSF) and Lunar/Mars EVA, it is foreseen that the existing paper cuff checklist (in use since the Apollo missions) will be inadequate because of limited data capacity, short useful life of materials, and difficult ground and on–orbit update capability. With the high demand for preflight crew time and the large number of EVA tasks, EVA crew training may not be as comprehensive as it has been in the past. To use crew time more efficiently, there will be more reliance upon generic preflight skills training that is supplemented by worksite–unique procedure and data access.

To correct the paper cuff checklist deficiencies and to make the extravehicular (EV) crew more independent of intravehicular (IV) and ground support, a helmet–mounted display (HMD) is being developed. The HMD is an electro–optical system designed to provide text, graphics, and possibly video for viewing within the EV helmet. This entire concept is targeted for implementation on an advanced extravehicular mobility unit (EMU) because of the prohibitive impact to the existing shuttle EMU. Because of its potential for minimizing the impact to crew worksite access, the HMD is seen as the preferred long–term solution over the electronic cuff checklist.

OPERATIONAL COMMENTS

The primary goals of the HMD include hands–free access to information with minimal power demand and low profile packaging to minimize any impacts to suit utilization. Suit performance data, detailed procedural data, manned maneuvering unit navigational data, and visual feedback from a helmet–mounted TV may be accessed using the HMD. Four designs have been demonstrated. In each, the HMD data are displayed as a virtual, see–through image located conveniently above the user's primary field of view inside are the EMU helmet. All displays can be interfaced to a speech recognizer for a totally hands–free environment.

- The Wright–Patterson HMD demonstrator consists of twin high–resolution (525–line) miniature CRT's (1–in. diameter by 3–in. length) that project a binocular image via an optical train/toroidal combiner to the user, providing a 24° by 45° image (1/3 center overlap).
- The Hamilton Standard HMD demonstrator provides a fully overlapped, binocular image from backlit, dense (320 by 220 pixel) transmissive LCD's and a projection optics train.
- The ARA optics HMD demonstrator provides a fully overlapped, binocular image from two miniature CRT's that project an image through relay optics, a holographic mirror, and a holographic two–element combiner, providing a 20–in. diagonal field–of–view virtual image.
- The Technology Innovation Group HMD demonstrator provides a binocular image from a single CRT reflected from a mirror and a curved holographic combiner to provide a 17–in. diagonal field–of–view image.

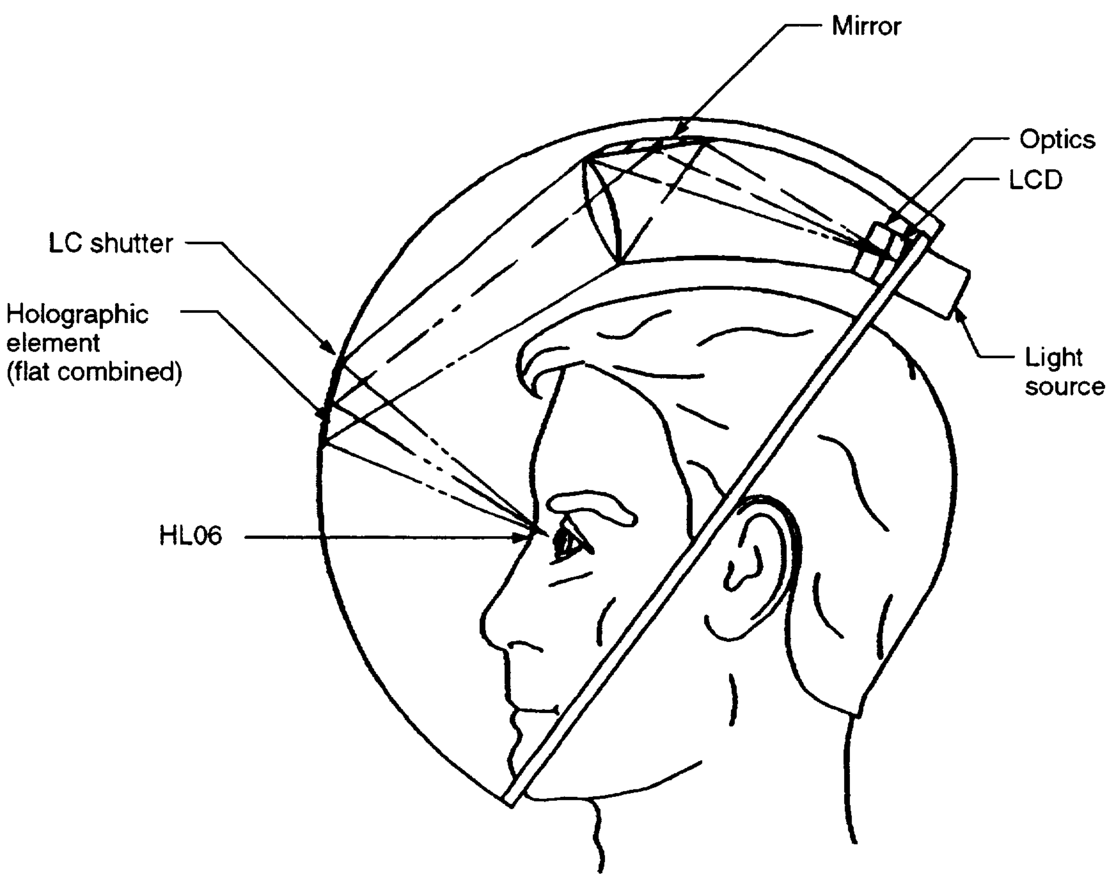
CONTACTS

Operational: R. Fullerton, NASA/DF42, (713) 483–2589
Technical: Jose A. Marmolejo, NASA/EC5, (713) 483–9233

EMU HELMET–MOUNTED DISPLAY

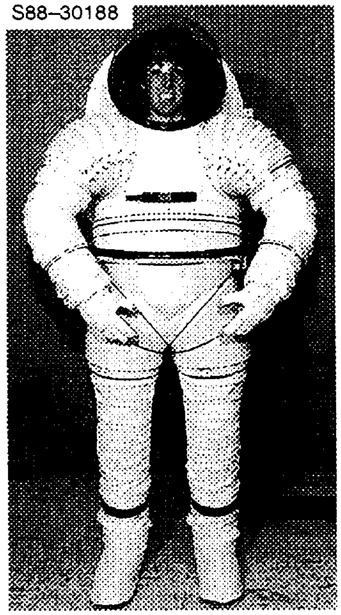
Technical Information	
Part number	TBD
Weight	<10 lb
Material/ construction	Glass Polycarbonate Aluminum
Load rating	RS–170 video input 110 V ac (60 Hz) 3 watts/CRT and 40–watt driver (Wright–Pat) TBD watts (Hamilton Standard)
Temperature range	Room temperature (development only)
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A		
B		
C		
D		
E		
F		
G		
H		
Z		

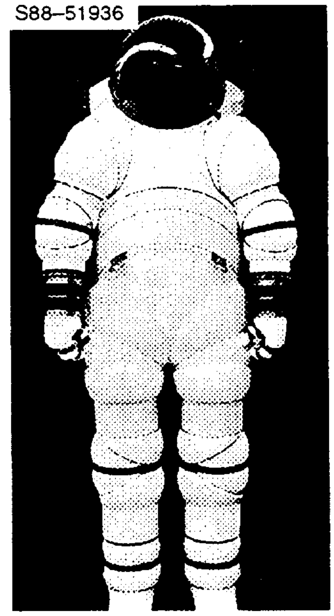


EXTRAVEHICULAR MOBILITY UNIT, ADVANCED

S88-30188



S88-51936



OVERVIEW

The extravehicular mobility unit (EMU) is actually a collection of new technologies being developed to create a high pressure garment so that no prebreathing is required and the risk of decompression sickness is minimized for high frequency EVA sorties. It also features life support systems that are regenerable, on–orbit maintainable, and do not vent overboard contaminants like cooling water. The current shuttle EMU requires a long duration reduction in cabin pressure to 10.2 psia or 4.0 hours of in–suit prebreathing of pure oxygen before each EVA. Low cabin pressure is undesirable in terms of degraded avionics cooling and for payload science, since this varies from ground–based control experiments. Long periods of prebreathing in the suit are uncomfortable and detract from productive crew time.

The pressure garment components of the high pressure suit have been developed at the Johnson Space Center and at the Ames Research Center. The Ames AX–5 is a full, hard suit; the JSC Mark III has both hard and soft components. Each suit is designed to operate at a suit pressure of 8 psid compared to the 4.3 psid pressure of the shuttle EMU. Both use a rear entry hatch concept for simpler donning and doffing. The shoulder bearings are canted inboard as much as possible to improve the range of motion of each arm. Both designs use modular components for quick and easy parts breakdown for cleaning, resizing, inspection, and stowing. Ankle and hip bearings combined with a waist bearing are used in place of a waist bearing alone for increased lower torso mobility. Development testing has shown that the optimum pressure garment would be made up of components from both the AX–5 and the Mark III. Fabrication of dexterous high pressure gloves is the most challenging aspect of this technology.

The life support components being developed include long life rechargable fuel cells, wax based water cooling, radiator cooling, automatic thermal comfort regulation, and cryogenic oxygen storage. One challenge of this technology is to package it in a backpack that is small enough to avoid degrading crew mobility and worksite access.

Further development of all the above technologies has been slowed in favor of continued near term use of the shuttle EMU for Space Station. Much of this technology is applicable to planetary exploration.

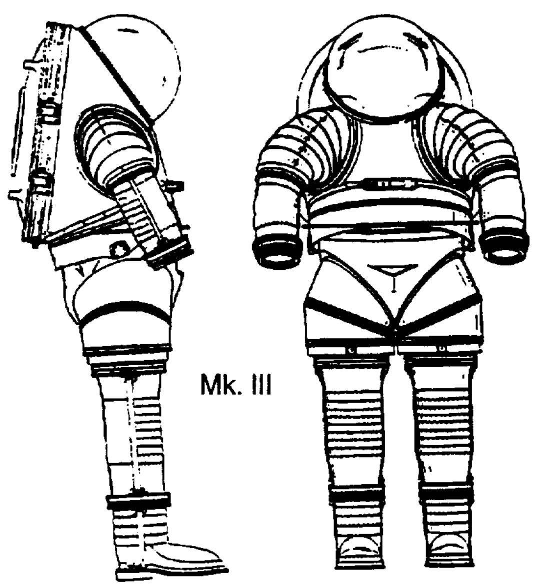
CONTACTS

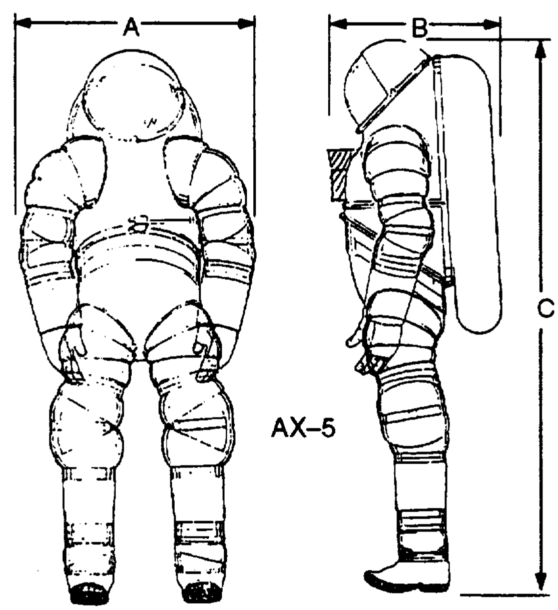
Technical: (Mark IV): J. Kosmo, NASA/JSC/EC6, (713) 483–9235
Technical: (AX–5): K. Vykukal, NASA/ARC, (415) 604–5386

EXTRAVEHICULAR MOBILITY UNIT, ADVANCED

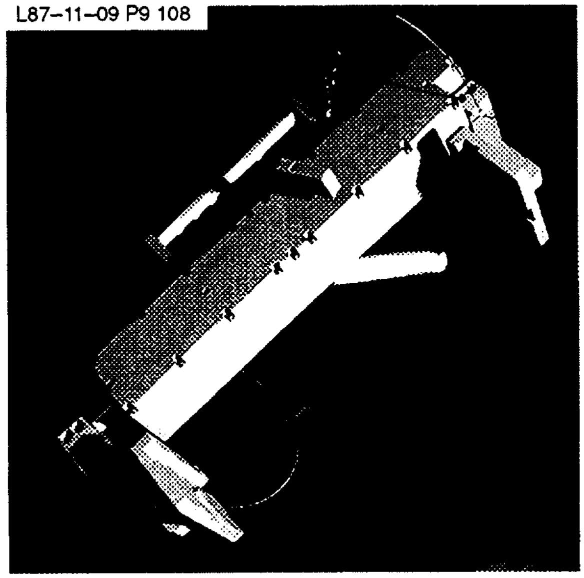
Technical Information	
Part number	
Weight	
Material/ construction	<table><tr><td></td><td>AX–5</td><td>MK–III</td></tr><tr><td>Shoulder</td><td>4 bearing</td><td>Rolling convolute, 2 bearing</td></tr><tr><td>Elbow</td><td>4 bearing</td><td>All fabric</td></tr><tr><td>Waist/hip</td><td>4 bearing</td><td>Rolling convolute waist 3–bearing hip</td></tr><tr><td>Knee</td><td>4 bearing</td><td>All fabric</td></tr><tr><td>Ankle</td><td>4 bearing</td><td>All fabric</td></tr><tr><td>Torso</td><td>Aluminum</td><td>Aluminum</td></tr><tr><td>Entry</td><td>Rear</td><td>Rear</td></tr><tr><td>Helmet</td><td>13 in. dome</td><td>13 in. dome</td></tr><tr><td>Boot</td><td>Aluminum</td><td>Fabric</td></tr><tr><td>Environmental</td><td>Dual hull</td><td>Enhanced TMG</td></tr></table>
Load rating	8.3 psid (nominal)
Temperature range	
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A	30	76.2
B	28	71.12
C	80	203.2





HANDLE, LARGE PORTABLE ORU



OVERVIEW

The large portable ORU handle is an infinitely adjustable latch–on handle designed to provide the astronaut with a convenient and safe means of handling the electronic black boxes of the Hubble Space Telescope (HST) should they need replacement while on orbit.

OPERATIONAL COMMENTS

The handle is a ratcheting, linear clamping device designed to mate with typical spacecraft electronic boxes. The device employs a double telescoping rack and pinion drive for a quick acting, highly compact design, a high resolution ratchet mechanism for locking, and silicon rubber grip pads to provide compliance and gripping friction.

Operation of the device involves two processes, selection of mode (LOCK or UNLOCK) and rotation of crank handle. Mode selection either engages or neutralizes the ratchet mechanism. In the LOCK mode, the crank handle can only be turned to tighten the device. In the UNLOCK mode the clamps can be extended or retracted. The device is available in two configurations (large and small) that cover a grip range from 11 to 32 in.

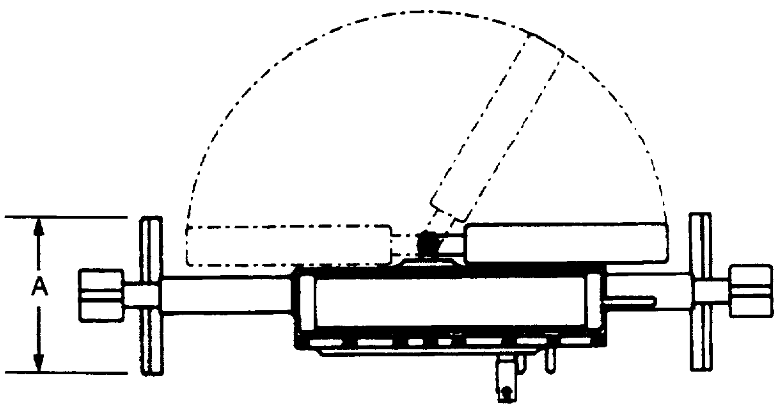
CONTACTS

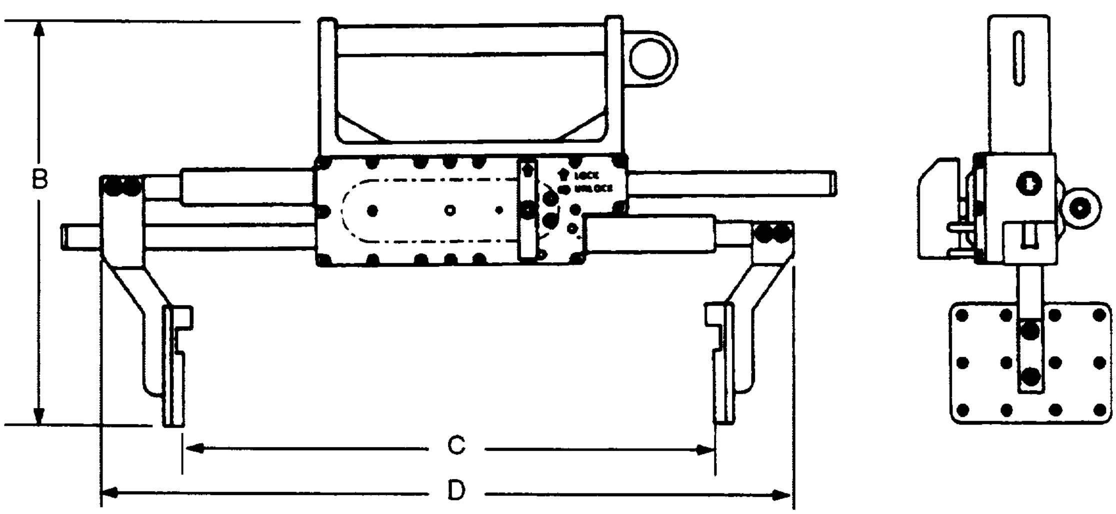
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: **R. Sheffield, LMSC/Dept 64–10, (408) 742–8464**

HANDLE, LARGE PORTABLE ORU

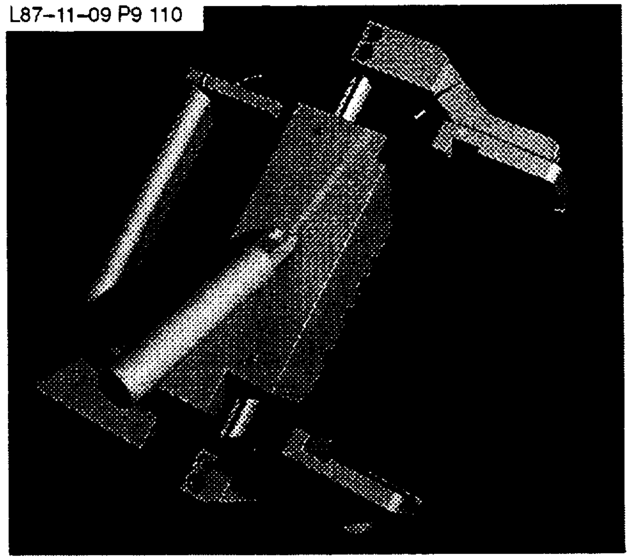
Technical Information	
Part number	SET97M22926–1
Weight	Not available
Material/ construction	Handle cushion – RTV
Load rating	
Temperature range	–150° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	4.80	**12.19**
B	10.35	**26.29**
C	11.70 to 32.00	**29.72 to 81.28**
D	18.53 to 35.92	**47.07 to 91.24**





HANDLE, SMALL PORTABLE ORU



OVERVIEW

The small, portable orbital replacement unit (ORU) handle is an infinitely adjustable latch–on handle designed to provide the astronaut with a convenient and safe means of handling the electronic black boxes of the Hubble Space Telescope (HST) should they need replacement while on orbit.

OPERATIONAL COMMENTS

The handle is a ratcheting, linear clamping device designed to mate with typical spacecraft electronic boxes. The device employs a double telescoping rack and pinion drive for a quick acting, highly compact design, a high resolution ratchet mechanism for locking, and silicon rubber grip pads to provide compliance and gripping friction.

Operation of the device involves two processes, selection of mode (LOCK or UNLOCK) and rotation of crank handle. Mode selection either engages or neutralizes the ratchet mechanism. In the LOCK mode, the crank handle can only be turned to tighten the device. In the UNLOCK mode the clamps can be extended or retracted. The device is available in two configurations (large and small) that cover a grip range from 4 to 14 in.

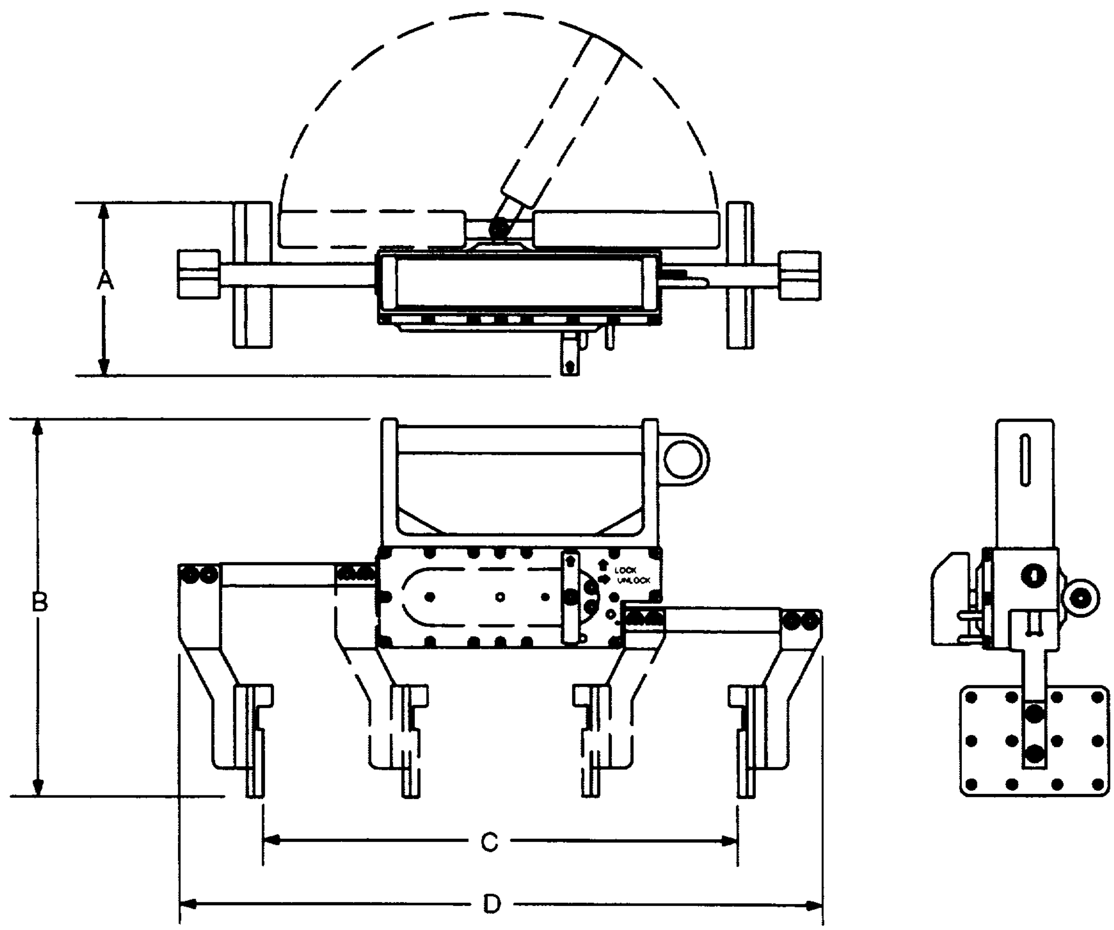
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: **R. Sheffield, LMSC/Dept 64–10, (408) 742–8464**

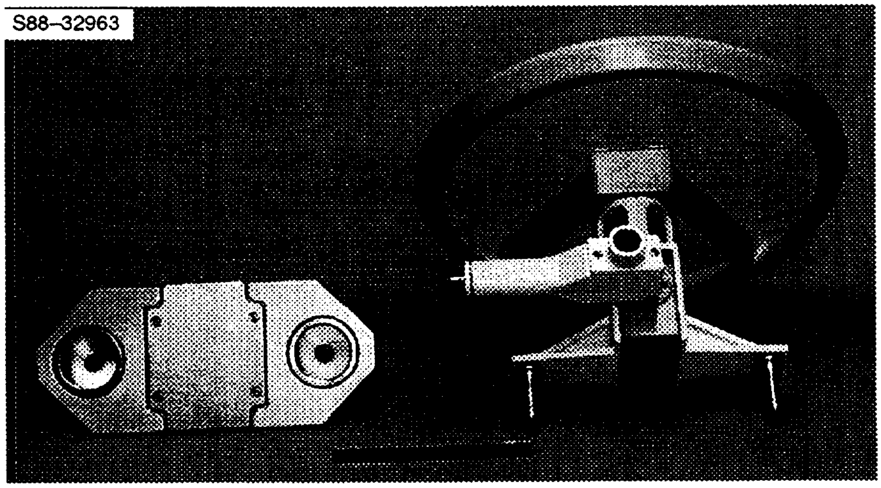
HANDLE, SMALL PORTABLE ORU

Technical Information	
Part number	SET97M22763-1
Weight	Not available
Material/ construction	Handle cushion – RTV
Load rating	
Temperature range	–150° to +250° F **(operational)**
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	4.80	12.19
B	10.35	26.30
C	4.10–13.93	10.41–35.38
D	8.99–17.46	22.83–44.35



HANDLING AID, MAGNETIC



OVERVIEW

The magnetic handling aid (MHA) is one of a family of magnetic **EVA aids undergoing development**. The MHA **was designed for** the proposed Shuttle Radiator Assembly Demonstration (SRAD) flight experiment. This mission **was to** demonstrate a crewmember's ability to assemble 50–ft long heat pipe radiators and administer subsequent maintenance activities associated with three possible methods of radiator handling. The method to be utilized involves an EVA crewmember with an MHA in the manipulator foot restraint (MFR) attached to the remote manipulator system (RMS). The MHA is the EVA hand–held version of the RMS magnetic end effector.

OPERATIONAL COMMENTS

The MHA provides the EVA crewmember with a method of manually handling a radiator element. Attachment of the MHA is accomplished by an interface between an insert installed in the radiator and an Eriez rare earth magnet. The MHA has a **steering** wheel configuration for **multiaxis** handling while attached to the radiator. It also provides an EVA handle giving one–handed operation to polarize and depolarize the magnet. The handle uses 180° lock–on and lock–off positions. A standoff or pedestal is attached between the wheel and the magnet saddle to allow for proper grip and clearance above the radiator stacked configuration.

The MHA is currently in prototype form. A high–fidelity mockup of this unit also exists.

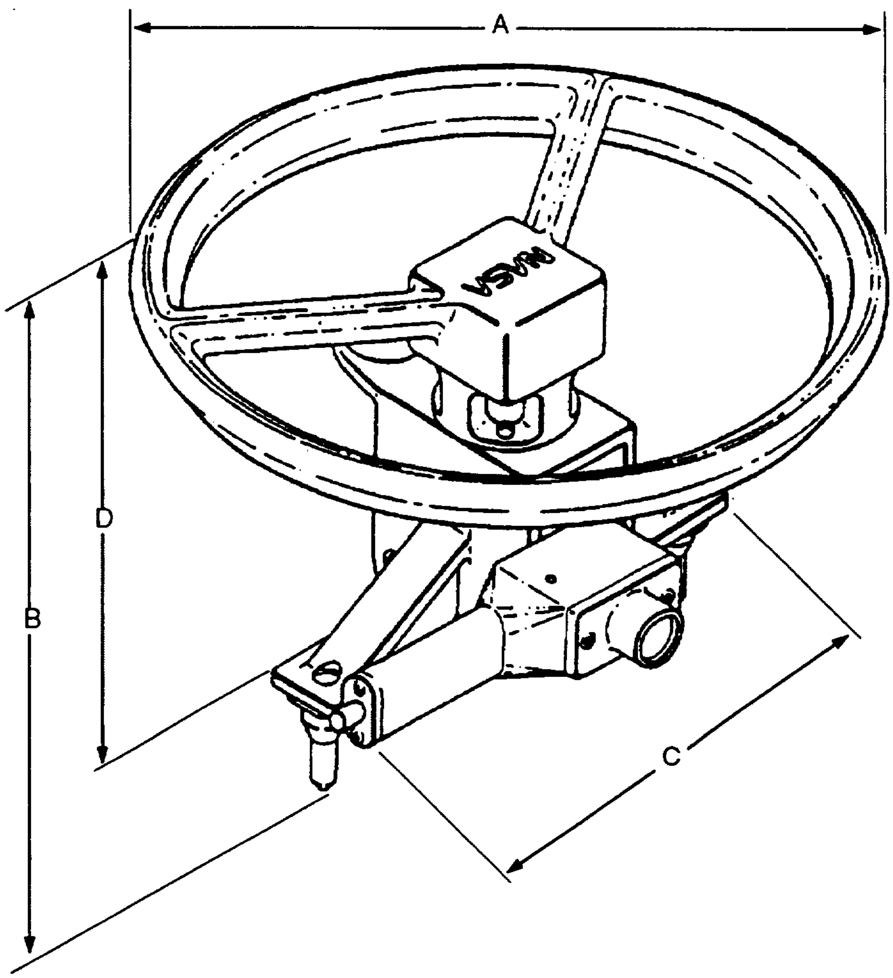
CONTACTS

Operational: R. C. Trevino, NASA/DF4, (713) 483–2597
Technical: **C. Hess**, NASA/**ER,** (713) 483–**9142**

HANDLING AID, MAGNETIC

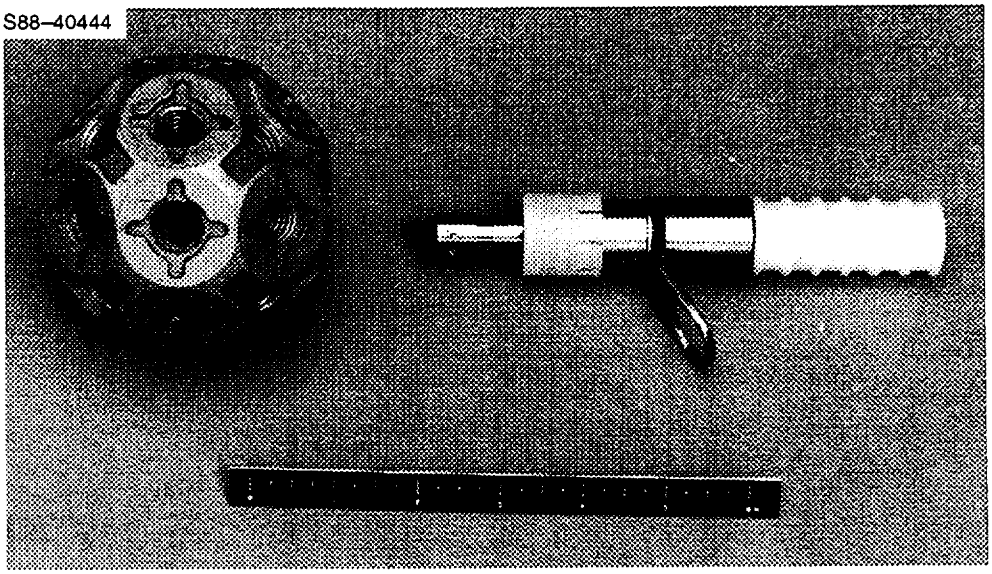
Technical Information	
Part number	Not available
Weight	15.0 lb (est)
	20.0 lb (max.)
Material/ construction	Aluminum alloy, 6061–T6 rare earth magnet
Load rating	
Temperature range	± 200° F
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A	15.44	39.22
B	10.25	26.04
C	9.00	22.86
D	8.25	20.96



HARPOON, MODIFIED

S88-40444



OVERVIEW

The **modified** harpoon is a tethering prototype device **originally** designed to fit into the open node holes of the Space Station Freedom (SSF) truss structure and latch into place. It provides a tethering location at the nodes for use in EVA and also provides a means of tethering the nodes for SSF construction. A spring–loaded bumper keeps the node tight on the harpoon until it is released.

OPERATIONAL COMMENTS

The harpoon is attached to the node by simply pushing it into any open hole location until it latches in place. To release the harpoon, pull the handle at the base outward until the harpoon disengages. **This harpoon concept has been found to be excellent for ease of EVA use as a true one–handed equipment tether. With the revision of SSF truss to a preintegrated design, this item currently has no SSF application.**

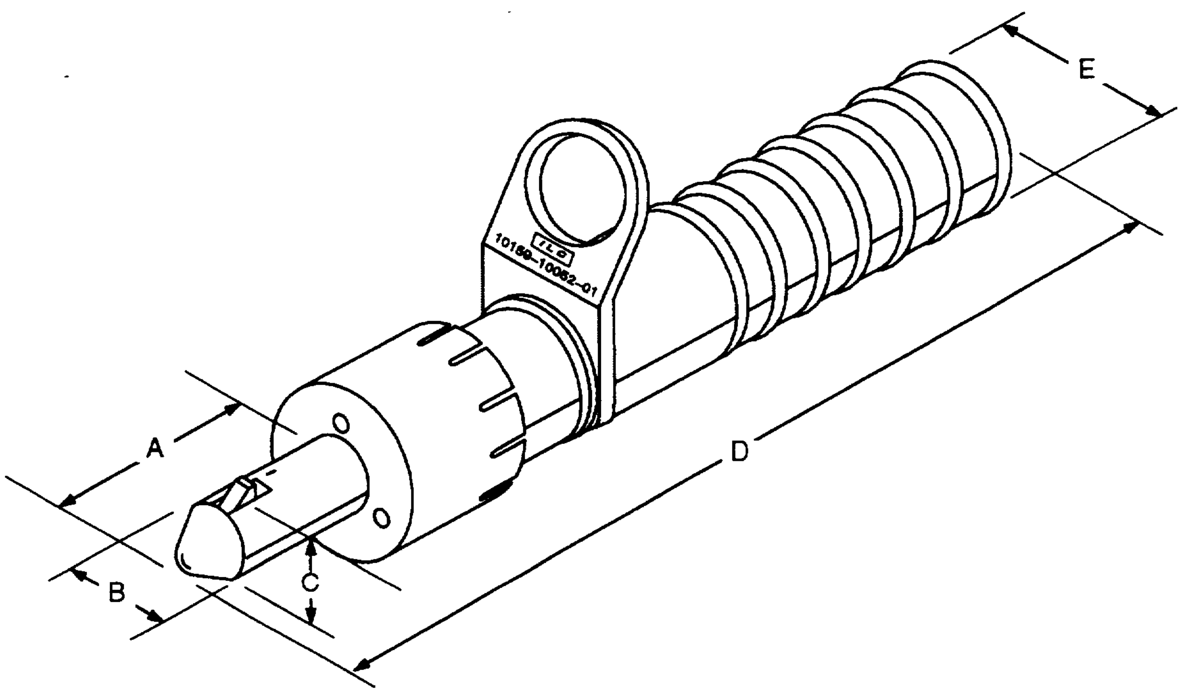
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

HARPOON, MODIFIED

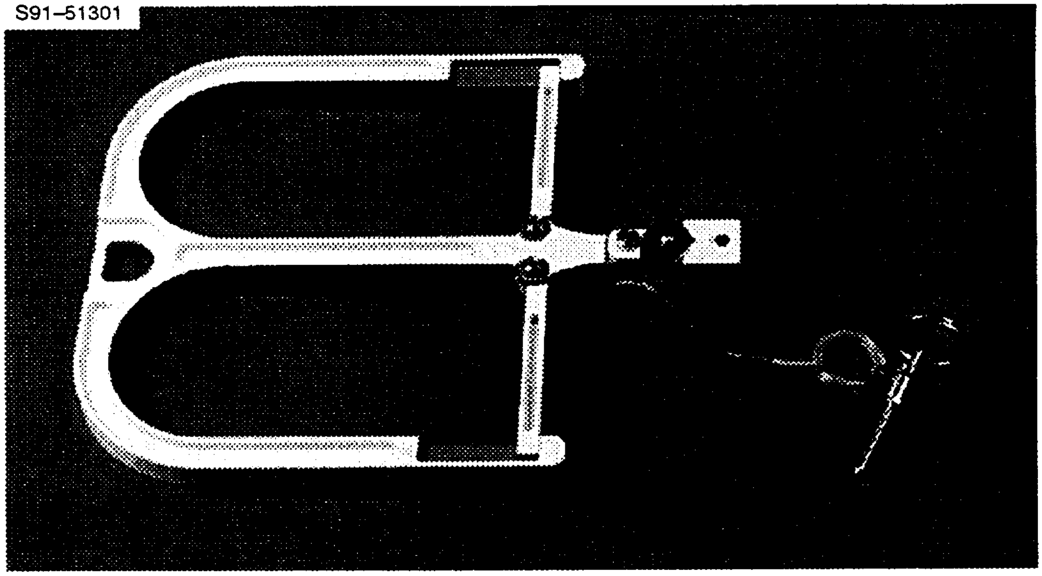
Technical Information	
Part number	10159–10052–01
Weight	0.15 lb
Material/ construction	Delrin Stainless steel Aluminum
Load rating	
Temperature range	–150° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A	1.40	3.56
B	0.50	1.27
C	0.70	1.78
D	6.65	16.89
E	1.00	2.54



HOOK, GRAPPLE

S91-51301



OVERVIEW

This item was a part of several different crew self-rescue (CSR) concepts for solving the EVA "man overboard" scenario on Space Station Freedom where no shuttle is available to assist. These concepts were evaluated as part of the STS-49 Assembly of Station by EVA Methods (ASEM). Each device was intended to cover rescue scenarios including tether mismanagement and tether or hook failure when a fellow EVA crewmember is not available. All CSR devices were concept evaluations only and did not represent final packaging for quick deployment. "Off-the-shelf" components were used where possible.

OPERATIONAL COMMENTS

A common end effector was developed for all three pole-type CSR devices on STS-49 (inflatable, bistem, and telescoping poles). It is designed to grapple a 2-in. strut and requires a pull-type motion by the crewman for grapple. Once grappled, it will tolerate a 100-lb load and remain attached until released by the crewmember. The end effector is attached with a pip pin to the end of each pole device. Two end effectors were stowed in the starboard provisions stowage assembly (PSA) for STS-49.

This end effector was designed before the station change to a preintegrated truss construction and is optimized for the previous 2-in. strut. Although some struts will exist on station, the current preintegrated truss design uses primarily I-beam segments. Thus, any operational pole-type device and any future end effector must be designed to grapple I-beam-type targets. The grappling device solution obviously does not cover all rescue scenarios, since the crewman must be able to see a regrapple target and have low enough rotation rates to employ such a device.

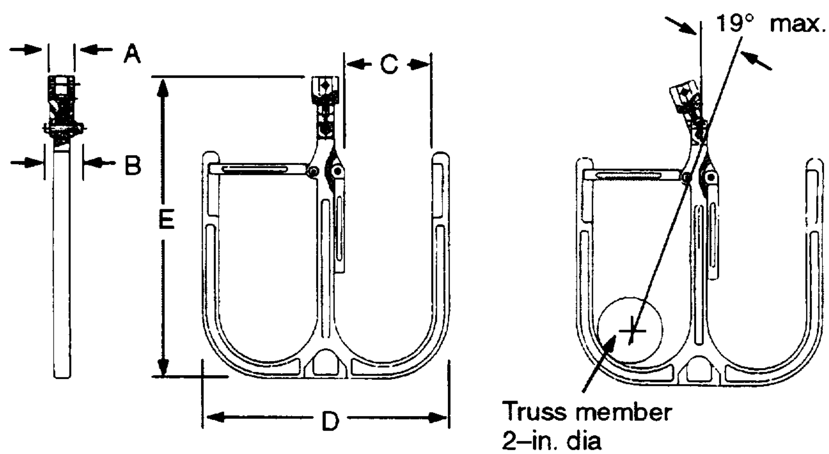
CONTACTS

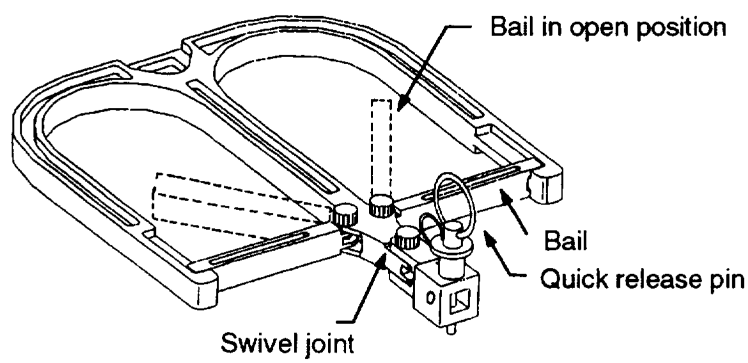
Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: R. Schwarz, NASA/EC5, (713) 483-2378

HOOK, GRAPPLE

Technical Information	
Part number	SED39122702–301
Weight	0.7 lb
Material/ construction	Aluminum
Load rating	100 lb (tension) 25 lb (compression)
Temperature range	
Quantity flown	Two on STS–49
Stowage	STBD PSA
Availability	Reference only

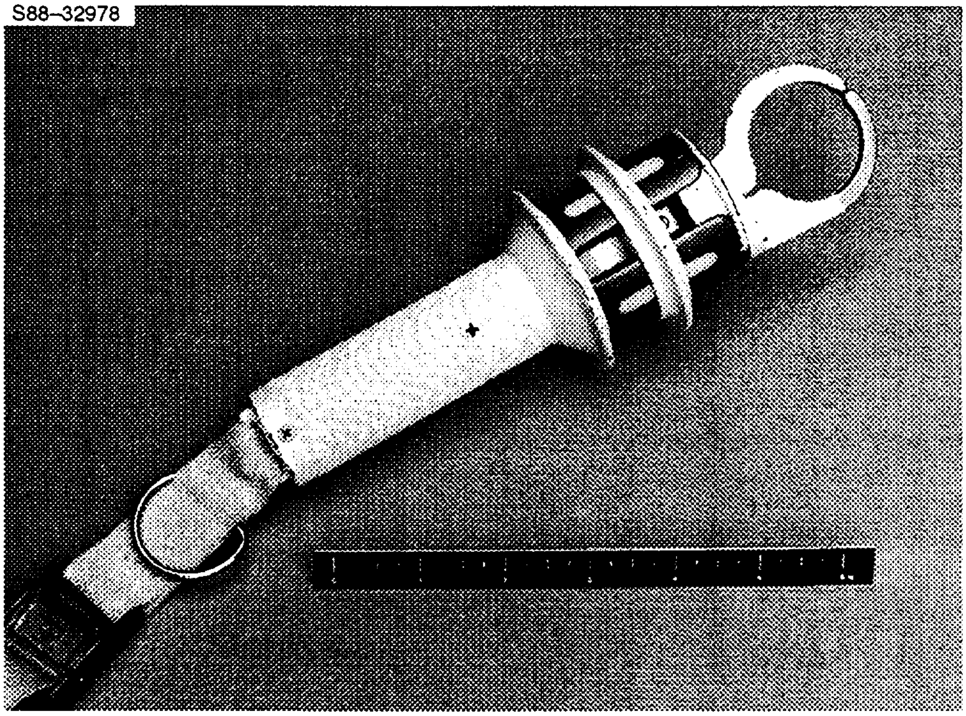
Dimensional Data		
	inches	cm
A	0.80	2.03
B	1.186	3.012
C	2.60	6.60
D	7.50	19.05
E	9.375	23.813





HOOK, ONE–HANDED TETHER

S88–32978



OVERVIEW

The one–handed tether hook consists of the hook along with a strap and french hook. The hook, which requires only one hand to operate, is designed to secure tools and hardware to the EVA crewmember or to a tether point. This tool **has not made it past the development stage**.

OPERATIONAL COMMENTS

The one–handed tether hook is operated by pulling the actuating ring to open the jaws. The jaws close automatically when the actuating ring is released.

An adjustable strap is attached at the base of the tether handle. The strap features a tensioning buckle for length adjustment and a french hook and D–ring for temporary restraint.

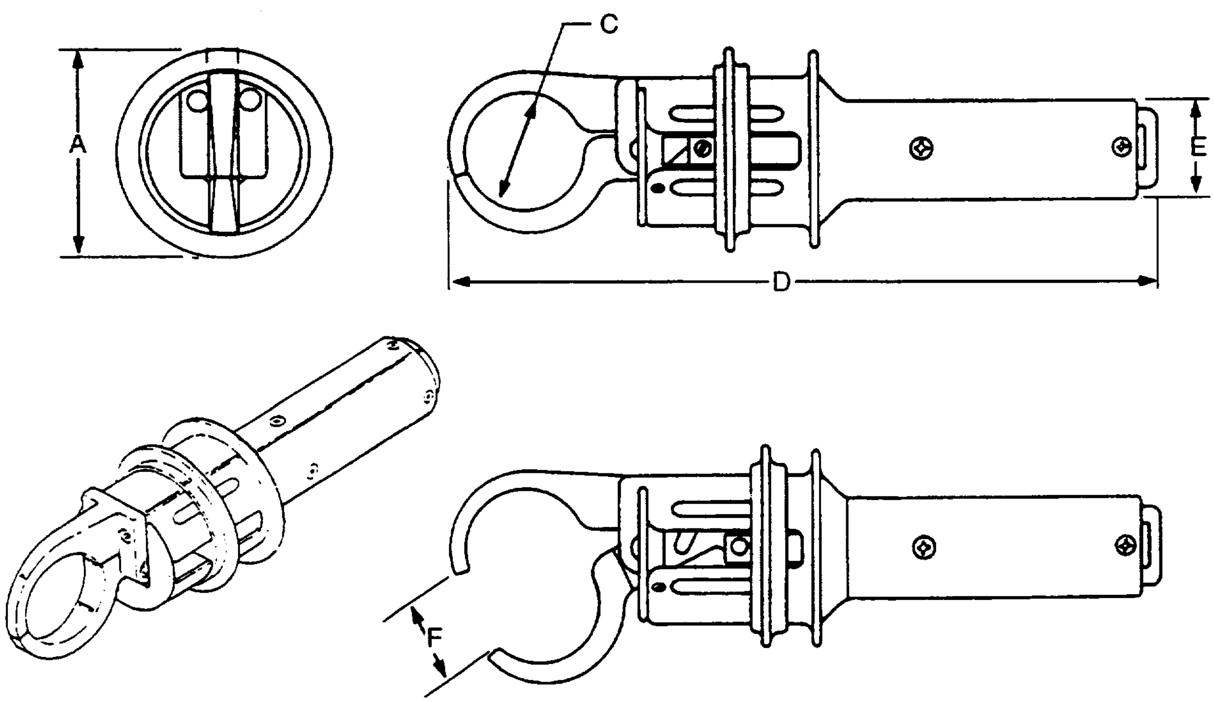
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

HOOK, ONE–HANDED TETHER

Technical Information	
Part number	10159–10050–01
Weight	TBD
Material/ construction	Aluminum Stainless steel Nomex strap
Load rating	
Temperature range	–150° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A	2.63	6.68
B	0.38	0.97
C	1.50	3.81
D	8.75	22.23
E	1.25	3.18
F	1.03	2.62



HOOK, QUICK ATTACH TETHER

S88-32974

OVERVIEW

The quick attach tether hook allows the crewmembers to rapidly attach and lock themselves to an EVA handrail or tether point by simply pressing the tether hook trigger against the handrail. This tool **has not made it past the development stage.**

OPERATIONAL COMMENTS

The hook is operated by first depressing a crossbar, located in the center of the tether hook, to place the trigger mechanism in the cocked position. A locking pin at the hook opening is retracted when the trigger mechanism is cocked. The hook is then ready to be attached to the handrail or tether point.

The hook is secured by placing the open end of the hook over a tether point and simultaneously depressing the trigger at the back of the hook opening. The locking pin is then thrust into a position that closes the hook opening and prevents the hook from inadvertently coming off the handrail. The locking mechanism can also be actuated by manually depressing a button on the back side of the hook.

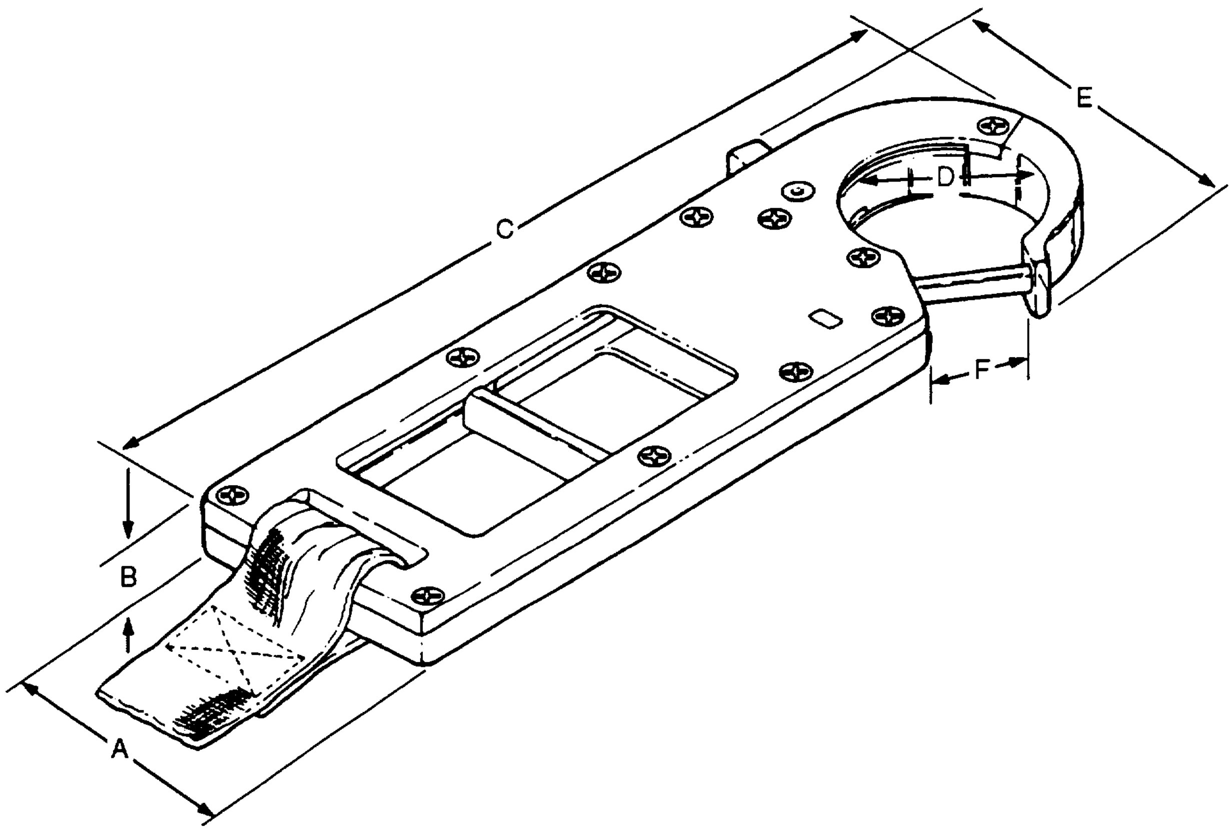
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

HOOK, QUICK ATTACH TETHER

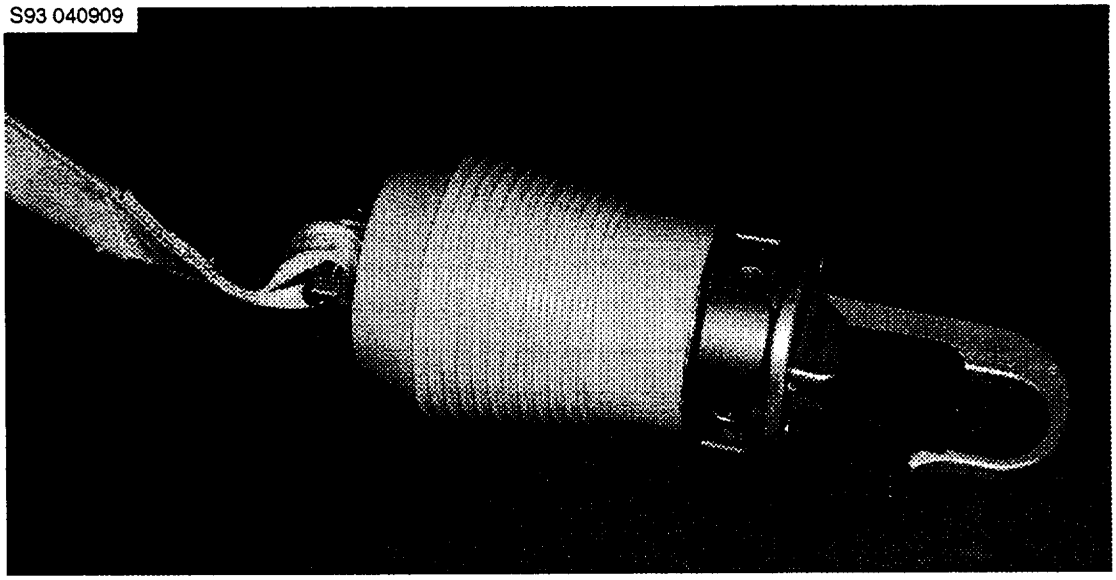
Technical Information	
Part number	10159–10051–01
Weight	0.45 lb
Material/ construction	Aluminum Stainless steel
Load rating	
Temperature range	–130° to +150° F (operational)
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A	2.10	5.33
B	0.5	1.27
C	7.5	19.05
D	1.5	3.81
E	2.87	7.29
F	0.90	2.29



HOOK, RADIAL SQUEEZE

S93 040909



OVERVIEW

This EVA tether hook is being developed as an alternative to the standard wrist and waist tether hooks currently in use throughout the shuttle program. In principle, the round grip of this hook can be grasped from any approach angle. Simply making a closed fist should actuate the hook. The large grip size of the handle fits more naturally into the neutral position of the gloved hand. This new design should help to minimize the overhead and fatigue associated with frequent operation of the shuttle EVA hooks during equipment handling.

OPERATIONAL COMMENTS

A single shaft is driven to operate this hook. To open the hook, the fingers are wrapped around the cylindrical body of the handle below the hook. When the fingers tighten around the handle, the index finger and thumb squeeze large opposing lock buttons while the other fingers and palm squeeze even larger opposing buttons to open the hook. These actions are intended to be transparent to the crew, since the buttons wrap all the way around the handle with an upper and lower set of four 90–degree segments. A soft rubberized covering protects the internal mechanisms from contamination. Installing the hook on a rigid tether point still requires both sets of buttons to be pushed, since most of the hand is always used, so the hook cannot be easily "slapped" on. Releasing the hook's handle allows the spring–loaded shaft to lock the hook closed.

This hook has potential as an improved equipment restraint for future shuttle and Space Station applications, since it lacks some of the negative features of the present shuttle hooks. It requires less precise finger dexterity because there is no double lock which must be pushed in parallel while squeezing the hook open. Avoidance of this complex finger action during high frequency equipment handling is critical to ensure EVA efficiency and minimize lower arm and hand fatigue. Ground and on–orbit evaluations are underway to assess this design.

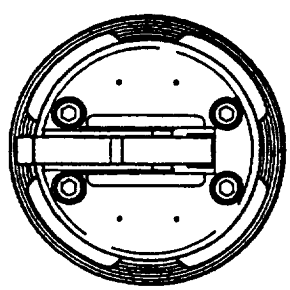
CONTACTS

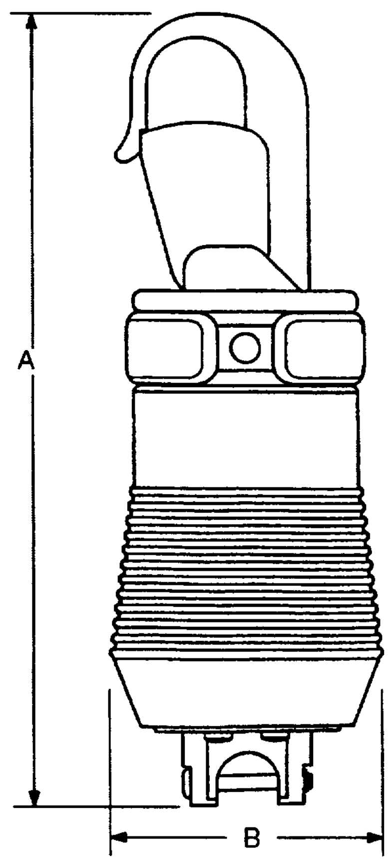
Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: W.B. Wood, NASA/EC5, (713) 483–9247

HOOK, RADIAL SQUEEZE

Technical Information	
Part number	SED39123077–301
Weight	
Material/ construction	Aluminum, stainless
Load rating	
Temperature range	
Quantity flown	One on STS–51
Stowage	Middeck locker
Availability	Developmental

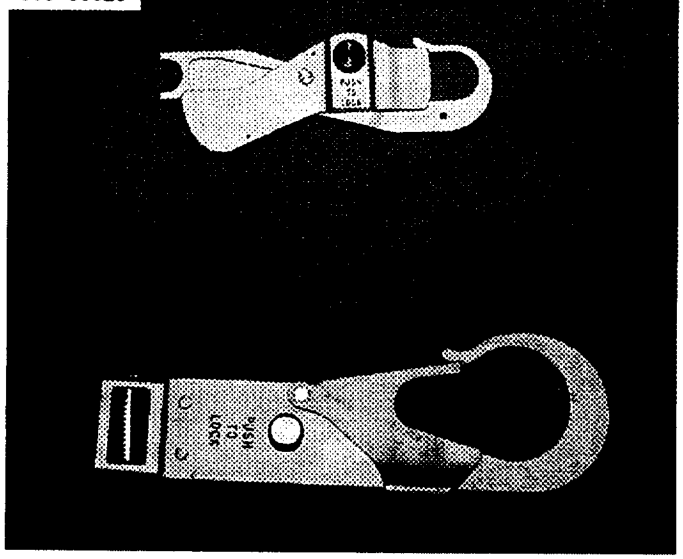
Dimensional Data		
	inches	cm
A	6.45	16.4
B	2.19	5.6
C		
D		
E		
F		
G		
H		





HOOK, SKYLAB

S93–39925



OVERVIEW

These EVA tether hooks are the predecessors to the current shuttle wrist and waist tether hooks. They are nearly identical in design except for their lock function. They have a single button that has detent positions in both the lock and released positions. These hooks are not presently in use (except for the airlock umbilical strain relief line of at least one orbiter) because it was found that they could be dangerous as a crew safety tether hook. They had a tendency to open by themselves when twisted around a tether point where the lock button could be forced to the unlocked position. There is a similar concern with the french hooks still in use in the shuttle program.

OPERATIONAL COMMENTS

The large and small Skylab hooks are identical in terms of their lock functions. When unlocked, a red band shows on the protruding button, and the hook is held closed with only a torsion spring. When locked, a green band is visible on the button. The closure bail of the large hook has a finger tab that is supposed to aid in its release, but it tends to be awkward for single–hand actuation.

The Skylab hooks still have potential as equipment restraints because they lack some of the negative features of the present shuttle hooks. They are less fatiguing and require less precise finger dexterity because there is only one lock button that can be actuated serially before trying to open the hook. When unlocked, this hook requires very little hand action for initial attachment. The dual lock buttons and simultaneous squeeze action to open the shuttle hook are major problems for frequent utilization.

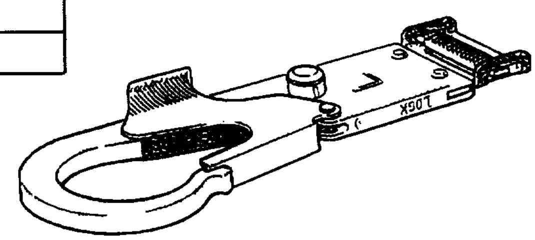
CONTACTS

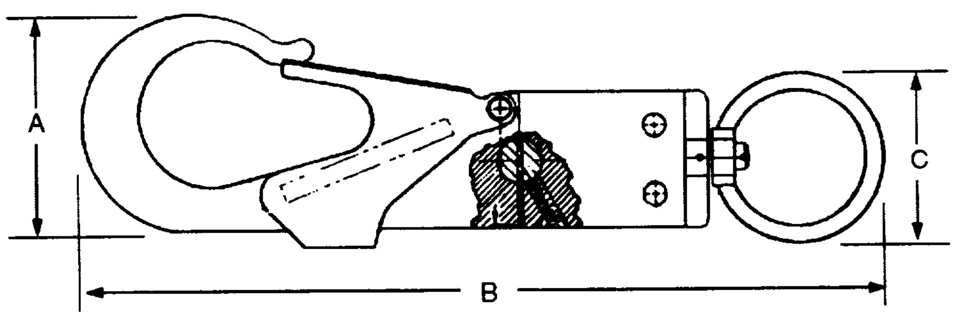
Operational: R. Trevino, NASA/DF42, (713) 483–2597
Technical: R. Marak, NASA/EC5, (713) 483–9144

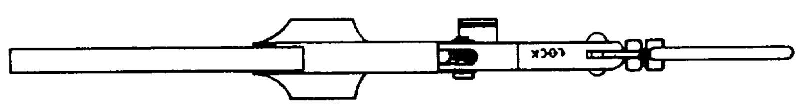
HOOK, SKYLAB

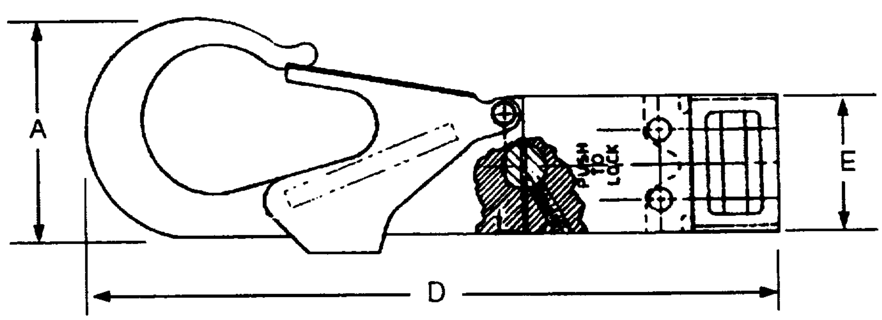
Technical Information	
Part number	SEB331002**00**–303 **or SV729617** (small hook) SEB33100221–304 (large hook)
Weight	
Material/ construction	Aluminum, stainless
Load rating	
Temperature range	
Quantity flown	
Stowage	
Availability	Reference only

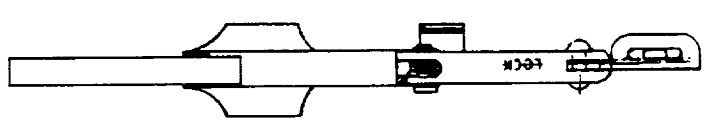
Dimensional Data		
	inches	cm
A	**2.45**	**6.22**
B	**8.67**	**22.02**
C	**1.89**	**4.80**
D	**7.54**	**19.15**
E	**1.50**	**3.81**



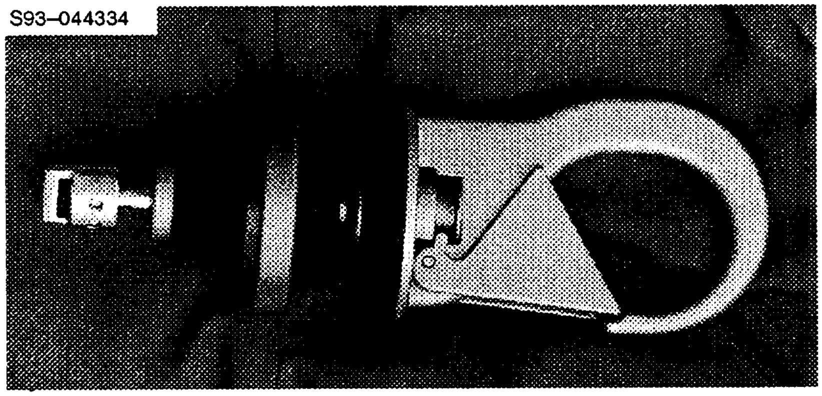


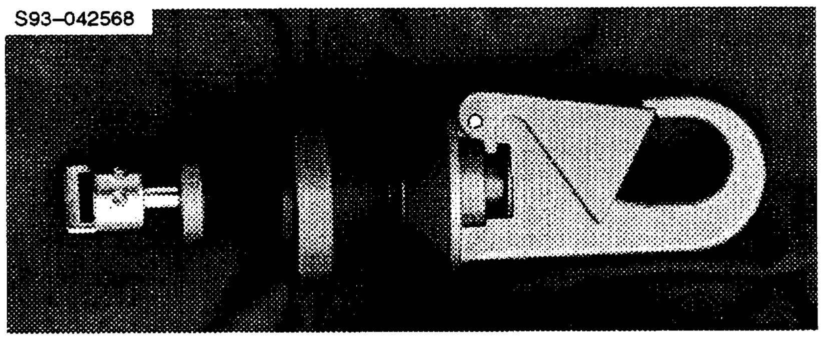






HOOK, SWIVEL





OVERVIEW

This EVA tether hook is being developed as an alternative to the standard wrist and waist tether hooks currently in use throughout the shuttle program. In principle, the round grip of this hook can be grasped from any approach angle. Simply making a closed fist should actuate the hook. The large grip size of the handle fits more naturally into the neutral position of the gloved hand. This new design should help to minimize the overhead and fatigue associated with frequent operation of the shuttle EVA hooks during equipment handling.

OPERATIONAL COMMENTS

A single shaft is driven to operate this hook. To open the hook, the fingers are wrapped around the sliding conical collar below the hook. The fingers below the collar force a locking disk to release so that the fingers above can push the whole collar down to open the hook's bailer bar. The wedging action of the fingers around the collar aids this process. Installing the hook on a rigid tether point is made very easy by grasping the lower face of the handle's collar to unlock the control shaft and by then pushing the bailer bar open with the tether point structure. Being able to "slap" on the hook in this manner conserves crew effort for other tasks. Releasing the hook's handle allows the spring-loaded shaft to lock the hook closed.

This hook has potential as an improved equipment restraint for future shuttle and Space Station applications because it lacks some of the negative features of the present shuttle hooks. It requires less precise finger dexterity because there is no double lock which must be pushed in parallel while squeezing the hook open. Avoidance of this complex finger action during high frequency equipment handling is critical to ensure EVA efficiency and minimize lower arm and hand fatigue. Ground and on-orbit evaluations are underway to assess this design.

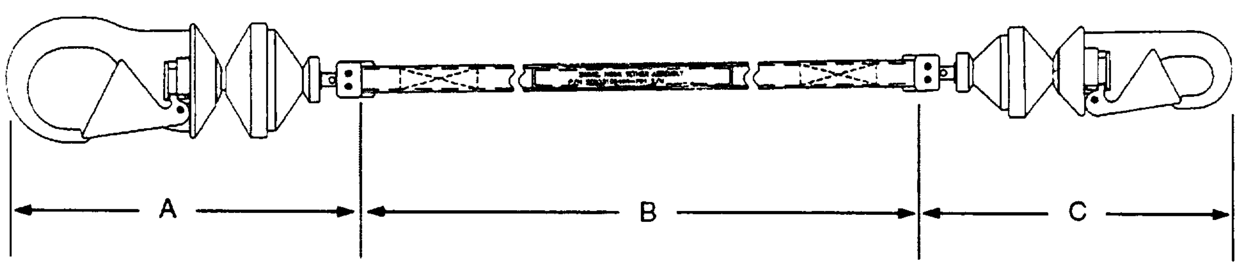
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483-2570
Technical: W.B. Wood, NASA/EC5, (713) 483-9247

HOOK, SWIVEL

Technical Information	
Part number	HSMS1015–01 (large) HSMS1015–02 (small) SED33105498–701 (tether assembly)
Weight	
Material/ construction	Aluminum, stainless
Load rating	200 lb (use load)
Temperature range	
Quantity flown	One on STS–51
Stowage	Middeck locker
Availability	Developmental

Dimensional Data		
	inches	cm
A	7.1	18.0
B	18.0	45.7
C	6.4	16.3
D		
E		
F		
G		
H		



HOOK, TRUSS STRUT

S89–25583

OVERVIEW

The truss strut hooks are prototype equipment tethers that **were originally** designed specifically to attach to the 2–in. diameter **struts** of **earlier** Space Station Freedom (SSF) **truss concepts.** The truss strut swivel hook (20159–10002–01) incorporates a pivoting handle, while the truss strut fixed hook (20159–10001–01) has a stationary handle.

OPERATIONAL COMMENTS

Each truss hook has two modes of operation: hard dock holds the hook in one location; soft dock allows for a loose sliding fit. Each hook also has a 42–in. strap with a cam buckle to allow for strap length adjustment.

The handle of the truss strut swivel hook is designed to pivot 90° clockwise or counterclockwise in parallel with the truss member for a total travel of 180° in 30° increments. This feature provides maximum flexibility for tight areas, such as near the node. **With the revision of SSF truss to a preintegrated design, this item currently has no SSF application.**

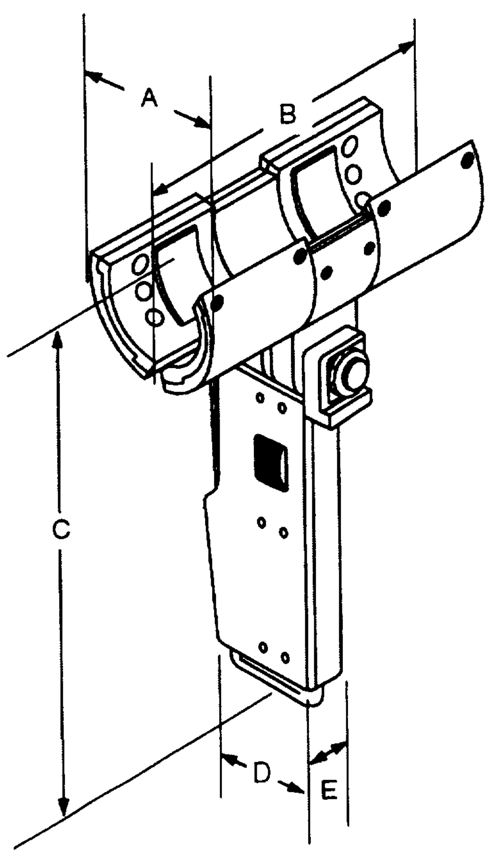
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

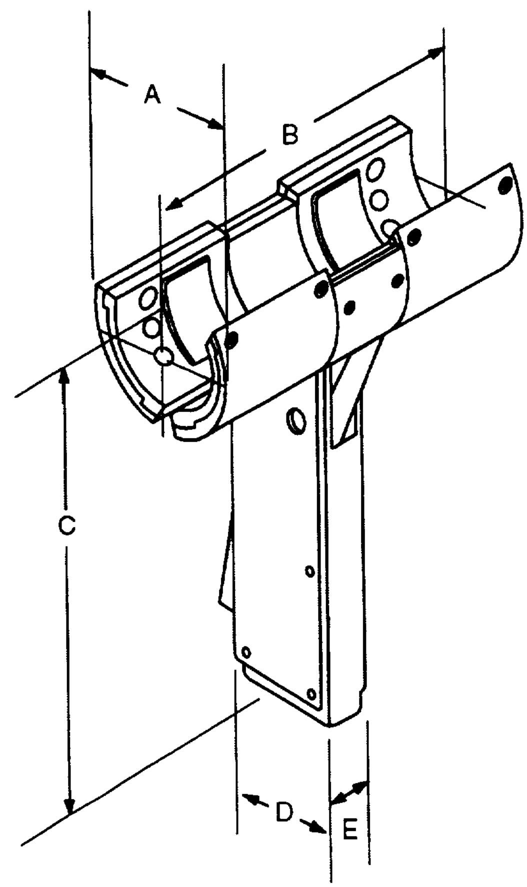
HOOK, TRUSS STRUT

Technical Information	
Part number	20159–10003–01 (fixed) 20159–10002–01 (swivel)
Part number	20159–10003–01 (fixed) 20159–10002–01 (swivel)
Weight	20159–10003–01 2.18 lb 20159–10002–01 2.45 lb
Material/ construction	Aluminum bronze Stainless steel Vespel
Load rating	
Temperature range	–150° to +250° F (operational)
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data				
	Fixed		Swivel	
	inches	cm	inches	cm
A	1.97–3.10	5.00–7.87	1.95–3.05	5.00–7.75
B	6.000	15.24	6.00	15.24
C	8.750	22.23	9.65	24.51
D	1.810	4.60	2.21	5.61
E	0.875	2.22	0.75	1.91



Swivel



Fixed

HYDRAZINE ANALYZER

S85-38100

OVERVIEW

The hydrazine analyzer (referred to as Interscan) is an off-the-shelf black box instrument that provided the capability for determining quantitative levels of hydrazine contamination **early in the orbiter EVA program**. The Interscan **was** passed into the airlock to test its atmosphere once it **had** been repressurized to cabin pressure. If contamination **was** detected by the Interscan, the EVA crew **was to** return to vacuum and sublimate (bake out) the hydrazine to space. **Like all hydrazine cleanup equipment, it was only manifested when a specific payload caused the EVA crew to be at risk of contamination.**

OPERATIONAL COMMENTS

The Interscan is an electrochemical gas detector that generates a current directly proportional to the hydrazine gas concentration found in the air. This current is converted to a voltage for display on a graduated meter.

If contamination was suspected, the Interscan **was** used during the post-EVA flight procedures following airlock repress to cabin pressure. Once the Interscan **had** been configured correctly, it **was** quickly passed through the airlock inner hatch to the extravehicular (EV) crew. This exchange **was to minimize** any airborne contamination spilled into the middeck. The EV crew **would** then direct the gas inlet of the Interscan at suspected contamination areas. If the meter read less than 1.6 parts per million (PPM), the inner hatch **could** be opened as long as two hydrazine removal canisters **were** installed. A greater than 1.6-PPM reading required that additional cleanup and safety procedures be performed by the EV crew. **This device has been replaced by the hydrazine monitor for current and future applications.**

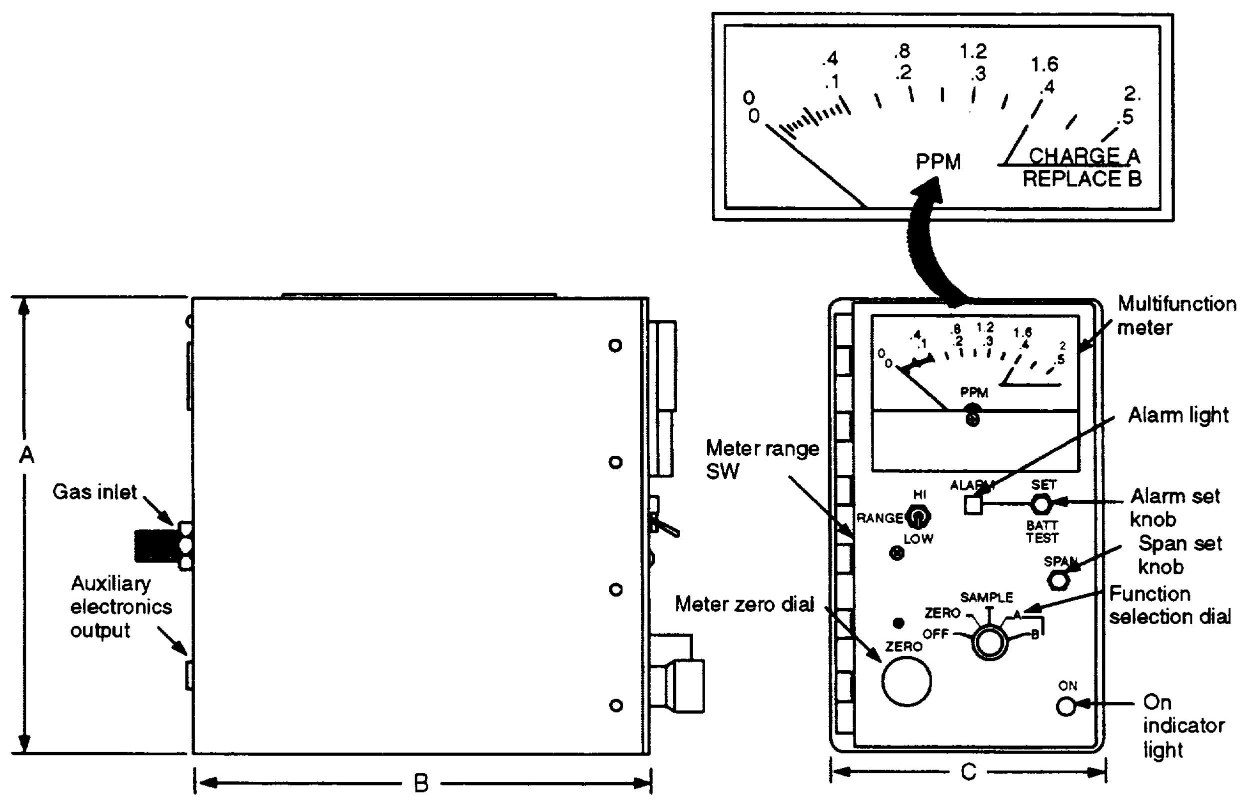
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483-2589
Technical: **J. Cross, Krug /SD42, (713) 483-8800**

HYDRAZINE ANALYZER

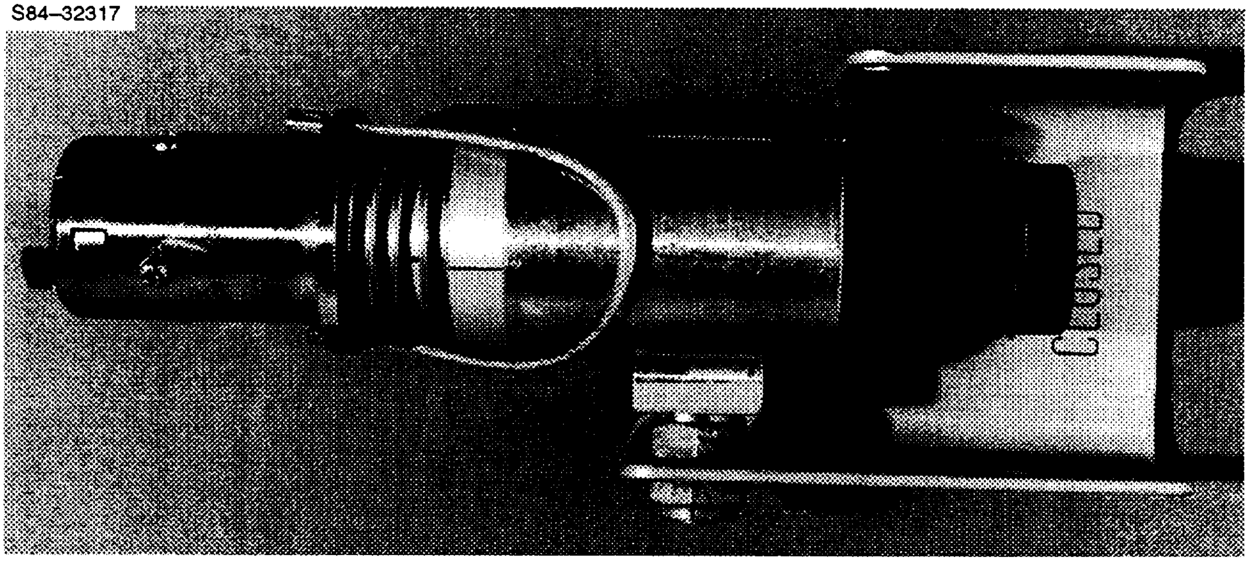
Technical Information	
Part number	SED42103121–302
Weight	4.1 lbm
Material/ construction	Aluminum case
Battery circuit A	Powered by four rechargeable NiCd batteries. Provides up to 10 hr continuous service (750 mA–h). Supplies power for pump, alarm light, on indicator light
Battery circuit B	Powered by two alkaline Mn02 C–cell batteries. Supplies a constant reference voltage to the gas sensor
Alarm light	Red LED, 600 nm peak wave length
Load rating	
Temperature range	
Quantity flown	**One**
Stowage	**Middeck locker**
Availability	Reference only

Dimensional Data		
	inches	cm
A	7.000	17.78
B	8.875	22.54
C	4.000	10.16



HYDRAZINE BALL VALVE HOUSING

S84–32317



OVERVIEW

The hydrazine ball valve housing is part of the hydrazine servicing tool set of the orbital refueling system (ORS). **It was used on STS 41–G to demonstrate on–orbit satellite refueling of** satellites from the orbiter. The **ball valve** connects to the fill and drain valve of the orbiting satellite, and a relief valve in the ball valve housing allows pressure bleed–off. A tether ring is attached to the housing.

OPERATIONAL COMMENTS

The ball valve housing screws onto the satellite valve to provide a redundant seal during satellite valve hex nut and seal cap removal and during multipurpose tool installation. The ball valve should be in the closed position when tools are being attached to the housing. **OPEN and CLOSED markings are engraved in 7/16–in. black letters on the handle.**

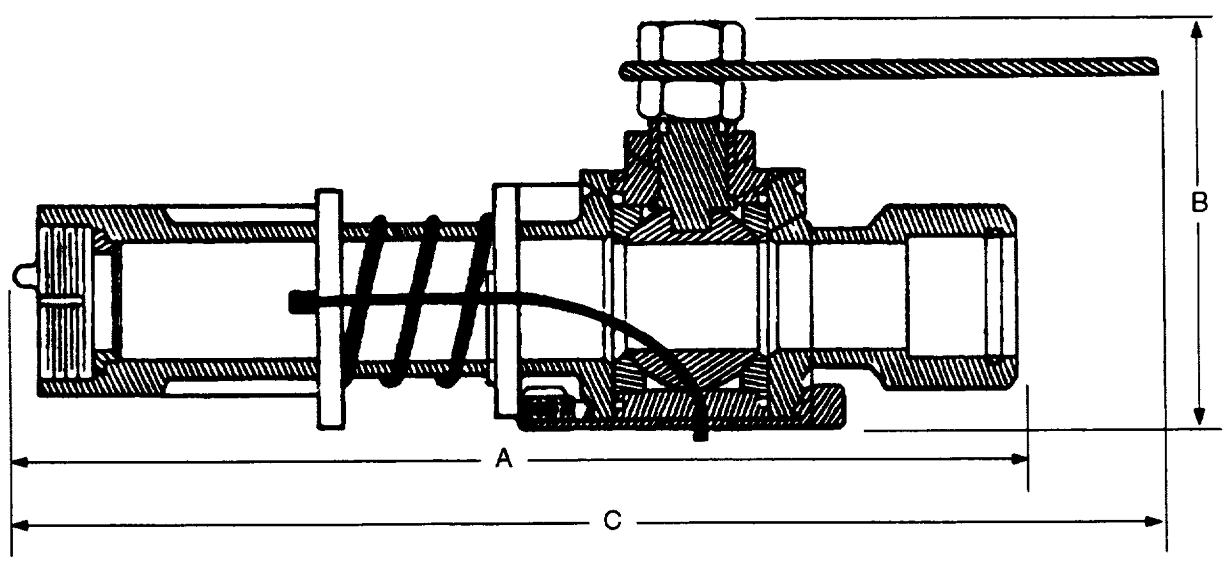
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. Marak**, NASA/EC5, (713) 483–9144

HYDRAZINE BALL VALVE HOUSING

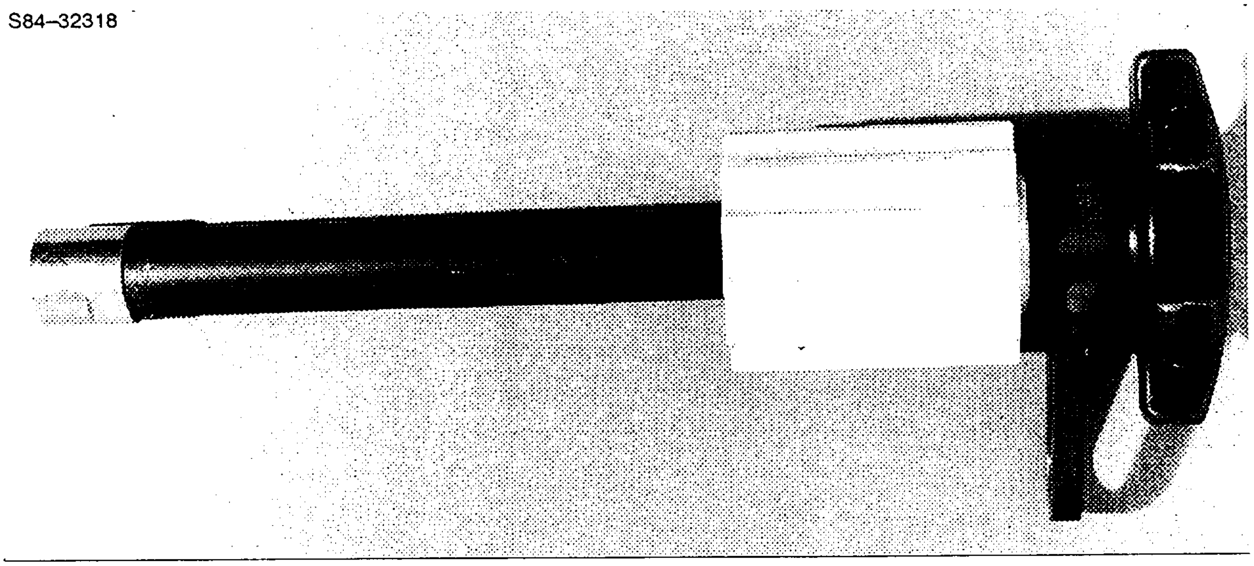
Technical Information	
Part number	SED 39116005
Weight	2.24 lb
Material/construction	Anodized aluminum
Load rating	Installed ball valve – 150 ± 50 in–lb maximum
Temperature rating	35° to 120° F
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	8.7500	22.23
B	3.4375	8.73
C	9.930	25.22



HYDRAZINE CAP RETAINER ASSEMBLY

S84–32318



OVERVIEW

The hydrazine cap retainer assembly is part of the hydrazine servicing tool set of the orbital refueling system (ORS). **It was used on STS 41–G to demonstrate on–orbit satellite refueling** from the orbiter. **This servicing tool removes** the **cap from the** fill and drain valve of the orbiting satellite. There is a plug on one end to remove the hydrazine cap and a mushroom handle on the other end. A sliding silver knob and tether ring are mounted on the tool shaft.

OPERATIONAL COMMENTS

The tool is inserted into the ball valve housing and the silver knob is rotated clockwise until hand–tight. The ball valve is opened, the mushroom handle is depressed to capture the cap, the tool is retrieved clear of the ball valve, the valve is closed, and the tool with the hydrazine cap is removed.

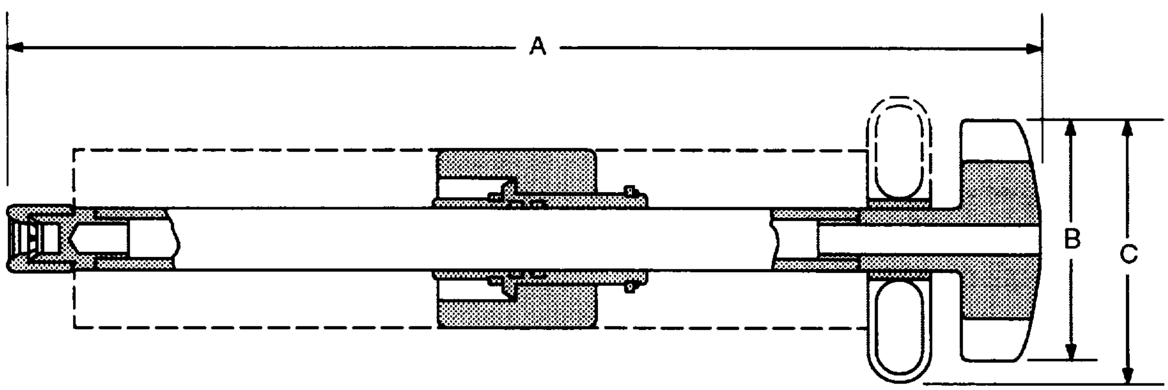
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. J. Marak**, NASA/EC5, (713) 483–9144

HYDRAZINE CAP RETAINER ASSEMBLY

Technical Information	
Part number	SED 39115758–**302**
Weight	1.0 lb
Material/ construction	Anodized aluminum
Load rating	Silver knob – 150 ± 50 in–lb maximum
Temperature range	35° to 150° F
Quantity flown	
Stowage	
Availability	Reference only

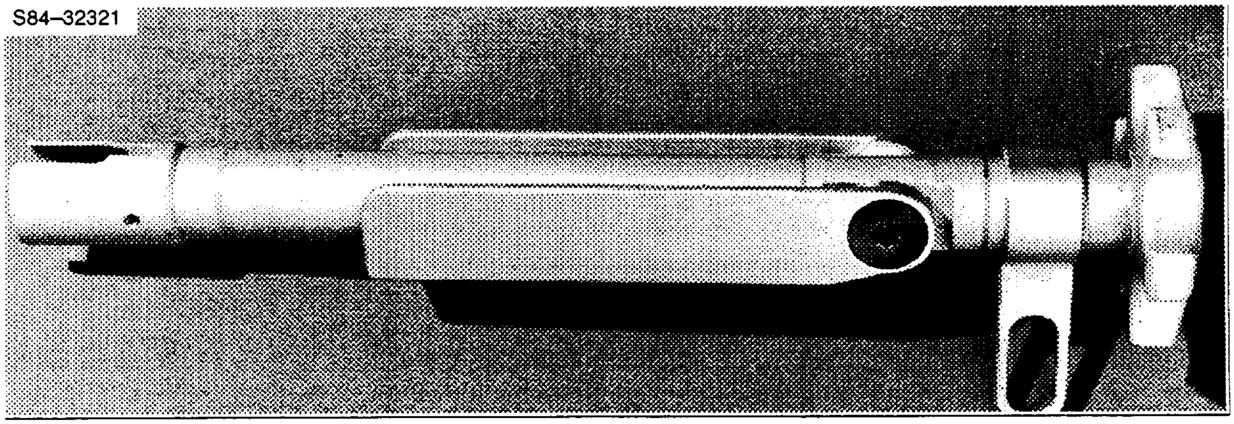
Dimensional Data		
	inches	cm
A	13.10	33.27
B	3.00	7.62
C	3.25	8.26



IL_6

HYDRAZINE DUST CAP REMOVER

S84-32321



OVERVIEW

The hydrazine dust cap remover is part of the hydrazine servicing tool set of the orbital refueling system (ORS). It was used on STS 41-G to demonstrate on-orbit satellite refueling from the orbiter. This tool removes the dust caps of the fill and drain valve of the orbiting satellite. There is a claw on one end to remove the dust caps and a mushroom handle on the other end. A swivel arm and tether ring are attached to the tool shaft.

OPERATIONAL COMMENTS

The tool is installed on the top left satellite valve by slipping the tool over the dust cap and rotating until the claw is engaged with the ridge on the dust cap. The dust cap is unscrewed and removed.

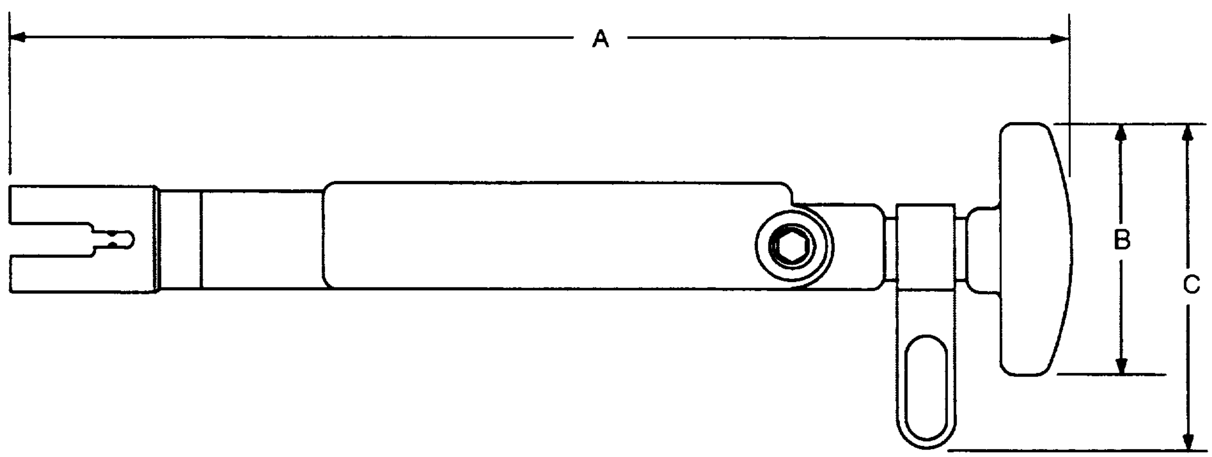
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: **R. J. Marak**, NASA/EC5, (713) 483-9144

HYDRAZINE DUST CAP REMOVER

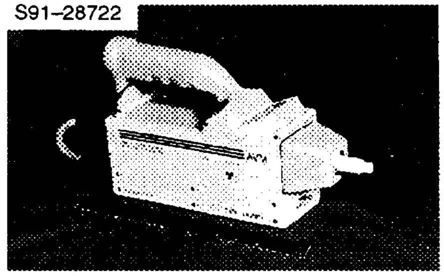
Technical Information	
Part number	SED 39116110
Weight	1.0 lb
Material/ construction	Anodized aluminum
Load rating	150 ± 50 in–lb maximum
Temperature range	35° to 150° F
Quantity flown	
Stowage	
Availability	**Reference only**

Dimensional Data		
	inches	cm
A	12.5	31.75
B	3.0	7.62
C	3.9	9.91



HYDRAZINE MONITOR

S91–28722



OVERVIEW

The hydrazine monitor, presently flown as a detailed test objective (DTO), is used inside a repressurized airlock to screen the extravehicular mobility unit (EMU) and EVA equipment for quantitative traces of hydrazine or monomethylhydrazine (MMH) before accessing the crew cabin and the intravehicular (IV) crew. Both fuels are suspected to be carcinogenic and/or irritating at very low concentrations (parts per billion) in the air. The monitor is a single handheld, battery–operated unit with a nozzle at one end that is run over the EMU to collect an air sample. Hydrazines that might be in the air sample cross a silicon rubber membrane and enter an ion mobility spectrometer. In the spectrometer, the fuels are ionized before being propelled toward a detector by an electric field. The movement of the ions is impeded by air, and the ions arrive at the detector at a time characteristic of the ion's size. Hydrazine and monomethylhydrazine have unique drift times that enable them to be distinguished from each other and from ammonia, which can also be present in the vehicle atmosphere. The monitor features an LCD readout for real–time feedback and a data logger to collect ion mobility spectra for postflight analysis. The prototype unit flown as DTO–640 on STS–37 and STS–49 has ongoing additional improvements to become an operational device.

OPERATIONAL COMMENTS

The monitor is operated with two pushbutton switches. Pressing the ON/OFF switch causes the display to light up. All the display elements are briefly visible as the monitor performs an initial electronics check. After 30 seconds, all go out except a large "G" and the word "WAIT." When the "WAIT" light goes off, the monitor is ready to use. The time the "WAIT" light is on depends on previous use. A 2–hour warmup period is performed early in each mission, and another 50–minute warmup is recommended before the EV crew returns to the airlock. The data logger has a 60–minute capacity and is operated by a pushbutton switch. A red LED flashes every 10 seconds when the data logger is active. A low batttery condition is indicated by "BL" followed by eight flashing bars, or a blank display if the battery is fully depleted.

The current operating procedure is to briefly open the hatch between the middeck and the repressurized airlock and pass the monitor through to the EV crew. An EV crewmember then runs the monitor's nozzle near the EMU surface for up to 8 minutes and watches the display. If hydrazines are detected, bars light up on the display. Four bars correspond to 100 parts per billion, which is the cabin limit allowed in the airlock. A reading of four bars or less requires no action. More bars require initiation of a cleanup procedure. To distinguish false readings, the protective cap/filter should be reinstalled and the unit run for 3 minutes to clear the sensor for a new reading. A set of three dots (no bars) will appear on the display if ammonia is detected. A false off–scale high reading can be induced by liquid water and can be cleared by cycling power and waiting 3 minutes for the "WAIT" message to clear before taking another reading.

Future upgrades should include certification for operation at cabin pressure after storage at vacuum to avoid violating cabin air integrity for passing into the airlock. Sensing for N_2O_4 (NO_2) and ammonia may be added to support SSF applications.

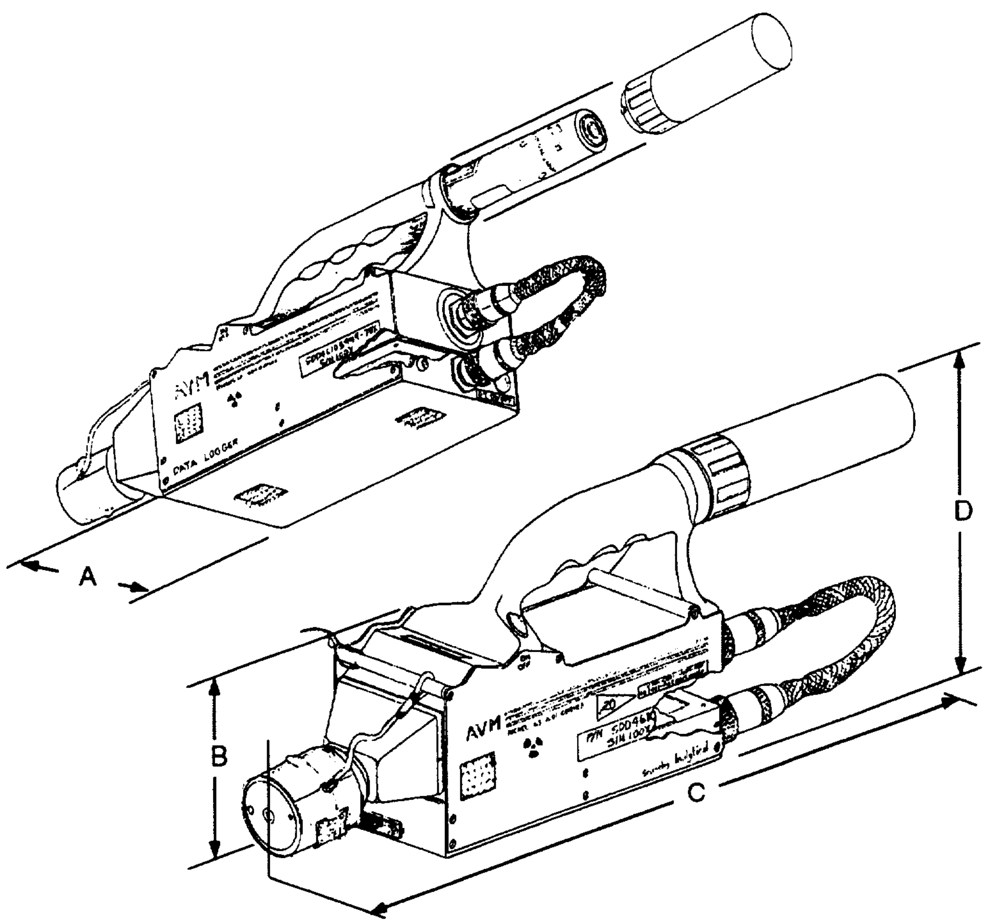
CONTACTS

Operational: C. Begley, JSC DF42, (713) 483–0678
Technical: J. Cross, JSC SD4, (713) 483–8800

HYDRAZINE MONITOR

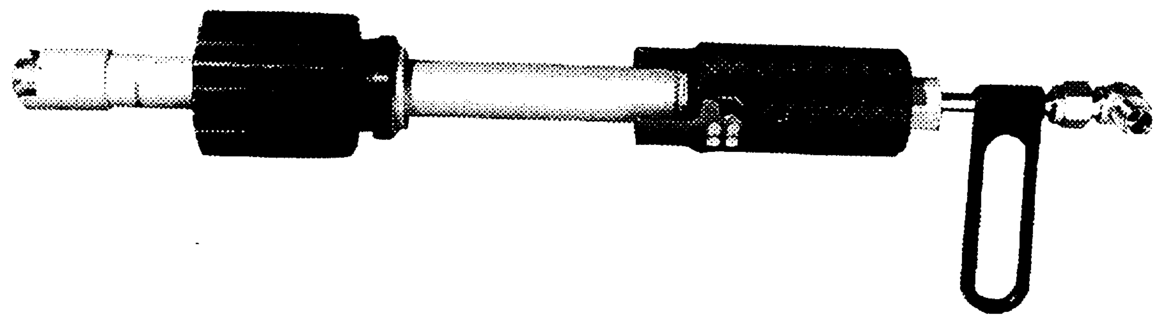
Technical Information	
Part number	SDD46015994–302
Weight	7.9 lb (3.5 kg) with battery
Material/ construction	Diecast aluminum housing
Load rating	7.5 to 14.7 psia operating pressure 5 to 20 psia storage pressure (not vacuum rated) 10 to 90% relative humidity 3 to 5–hour battery life 25 to 500 parts per billion hydrazine detection (1 to 8 bars)
Temperature range	32° to 104° F (operating) 14° to 113° F (storage)
Quantity flown	One
Stowage	Middeck locker
Availability	Developmental

Dimensional Data		
	inches	cm
A	3.38	8.59
B	5.1	12.95
C	19.75	50.17
D	8.0	20.32



HYDRAZINE MULTIPURPOSE TOOL

S84–32326



OVERVIEW

The hydrazine multipurpose tool is part of the hydrazine servicing tool set of the orbital refueling system (ORS). **It was used on STS 41–G to demonstrate on–orbit satellite refueling from the orbiter. This tool** connects to the fill and drain valve of the orbiting satellite **via the ball valve. It was** attached by a flexline to the ORS service line prior to launch. A B–nut is on one end of the tool, and the flexline is on the other. Two knobs (a large blue one and a small green one) and a tether ring are mounted on the tool shaft.

OPERATIONAL COMMENTS

The tool is attached to the ball valve housing by rotating the large blue knob clockwise. **The red clips hold the two knobs together for B–nut engagement**. The ball valve is opened, and the small green knob is rotated clockwise until the B–nut is seated on the valve fitting.

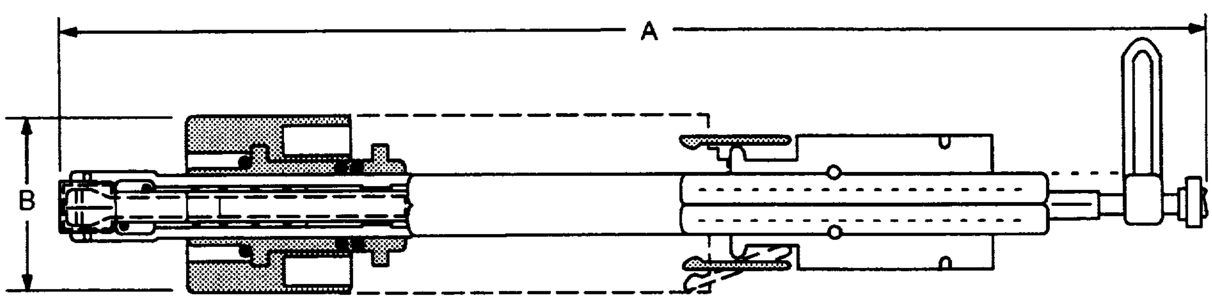
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. J Marak**, NASA/EC5, (713) 483–9144

HYDRAZINE MULTIPURPOSE TOOL

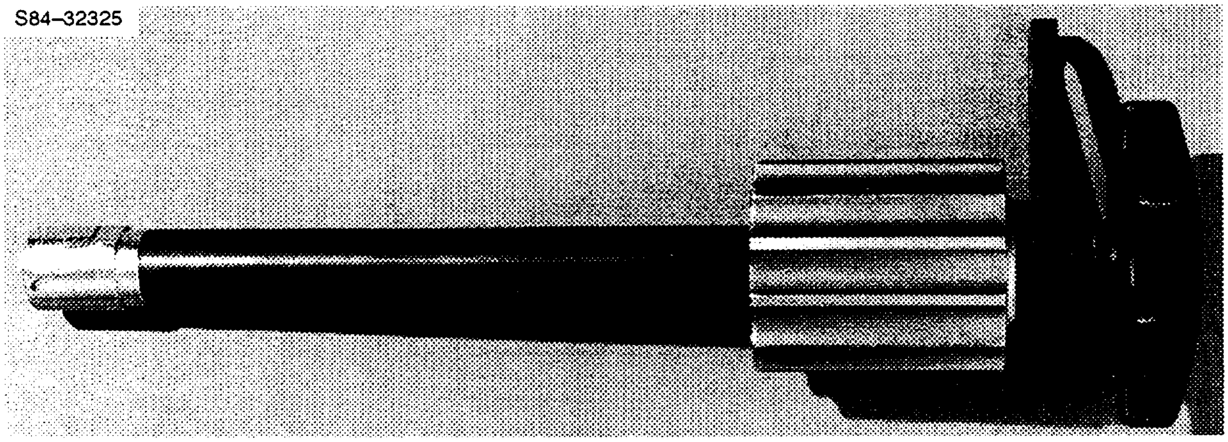
Technical Information	
Part number	SED 39115847–**301**
Weight	1.7 lb
Material/ construction	Anodized aluminum
Load rating	Large blue knob – 105 ± 5 in–lb Small green knob – 150 ± 5 in–lb maximum
Temperature range	35° to 150° F
Quantity flown	
Stowage	
Availability	**Reference only**

Dimensional Data		
	inches	cm
A	14.2	36.07
B	4.5	11.43



HYDRAZINE NUT RETAINER ASSEMBLY

S84–32325



OVERVIEW

The hydrazine nut retainer assembly is part of the hydrazine servicing tool set of the orbital refueling system (ORS). **It was used on STS 41–G to demonstrate on–orbit satellite refueling from the orbiter. This tool removes the hex nut from** the fill and drain valve of the orbiting satellite. This tool has a friction collar on one end and a mushroom handle on the other end. A sliding red knob and tether ring are mounted on the tool shaft.

OPERATIONAL COMMENTS

The tool is inserted into the ball valve housing, and the red knob is rotated clockwise until hand–tight. The ball valve is opened, the friction collar is depressed on the hex nut, the nut is unscrewed, the tool is retrieved clear of the ball valve, the valve is closed, and the tool with the hex nut is removed.

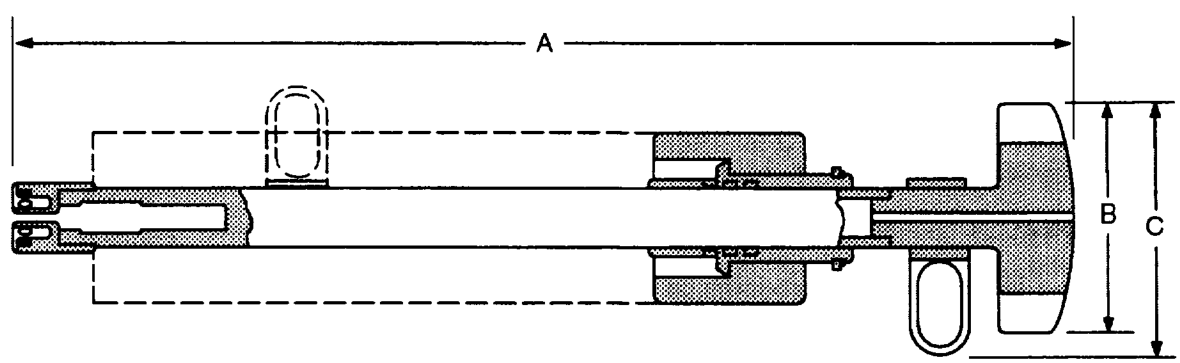
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. J. Marak**, NASA/EC5, (713) 483–9144

HYDRAZINE NUT RETAINER ASSEMBLY

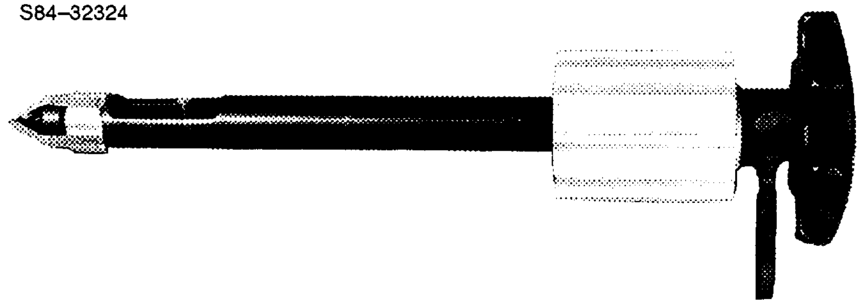
Technical Information	
Part number	SED 39115766
Weight	1.1 lb
Material/ construction	Anodized aluminum
Load rating	Red knob – 150 ± 50 in–lb maximum
Temperature range	35° to 150° F
Quantity flown	
Stowage	
Availability	**Reference only**

Dimensional Data		
	inches	cm
A	10.75	27.31
B	3.00	7.62
C	3.25	8.26



HYDRAZINE RETRIEVAL TOOL

S84–32324



OVERVIEW

The hydrazine retrieval tool is part of the hydrazine servicing tool (HST) set of the orbital refueling system (ORS). It was used on STS 41–G to demonstrate on–orbit satellite refueling from the orbiter. This tool is used to remove the hex nut from the satellite fill and drain valve if the nut does not come out with the hydrazine nut retrieval tool. This tool has a grapple plunger on one end and a mushroom handle on the other end. A silver knob and a tether ring are mounted on the tool shaft.

OPERATIONAL COMMENTS

The tool is inserted into the ball valve housing, and the silver knob is rotated clockwise until hand–tight. The ball valve is opened, the grapple plunger is depressed onto the hex nut, the tool is retrieved clear of the ball valve, the valve is closed, and the tool with the hex nut is removed.

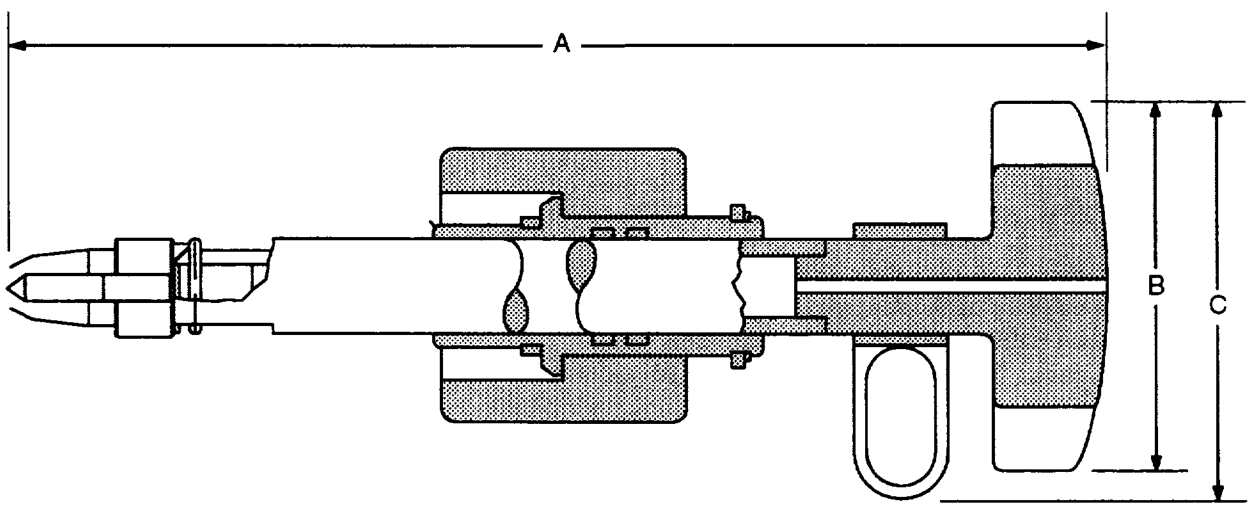
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. Marak, NASA/EC5, (713) 483–9144

HYDRAZINE RETRIEVAL TOOL

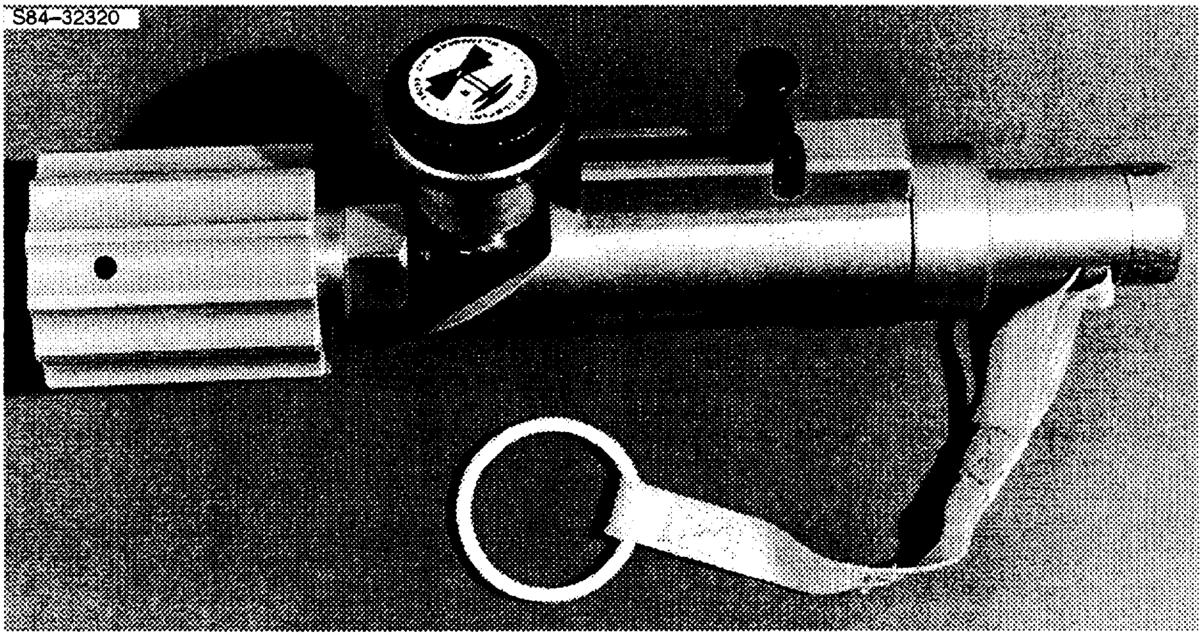
Technical Information	
Part number	SED 39115865
Weight	1.06 lb
Material/ construction	Anodized aluminum
Load rating	Silver knob – 150 ± 50 in–lb maximum
Temperature range	35° to 150° F
Quantity flown	
Stowage	
Availability	**Reference only**

Dimensional Data		
	inches	cm
A	10.75	27.31
B	3.00	7.62
C	3.25	8.26



HYDRAZINE SEAL VERIFICATION TOOL

S84–32320



OVERVIEW

The hydrazine seal verification tool is part of the hydrazine servicing tool set **of the orbital refueling system (ORS) demonstrated on STS 41–G**. The tool is a pressurized gas–containing assembly **that** provides a leak check capability to ensure correct installation of the ball valve housing. The tool has a silver knob on one end, a green seal valve knob mounted perpendicularly to the tool housing, **a blue seal valve lock** and a Bourdon tube pressure gauge on the other end. The tool is launched with a protective cover and tether ring.

OPERATIONAL COMMENTS

The hydrazine seal verification tool is installed on the ball valve by inserting and rotating the **large** silver knob clockwise (hand–tight) and rotating the green seal valve knob counterclockwise. Verify seal tool cavity pressure (600 to 800 psia). Check pressure decay for leak. Two of these tools **were** flown.

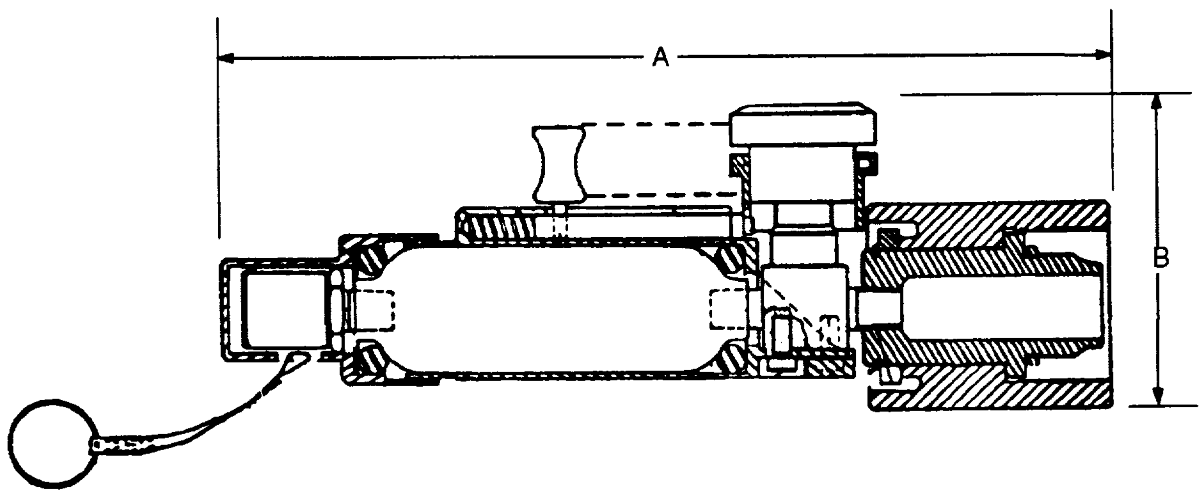
CONTACTS

Operational: C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. Marak,** NASA/EC5, (713) 483–9144

HYDRAZINE SEAL VERIFICATION TOOL

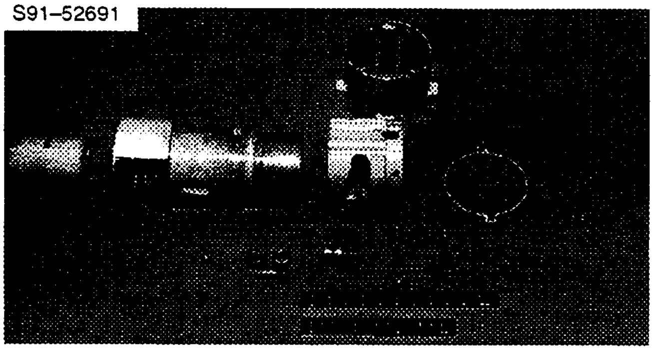
Technical Information	
Part number	SED 39116439
Weight	1.32 lb
Material/ construction	Anodized aluminum
Load rating	Silver knob – 150 ± 50 in–lb maximum
Temperature range	35° to 150° F
Quantity flown	**Two on STS 41–G**
Stowage	
Availability	**Reference only**

Dimensional Data		
	inches	cm
A	8.3	21.08
B	3.0	7.62

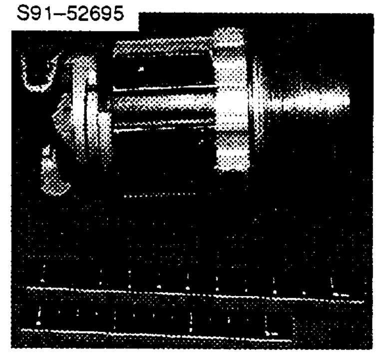


JOINT, TRUSS

S91–52691



S91–52695



OVERVIEW

The truss joint, also known as the Langley joint, was used on STS–49 as part of the Assembly of Station by EVA Methods (ASEM) to assemble a truss composed of fourteen 2–in.–diameter strut pieces, eight legs, five nodes, and four Y–fittings. When fully assembled, the basic truss was a little less than 15 ft on a side. The LaRC joint consists of the active latching joint and the passive stub. The joint is connected by a tongue and groove arrangement that allows the direct mating of the two halves. The black bands on the collar assist in EVA identification of the open, soft–docked, and locked configurations.The LaRC joint collars have dog ears that assist in gripping the joint and also provide an interface for a spanner wrench.

OPERATIONAL COMMENTS

The struts associated with these joints were color coded and numbered to provide EVA identification for assembly and stowage. The joint has three configurations for assembly and disassembly: open, soft–docked, and locked. The joint is open or free to remove when the collar is rotated counterclockwise, as viewed when looking from the opposite end of the truss strut. White bands (actually anodized or unpainted) on the collar line up with black bands on the body of the joint to indicate this position. Soft dock is achieved by rotating the collar 45° clockwise to a soft detent. This position is indicated when the black and white bands cross halfway. In the soft–dock position, an internal spring–loaded plunger retracts a locking pin as the joint halves are pushed together and then extends and locks in place. When in soft dock, the joint has full load–carrying capability and cannot be inadvertently demated. A counterclockwise force on the joint causes the collar to rotate back to the open position and retract the plunger and locking pin. The joint is locked by rotating the collar an additional 45° in the clockwise direction. The collar's closure torque is 20 to 40 in–lb. When fully locked, the black bands on the collar line up with the black bands on the body of the joint. From the fully locked position, the joint is demated by pulling the collar back toward the center of the strut and, with the collar held back, rotating the joint 90° counterclockwise through soft dock to the open position.

To maintain high strength after assembly, the joints have little linear misalignment compliance during assembly. Because of this and the long length of individual struts, truss assembly by one crewmember is very difficult. These joints failed to provide an easy–to–use contingency release mechanism. Each joint was launched in the soft–dock position to reduce EVA overhead, but many were found locked due either to launch loads or to inadvertent crew contact during prior EVA sorties. This joint was designed before the station change to a preintegrated truss construction. Although some struts will exist on station, the current preintegrated truss design uses primarily I–beam segments and does not use any of these joints.

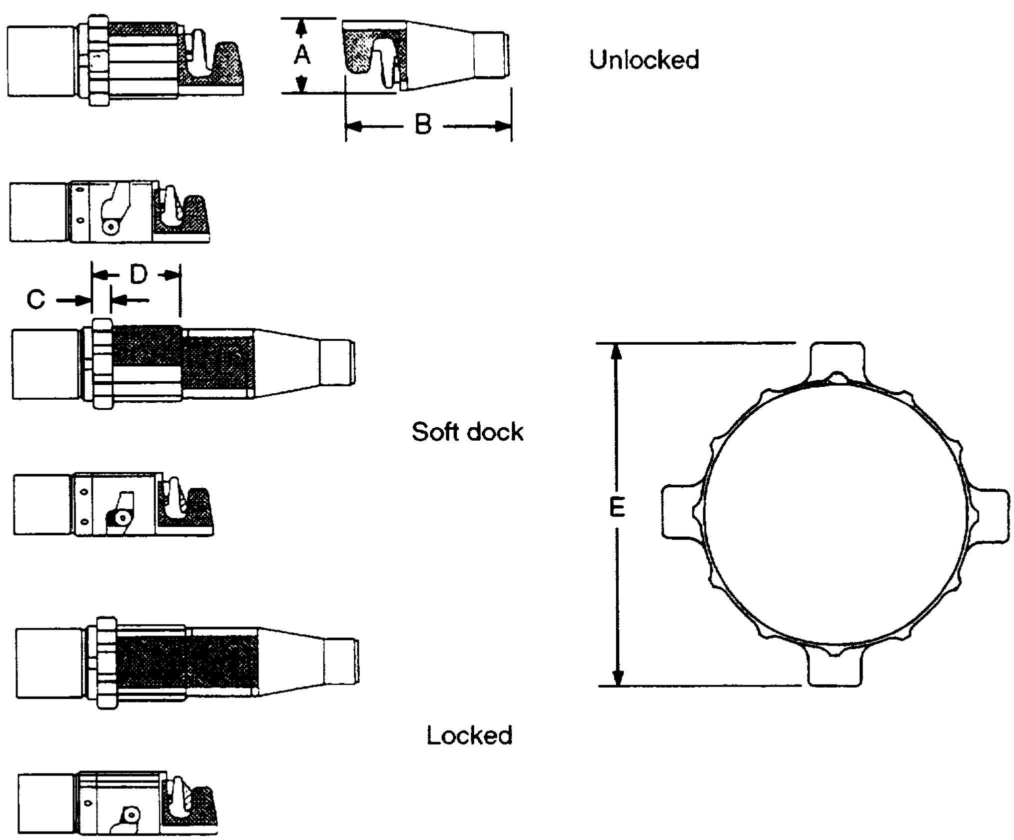
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. Schwarz, NASA/EC5, (713) 483–2378

JOINT, TRUSS

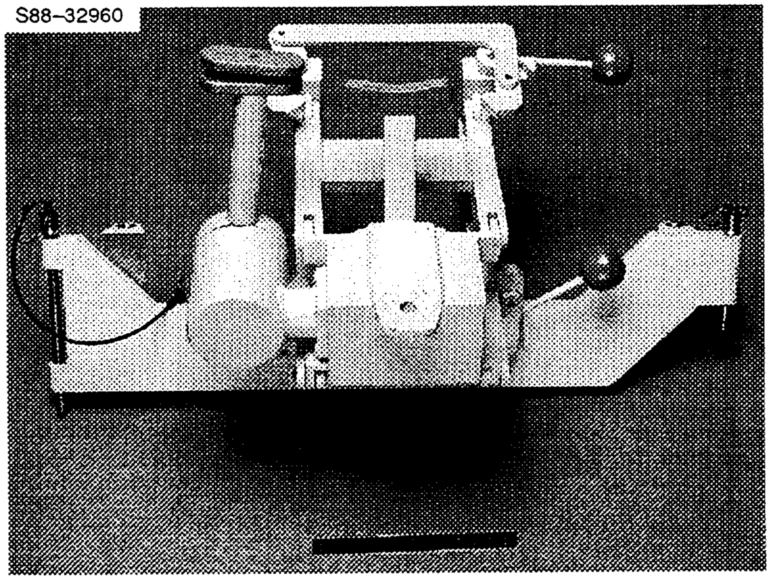
Technical Information	
Part number	LD–1033898 (passive stub) LE–1095303 (active joint)
Weight	
Material/ construction	Aluminum, stainless steel Braycoat oil
Load rating	20000 lb (ultimate tension) 320 ft–lb (ultimate bending – major axis) 420 ft–lb (ultimate bending – minor axis)
Temperature range	–50° to +110° F (operational)
Quantity flown	One on STS–37 and 39 on STS–49
Stowage	Crew loads instrumented pallet on STS–37 ASEM MPESS on STS–49
Availability	Reference only

Dimensional Data		
	inches	cm
A	2.12	5.38
B	3.49	8.86
C	0.44	1.12
D	1.90	4.83
E	2.30	5.84



MAGNETIC PANEL ATTACHMENT DEVICE

S88–32960



OVERVIEW

The magnetic panel attachment device (MPAD) **was designed as** a mechanical interface between the manned maneuvering unit (MMU) and a radiator panel typical to Space Station Freedom. Two quick disconnect pip pins attach the MPAD to the arms of the MMU and a magnet on the MPAD attaches to a ferrous steel insert located on the radiator panel. The MPAD **was to** be used during the proposed Shuttle Radiator Assembly Demonstration (SRAD) flight experiment.

OPERATIONAL COMMENTS

The MPAD must first be attached to the MMU before the MMU can position the MPAD for capture of a panel. The MMU is used to insert the docking tab at the tip of the MPAD into the docking insert on the panel. A small (soft dock) magnetic force is applied at insertion. Once soft dock is achieved, a large (hard dock) magnetic force is applied prior to flying with the panel.

The MPAD provides two geometric positions: docking/flying position and retracted position within grasping reach of the MMU operator's gloved hands.

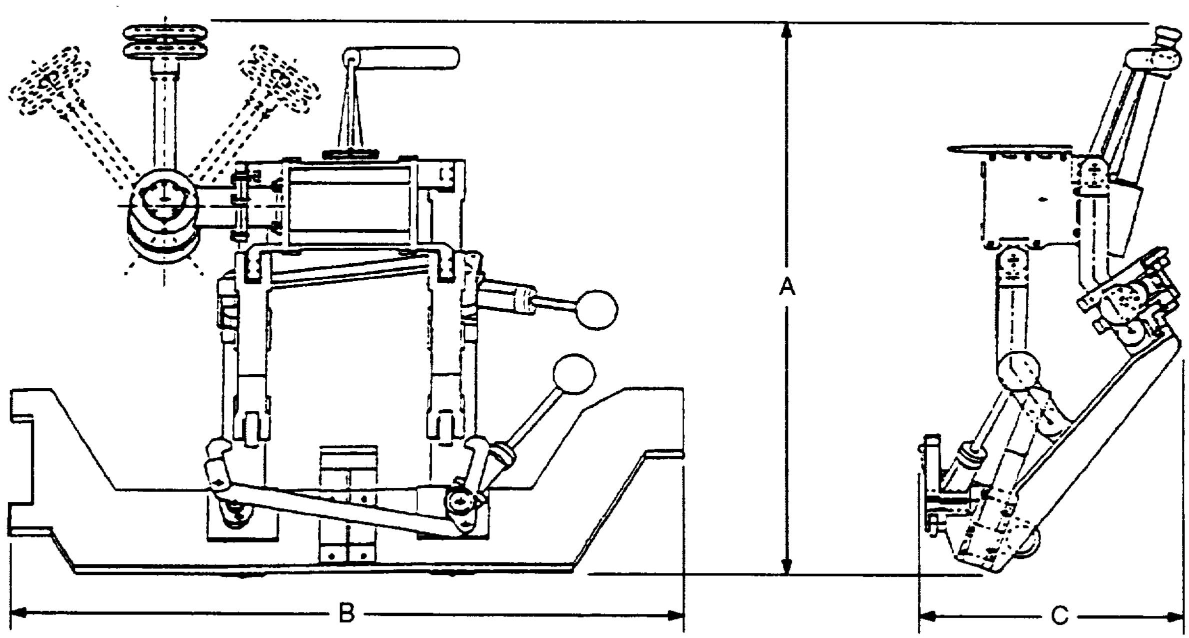
CONTACTS

Operational: R. C. Trevino, NASA/DF4, (713) 483–2597
Technical: **R. Marak**, ILC/EC5, (713) 483–91**44**

MAGNETIC PANEL ATTACHMENT DEVICE

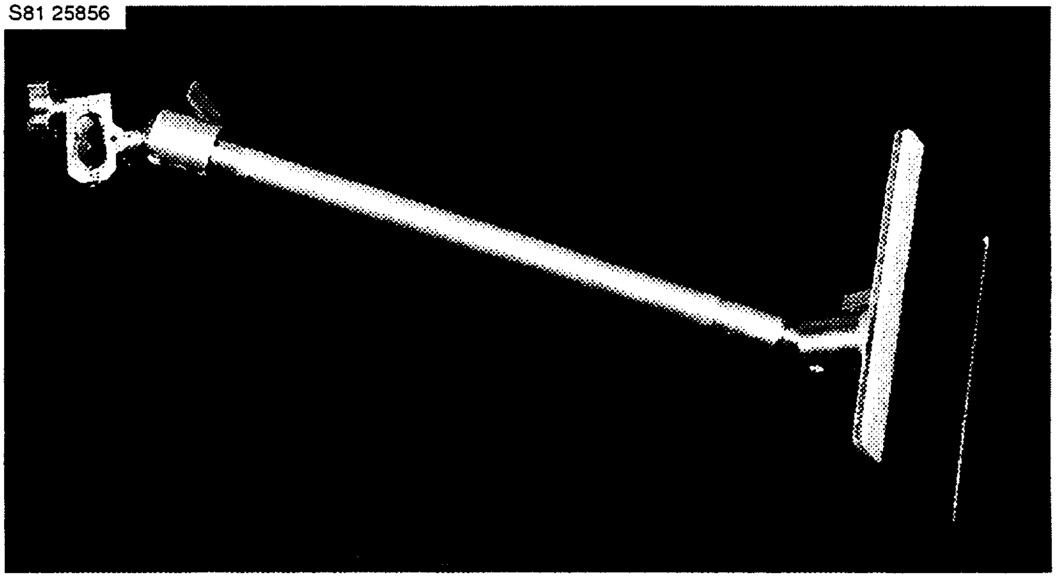
Technical Information	
Part number	SED39118650 **SED39118660 (bolt on stowage assembly)**
Weight	30 to 40 lb (TBD)
Material/ construction	Stainless steel, aluminum alloy, ferrous magnetic carbon steel, aluminum, bronze
Load rating	
Temperature range	–150° to 200° F
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A	21.0	53.34
B	24.0	60.96
C	10.0	25.40



MIRROR, DONNING

S81 25856



OVERVIEW

The donning mirror was developed as a visual aid for self–donning of the extravehicular mobility unit (EMU). It was flown briefly on the early shuttle flights when only the commander and pilot were onboard and no intravehicular (IV) support crewmember was available. The mirror specifically aided in the connection of the upper and lower torso body seal closure. It also assisted with biomed and cooling garment connectors, which are similarly difficult to see.

OPERATIONAL COMMENTS

Since the EMU was originally designed for self–donning, aids like this mirror have been devised to make this design goal practical. The mirror was clamped to a handrail prior to donning the upper torso. It could then be fine–tuned while in the upper torso to get ready for the various connections located at the waist. Now that IV crewmembers are available on all missions, this mirror is no longer manifested.

The mirror features a clamp that fits the oval cross section of a standard handrail tube. Lockable ball joints at the clamp and mirror ends provide adjustment capability. The shaft has an adjustable length. Like the EMU wrist mirror and the Intelsat inspection mirror, this mirror is made of highly polished stainless steel to eliminate any of the risk associated with glass breakage and sharp edges of standard mirrors.

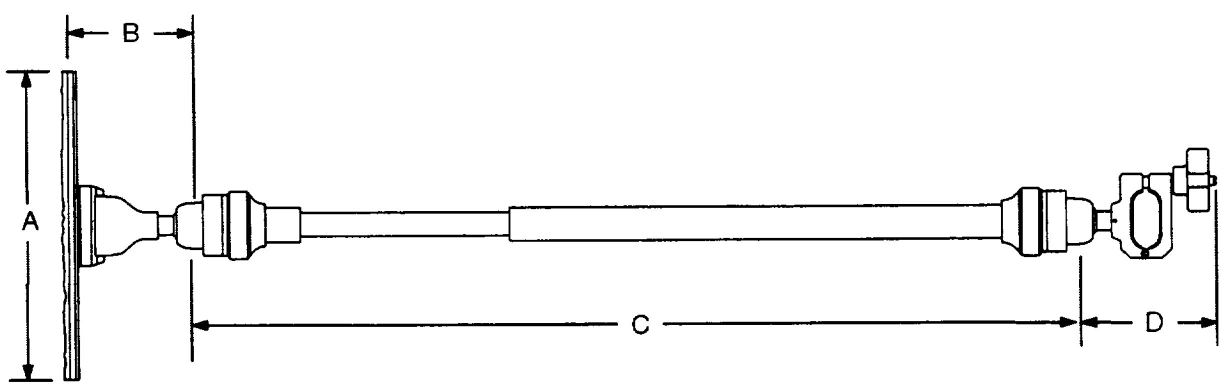
CONTACTS

Operational: R. Fullerton, NASA/DF42, (713) 483–2589
Technical: G. Lutz, NASA/EC6, (713) 483–9257

MIRROR, DONNING

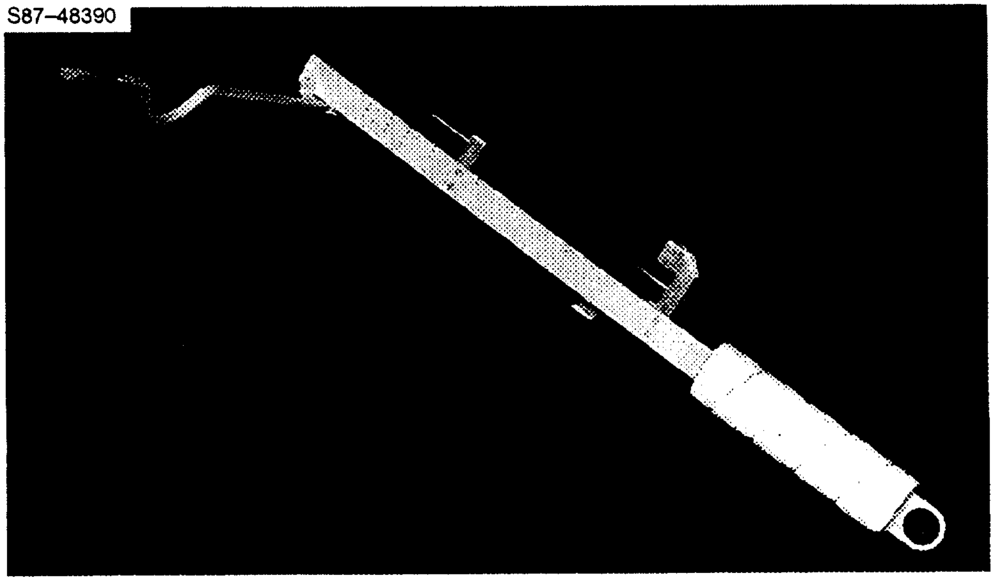
Technical Information	
Part number	**10108–10008–03**
Weight	
Material/ construction	Aluminum, stainless steel
Load rating	
Temperature range	
Quantity flown	**One**
Stowage	Middeck locker
Availability	Reference only

Dimensional Data		
	inches	cm
A	7.88	20.0
B	2.88	7.3
C	16.1 – 25.9	40.9 – 65.8
D	3.35	8.5
E		
F		
G		
H		



MMU RANGE FINDER

S87-48390



OVERVIEW

The manned maneuvering unit (MMU) range finder is a handheld device that gives the extravehicular activity crewmember an approximate indication of range from an object. The holes and notches machined into the bar are sighting guides for estimating distance. It was flown on STS 41-B and had a +20 percent accuracy as compared to the orbiter electronic range finder.

OPERATIONAL COMMENTS

During MMU flight, the range finder is stowed with an attached tether, on a bracket of the hand controller. For range readings, the sighting gauge is rotated 90° and touched to the helmet visor. The crewmember holds the handle of the sight bar and counts the holes and notches seen relative to an object of known size. This range finder is calibrated for a free flying orbiter.

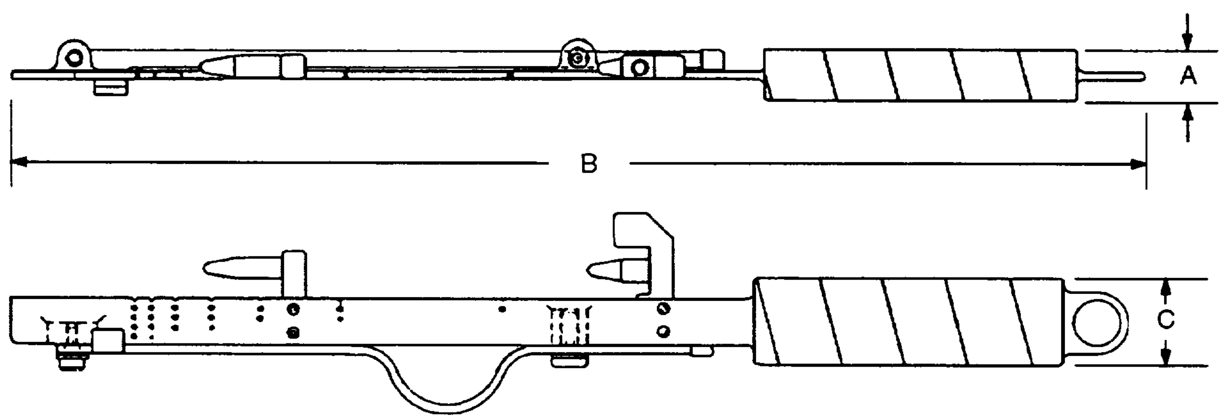
CONTACTS

Operational: R. Fullerton, NASA JSC/DF42, (713) 483-2589
Technical: **C. Hess**, NASA JSC/ER, (713) 483-**9142**

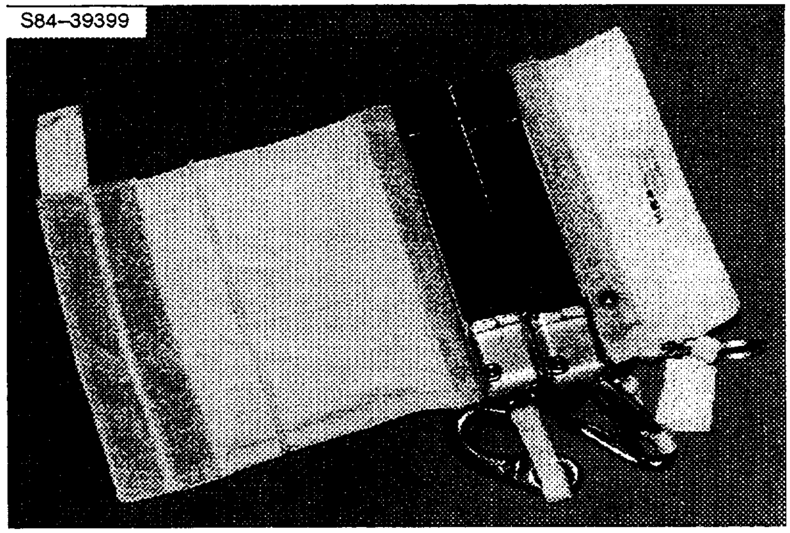
MMU RANGE FINDER

Technical Information	
Part number	10159–10021–01
Weight	0.69 lb (312 grams)
Material/ construction	Aluminum alloy
Load rating	5– to 8–lb pull force to release from MMU mount
Temperature range	–140° to +190° F
Quantity flown	One on STS 41–B
Stowage	Middeck locker
Availability	Reference only

Dimensional Data		
	inches	cm
A	0.75	1.91
B	15.8	40.13
C	1.25	3.18



PAM–D WEDGE



OVERVIEW

The payload assist module, type D (PAM–D) wedge is an aluminum bar with a flat, rotating tip. The wedge was designed as a contingency tool for use if the PAM–D sunshield fails to open.

OPERATIONAL COMMENTS

If the PAM–D sunshield does not open automatically, an extravehicular (EV) crewmember inserts the wedge into the rotary actuator of the sunshield, thereby closing the switch. The crewmember turns the end of the wedge, causing the tip to turn by means of a shaft inside and lock the wedge in place. When the sunshield indicates open to intravehicular (IV) crewmembers, an EV crewmember can safely cut the cables to allow manual opening of the sunshield.

The PAM–D wedge has a stainless steel tether ring for attachment to a tool caddy or to a wrist or waist tether. Wedges are usually stowed in tool caddies in sets of two. **This tool is no longer part of the standard orbiter manifest**.

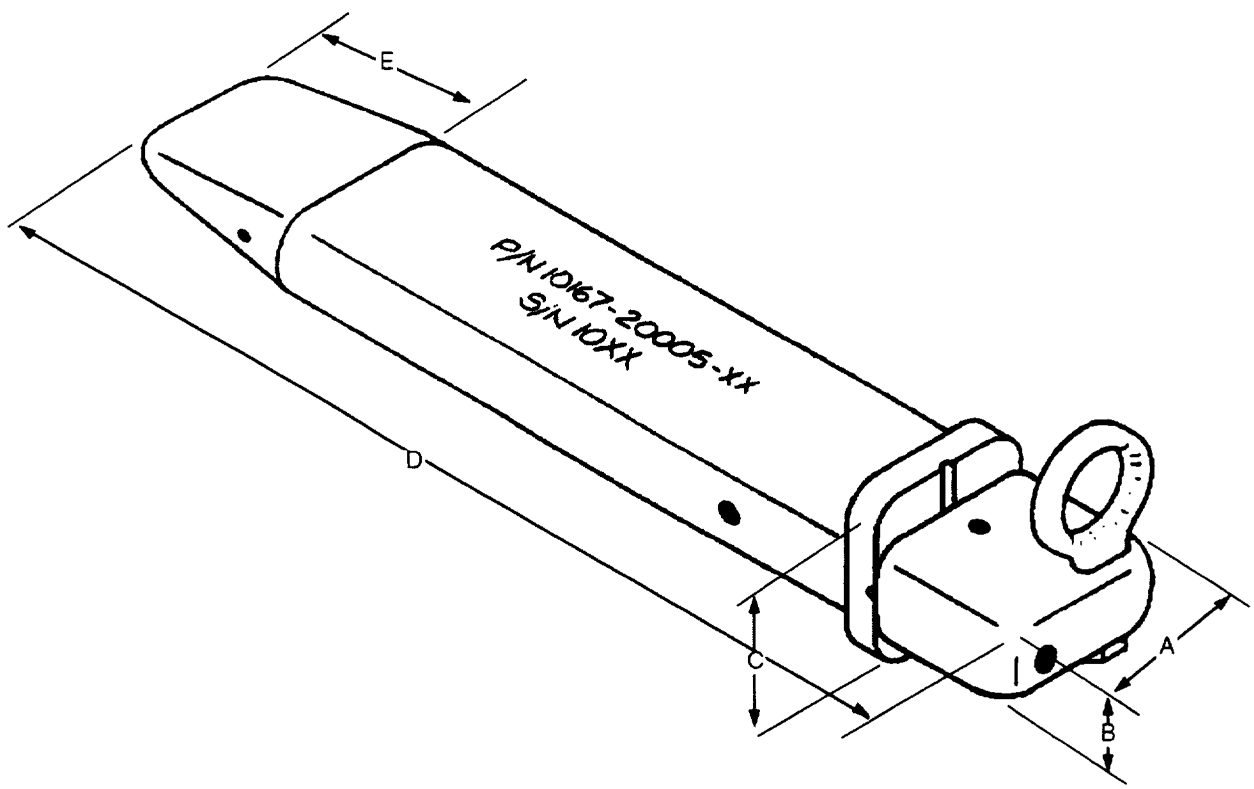
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

PAM–D WEDGE

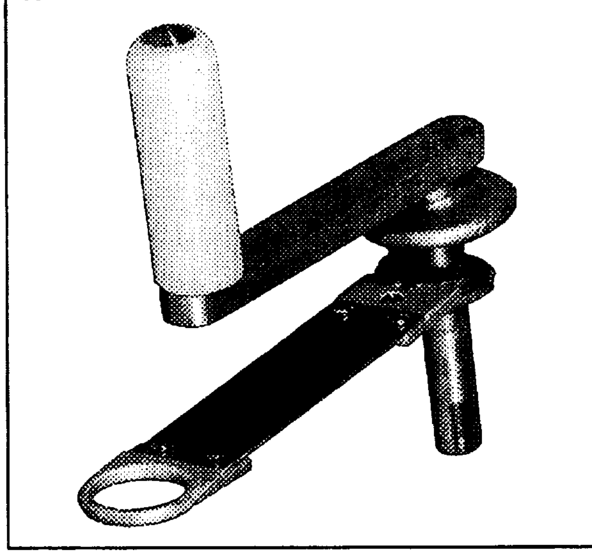
Technical Information	
Part number	**10167–10067–06 (wedge caddy)** 10167–20005–03 **(wedge alone)**
Weight	0.47 lb (each)
Material/ construction	Aluminum alloy
Load rating	
Temperature range	–200° to 250° F (operational), **+350° F (stowage)**
Quantity flown	Two (one set)
Stowage	PSA
Availability	Reference only

Dimensional Data		
	inches	cm
A	1.44	3.66
B	0.63	1.60
C	1.25	3.18
D	7.75	19.69
E	1.50	3.81



PAYLOAD CLAMP ASSEMBLY DRIVER

S84-46681



OVERVIEW

The payload clamp assembly (PCA) driver is an L-shaped handle with a long 1/4-in. hex socket on the end. A rotating tether attachment point allows tethering while the tool is in use. The above photograph is of a training tool mockup.

OPERATIONAL COMMENTS

The PCA driver is used to release or lock the payload clamps manually if the payload clamp actuator mechanism of the instrument pointing system (IPS) fails. Squeezing the tool's mushroom-shaped head releases ball locks, allowing the tool to slide onto the PCA drive hex and lock in place. The PCA drive handle should be used only if the torque limited PCA driver cannot produce sufficient torque. This tool was flown on IPS missions and was stowed in the provisions stowage assembly (PSA). The IPS no longer uses the type of payload clamps that this tool operates.

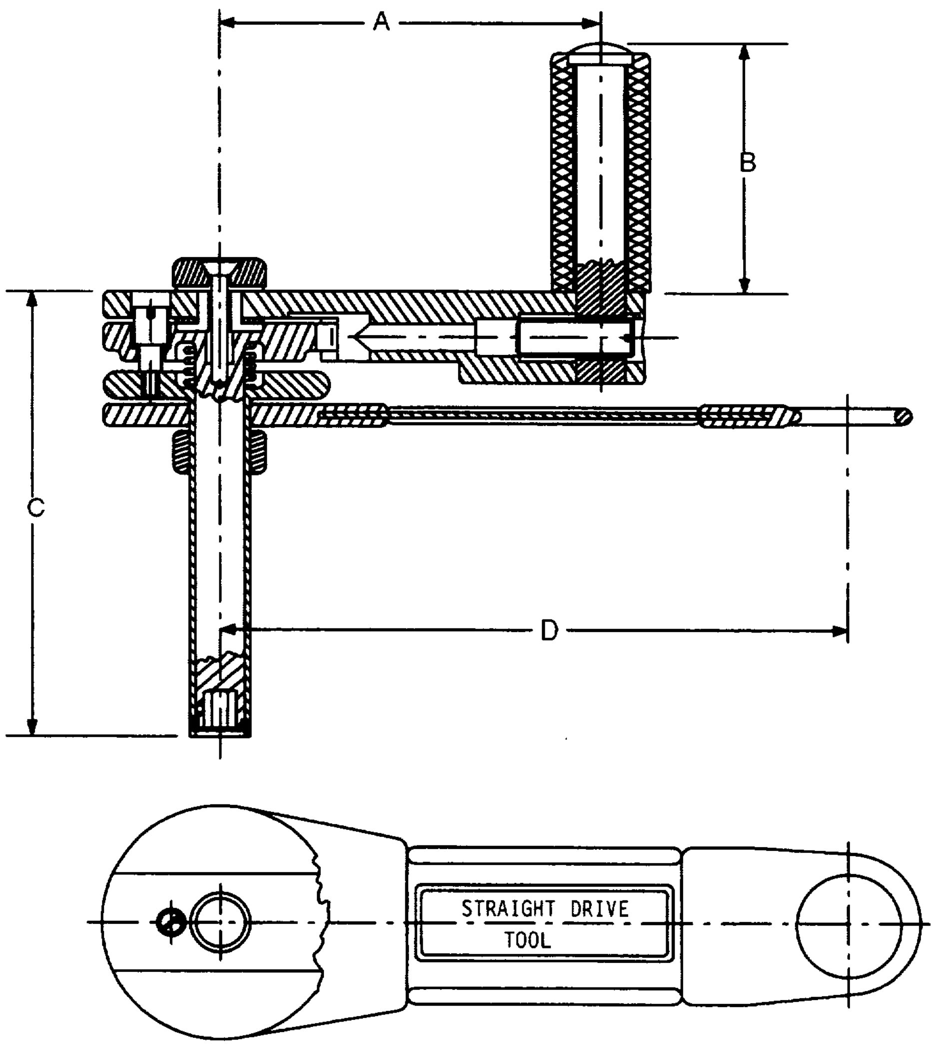
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: **J. Sexton, MSFC, (205) 544-5359**

PAYLOAD CLAMP ASSEMBLY DRIVER

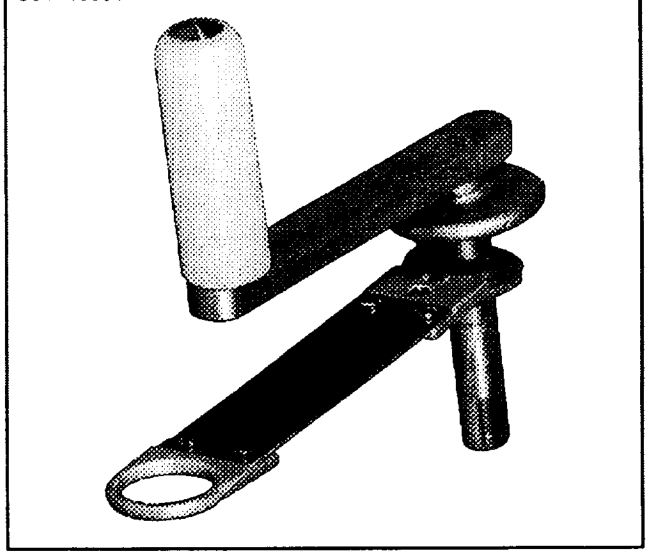
Technical Information	
Part number	883–400330.00.0
Weight	Not available
Material/ construction	Aluminum with plastic handle, tool steel drive
Load rating	
Temperature range	–150° to 250° F
Quantity flown	
Stowage	
Availability	Flight specific

Dimensional Data		
	inches	cm
A	3.94	10.01
B	2.95	7.49
C	4.01	10.19
D	6.42	16.31



PAYLOAD CLAMP ASSEMBLY TORQUE LIMITED DRIVER

S84-46681



OVERVIEW

The payload clamp assembly (PCA) torque limited driver is an L-shaped handle with a long 1/4-in. hex socket on the end. A torque limiting mechanism is built into the handle, which limits the torque to 1.475 ft-lb. A rotating tether attachment point allows tethering while the tool is in use. The above photograph is of a training tool mockup.

OPERATIONAL COMMENTS

The PCA torque limited driver is used to release or lock the payload clamps manually if the payload clamp actuator mechanism of the instrument pointing system (IPS) fails. Squeezing the tool's mushroom-shaped head releases ball locks, allowing the tool to slide onto the PCA drive hex, and lock in place. This tool was flown on IPS missions and was stowed in the provisions stowage assembly (PSA). The IPS no longer uses the type of payload clamps which this tool operates.

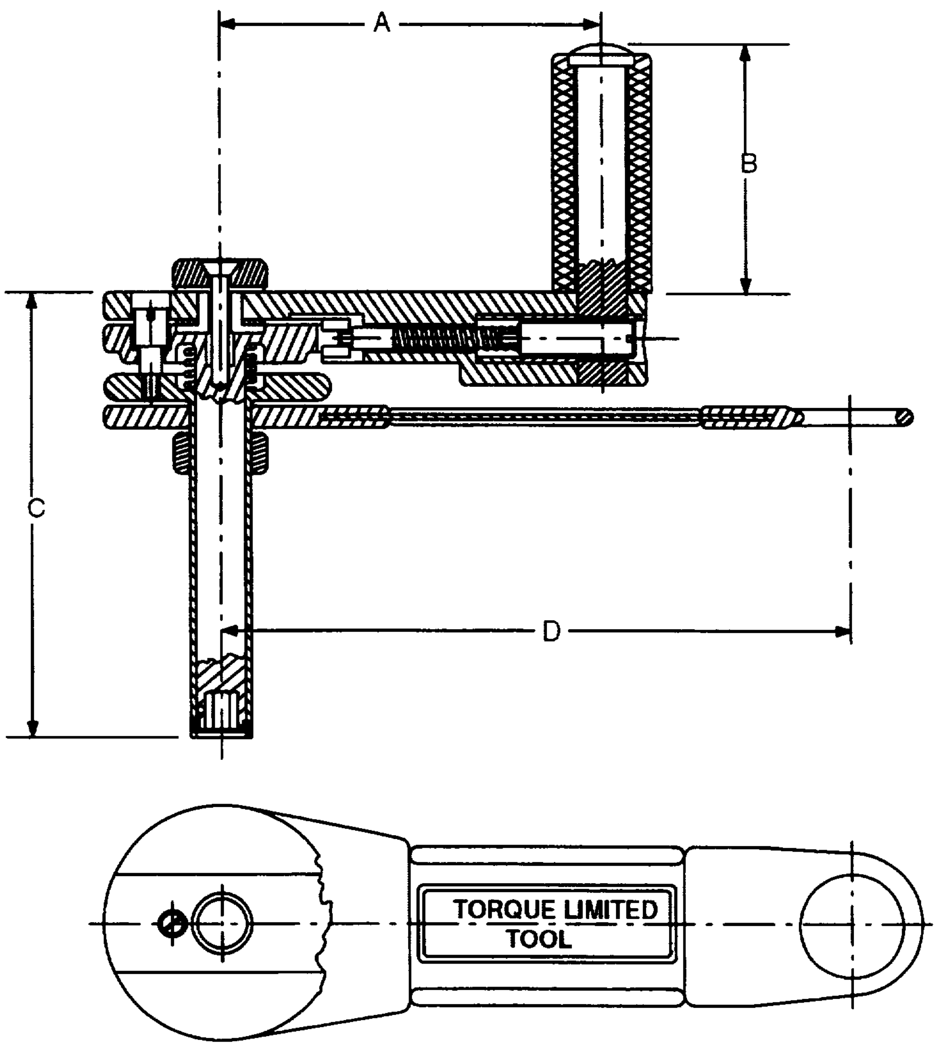
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483-2597
Technical: **J. Sexton, MSFC, (205) 544-5359**

PAYLOAD CLAMP ASSEMBLY TORQUE LIMITED DRIVER

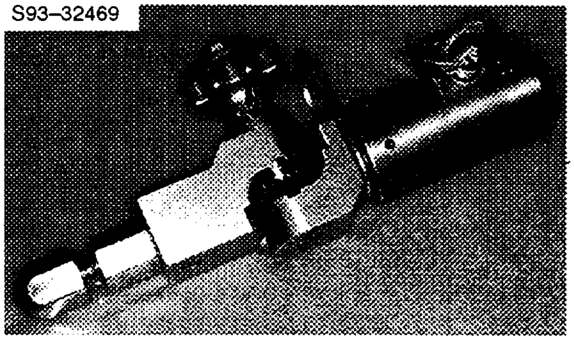
Technical Information	
Part number	883–400320.00.0
Weight	Not available
Material/ construction	Aluminum frame, plastic rotating handle, tool steel drive
Load rating	**1.475 ft–lb**
Temperature range	–150° to 250° F
Quantity flown	
Stowage	**PSA**
Availability	Reference only

Dimensional Data		
	inches	cm
A	3.94	10.01
B	2.95	7.49
C	4.01	10.19
D	6.42	16.31

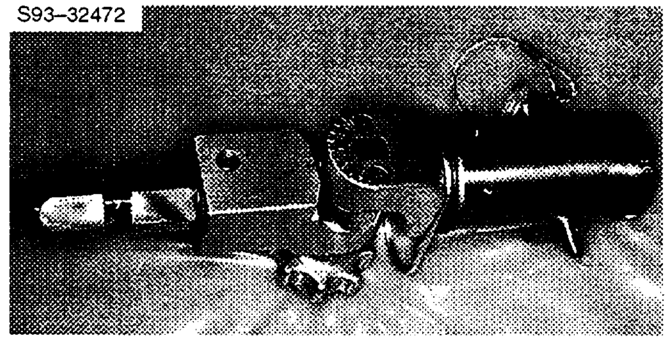


PFR ARTICULATING SOCKET

S93–32469



S93–32472



OVERVIEW

The portable foot restraint (PFR) articulating socket has a 12–point socket on one end connected by a gimbal joint to a hex **probe** at the other end. There is a **rotating** tethering point between the gimbal joint and socket. **This device provides several beneficial capabilities compared to a lone foot restraint, including more degrees of freedom and length/height for accessing a worksite**.

OPERATIONAL COMMENTS

The PFR articulating socket interfaces with the PFR socket at the hex **probe** end and with the PFR **probe** at the socket end. By manipulating the knob on the articulating socket, the crewmember can set the PFR at the position desired for EVA. **The adjustment knob features a 7/16–in. hex stud for contingency release of an overtorqued or jammed knob**. The hex probe end of the articulating socket can be placed in a PFR socket in any of 12 positions 30° apart and may be directed in 15° increments in a ±2° range. **To aid set up, alignment marks and numbers have been added to the latest configuration at the socket and probe. The pip pin side of the socket is baselined as 12 o'clock. To provide adequate socket–probe mate/demate mechanical tolerance, an attached PFR tends to wobble slightly**. A tethered **3/8–in. diameter pip** pin locks the PFR extension arm into the articulating socket. **The lanyard is long enough for bidirectional pin insertion. To prevent accidental release, the lanyard attaches directly to the pip pin body, not** to the pull ring.

In an upcoming design, the joint and knob have been replaced by a pushbutton actuated assembly. This promises to ease reconfiguration time and effort.

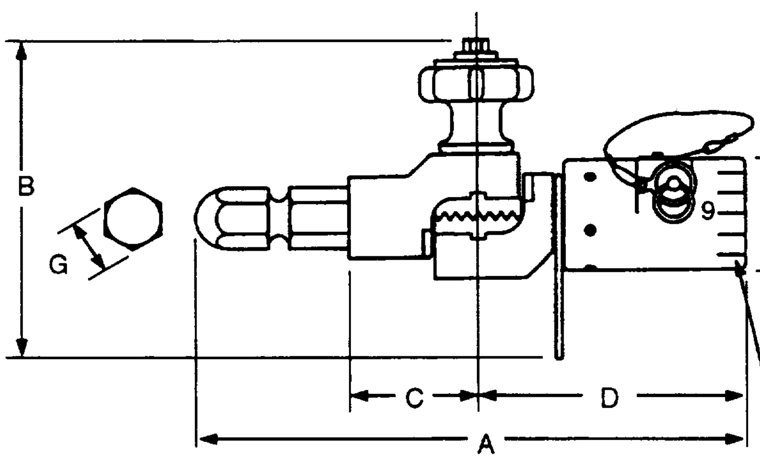
CONTACTS

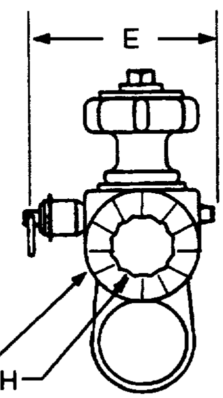
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. J. Marak**, NASA/EC5, (713) 483–9144

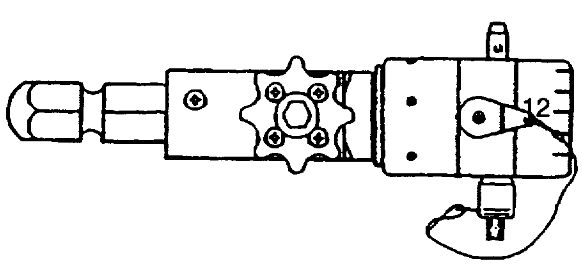
PFR ARTICULATING SOCKET

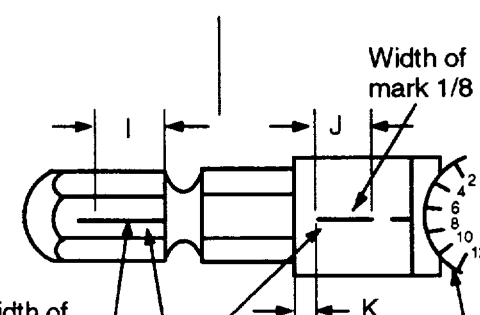
Technical Information	
Part number	10159–10035–03
Weight	1.72 lb (–02)
Material/ construction	Stainless steel, aluminum socket
Load rating	100 lb applied 72 in. above socket base 1800 in–lb torque
Temperature range	
Quality flown	
Stowage	Payload bay
Availability	Reference only

Dimensional Data		
	inches	cm
A	11.2200	28.50
B	6.8800	17.48
C	2.7500	6.99
D	5.2200	13.26
E	3.7500	9.53
F	2.0000	**5.08**
G	0.9990	2.54
H	1.0045 across flats	2.55
I	**0.8750**	**2.22**
J	**1.0000**	**2.54**
K	**0.3125**	**0.79**



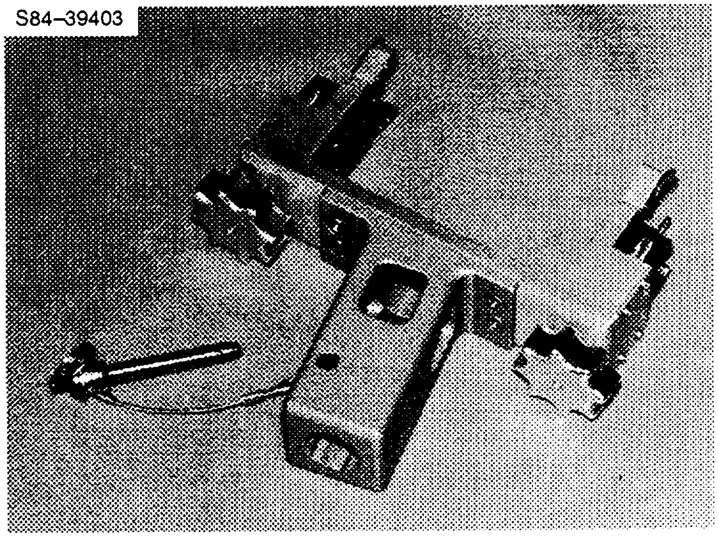






PFR CENTERLINE CLAMP ASSEMBLY

S84–39403



OVERVIEW

The portable foot restraint (PFR) centerline clamp assembly was originally designed to attach the PFR platform assembly to the centerline latches of the payload bay doors. After installation, the PFR/centerline clamp system provides contingency restraint for a crewmember using the centerline latch bypass tool during closure or repair of the payload bay centerline door latches. The clamp consists of two tightening knobs, capture jaws, and alignment tabs. It has a yaw adjustment capability of 360° in 30° increments. The inside diameter of the clamp is 5.08 centimeters.

OPERATIONAL COMMENTS

The PFR centerline clamp attaches to the centerline latch passive roller guides and allows access to the centerline latches. The clamp jaws will snap onto the latch rollers during installation. The tightening knobs are then used to complete the installation, securing the clamp to the centerline latch. **This item is no longer flown since crew training has shown that foot restraints are not required for centerline latch tool installation when the mini–workstation is used as the body restraint.**

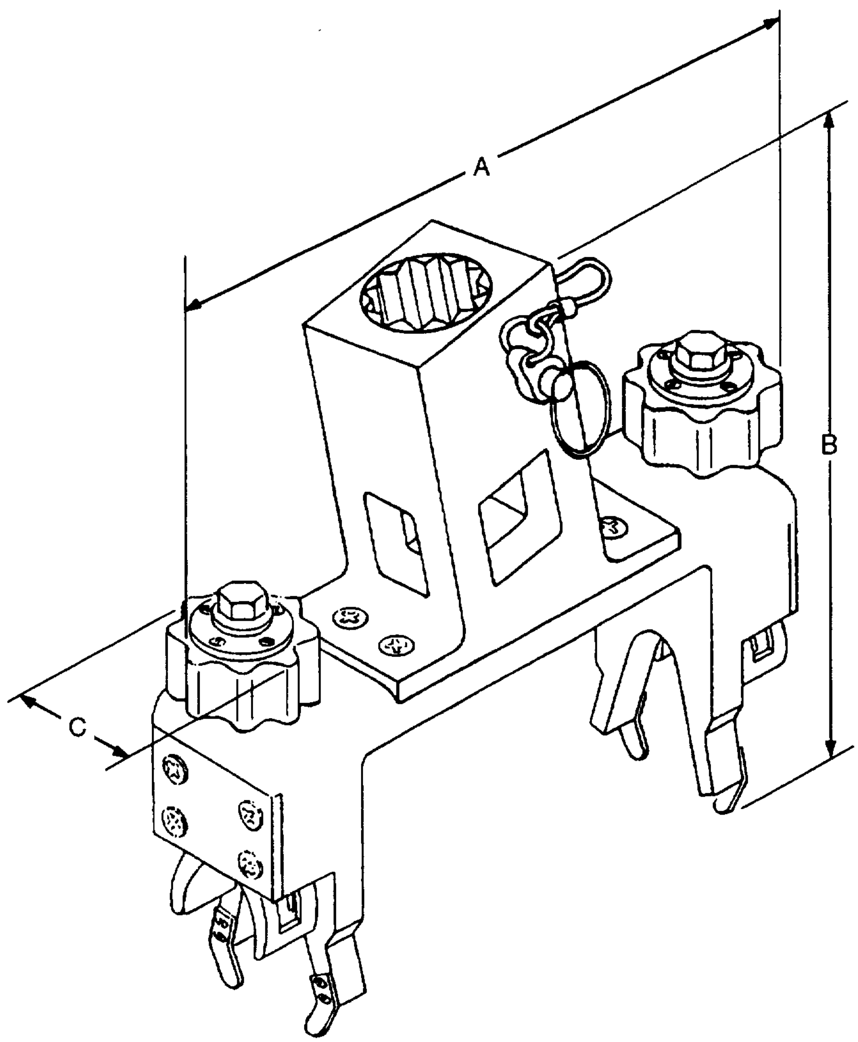
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

PFR CENTERLINE CLAMP ASSEMBLY

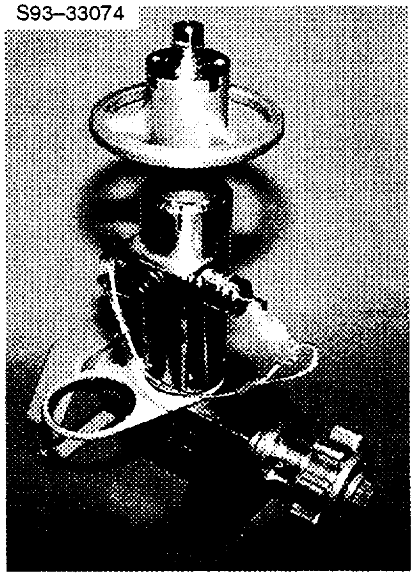
Technical Information	
Part number	**10155–20004–03**
Weight	**1.72 lb**
Material/ construction	Stainless steel, aluminum
Load rating	
Temperature range	–200° to 250° F (operational)
Quantity flown	One **(previously)**
Stowage	PSA **(previously)**
Availability	**Reference only**

Dimensional Data		
	inches	cm
A	9.12	23.16
B	8.70	22.10
C	2.00	5.08

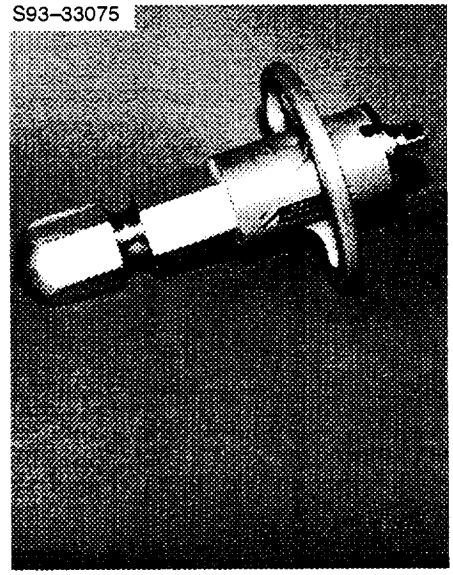


PFR PROBE BOLT HEAD

S93–33074



S93–33075



OVERVIEW

This device was developed to support extravehicular activity (EVA) flight experiments related to bolt torquing. Recent EVA detailed test objectives (DTO's) have been manifested that should be of minimal impact to stowage volume, launch mass, and new equipment development. Since few flights have bolts that can be driven by the EVA crew without jeopardizing the structural integrity of a payload or the orbiter system, this item takes advantage of the bridge rail foot restraint socket now flown on all missions. Torque can be applied anywhere there is free space in the payload bay. This gives the crew the capability to input high torques with various body restraint techniques. To round out the bolt torque data gathered from a fixed foot restraint on STS–37, this unit will be used to quantify torque capability while free floating and in a robotic based foot restraint.

OPERATIONAL COMMENTS

The bolt head of this device conforms to the standardized EVA bolt dimensions and tolerances. The hex probe inserts in any foot restraint socket and is secured with a 3/8–in. diameter pip pin. A fixed ring around the probe acts as a tether point for transport and handling. There are two versions one of which has a fixed bolt head that can be statically torqued in either direction. The other can be tightened or loosened, but is captively free spinning when fully loosened.

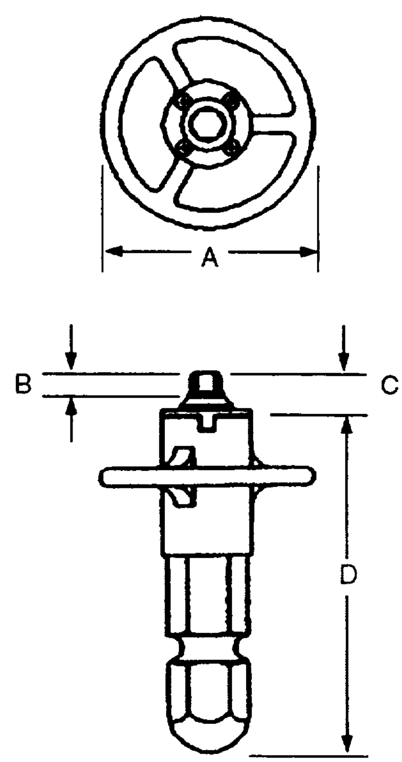
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: R. Marak, NASA/EC5, (713) 483–9144

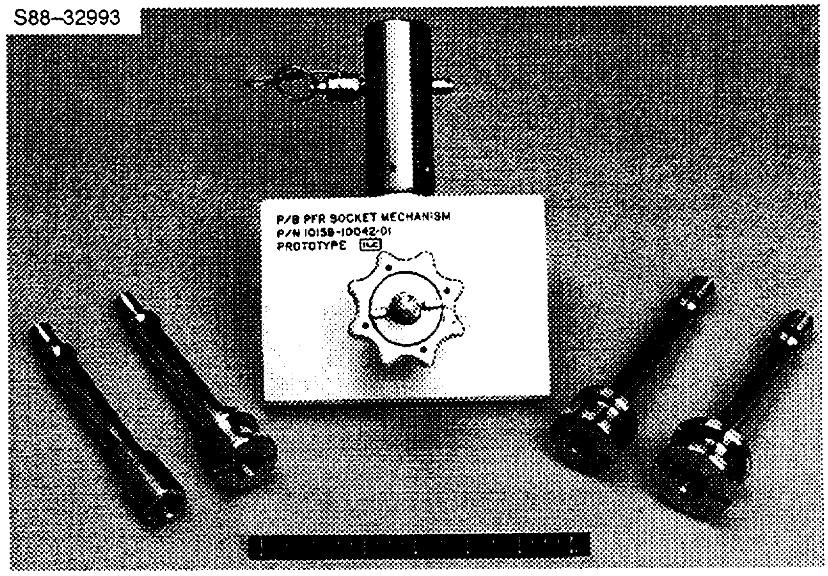
PFR PROBE BOLT HEAD

Technical Information	
Part number	SED39124555–301 (fixed bolt) SED39124553–301 (rotating bolt)
Weight	1.0 lb
Material/ construction	CRES bolt head, aluminum probe
Load rating	600 in–lb limit load (fixed bolt) 840 in–lb tested load (fixed bolt) 500 in–lb limit load (rotating bolt 700 in–lb tested load (rotating bolt)
Temperature range	
Quantity flown	One SED38124555 on STS–57 One SED38124553 on STS–51
Stowage	Middeck locker
Availability	Reference only

Dimensional Data		
	inches	cm
A	3.00	7.62
B	0.37	0.94
C	0.55	1.40
D	4.91	12.47



PFR SOCKET, SILL LONGERON



OVERVIEW

The sill longeron portable foot restraint (PFR) socket, **also known as the payload bay PFR socket mechanism,** allows the existing PFR to be mounted at numerous points in the cargo bay.

OPERATIONAL COMMENTS

The sill longeron PFR socket is designed to be mounted on the sill longeron with one of four special bolts that are supplied with the socket. The special bolts are installed into existing holes in the longeron and the socket is clamped to the bolt by turning a fluted knob. The knob has a locking feature that ensures that the clamp will not loosen once the desired clamping force has been attained. **The knob also features a 7/16–in. hex stud for contingency release of an overtorqued or jammed knob.**

A permanently tethered **3/8–in. diameter** pip pin holds the PFR in place at the desired orientation. **The socket assembly may be launched preinstalled on the sill longeron. The lanyard is long enough for bidirectional pin insertion. It attaches to the pip pin body as opposed to the pull ring to prevent accidental release**. This structure can withstand a load of 100 lb applied 72 in. above the base of the 12–point socket. A 1.5–in. inside diameter tether ring is part of the socket assembly.

Future improvements will include the addition of alignment marks and numbers on the socket.

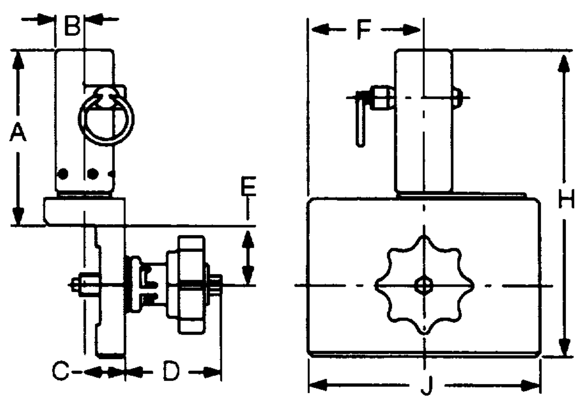
CONTACTS

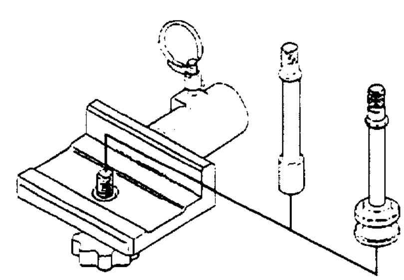
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

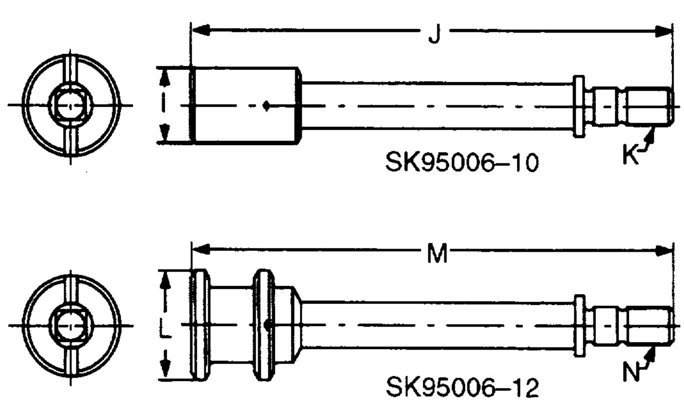
PFR SOCKET, SILL LONGERON

Technical Information		
Part number	10159–10042–01 SK95006–10–01 SK95006–12–01 SK95006–12–02 SK95006–12–03	(socket) (bolt no. 1) (bolt no. 2) (bolt no. 3) (bolt no. 4)
Weight	Socket Bolt no. 1 Bolt no. 2 Bolt no. 3 Bolt no. 4	4.258 lb 0.564 lb 0.706 lb 0.780 lb 0.856 lb
Material/ construction	Socket – Aluminum Stainless steel Aluminum bronze Bolts – Stainless steel	
Load rating	**100 lb applied 72 in. above socket base 1800 in–lb torque**	
Temperature range	–130° to +150° F (operational)	
Quantity flown		
Stowage		
Availability	Developmental	

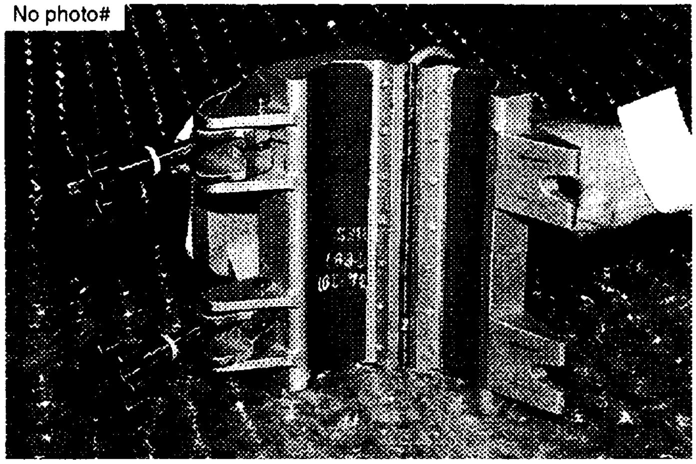
Dimensional Data		
	inches	cm
A	4.625	11.75
B	1.0045 across flats	2.55
C	0.250	0.64
D	3.87	9.83
E	1.750	4.45
F	3.000	7.62
G	6.000	15.24
H	8.250	20.96
I	0.935	2.37
J	6.290	15.98
K	0.5–2OUNJF–3A	1.27–2OUNJF–3A
L	1.372 (–01) 1.497 (–02) 1.716 (–03)	3.48 (–01) 3.80 (–02) 4.36 (–03)
M	6.290 (–01) 6.370 (–02/03)	15.98 (–01) 16.18 (–02/03)
N	0.5–2OUNJF–3A(–01) 0.62–18UNJF–3A(–02/03)	

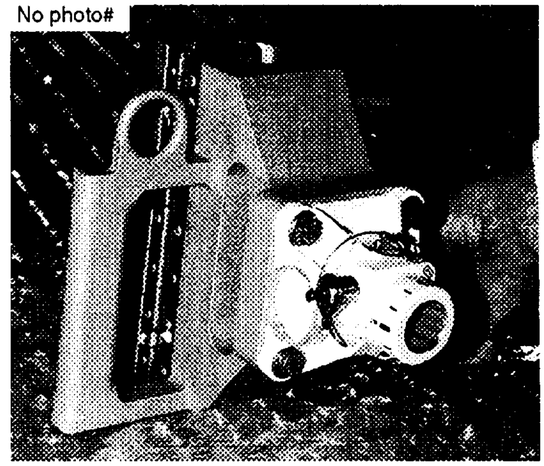






PFR STRUT CLAMP





OVERVIEW

The protable foot restraint (PFR) strut clamp is an extravehicular activity (EVA)–installable device that provides the capability to attach a foot restraint onto a 2–in.–diameter strut. It was designed to be used on STS–49 as part of the assembly of station by EVA methods (ASEM) to restrain a crewmember during truss operations. It also proved invaluable during the Intelsat rescue activities. For STS–49, the clamp was stowed in the port node box for launch and landing. This clamp includes a standard 12–point foot restraint socket, a handle, and a tether loop for transport to and from worksites. It lacks a bayonet fitting for mini–workstation transport.

OPERATIONAL COMMENTS

The clamp body has an integrally machined handle for installation and handling. The inside jaws of the clamp have a rubber insert on both halves. The clamp hinge has a torsional spring that holds it in the closed position and provides a soft–dock capability. Rotating knobs are used for tightening and loosening the clamp. The knobs are locked into place by screwing them into counterbored slots on the outer clamp housing. Each knob rotates about a pivoting pin that is connected to a torsional spring. The knob shaft has dual snaprings that prevent separation of the shaft from the clamp housing. A 7/16–in. hex fitting is provided on each knob for contingency loosening. The clamp was launched in the ready–to–be–installed configuration with the knobs loosened.

The PFR socket has clock markings, with 12 o'clock referenced to the pip pin side of the socket. These markings aid in proper alignment of the PFR for yaw.

During flight, the rubber inserts of the strut clamp tended to stick to the strut after the **clamp was left installed between EVA sorties with the** knobs tightened. The knobs required too many turns for release and engagement.

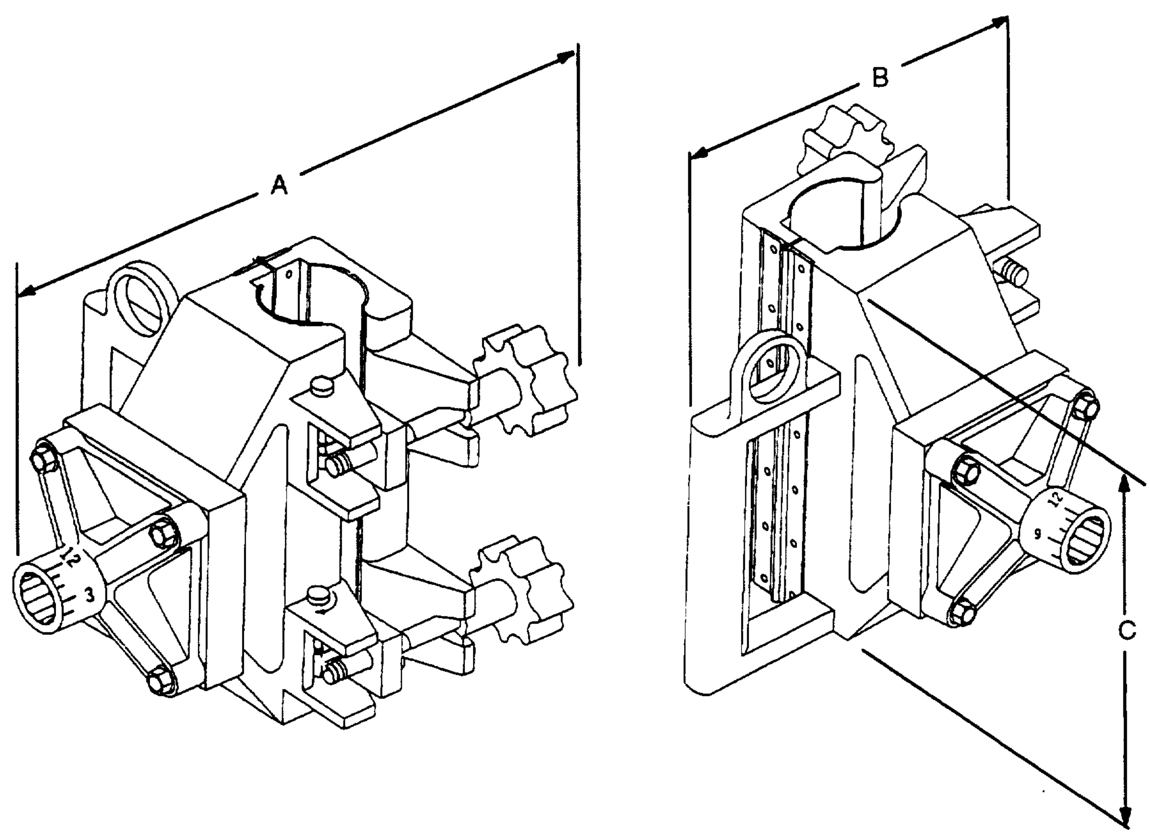
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. Schwarz, NASA/EC5, (713) 483–2378

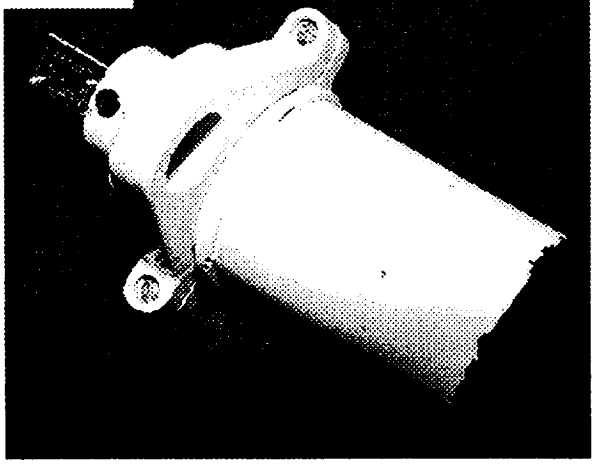
PFR STRUT CLAMP

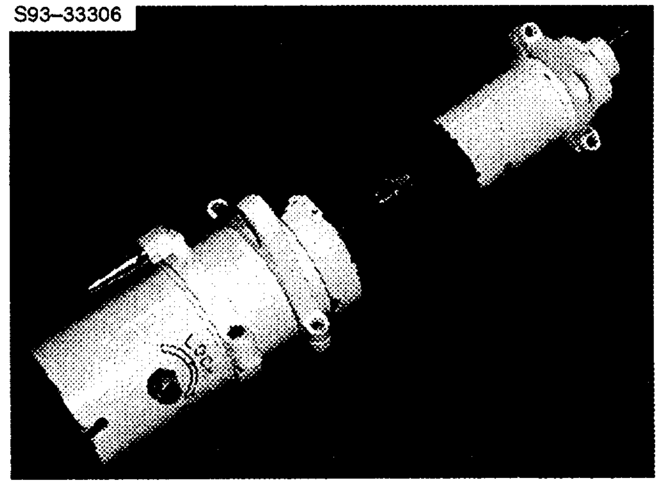
Technical Information	
Part number	1F09875
Weight	12 lb
Material/ construction	Aluminum Silicone–rubber–coated clamp
Load rating	30–lb tether point 1000–psi clamping pressure (max.) 100–lb PFR load (19 in. above socket) 720–in–lb torsion (with 15 in–lb knob torque) 25 in–lb knob torque (max.)
Temperature range	–150° to +160° F (stowage) –30° to +120° F (operational)
Quantity flown	One on STS–49
Stowage	ASEM port node box in payload bay
Availability	Reference only

Dimensional Data		
	inches	cm
A	10.5	26.7
B	8.0	20.3
C	8.0	20.3



PIN PULLER/SOCKET


S93–29243


S93–33306

OVERVIEW

The pin puller is a contingency tool specifically developed to assist with actuating and safing the forward and aft restraint structures of the (ACTS/TOS) spacecraft. If the primary and secondary electromechanical actuators which support spacecraft deployment and landing restraint were to fail, they would have to be isolated by pin puller assemblies. The primary actuator has a pyro puller, but the secondary puller has only a manually operated puller. The pyro pin puller may also require manual actuation if it fails. Each pin puller offers an extravehicular activity (EVA) interface that is protected from contamination by a dust cap that must be removed using a separate tool.

OPERATIONAL COMMENTS

ACTS/TOS has pairs of actuators on the forward restraint assembly for latching/unlatching and opening/closing a clamshell that holds down the spacecraft. There is another pair of actuators for raising/lowering the aft tilt table before and after payload deploy. Prior to release of an actuator's locking pin, some form of restraint is required to ensure that the component being overridden is not free for uncontrolled motion. The alternate actuator or another EVA–installed device can provide the needed restraint. It is possible that the orbiter jets will need to be in free drift mode to aid in unrestrained component control as well.

To release an actuator pin after the dust cap has been removed, the pin puller housing is threaded clockwise 7–1/4 turns onto the dust cap fitting. The pin puller drive screw is lowered so that the puller bolt has freedom to engage and pull the actuator pin. This involves rotating the 1.5–in. hex counterclockwise to a hard stop. The pin puller bolt is then threaded into the actuator pin using a 7/16–in. hex drive rotated 6–1/2 turns clockwise. The 1.5–in. hex is then driven six turns clockwise to pull the actuator pin. After the payload has been deployed or secured for landing, the pin puller is removed and stowed by turning the pin puller bolt and housing counterclockwise. A pair of 7/16–in. hex drive set screws on the housing prevent unwanted housing rotation until the bolt is fully backed out. A spring within the pin puller housing will push the pin back down into its original launch configuration. A manual EVA ratchet is used with a 7/16–in. socket and the special 1.5–in. pin puller socket to drive the above mechanisms. Visual aids and markings assist in verifying proper rotation of each component.

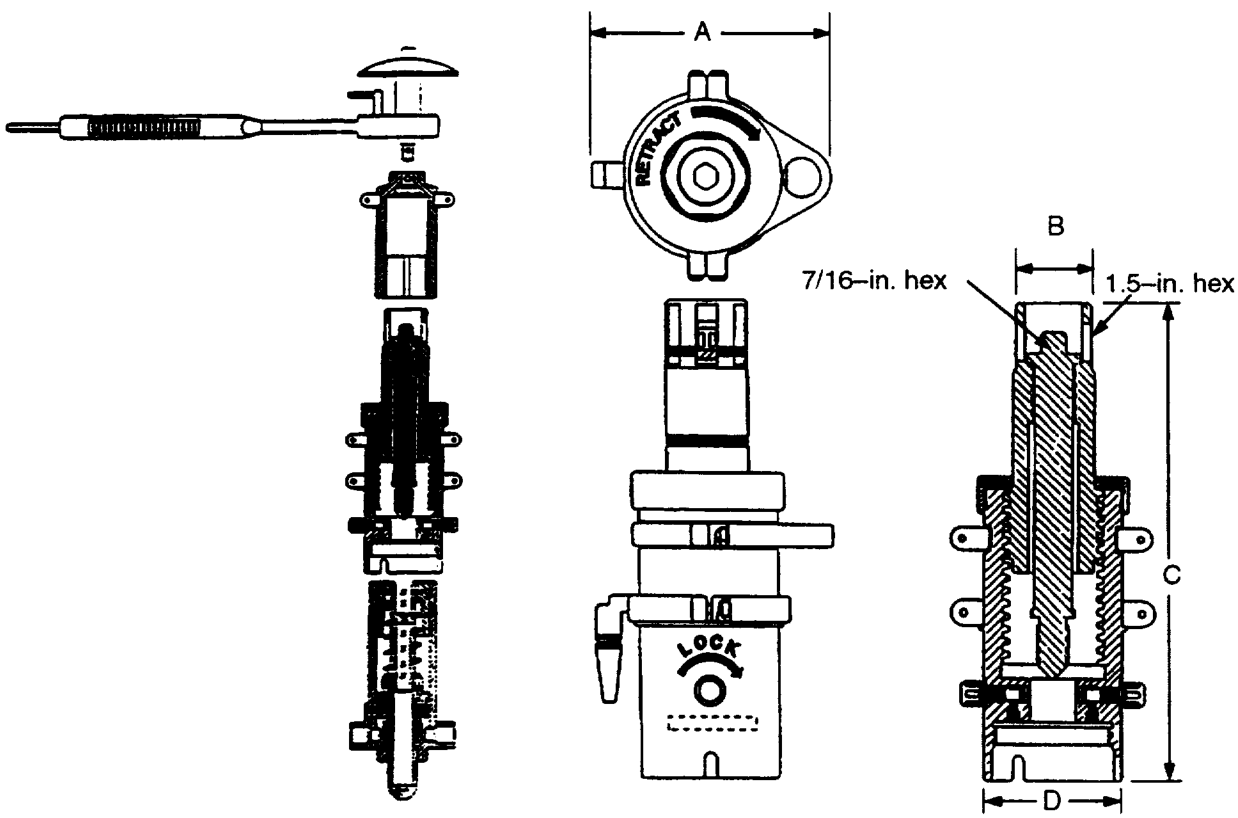
CONTACTS

Operational: O. Koehler, JSC/DF42, (713) 483–4363
Technical: F. Sanders, NASA, MSFC/EE43, (205) 544–0164

PIN PULLER/SOCKET

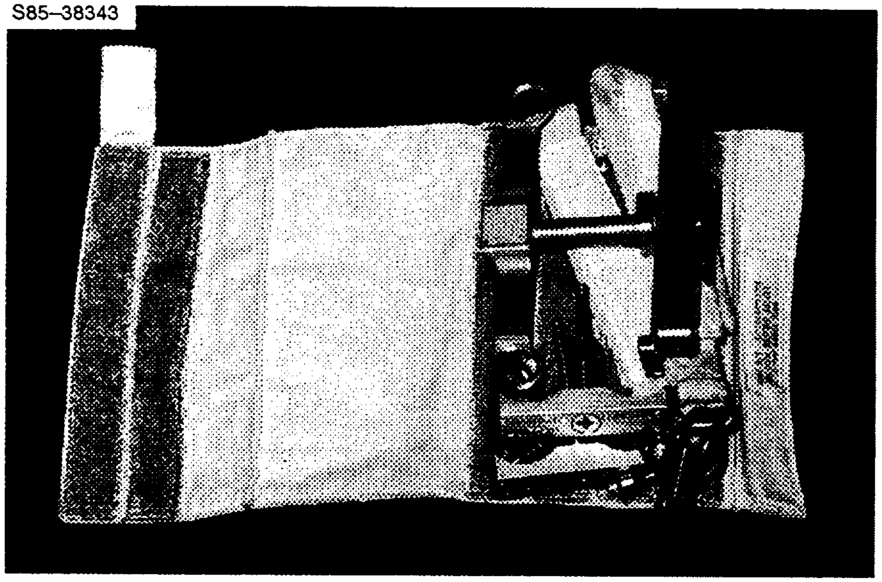
Technical Information	
Part number	97M52681–1 (pin puller) 97M52691–1 (socket)
Weight	3.2 lb (pin puller) 4.0 lb (socket)
Material/ construction	Aluminum, stainless steel
Load rating	40.4 ft–lb pin retraction (max.)
Temperature range	
Quantity flown	Three pin pullers One pin puller socket
Stowage	Middeck
Availability	Reference only

Dimensional Data		
	inches	cm
A	4.65	11.8
B	1.49	3.8
C	7.48	19
D	2.75	7



PIN, SAFING

S85–38343



OVERVIEW

The safing pin was developed as an extravehicular activity (EVA)–crew–installed item to secure the pyrotechnic safe and arm device of the Leasat perigee kick motor on STS 51–I. The spacecraft had problems after initial deployment on STS 51–D and required this device as one of several means to ensure EVA crew and orbiter safety. Two units were installed throughout the EVA. A third unit was reserved as a spare to ensure mission success. Each had a Velcro strap that wrapped around the safe and arm device to prevent inadvertent release. The prime units were transported on a tool caddy; the spare was kept on a tool board.

OPERATIONAL COMMENTS

Each pin was derived from a similar item used during ground processing of the spacecraft. Each pin was installed by a crewmember working from a sill longeron mounted foot restraint. The orbiter remote manipulator presented each safe and arm device to the crewmember. Thermal blankets had to be pulled back to expose the installation point. The pins were stowed in the Leasat tool container assembly for launch and landing.

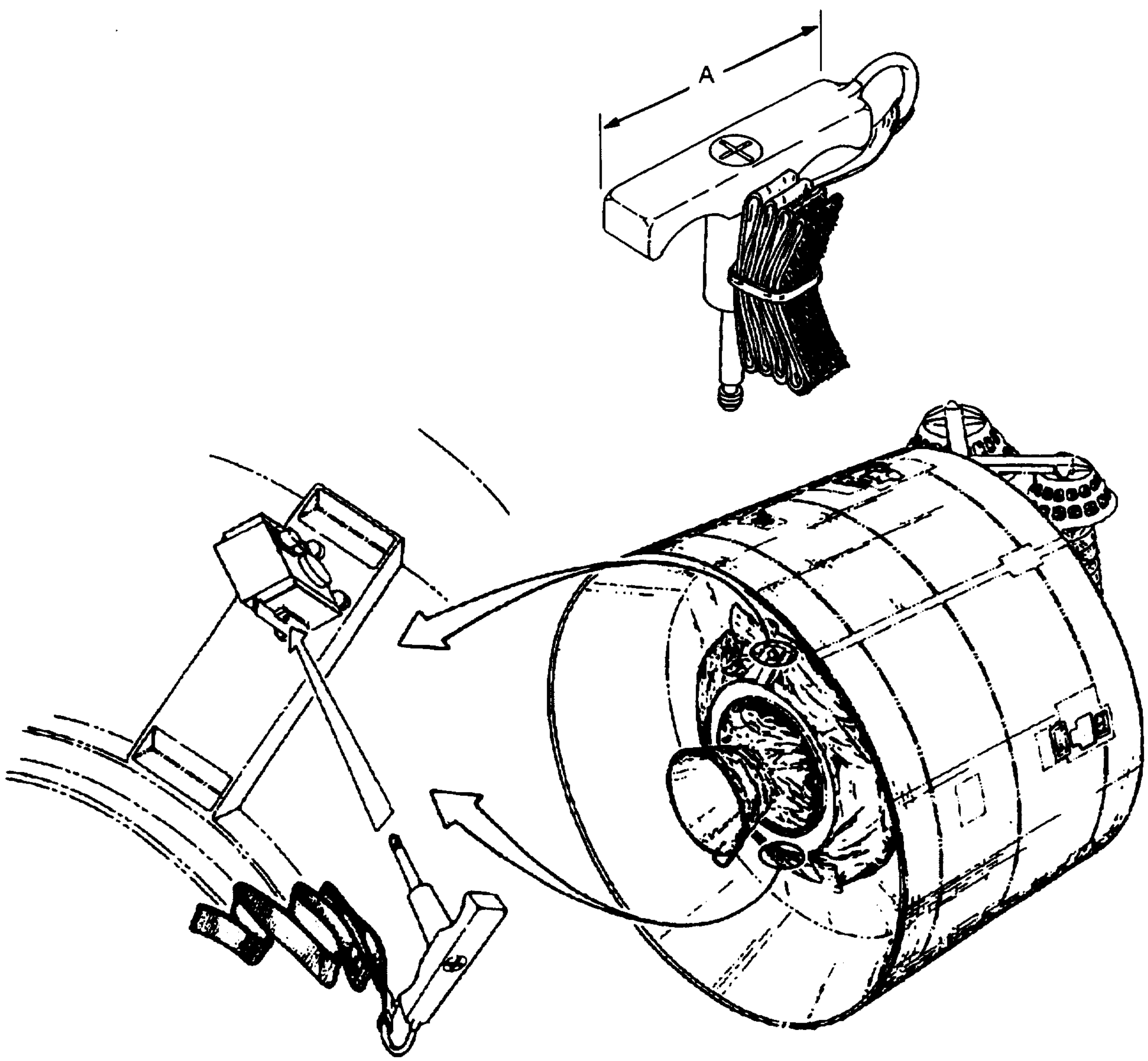
CONTACTS

Operational: R. C. Trevino, NASA JSC/DF42, (713) 483–2597
Technical: **R. J. Marak, NASA/EC5, (713) 483–9144**

PIN, SAFING

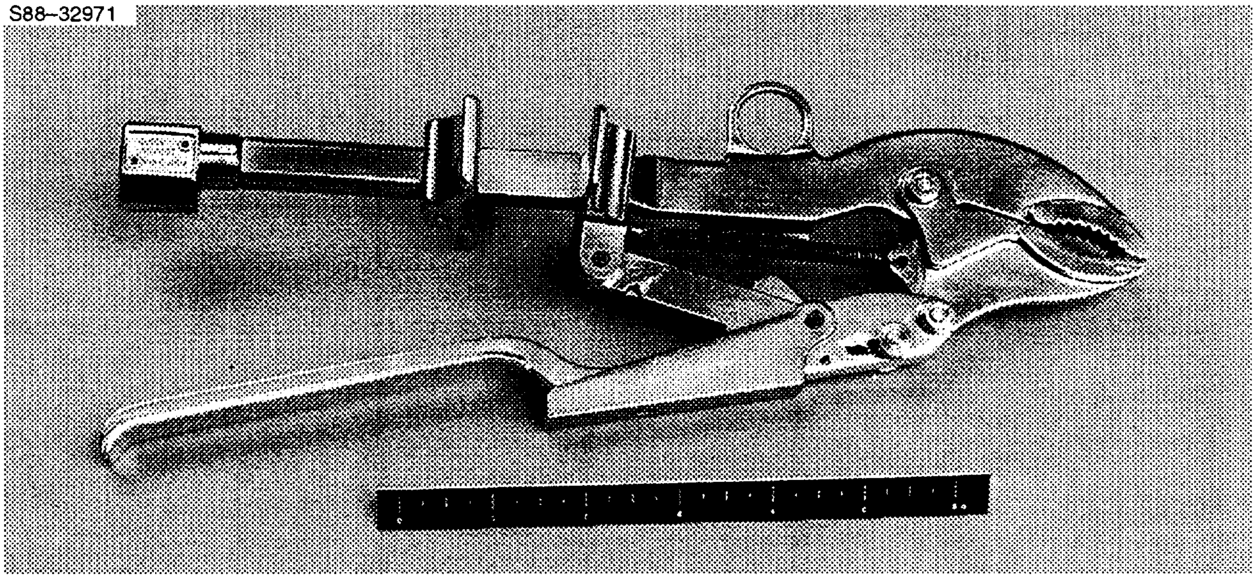
Technical Information	
Part number	10176–20126–01
Weight	0.3 lb
Material/ construction	Aluminum handle, stainless pin
Load rating	
Temperature range	
Quantity flown	Three on STS 51–I
Stowage	Flight–unique payload bay tool box
Availability	Reference only

Dimensional Data		
	inches	cm
A	2.9	7.4



PLIERS, ONE–HANDED VISE–GRIP

S88–32971



OVERVIEW

The quick–adjust Vise–Grips are similar to standard off–the–shelf Vise–Grips except that the tool is designed for one–handed operation. The tool is manifested as a contingency tool for extravehicular activity. A tether ring is provided at the top of the tool near the jaws.

OPERATIONAL COMMENTS

Adjustment of the Vise–Grips is accomplished by sliding the adjustment collar to the desired position and allowing the jaws to fit over the object to be gripped. Positively gripping the object is performed by squeezing the long handle on the bottom of the tool. To release, squeeze the small handle at the base of the long handle.

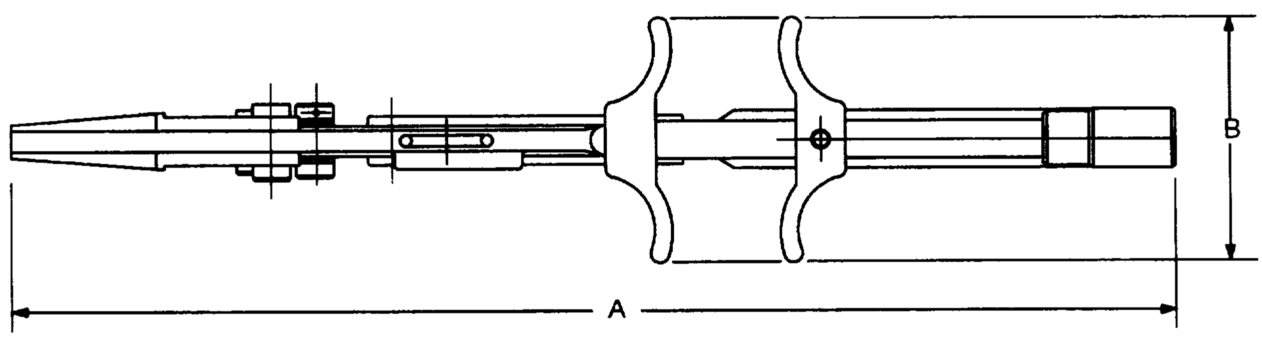
CONTACTS

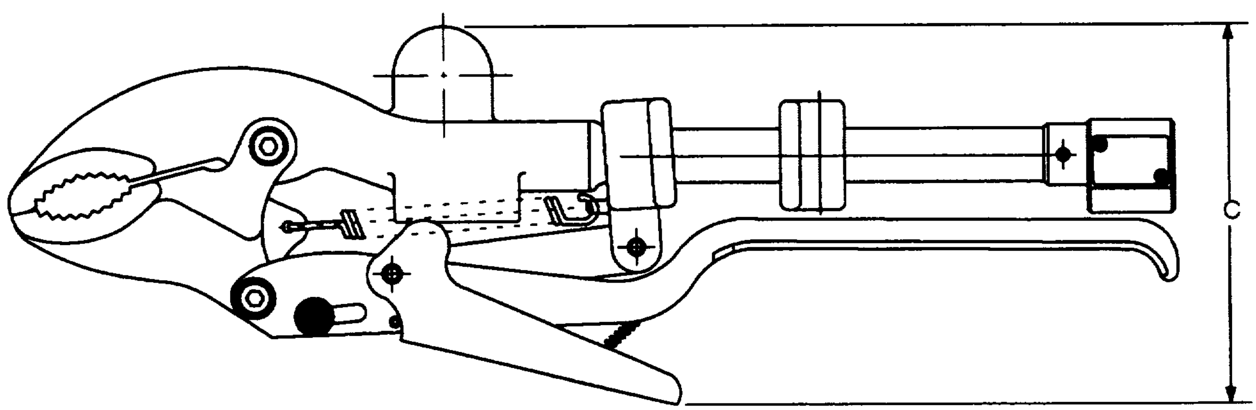
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

PLIERS, ONE HANDED VISE–GRIP

Technical Information	
Part number	10159–10038–01
Weight	1.62 lb
Material/ construction	Stainless steel
Load rating	
Temperature range	–130° to +150° F (operational)
Maximum opening	1.80 in.
Grip range	Up to 1.25 in. thickness
Opening diameter	0.38 in. to 1.62 in.
Quantity flown	
Stowage	
Availability	Developmental

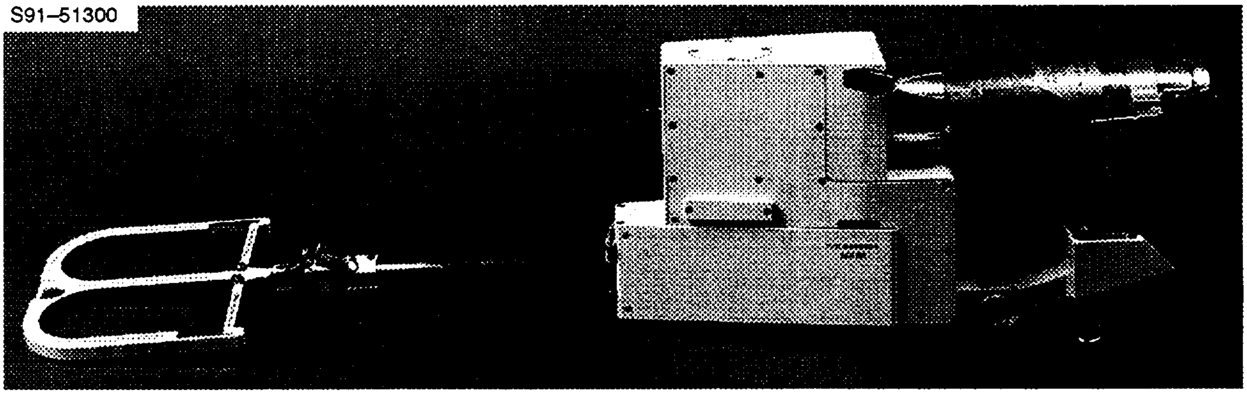
Dimensional Data		
	inches	cm
A	11.80	29.97
B	2.50	6.35
C	3.80	9.65





POLE, BISTEM

S91–51300



OVERVIEW

The bistem pole (BP) was one of several different crew self–rescue (CSR) concepts for solving the extravehicular activity (EVA) "man overboard" scenario on Space Station Freedom where no shuttle is available to assist. Evaluation of these concepts was conducted as part of the STS–49 Assembly of Station by EVA Methods (ASEM). Each device was intended to cover rescue scenarios, including tether mismanagement and tether or hook failure, when a fellow EVA crewmember is not available. This device has a grapple hook on the end of two strips of spring steel that overlap upon deployment to form a rigid pole. All CSR devices were concept evaluations only and did not represent final packaging for quick deployment. "Off–the–shelf" components were used where possible.

OPERATIONAL COMMENTS

The BP uses the Hubble Space Telescope EVA power tool for an electrical powered deployment of two tape–measure–like strips of spring steel that, in an equilibrium state, form a tubular rigid pole. A Kevlar sock protects the crew from the sharp edges of the bistem material. The power tool controls are used to control extension or retraction of the pole at two different speeds. Total extension length is 20 ft. Once the target is grappled, a powered approach is used by the crewman. This device is too large to attach to the mini–workstation and was to be evaluated while attached to the crewman via a wrist tether. The BP allows more than one grapple attempt, limited only by the life of the power tool battery. There is a contingency retraction mechanism for a manual wrench. Only one BP was manifested for STS–49 and was stowed in the starboard provisions stowage assembly (PSA).

The BP as designed is too large and obviously needs its own power source with direction and speed controls closer to the trigger. The extended pole has a tendency to buckle during return to a grapple target if the approach is interrupted. The grappling device solution obviously does not cover all rescue scenarios, since the crewman must be able to see a regrapple target and have rotation rates low enough to employ such a device.

Future self–rescue development is concentrating on a mini manned maneuvering unit known as the simplified aid for EVA rescue (SAFER).

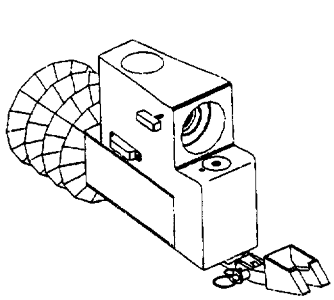
CONTACTS

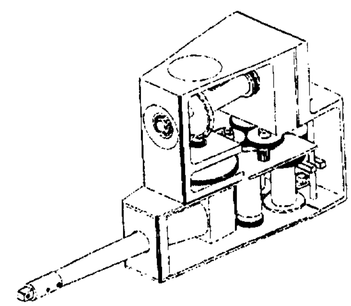
Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: **R. Schwarz**, NASA/EC5, (713) 483–**2378**

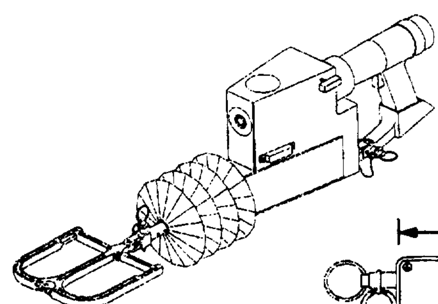
POLE, BISTEM

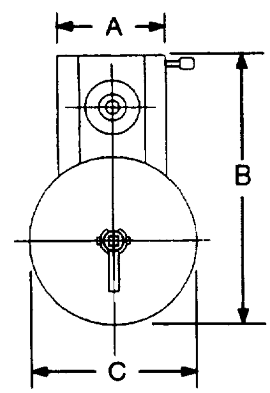
Technical Information	
Part number	SED391222700–301
Weight	20.0 lb (without power tool and end effector)
Material/ construction	Aluminum housing, Kevlar protective sheath, Loctite
Load rating	100 lb (tension) 2 to 3 ft/sec extension rate (hi speed) 0.5 to 1.0 ft/sec retract rate (lo speed)
Temperature range	
Quantity flown	One on STS–49
Stowage	STBD PSA
Availability	Reference only

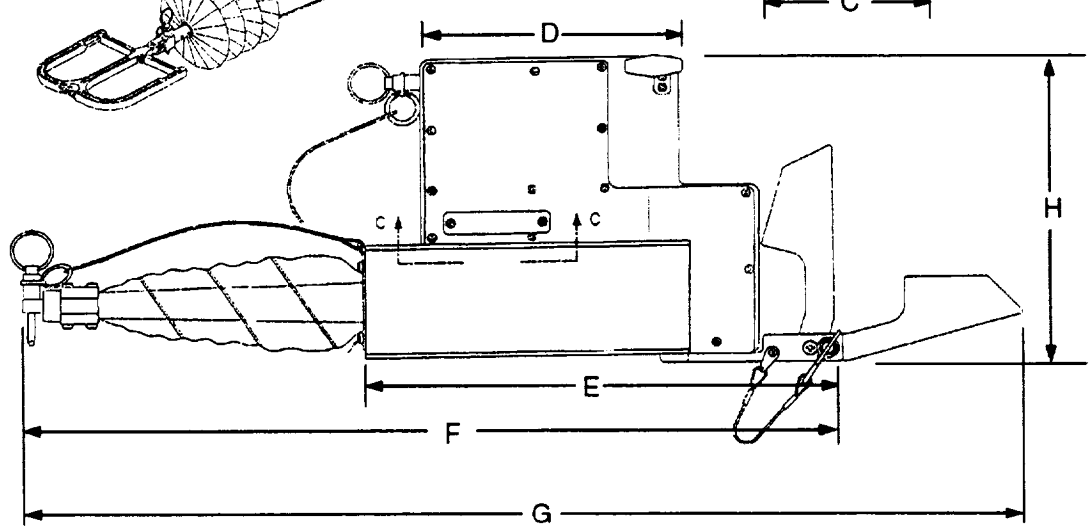
Dimensional Data		
	inches	cm
A	5.00	12.4
B	9.75	24.77
C	6.00	15.24
D	6.70	17.02
E	12.60	32.00
F	21.17	53.77
G	26.19	66.52
H	8.54	21.69





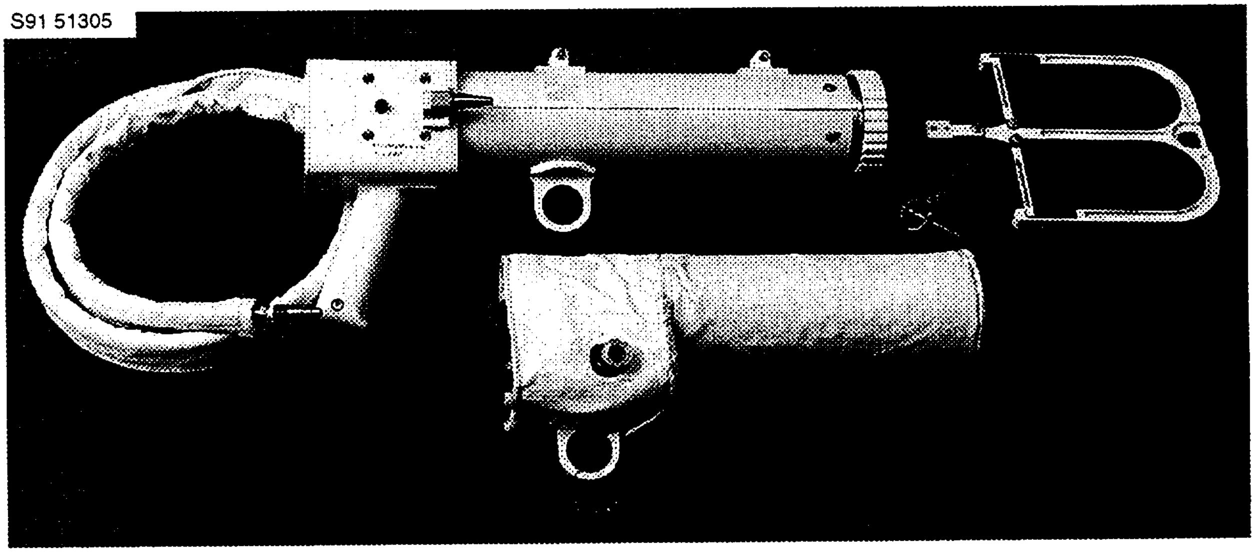






POLE, INFLATABLE

S91 51305



OVERVIEW

The inflatable pole (IP) was one of several different crew self–rescue (CSR) concepts for solving the extravehicular activity (EVA) "man overboard" scenario on Space Station Freedom where no shuttle is available to assist. Evaluation of these concepts was conducted as part of the STS–49 Assembly of Station by EVA Methods (ASEM). Each device was intended to cover rescue scenarios including tether mismanagement and tether or hook failure when a fellow EVA crewmember is not available. This device utilizes compressed nitrogen to inflate a cloth tube with a grapple hook attached. All CSR devices were concept evaluations only and did not represent final packaging for quick deployment. "Off–the–shelf" components were used where possible.

OPERATIONAL COMMENTS

The IP is a 2–in.–diameter tubular sock stowed in a deployment gun and attached to a small bottle of compressed nitrogen. The sock is made of Kevlar material, and the gun's trigger releases a friction brake that allows the crewman to deploy the pole to any length up to the full extension of 12 ft. It was originally intended to have a 20–ft extended length, but the length of the final product was cut short for engineering simplicity. The bottle has valve controls to allow pressure to the gun. A pressure gauge indicates state of charge for the N_2 supply tank. Both the gun and bottle can be attached to the crewman's mini–workstation. Once the IP is deployed and the target is grappled, the sock is deflated by a vent valve on the nitrogen bottle and the crewman pulls himself in hand over hand. No reuse of the IP is possible during an EVA. Repacking of the sock in the gun is possible during intravehicular activities post–EVA. Two IP's were carried on STS–49 in middeck lockers.

The IP as designed is obviously too large and should have its gas source located in the gun or the crewman's suit. The grappling device solution does not cover all rescue scenarios, since the crewman must be able to see a regrapple target and have low enough rotation rates to employ such a device.

Future self–rescue development is concentrating on a mini manned maneuvering unit known as the simplified aid for EVA rescue (SAFER).

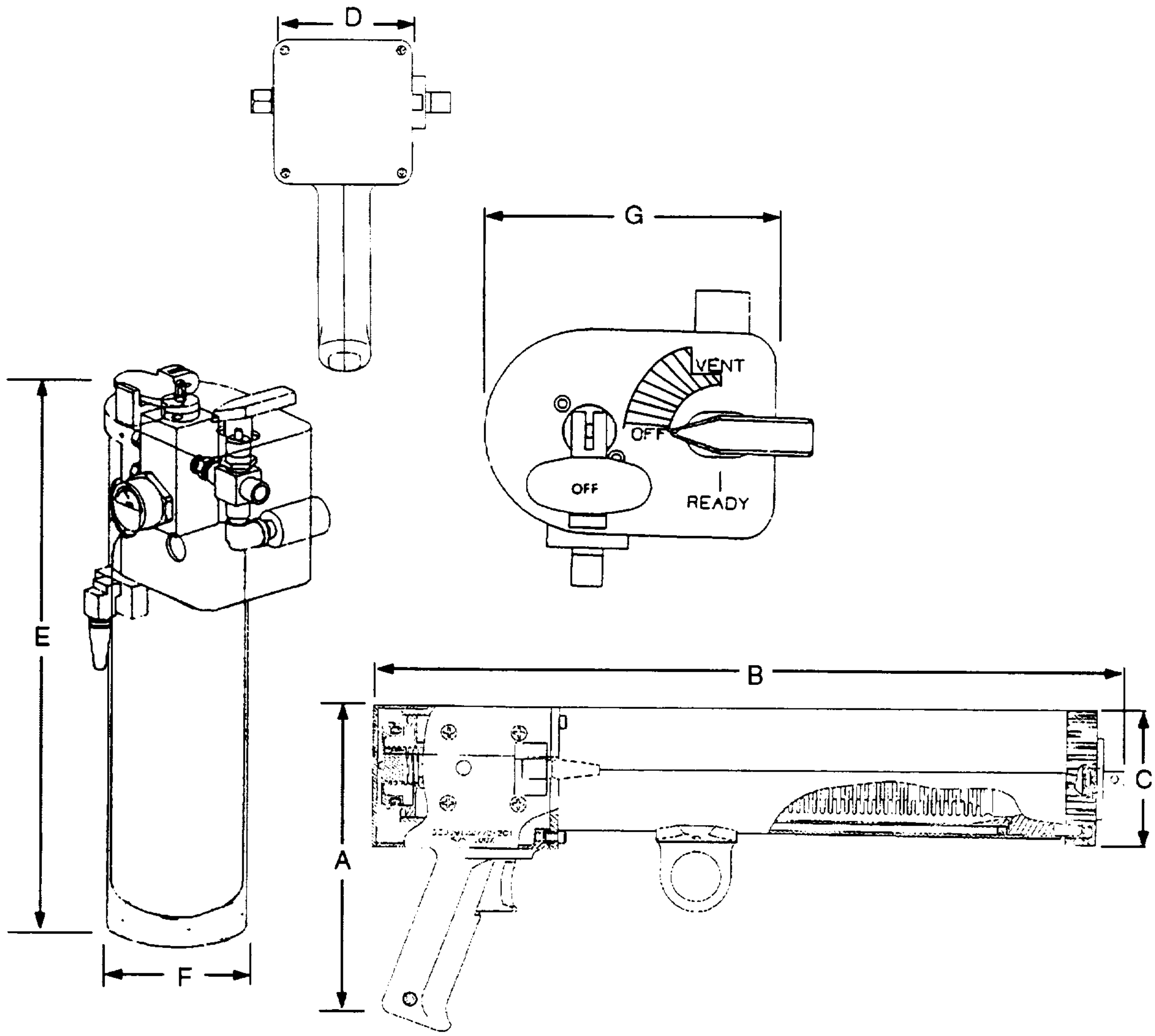
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. Schwarz, NASA/EC5, (713) 483–2378

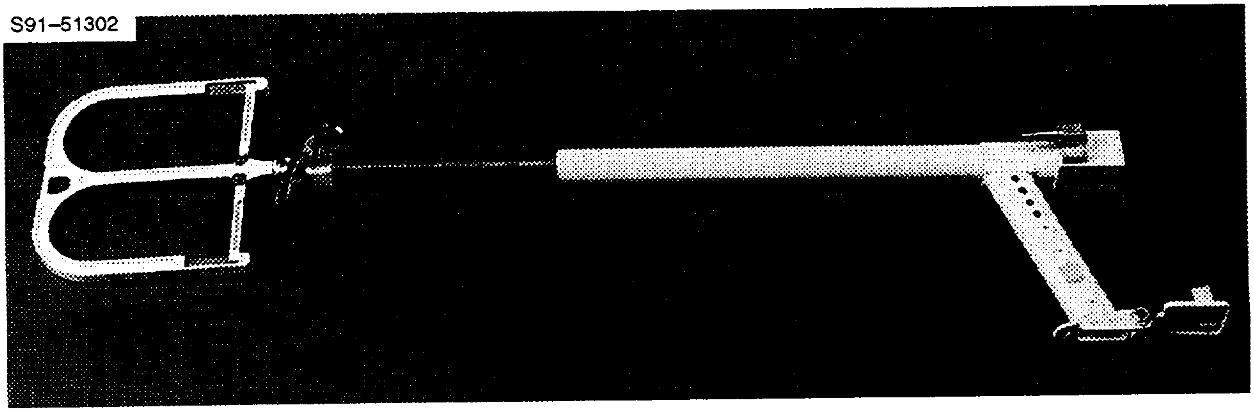
POLE, INFLATABLE

Technical Information	
Part number	SED39122774–302
Weight	14.5 lb (without end effector)
Material/ construction	Aluminum housing, Kevlar tube, Ortho fabric thermal garment, Braycoat grease, Loctite
Load rating	100 lb (tension) 0.32 lb nitrogen per tank (29 in^3) 1900–psi N_2 supply tank (nominal) 4500–psi N_2 supply tank (leak before burst) 30 psi (regulation to fabric tube)
Temperature range	160° F (max.)
Quantity flown	Two on STS–49
Stowage	Middeck locker
Availability	Reference only

Dimensional Data		
	inches	cm
A	8.30	21.08
B	18.69	47.47
C	3.42	8.69
D	4.85	12.32
E	13.82	35.10
F	3.175	8.06
G	4.00	10.16



POLE, TELESCOPING



OVERVIEW

The telescoping pole (TP) was one of several different crew self–rescue (CSR) concepts for solving the extravehicular activity (EVA) "man overboard" scenario on Space Station Freedom where no shuttle is available to assist. Evaluation of these concepts was conducted as part of the STS–49 Assembly of Station by EVA Methods (ASEM). Each device was intended to cover rescue scenarios including tether mismanagement and tether or hook failure when a fellow EVA crewmember is not available. This device has a grapple hook on the end of seven tube segments that extend out to form a rigid pole. All CSR devices were concept evaluations only and did not represent final packaging for quick deployment. "Off–the–shelf" components were used where possible.

OPERATIONAL COMMENTS

The TP is a modified off–the–shelf device comprising seven concentric tubes that compress to approximately 2 ft and extend to 12 ft. It was originally intended to have a 20–ft extended length, but the length of the final product was cut short for engineering simplicity. The crewman manually deploys and retracts the pole with the friction–type fittings for desired length. The handle has a flip–down reaction fitting to steady the assembly against the arm during use. Once the target is grappled, the crewman uses a manual retraction of the segments to approach the target. An internal Kevlar cord backs up the length of the pole in case there is a failure. The TP can be attached to a mini–workstation if desired, although its compressed length makes this cumbersome. Unlimited grapple exercises can be accomplished with the TP. It was stowed in the starboard provisions stowage assembly (PSA) for STS–49.

The TP in its 2–ft compressed state is too long for easy stowage on the suit throughout an EVA. The grappling device solution obviously does not cover all rescue scenarios, since the **crewmember** must be able to see a regrapple target and have low enough rotation rates to employ such a device. This simple device has considerable potential as an aid for transferring small cargo between crewmembers and worksites.

Future self–rescue development is concentrating on a mini manned maneuvering unit known as the simplified aid for EVA rescue (SAFER).

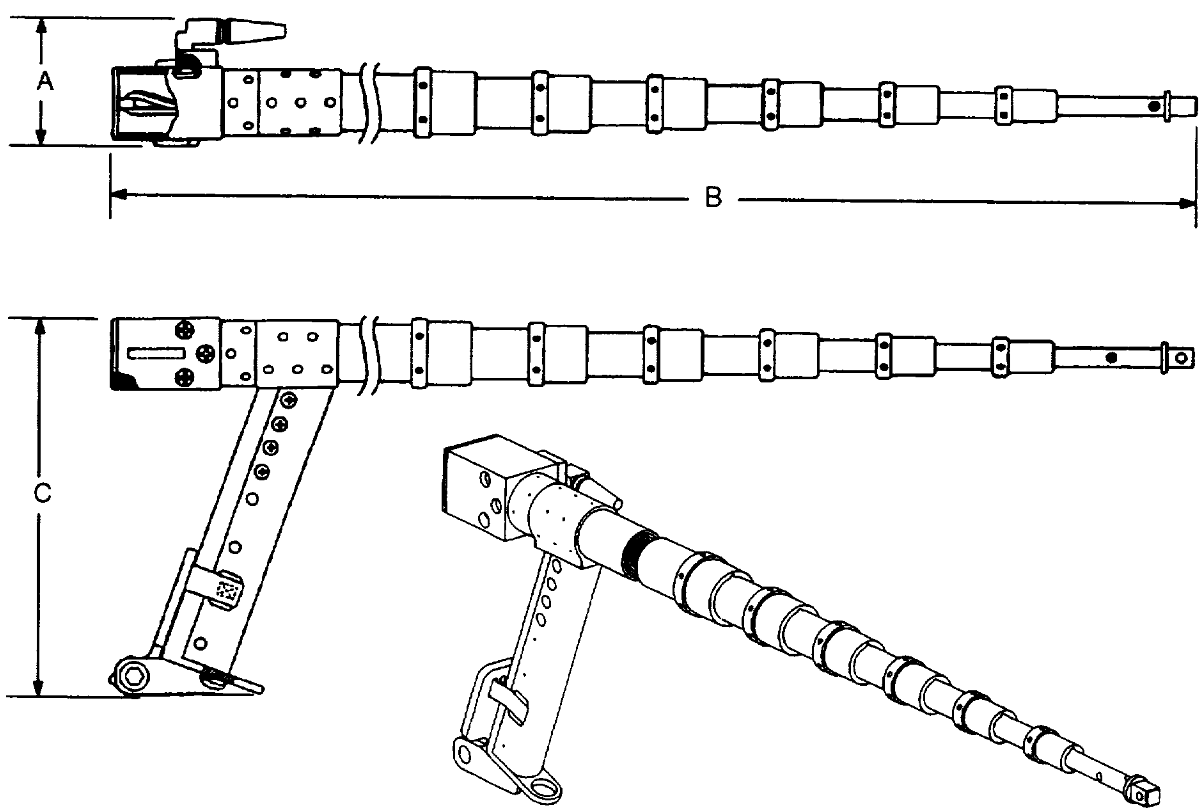
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. Schwarz, NASA/EC5, (713) 483–2378

POLE, TELESCOPING

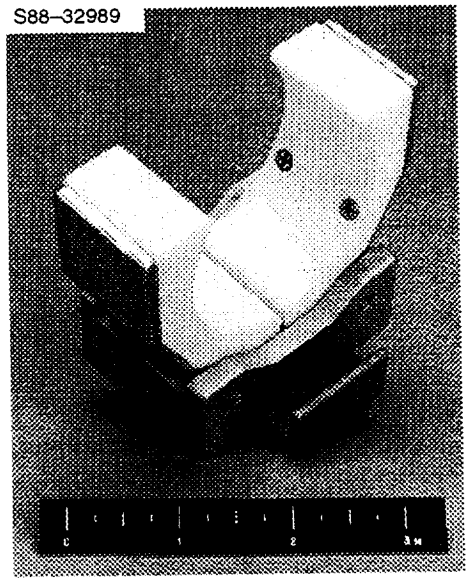
Technical Information	
Part number	SED39120523–302
Weight	4.0 lb (without end effector)
Material/ construction	Aluminum, Kevlar cord, Vibratite
Load rating	100 lb (tension) 25 lb (**compression**) 5 to 10 lb (tube friction)
Temperature range	
Quantity flown	One on STS–49
Stowage	STBD PSA
Availability	Reference only

Dimensional Data		
	inches	cm
A	2.52	6.40
B	26.7 to 138.0	67.82 to 350.52
B	26.7 to 138.0	67.82 to 350.52
C	7.42	18.85



C-17

POWER TOOL RETAINING MECHANISM



OVERVIEW

The power tool retaining mechanism is designed to be a universal tool clamp and can easily be modified to accommodate various tool configurations. Securing or removing a tool from the clamp does not require a large force since the design does not rely on the resiliency of the clamp material for retention. The tool incorporates a positive lock when in the closed position.

OPERATIONAL COMMENTS

This retaining mechanism does not function alone as a launch restraint. It is primarily intended for temporary restraint at a worksite. To secure a tool in the tool retaining mechanism, place the tool in the open clamp and push against its back edge. The spring-loaded jaws will automatically close and lock. To remove a tool, simply press the latch lever at the base of the clamp.

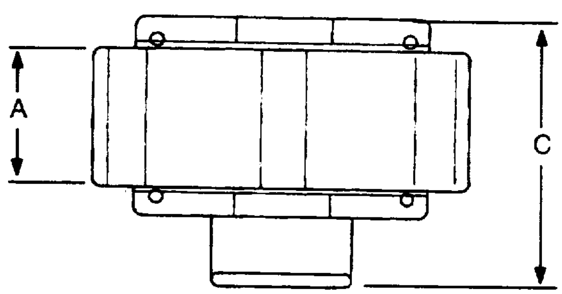
CONTACTS

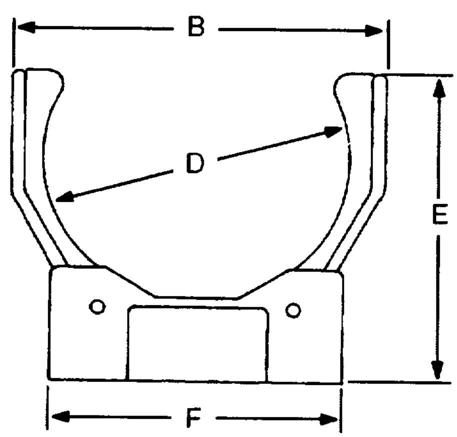
Operational: S. Rainwater, NASA/DF42, (713) 483-1755
Technical: R. J. Marak, NASA/EC5, (713) 483-9144

POWER TOOL RETAINING MECHANISM

Technical Information	
Part number	10159–10054–01 10159–10054–02
Weight	1.05 lb
Material/ construction	Aluminum Teflon
Load rating	
Temperature range	–130° to 150° F (operational)
Quantity flown	
Stowage	
Availability	Developmental

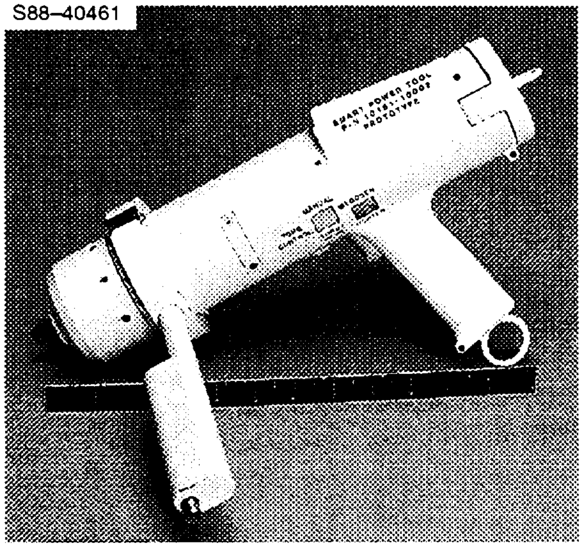
Dimensional Data		
	inches	cm
A	1.25	3.18
B	3.38	8.59
C	2.38	6.05
D	2.25 (–01) 2.75 (–02)	5.72 6.99
E	3.94	10.01
F	2.56	6.50



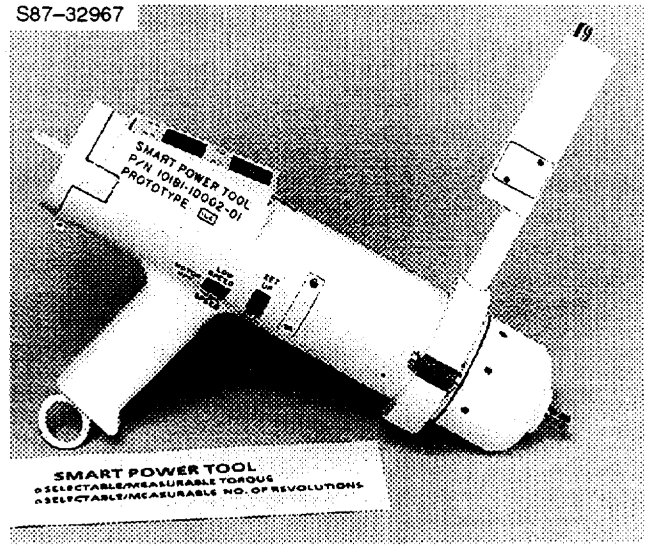


POWER TOOL, SMART

S88–40461



S87–32967



OVERVIEW

The smart power tool is a hand–held, battery–powered, microprocessor–controlled device with regulated torque and revolution. It has a 3/8–in. drive drop–proof tether fitting for attaching sockets, screwdrivers, drill bits, and similar items. User interfaces include two digital displays for set and actual values, a hi–lo speed switch, a forward–reverse switch, a manual torque/torque only/revolution switch, and an up–down set switch. Power is provided by a 7.2–V rechargeable battery pack that plugs into the back end of the tool. This tool is in development.

OPERATIONAL COMMENTS

The smart power tool can be used for any EVA task that requires the precisely regulated outputs of torque, revolutions, or a combination of the two. The parameters are keyed in by the user and then electronically regulated by the tool. Torque can be set from 5 to 180 in–lb and revolutions from 0.5 to 125. Two speeds are available, high at 60 rpm and low at 20 rpm. The tool is operated much like a cordless drill via a pistol grip and trigger arrangement. A torque reaction arm that attaches near the front of the tool is also in development.

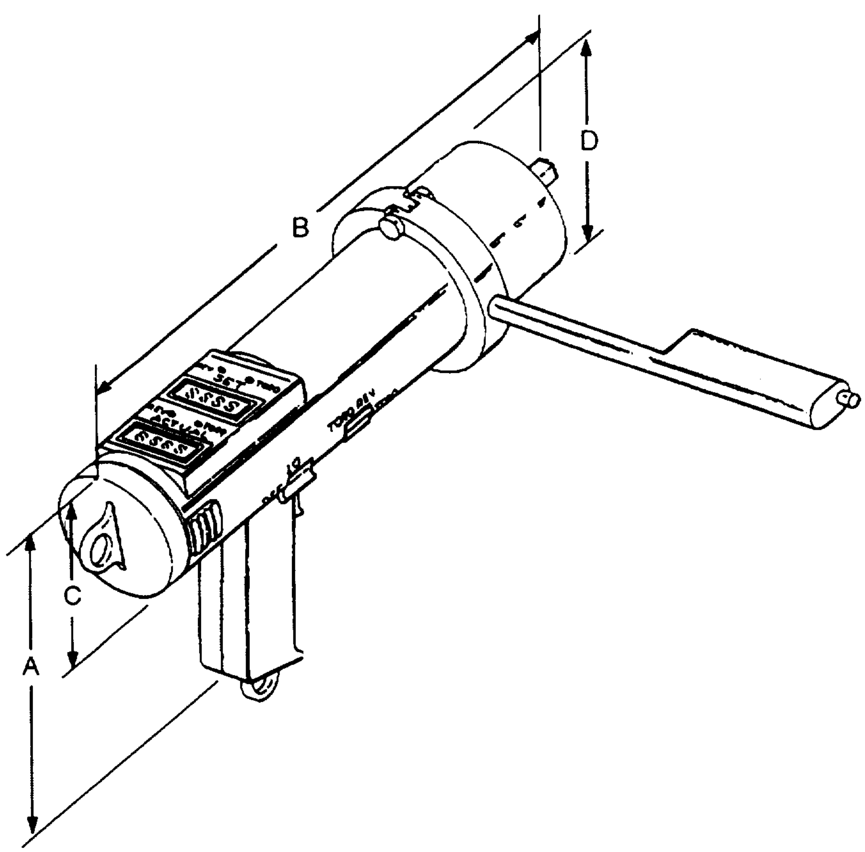
CONTACTS

Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

POWER TOOL, SMART

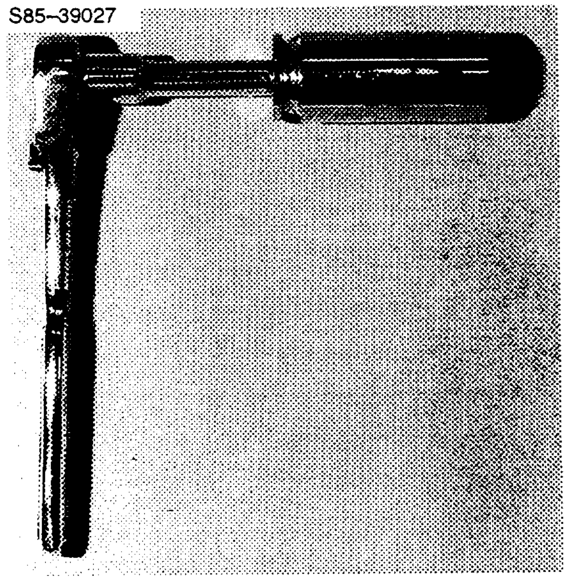
Technical Information	
Part number	10181–10002–01
Weight	12.0 lb (estimate)
Material/ construction	Housing – Aluminum Gears – Copper and stainless steel Magnetic particle brake/clutch Solid state electronic circuitry NiCd battery
Load rating	
Temperature range	–150° to +250° F (operational)
Settings	Torque – 5 to 180 in–lb (1 in–lb increments) Revolutions – 0.5 through 125 (0.5 rev increments) Speed – LO 20 rpm HI 60 rpm Direction – forward and reverse
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A	6.5	16.51
B	14.5	36.83
C	2.5	6.35
D	2.0	5.08



RATCHET WITH 15/16–INCH SOCKET

S85–39027



OVERVIEW

The ratchet with 15/16–in. socket is a combination of common tools modified for **contingency** extravehicular activity use. It is comprised of a 3/8–in. drive ratchet, an extension, and a 15/16–in., 12–point deep socket. The socket is pinned to the extension, which is pinned to the ratchet. **It was designed specifically for SPARTAN payload use.**

OPERATIONAL COMMENTS

The ratchet with 15/16–in. socket is a disconnect tool used in **the past in** a contingency situation to remove the remote engagement mechanism to mission–peculiar equipment support subsystem bolts. The ratchet can be used with any 15/16–in. hex bolts or nuts. **It has been replaced by a new design with a long, telescoping handle.**

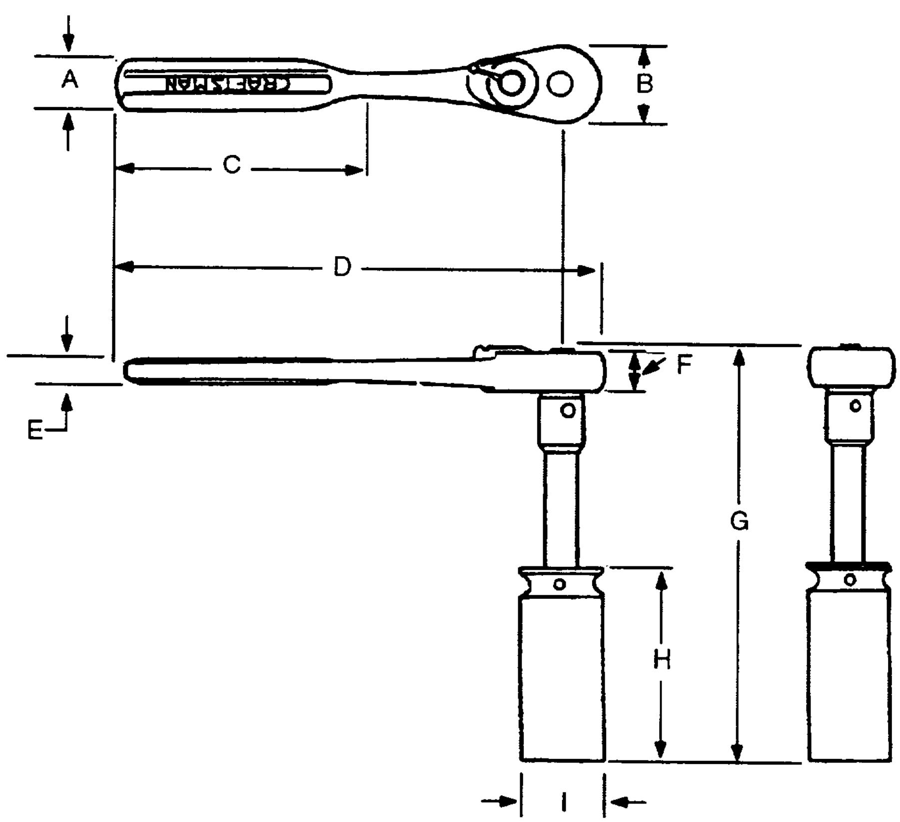
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: R. Scott, NASA/GSFC, (301) 286–2210

RATCHET WITH 15/16–INCH SOCKET

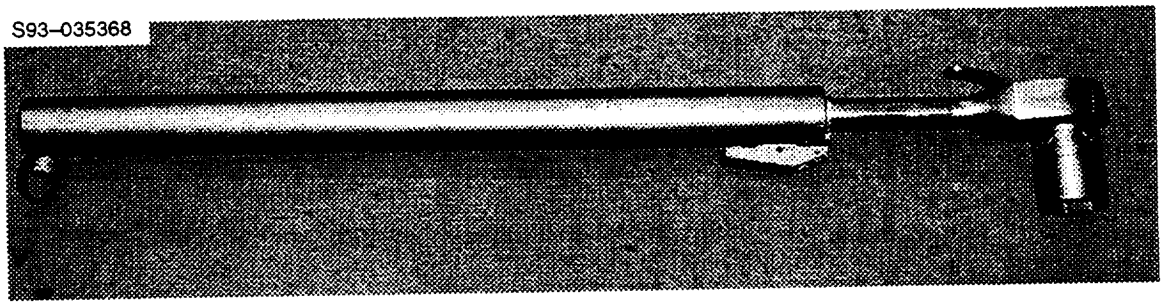
Technical Information	
Part number	GC 38169
Weight	1.1 lb
Material/ construction	Nickel–plated stainless steel
Load rating	100 in–lb
Temperature range	–130° to 150° F
Socket depth	
Quantity flown	
Stowage	
Availability	**Reference only**

Dimensional Data		
	inches	cm
A	0.760	1.93
B	1.156	2.94
C	3.430	8.71
D	6.750	17.15
E	0.380	0.97
F	0.600	1.52
G	5.900	14.99
H	2.760	7.01



RATCHET WITH TELESCOPING 15/16–INCH SOCKET

S93–035368



OVERVIEW

This ratchet is a contingency tool specifically developed to assist with safing the Spartan payload on its launch carrier. If the holddown latches of the carrier release/engage mechanism (REM) fail, they can be driven manually with this ratchet. If the manual latch drive also fails, the REM and payload can be jettisoned. To drive the high torque of these backup mechanisms, the ratchet telescopes to provide a 30–in.–long moment arm. A foot restraint can be mounted on the carrier to restrain the crew for each of these tasks. The ratchet is stowed on the carrier very near the manual latch drive interface. A tether point on the handle facilitates extravehicular activity (EVA) handling.

OPERATIONAL COMMENTS

To be driven manually, the REM latches must first be uncoupled from the clutch mechanism. This uncoupling is performed with a built–in drive handle that is driven 15 turns clockwise. The launch lock of the EVA backup latch drive is then disengaged by pushing its collar in and rotating counter clockwise roughly 80°. The ratchet handle is extended and locked in place after pressing a button underneath the ratchet socket. The 15/16–in. hex of the REM drive shaft must be turned counterclockwise 200° to a hard stop to close the latches to their overcenter locked positions. Alignment marks on the backup drive aid in recognition of backup–drive lock, unlock, and full latch motion.

To jettison the REM and payload, eight bolts must be released after cutting an electrical wire bundle. There are two bolts at each corner of the payload. These bolts have 15/16–in. heads and require 13 counterclockwise turns to release. After task completion, the ratchet is secured on the payload bay carrier with a simple passive/active latch and locking pip pin.

This particular tool has replaced a set of two separate tools that were flown prior to the latest redesign of the REM.

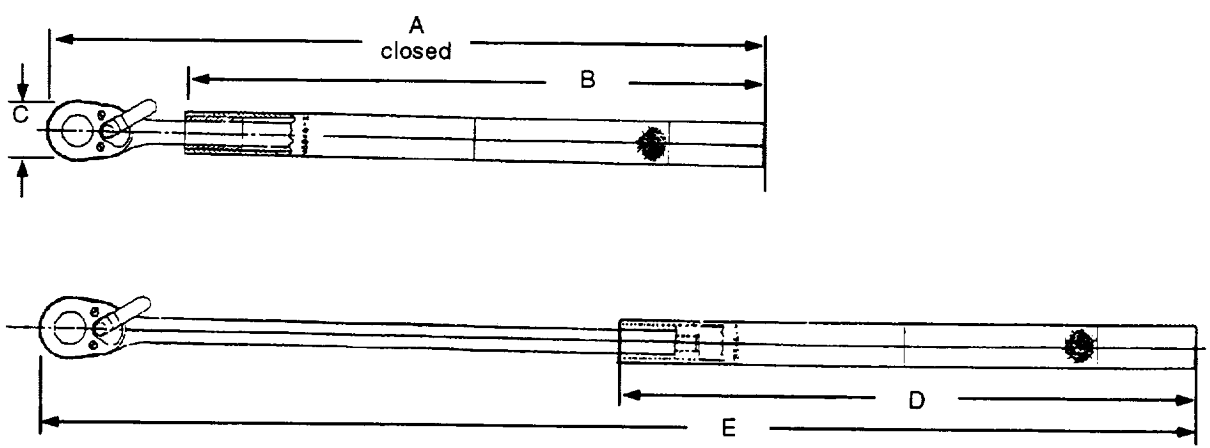
CONTACTS

Operational: W. Wedlake, NASA/DF42, (713) 483–7141
Technical: J. Pownell, NASA GSFC, (301) 286–5321

RATCHET WITH TELESCOPING 15/16–INCH SOCKET

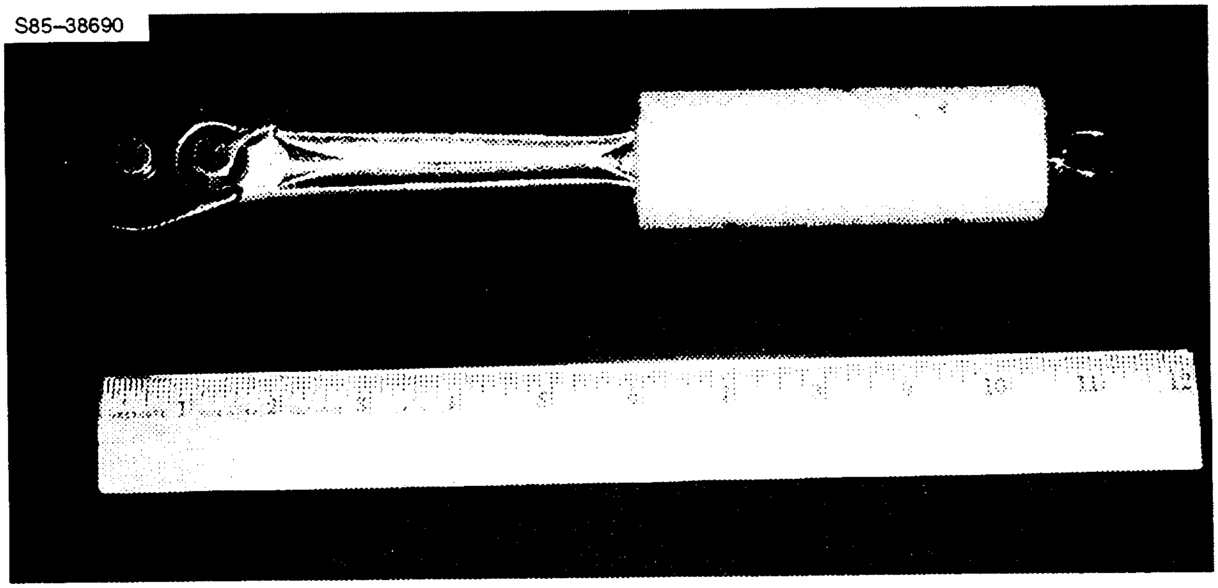
Technical Information	
Part number	N8846
Weight	4.0 lb
Material/ construction	Stainless steel
Load rating	250 ft–lb 100 to 125 ft–lb latch engage torque (nominal) 67 ft–lb latch disengage torque (nominal) 150 ft–lb jettison bolt breaking torque 8.5 ft–lb jettison bolt running torque
Temperature range	
Quantity flown	One
Stowage	Payload bay
Availability	Reference only

Dimensional Data		
	inches	cm
A	18.64	47.35
B	15.0	38.1
C	1.58	4.0
D	15.0	38.1
E	30.0	76.2



RATCHET, 1/2–INCH DRIVE

S85–38690



OVERVIEW

The 1/2–in. drive ratchet is a common ratchet modified for extravehicular activity (EVA) **mission success**. It allows continuous ratcheting in both clockwise and counterclockwise directions; a small lever is used to select direction. The handle is built up and wrapped with Velcro to provide easy grasping by the gloved hand. A tether ring attached to the end allows wrist tether **or tool caddy** attachment.

OPERATIONAL COMMENTS

The 1/2–in. drive ratchet **was created for** disconnecting the Spacelab scientific airlock hatch in the event that the hatch **could not** close. It can be used with any 1/2–in. square drive interface. **Since the EVA drive ratchet standard is the 3/8–in. square drive, this tool has no commonality with other EVA tools. It also lacks a drop–proof tether interface.**

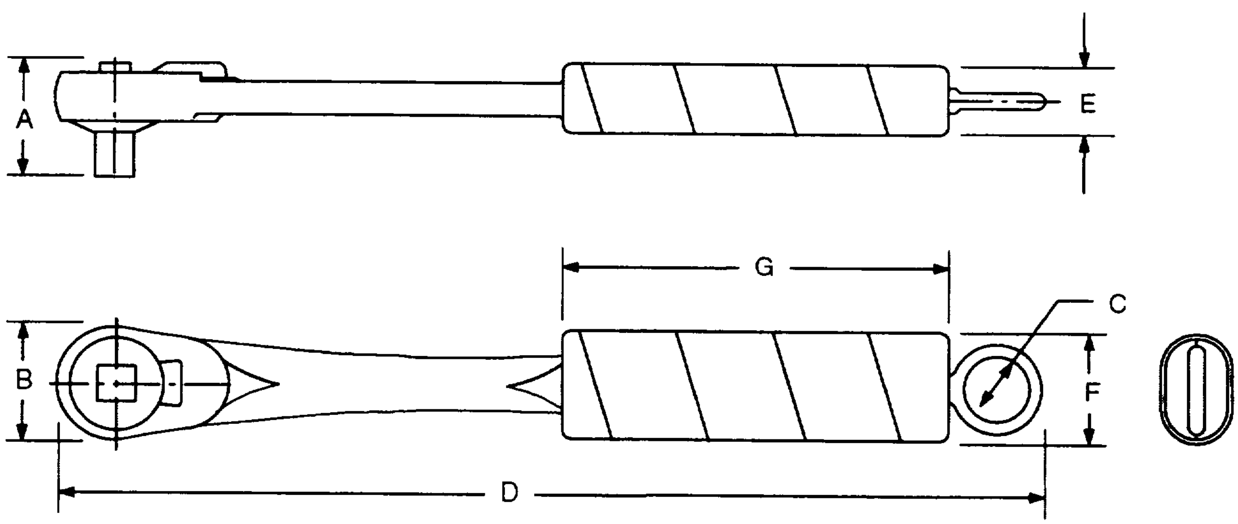
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

RATCHET, 1/2–INCH DRIVE

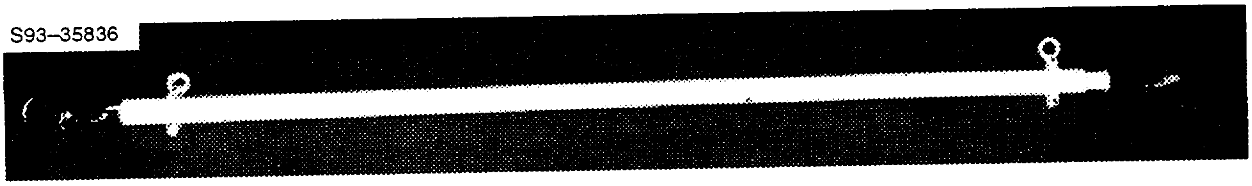
Technical Information	
Part number	**Not available**
Weight	0.8 lb
Material/ construction	Tool steel, Velcro–covered handle, and tether ring
Load rating	Less than 25 ft–lb
Temperature range	
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	1.58	4.01
B	1.66	4.22
C	0.67	1.70
D	11.68	29.67
E	0.75	1.91
F	1.25	3.18
G	4.00	10.16



RATCHET, 3/4–INCH DRIVE

S93–35836



OVERVIEW

The 3/4–in. drive ratchet, also known as the latch arm wrench ratchet, is a contingency tool specifically developed to assist with safing the forward restraint structure of the ACTS/TOS spacecraft. If the primary and secondary electromechanical actuators which support latching the spacecraft restraint for launch and landing were to fail, they would have to be isolated by pin puller assemblies and then the latch would be manually driven to open or close. This tool has a long moment arm to ease the effort involved with the high torque of the latch mechanism. The end opposite from the ratchet head has a box end wrench to cover ratchet failure. A tether point and mini–workstation bayonet fitting are provided on the ratchet shaft to facilitate extravehicular activity (EVA) transport and handling.

OPERATIONAL COMMENTS

ACTS/TOS has pairs of actuators on the forward restraint assembly for latching/unlatching a clamshell that holds down the spacecraft. Since this forward clamshell violates the payload bay envelope when open and is not certified for entry in an unlatched configuration, it must be closed and latched down in an overcenter and locked configuration. The latch may also need to be opened to allow payload deployment. A tension device is used to hold the top and bottom segments of the clamshell together tightly so that latch engagement forces are kept to a minimum for the EVA crew.

The latch arm wrench is a 5–ft long, 3/4–in. drive ratchet wrench designed to generate the 320 ft–lb torque required to drive the clamshell latch through the overcenter position. To open or close the latch after the tension device has secured the clamshell, a pair of electrical cables that interfere with tool attachment must first be disconnected and moved aside. A large special socket assembly is then locked in place to drive the latch interface. The latch actuator is then uncoupled, using the dust cap removal tool and pin puller, before installing the latch wrench. The wrench has a pip pin which secures it to the latch drive socket. The wrench is turned counterclockwise to drive the latch closed and overcenter locked or the opposite direction to open. Markings on the latch drive socket guide proper drive directions. The worksite is finally closed out by removing and stowing the EVA devices. The wrench stows on a payload bay sidewall carrier.

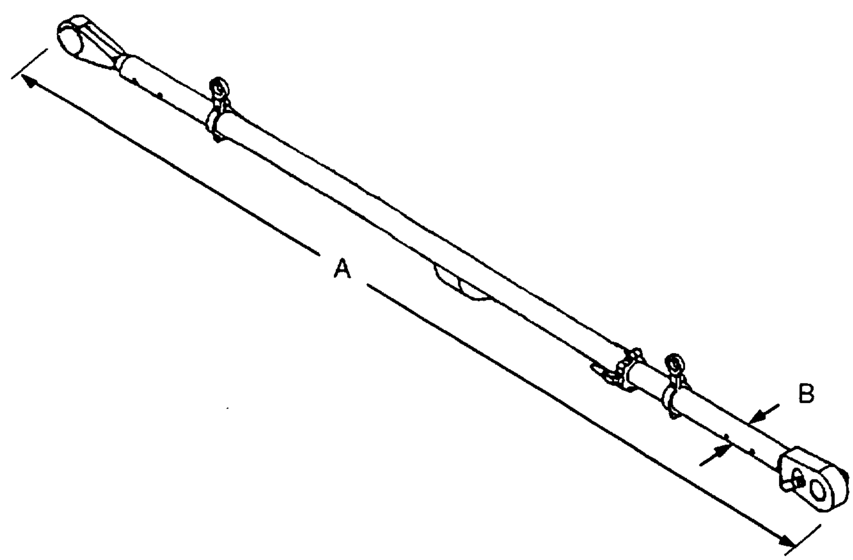
CONTACTS

Operational: O. Koehler, JSC/DF42, (713) 483–4363
Technical: F. Sanders, NASA MSFC/EE43, (205) 544–0164

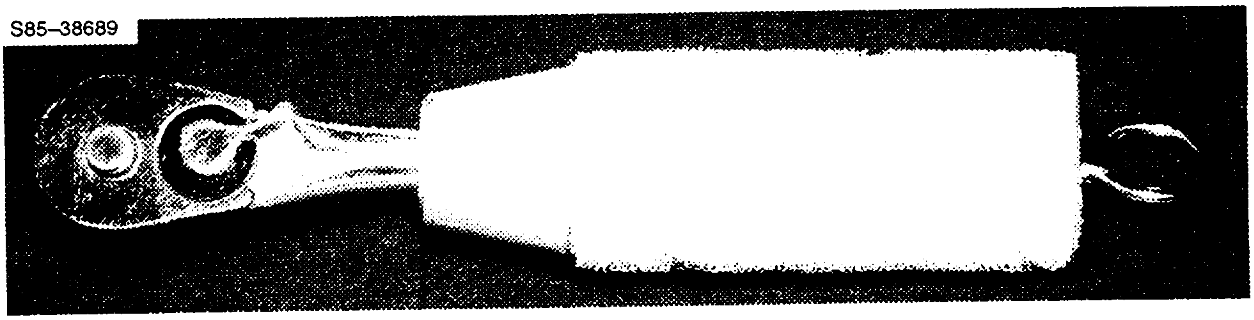
RATCHET, 3/4–INCH DRIVE

Technical Information	
Part number	97M52762–1
Weight	17.0 lb
Material/ construction	Aluminum, stainless steel
Load rating	320 ft–lb latch drive torque (max.)
Temperature range	
Quantity flown	One
Stowage	Payload bay
Availability	Reference only

Dimensional Data		
	inches	cm
A	62.40	158.5
B	1.38	3.5



RATCHET, 3/8–INCH DRIVE (SAL)



OVERVIEW

The 3/8–in. drive ratchet is a bidirectional ratcheting tool with continuous ratcheting in both directions. A lever is provided for selection of ratchet direction. A tether ring is provided for tethering.

OPERATIONAL COMMENTS

The 3/8–in. drive ratchet **was created** as a contingency experiment table jettison tool for the Spacelab scientific airlock (SAL). It has a Velcro–wrapped handle and an attached tether ring. **When flown in the past, it was** wrapped in a Velcro–lined tool caddy along with the 1/2–in. drive ratchet and the carryout bracket. **It lacks a drop–proof tether interface.**

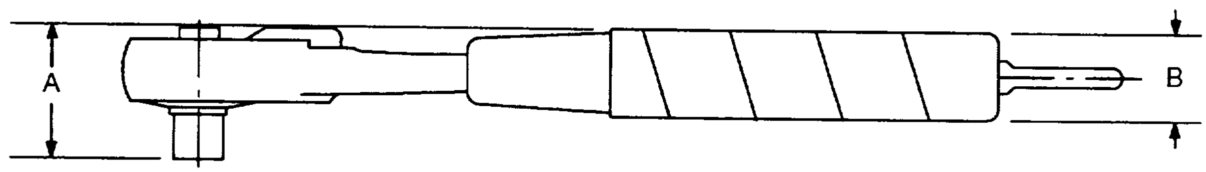
CONTACTS

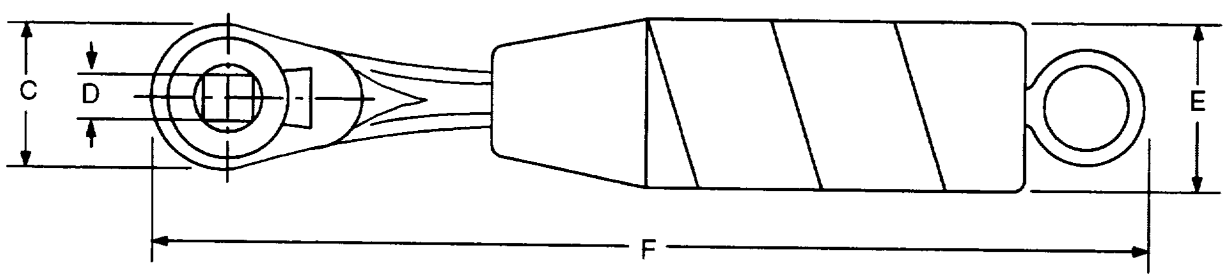
Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

RATCHET, 3/8–INCH DRIVE (SAL)

Technical Information	
Part number	10159–20079–01
Weight	0.84 lb
Material/ construction	Tool steel, Velcro–covered handle, tether ring
Load rating	
Temperature range	–250° to 200° F
Quantity flown	One
Stowage	Tool caddy in SAL
Availability	Reference only

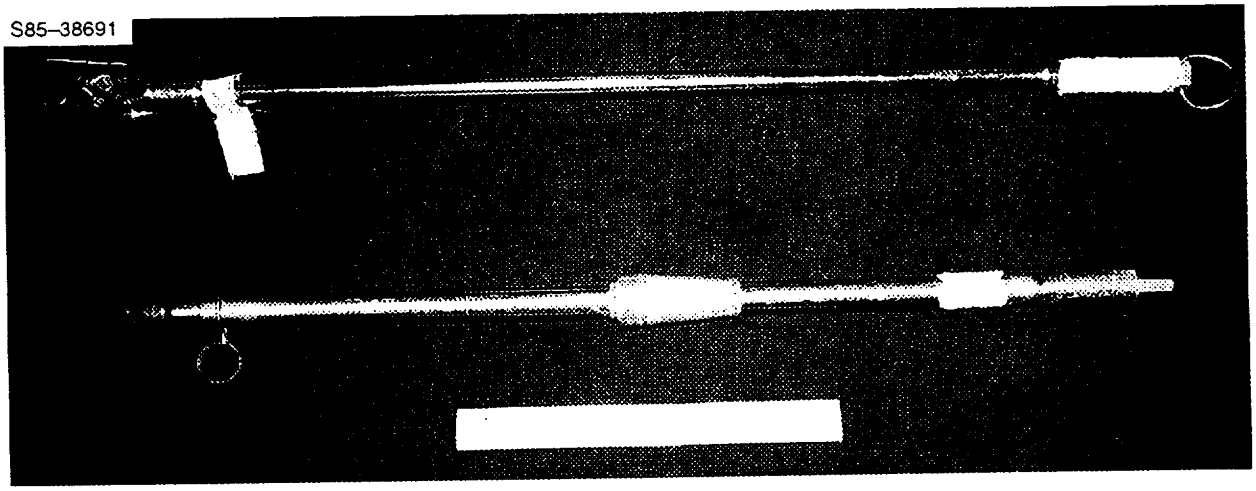
Dimensional Data		
	inches	cm
A	1.190	3.02
B	0.800	2.03
C	1.200	3.05
D	0.375	0.95
E	1.400	3.56
F	8.300	21.08





RATCHET, MST MANUAL BACKUP

S85–38691



OVERVIEW

The module servicing tool (MST) manual backup is a large standard 3/4–in. drive ratchet handle and extension/socket combination. The ratchet is 39 in. long, and the extension/socket combination is 32 in. long with a 3/4–in. hex head. The ratchet handle is wrapped with Velcro and has a rotating tether ring at the handle end. The extension has a rotating hand grip near the middle of the extension and a rotating tether ring near the drive end.

OPERATIONAL COMMENTS

The MST manual backup tool is used only in the event of a contingency situation in which a modular jack screw cannot be released with the primary MST. It can be used as a standard ratchet–extension combination to loosen and tighten the multimission modular spacecraft module retention hardware with torques of up to 375 ft–lb. A switch allows selection of ratcheting direction.

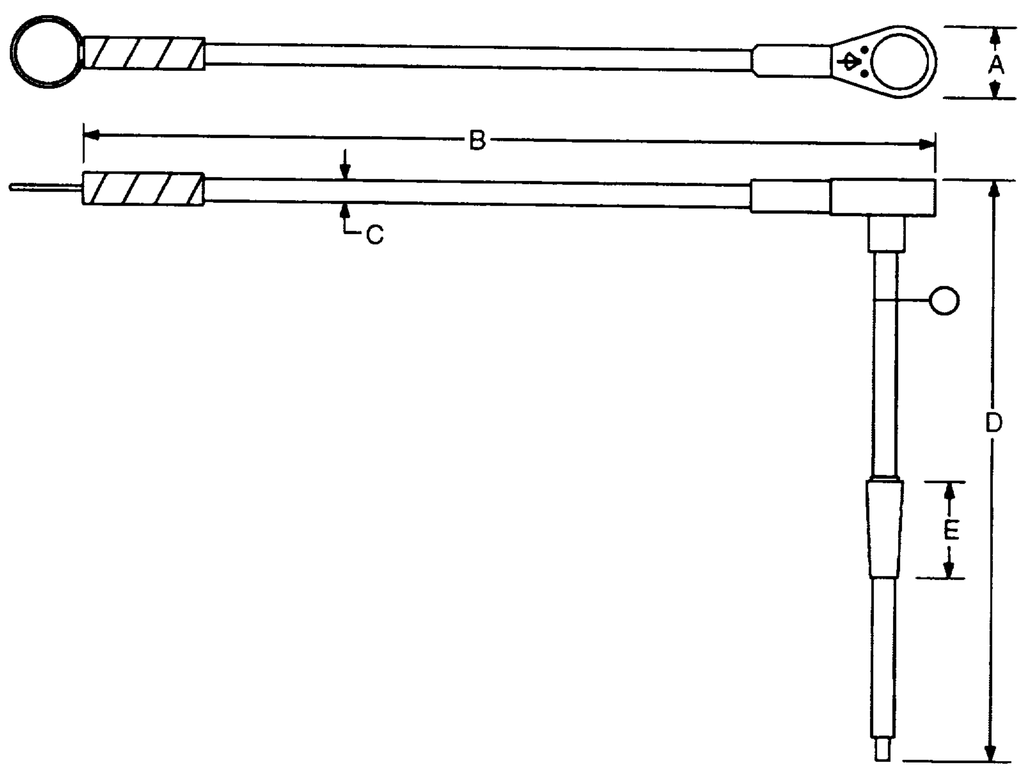
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: K. Olson, NASA/GSFC/442, (205) 772–7660

RATCHET, MST MANUAL BACKUP

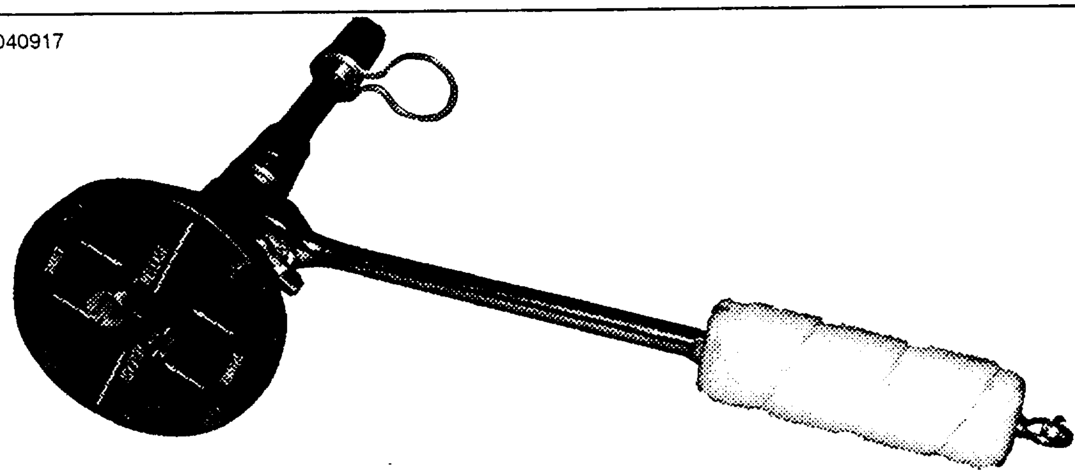
Technical Information	
Part number	Shaft – 1413466
	Ratchet – 1413468
Weight	14.7 lb
Material/ construction	Ratchet – Snap–On Tool Co. #L72T Extension – Snap–On Tool Co. #GLA62 Velcro–wrapped handle, aluminum rotating hand grip, tether rings Coating – Blue Chemglaze
Load rating	375 ft–lb (max.)
Temperature range	
Socket depth	
Quantity flown	**One for STS 41–C**
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	3.5	8.89
B	39.0	99.06
C	0.8	2.03
D	34.4	87.38
E	4.0	10.16



RATCHET/SOCKET SYSTEM

S93–040917



OVERVIEW

This ratchet and socket system is a developmental drive tool set that serves as an alternative to the present drop–proof tether system. This new system requires no separate tool (i.e., pip pin) to mate/demate components and, therefore, reduces EVA crew overhead. It also permits the consolidation of several ratchet tools currently being flown. This should save stowage volume and launch weight for other items. In theory, this design combines the best EVA features of existing similar tools to create a single adaptable tool with less EVA overhead and less hand fatigue.

The system consists of a modified 3/8–in. drive ratchet, a removable ratchet spinner, and removable sockets and extension retained in a special caddy. The release mechanism works on the same principle as a double acting pip pin: moving a shaft in one direction releases the spinner and moving it in the other direction releases the sockets/extension. In contrast to the current drop–proof tether system, all sockets are passive with no moving parts.

OPERATIONAL COMMENTS

The ratchet spinner provides a mushroom–headed palm wheel like the Essex wrench. The spinner can be used when ratchet throw is physically restricted, to avoid overtorquing, or when resistance (backdriving) is too low for ratchet operation. Since the spinner is removable, the ratchet can be used in tight areas (e.g., sill longeron mounted payload latches). The socket caddy will provide both standard and deep well sockets as well as allen drives. **Five socket sizes are currently available: 5/16, 3/8, 7/16, 1/2 and 9/16**. The extension slot adjusts to accommodate extensions from 2 in. to about 8 in. long depending on mission requirements.

As a safety measure to preclude inadvertent tool loss, actuation of the release mechanisms involves two separate motions. To release the spinner, a button on top of the spinner slides outboard and then is pushed down while the spinner is pulled free. To release an extension or socket attached directly to the ratchet, a similar button is pushed outboard in the opposite direction and also pushed down. Markings on the spinner help direct these actions. To release a socket from the end of an extension, a collar on the extension is rotated around the shaft and then slid along the shaft length. Engagement of each component is achieved with the same techniques. The socket caddy is even simpler. It works much like a coin dispenser where two tabs are squeezed together so that sockets can be pulled free after attachment to the drive tool. This entire system is also being made compatible with existing EVA power tools. Sockets are custom built for this application with dimples cut into all four interior faces of the square drive end to accept the drive tool ball detents.

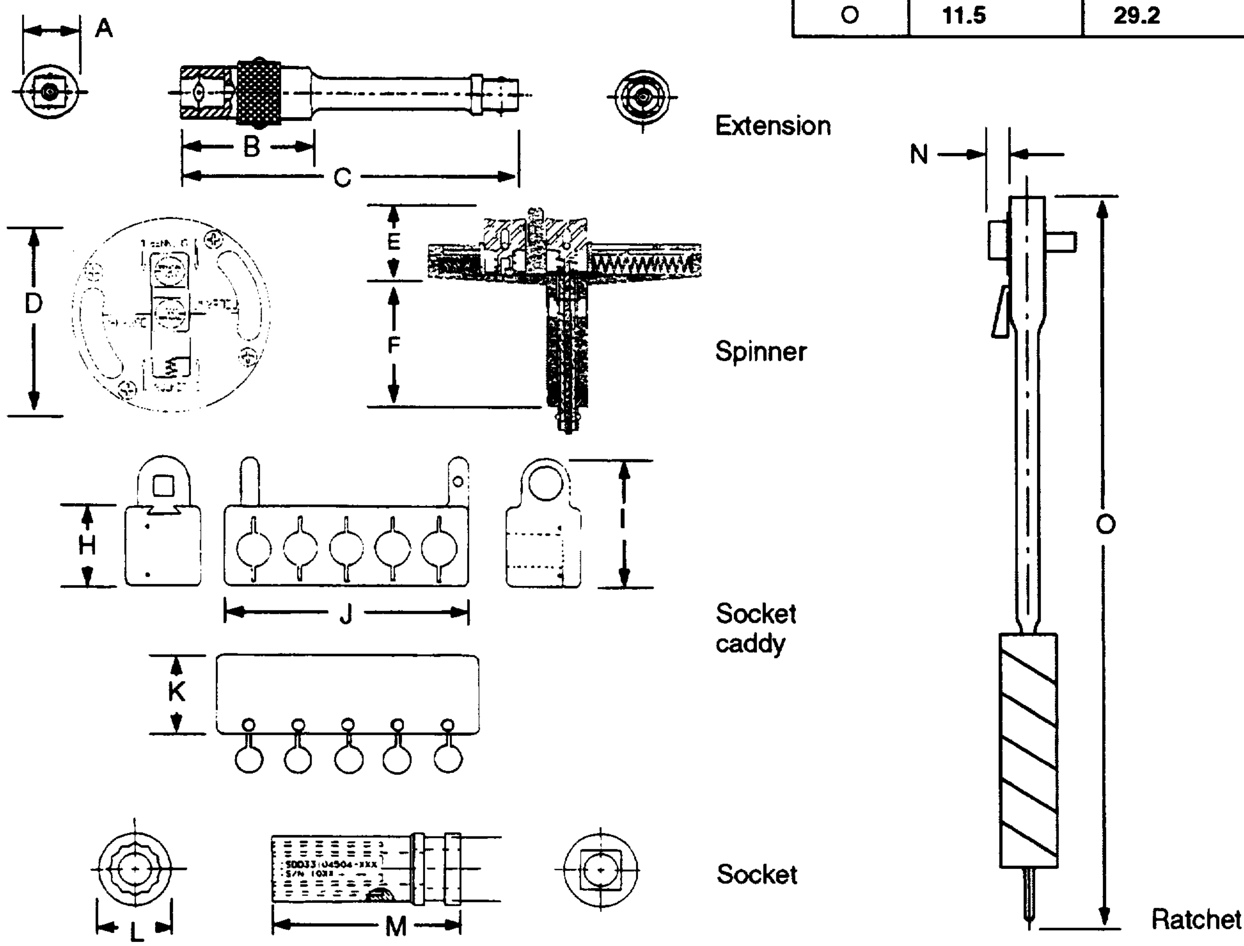
CONTACTS

Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

RATCHET/SOCKET SYSTEM

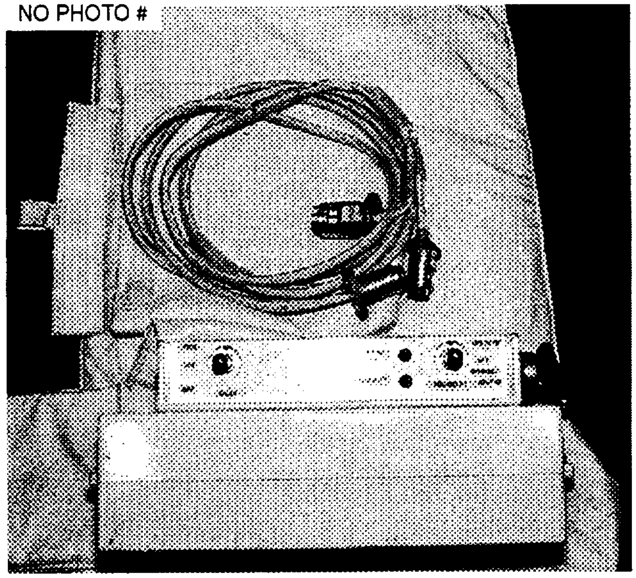
Technical Information	
Part number	SED33104505–301 (socket caddy) SDD33104504 (sockets) V628–650881–005 (ratchet) SED33105440–301 (ratchet spinner)
Weight	1.5 lb – Sockets and caddy 1.75 lb – Ratchet
Material/ construction	Aluminum – Caddy MP35N – Sockets Aluminum, stainless steel – Ratchet
Load rating	45 ft–lb ratchet xx ft–lb spinner
Temperature range	
Socket depth	0.36 or 1.08 inches
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A	**0.68**	**1.73**
B	**2.00**	**5.08**
C	**2 minimum**	–
D	**3.38**	**8.59**
E	**0.88**	**2.24**
F	**1.50**	**3.81**
G	**0.50**	**1.27**
H	**1.60**	**4.06**
I	**2.60**	**6.60**
J	**5.0**	**12.7**
K	**2.00**	**5.08**
L	**0.469–0.720**	**1.19–1.83**
M	**1.11 or 1.83**	**2.82 or 4.65**
N	**0.25**	**0.64**
O	**11.5**	**29.2**



REMOTE POWER UNIT

NO PHOTO #



OVERVIEW

The remote power unit (RPU) was developed as an extravehicular activity (EVA)–crew–installed "hot wire" device to power several relays and facilitate deployment of the Leasat OMNI antenna on STS 51–I. The spacecraft had problems after initial deployment on STS 51–D and required this device so that ground commands could be received by the antenna. One unit was temporarily attached to the spacecraft at a test access panel on top of the spacecraft. Two units were flown to ensure mission success. Each had a handling strap and a bayonet fitting for transport to the worksite. They were also transported and stored in a flight–unique protective transfer bag during EVA.

OPERATIONAL COMMENTS

The RPU received power from a standard 16.8–V extravehicular mobility unit (EMU) battery installed prior to EVA. Three banks of capacitors were connected in series to develop an output of 45 V. While still in the cabin, the crew verified the RPU squib driver output and relay power circuits, using a cabin checkout box. This checkout box was basically an enhanced breakout box, consisting of connectors, jumper wire, and tip jacks. It had no active components, electromechanical devices, or indicators. Two units were flown for redundancy. Part of its harness connected to a middeck power outlet; the rest connected to a special test port on each RPU. A standard multimeter was used to check out other RPU functions.

Prior to connecting the RPU to the spacecraft, a closeout plate held by nine captive screws had to be removed. Two electrical flight caps were removed from the test port, and two connectors from the RPU were mated to allow OMNI antenna deployment. Deployment involved enabling several relays and applying power to squibs that restrained the antenna. After removing the electrical connectors and installing new caps, a fiberglass closeout plate was clipped on. The RPU and its 11–ft–long wire harness were removed after antenna deployment and were returned to the airlock at the end of the EVA.

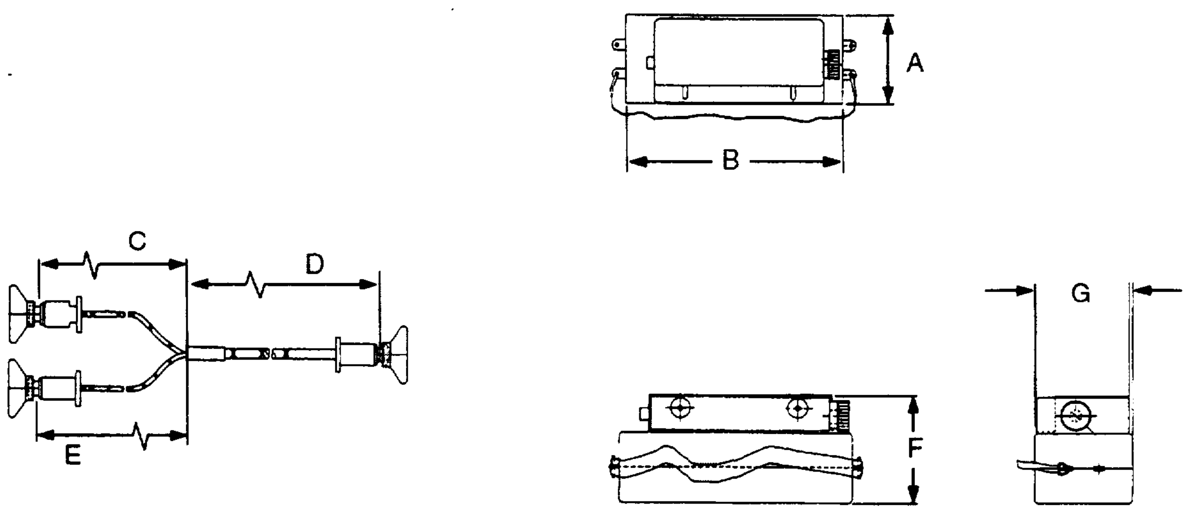
CONTACTS

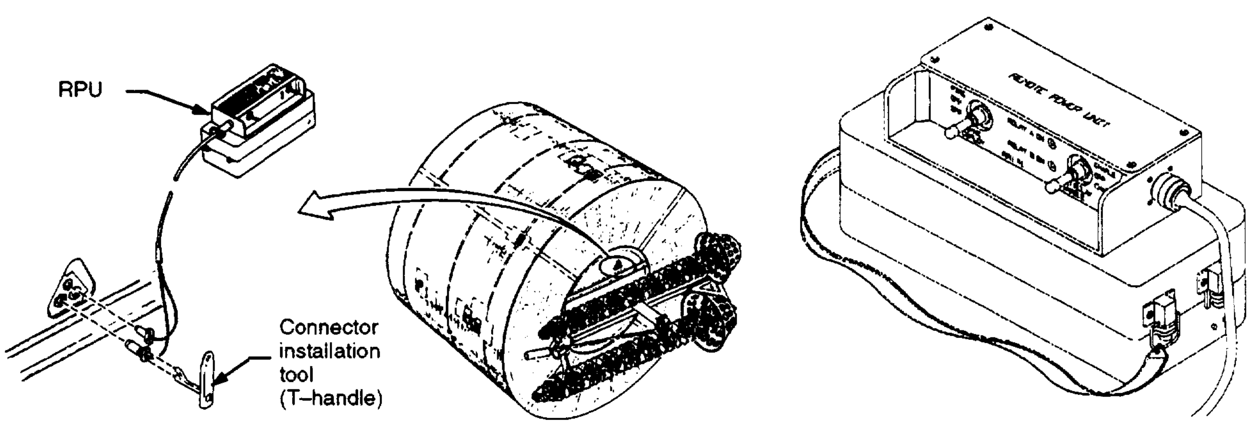
Operational: R. C. Trevino, NASA JSC/DF42, (713) 483–2597
Technical: **R. Marak, NASA/EC5, (713) 483–9144**

REMOTE POWER UNIT

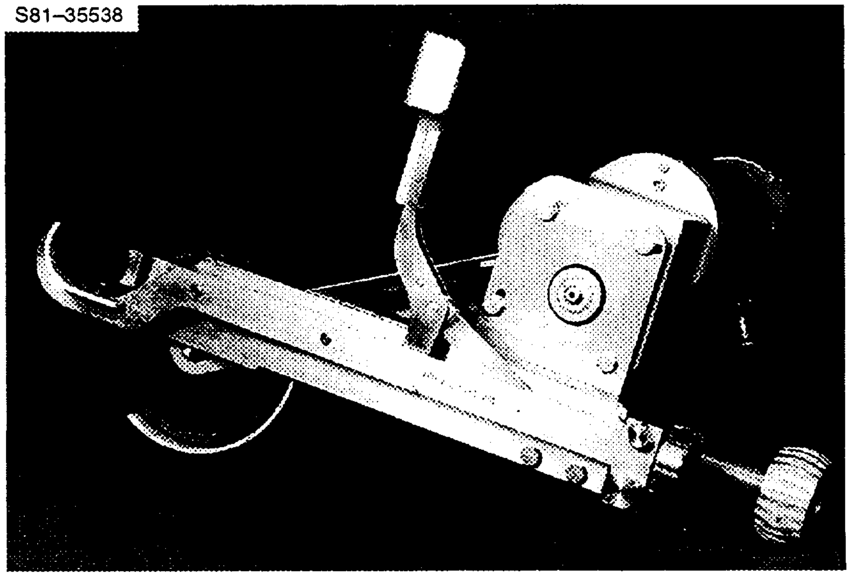
Technical Information	
Part number	3649630–100
Weight	6.9 lb (RPU and wire harness)
Material/ construction	Aluminum housing, fabric carrying strap
Load rating	N/A
Temperature range	–80° to +80° F
Quantity flown	Two on STS 51–I
Stowage	Middeck locker
Availability	Reference only

Dimensional Data		
	inches	cm
A	5.31	13.49
B	12.76	32.41
C	12.0	30.48
D	120.0	304.8
E	12.0	30.48
F	5.88	14.94
G	5.00	12.7





SAW



S81–35538

OVERVIEW

The saw is a circular hand–held power saw comprising a frame, an electric motor, a blade housing, a depth–of–cut adjustment, a tube holder, and a load indicator. The saw will cut a tube or rod of up to 1.25 in. It requires a 110–V, 400–cycle ac external power source.

OPERATIONAL COMMENTS

The saw was designed to cut the actuation rods of the bulkhead latches in the event that they fail to close. They must be cut for a crewmember to backdrive the bulkhead latches to allow three–point latch tool attachment. The tube holder is used to hold the tube firmly against the blade. The depth of cut is controlled by turning a knob on the end of the frame. Built into the motor housing is a load indicator consisting of three lights: green, indicating very little load; yellow, indicating a normal load; and red, indicating an overload and possible stalling. **Development of this tool was never completed.**

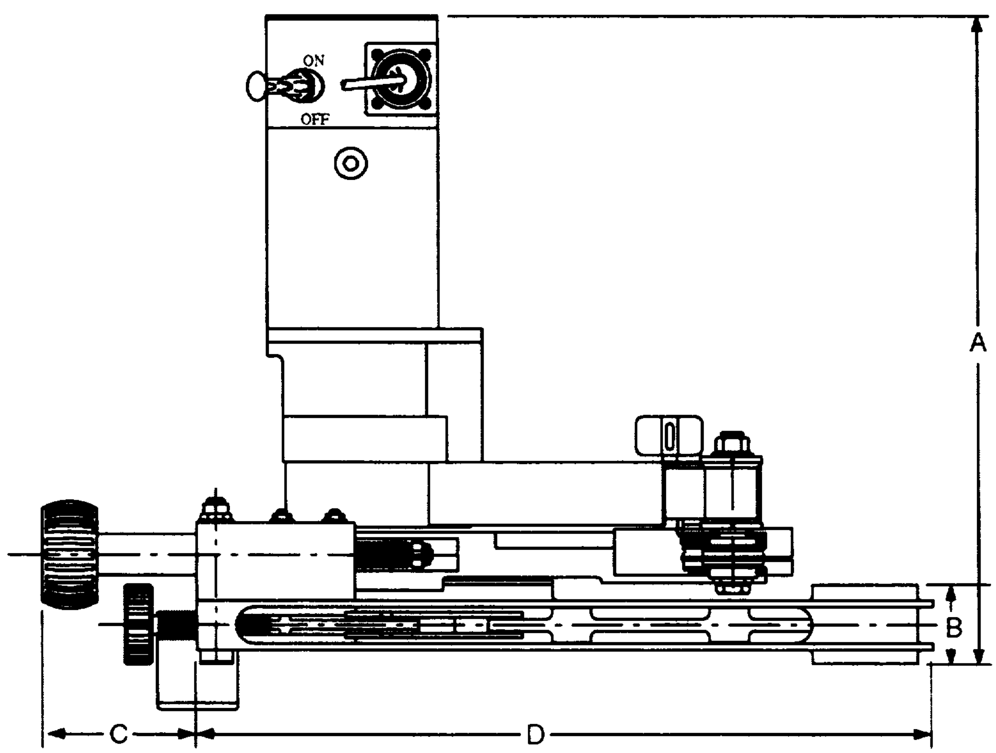
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: J. D. Bradley, NASA/ES6, (713) 483–8812

SAW

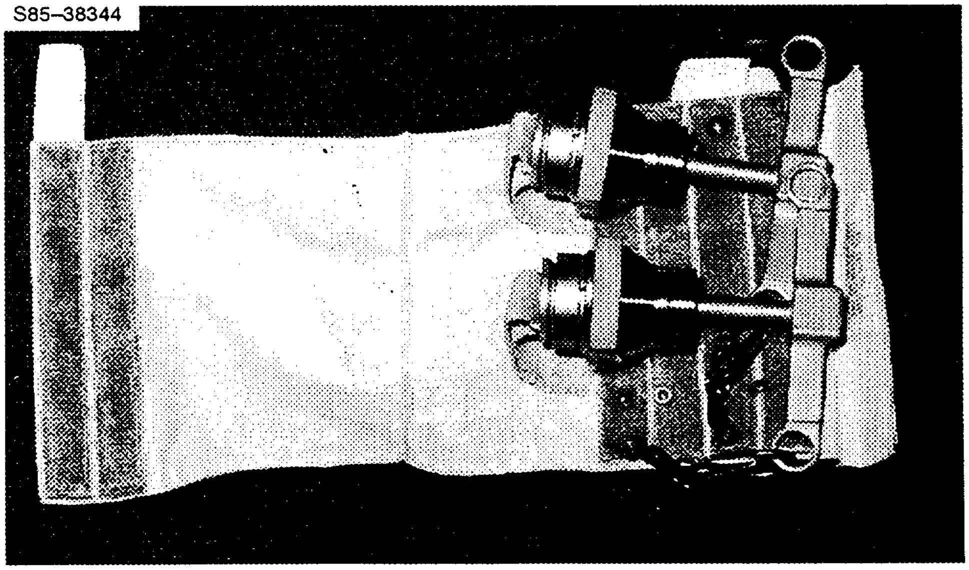
Technical Information	
Part number	SED33101842–307
Weight	12.5 lb
Material/ construction	Frame – Stainless steel Motor and blade housings – Aluminum Belt – Kevlar/polyurethane **Blade – 4–in. diameter tungsten carbide blade, 5/8–in. arbor**
Power requirements	400 cycle ac; external source 110 V
Blade speed	1100 rpm
Maximum depth of cut	1.25 in.
Load rating	
Temperature range	
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	12.125	30.80
B	1.500	3.81
C	2.813	7.15
D	13.875	35.24



SHORTING PLUG

S85–38344



OVERVIEW

The shorting plug assembly consists of a shorting plug, a handle, and a dust cap/protective cover. The shorting plug was designed to mate/interface with the Leasat umbilical electrical connector. The handle, with its pushbutton release mechanism, was used to remove the plug from and install the plug onto the umbilical connector.

OPERATIONAL COMMENTS

The handle is installed onto the plug by pushing it through the slot located at the top of the shorting plug. The handle locks itself into place. The shorting plug is then installed onto the electrical connector and the handle is removed by pushing its release button. The shorting plug remained installed on the Leasat umbilical electrical connector. The dust cap/protective cover was used to protect the plug from contamination when not in use.

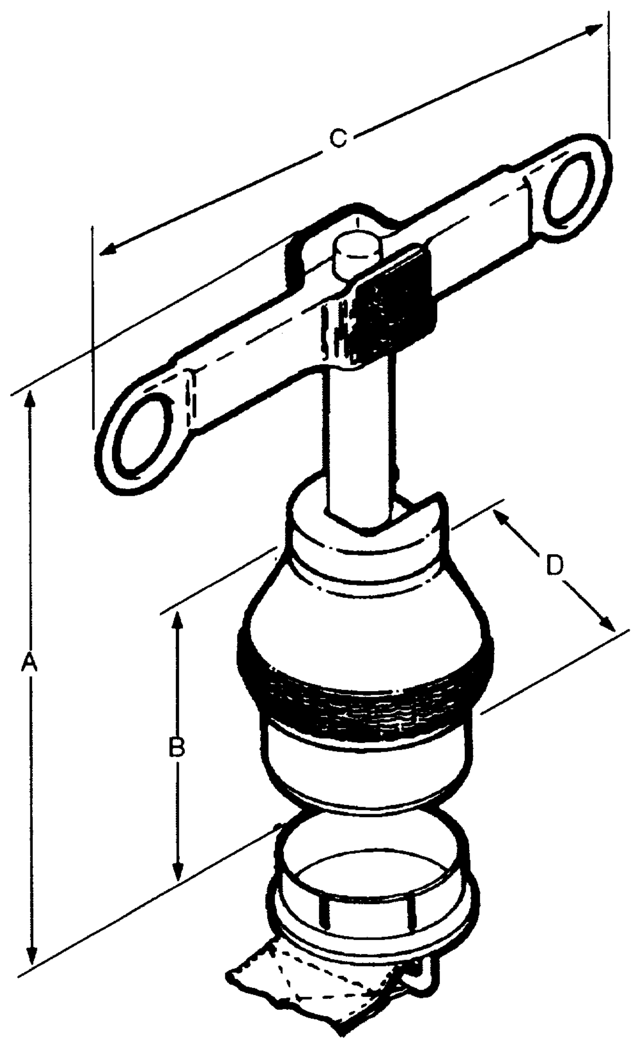
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 488–2597
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

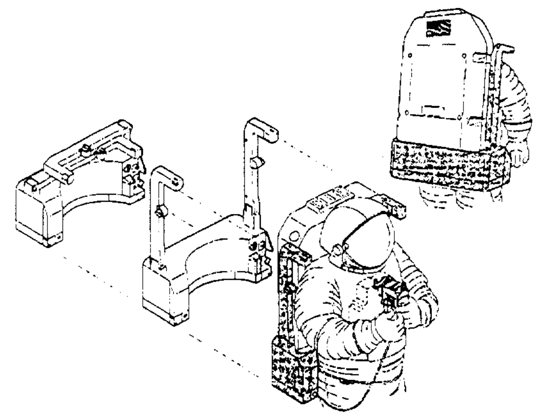
SHORTING PLUG

Technical Information	
Part number	10176–20111–01 (with T–handle) 10176–20111–02 (without T–handle) 10176–20113–01 (T–handle)
Weight	0.90 lb
Material/ construction	Aluminum Stainless steel
Load rating	
Temperature range	–60° to +180° F (operational) **–95° to +180° F (stowage)**
Quantity flown	
Stowage	
Availability	Referency only

Dimensional Data		
	inches	cm
A	5.20	13.21
B	2.60	6.60
C	5.88	14.94
D	2.28	5.79



SIMPLIFIED AID FOR EVA RESCUE



OVERVIEW

The simplified aid for extravehicular activity (EVA) rescue (SAFER) is the latest crew self–rescue concept for solving the EVA "man overboard" scenario on Space Station Freedom where no shuttle is available to assist. It is intended to cover rescue scenarios including tether mismanagement and tether or hook failure when a fellow EVA crewmember is not available. This particular device provides the capability for the extravehicular (EV) crewman to "fly" back to the vehicle. It can also serve as an alternative translation aid for contingency access to remote sites where no manual aids (e.g., handrails) currently exist. Orbiter external tank door closure is specifically enhanced with this device. It is designed as a simplified version of the manned maneuvering unit (MMU) with a self–contained single–string propulsive backpack. Numerous MMU proven components are used. Evaluation of this concept is anticipated as part of an upcoming shuttle flight. An operational unit will be based upon this development unit. Stowage is currently planned for the airlock floor in a standard airlock stowage bag.

OPERATIONAL COMMENTS

SAFER attaches to the extravehicular mobility unit (EMU) backpack with most of the structure below the backpack to minimize crewmember interference. Four static pins interface with the EMU airlock wall mount plates and a "push and turn" 90° latch locks SAFER to the EMU MMU latch plates. Twenty–four gaseous nitrogen, solenoid–driven thrusters provide six degree–of–freedom maneuvering control. The nitrogen tanks can be recharged on orbit by the EVA crew in the payload bay. The thruster pressure regulator has an integral nonpropulsive relief valve to protect against a regulator problem or pressure buildup from thermal expansion. A manually operated isolation valve protects the low pressure system from the high pressure system and can be used for fault isolation. The upper thruster assemblies are mounted on arms that fold down for stowage.

A single hand controller attaches to the EMU display and control module on the crewmember's chest during use. It provides both translation and rotation commands using a mode select switch. A 28 V dc battery pack powers SAFER avionics and is replaceable during EVA. Instrumentation includes a 0–to 4000–psi tank pressure gauge and transducer, a 0– to 1000–psi regulator outlet transducer, and a set of temperature transducers for the supply tanks, regulator outlet, and battery. All transducer data can be read by the crew on a 16–character liquid crystal display on the hand controller. System performance is recorded for postflight analysis. Automatic attitude hold (AAH) is provided via a set of angular rate sensors and an accelerometer. AAH is selected by depressing a pushbutton on the hand controller grip. Thruster control logic determines the proper jets to fire in response to hand controller and AAH commands. Software self–tests confirm proper thruster, hand controller, rate sensor, and pressure regulator operation before use. Other checks are performed continuously during use.

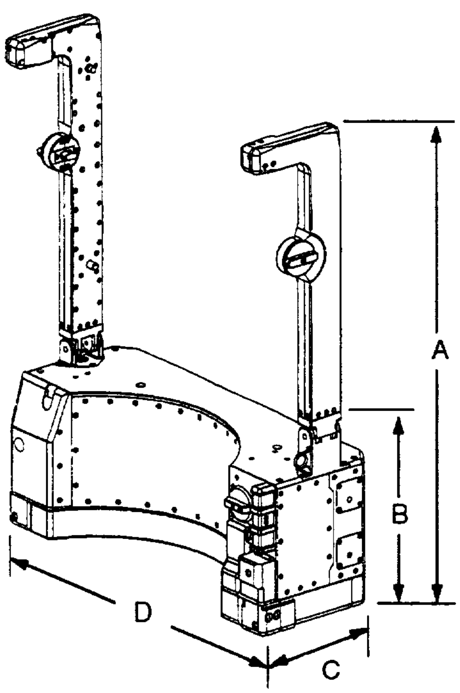
CONTACTS

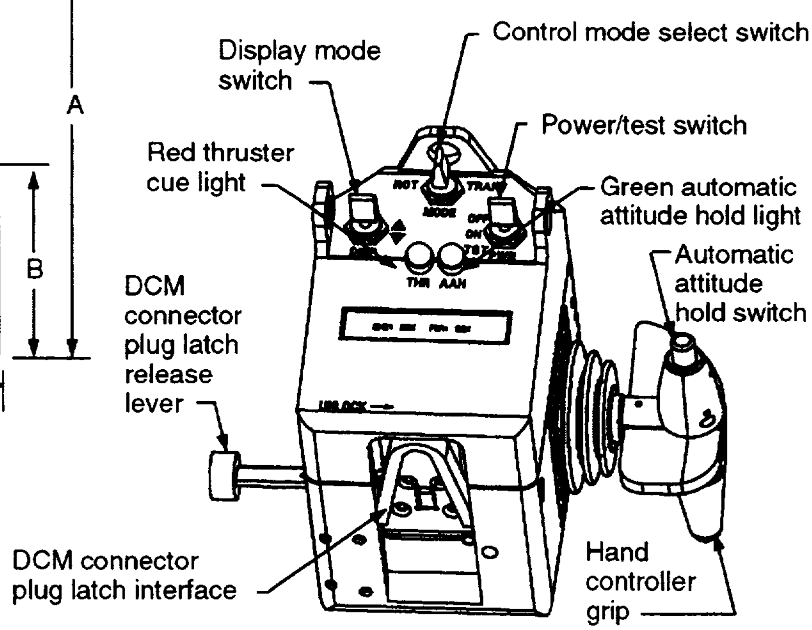
Operational: S. Bleisath, NASA JSC/DF42, (713) 483–1756
Technical: C. Hess, NASA JSC/ER4, (713) 483–9142

SIMPLIFIED AID FOR EVA RESCUE

Technical Information	
Part number	SED39123846–301
Weight	110 lb max. (not including stowage provisions)
Material/ construction	Aluminum structure/skin, stainless steel tanks and pressure lines
Load rating	1 ft/sec or 300 lb (functional impact) 2 ft/sec or 600 lb (safe nonfunctional impact) 10 ft/sec (delta V with max. charge) 0.8 lb (thrust per jet) 3600–psi N2 supply tank (max.) 350 to 3600–psi (inlet regulation) 300/575–psi relief valve (crack open/max. open) ± 30–deg/sec rate sensing ± one–g linear acceleration sensing
Temperature range	TBD
Quantity flown	One
Stowage	Airlock floor in standard airlock stowage bag
Availability	Developmental

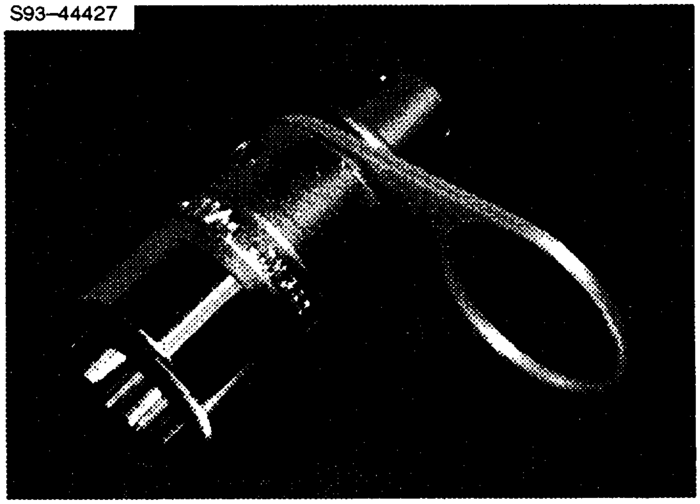
Dimensional Data		
	inches	cm
A	35	88.9
B	14	35.56
C	10	25.4
D	26	66.04





SOCKET, 1–1/16 INCH

S93–44427



OVERVIEW

This 1–1/16–in. socket is intended for contingency EVA use to aid in removal of loosened passive latch bolts during the jettison of an orbiter payload. It features a 12–point socket and attaches to any drive tool equipped with a 3/8–in. output drive. It lacks a drop–proof tether interface and has only a rotating tether ring for restraint and transport.

OPERATIONAL COMMENTS

This tool is used after the orbiter torque multiplier has loosened the high torque bolt of a payload passive retention latch. Instead of using the torque multiplier to fully release the bolt, this socket can be used with a manual wrench to speed up the jettison process. The tether ring can rotate relative to the body of the tool to avoid snags.

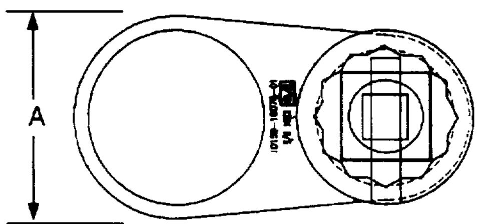
CONTACTS

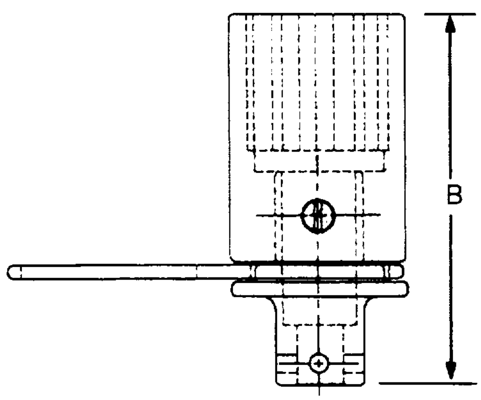
Operational: W. Wedlake, JSC/DF42, (713) 483–2568
Technical: R. Marak, NASA/EC5, (713) 483–9144

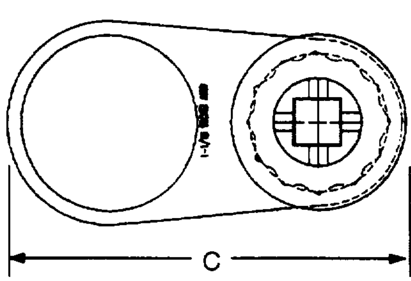
SOCKET, 1–1/16 INCH

Technical Information	
Part number	10159–10078–01
Weight	
Material/ construction	Chrome–plated tool steel (socket) CRES (adapter)
Load rating	
Temperature range	
Quantity flown	One
Stowage	Middeck locker
Socket depth	0.75 in.
Availability	Reference only

Dimensional Data		
	inches	cm
A	1.75	4.45
B	3.2	8.13
C	3.4	8.64

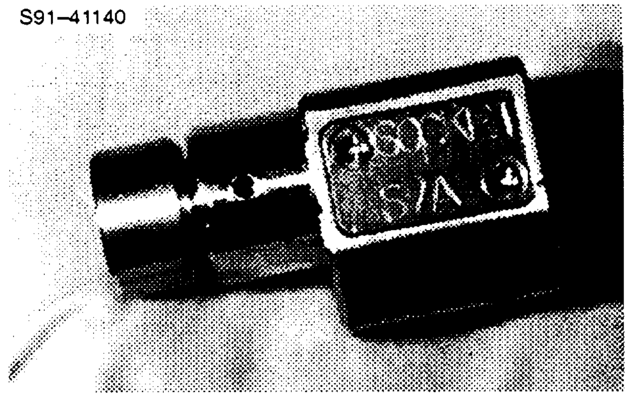




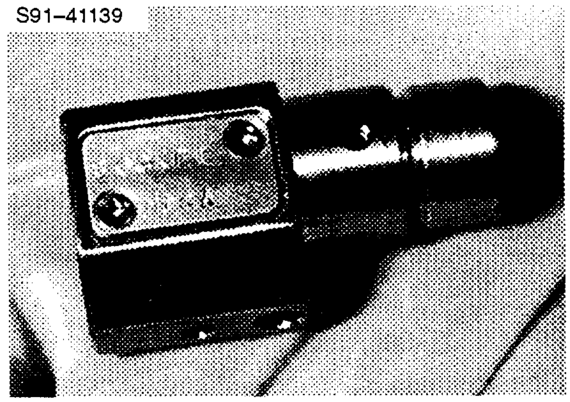


SOCKETS, 11/32– AND 3/16–INCH

S91–41140



S91–41139



OVERVIEW

The 11/32–in. and 3/16–in. sockets are also known respectively as the solar array and high gain antenna sockets. They were specifically designed to support contingencies related to the upper atmosphere research satellite (UARS). The 11/32–in.socket interfaces with the drive shaft input of the solar array hinge. The 3/16–in. socket fits the motor for the high gain antenna retention latch. Each socket features a 3/8–in. drop–proof tether.

OPERATIONAL COMMENTS

Each socket was baselined to be used with the mini power tool, but will work with any power tool or manual ratchet with a male drop–proof tether drive. Unlike normal extravehicular activity sockets, these sockets have a very shallow depth to fit UARS–unique drive mechanisms. A pip pin is used to connect the sockets to and disconnect them from drive tools. They were launched in a middeck locker for STS–48.

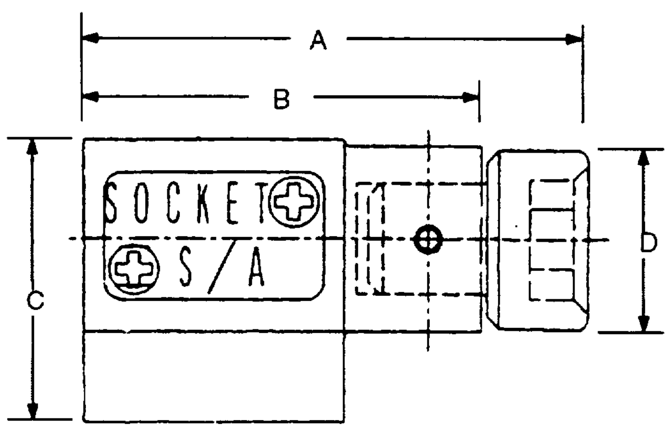
CONTACTS

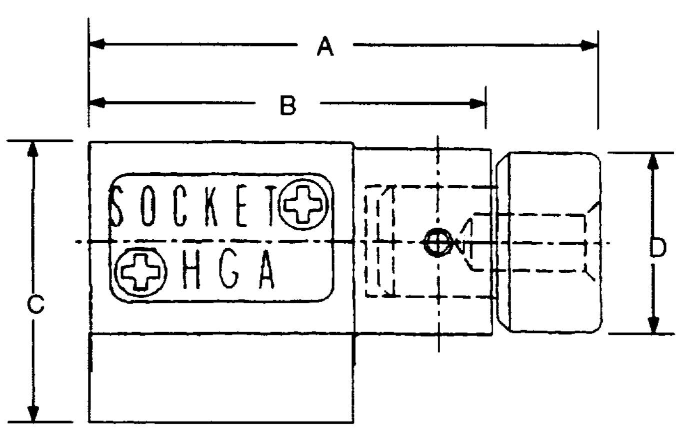
Operational: R. McDaniel, NASA/DF42, (713) 483–2570
Technical: R. Rashford, GSFC, (301) 286–7183

SOCKETS, 11/32– AND 3/16–INCH

Technical Information	
Part number	47–284545–G1 (11/32) 47–284557–G1 (3/16)
Weight	0.28 lb (11/32) 0.29 lb (3/16)
Material/ construction	CRES, aluminum
Load rating	
Temperature range	
Socket depth	0.25 in. (11/32) 0.375 in. (3/16)
Quantity flown	One each for STS–48
Stowage	Middeck locker
Availability	Reference only

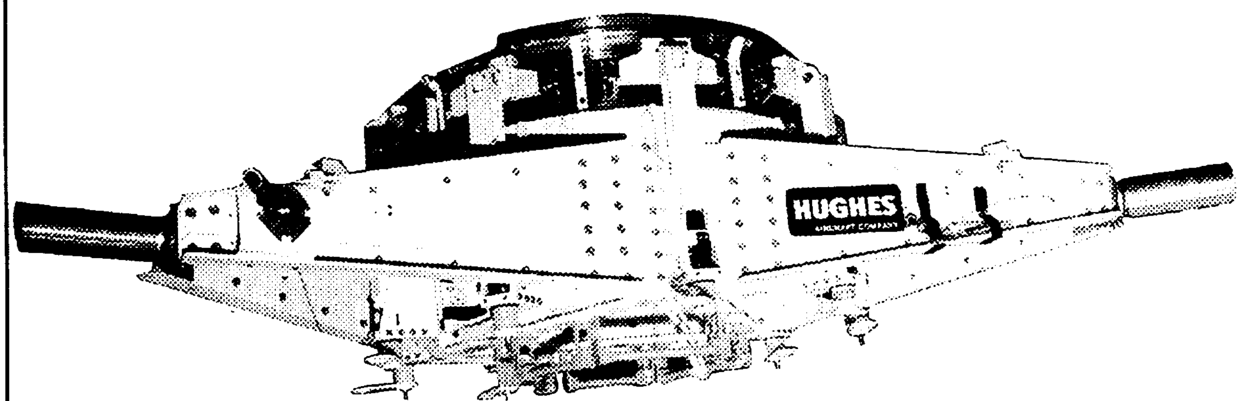
Dimensional Data		
	inches	cm
A	**1.69**	**4.29**
B	1.33	3.38
C	1.01	2.57
D	0.70	1.78





SPACECRAFT ADAPTER

S84–42435



OVERVIEW

The spacecraft adapter structure (SAS), also known as the spacecraft adapter, was designed for the Hughes communication satellite retrieval mission. The structure is latched to the apogee kick motor adapter ring of the Hughes HS376 satellite and then mounted to a Spacelab pallet for reentry. It was used for the Westar VI and Palapa B–2 satellites. Two identical spacecraft adapters exist.

OPERATIONAL COMMENTS

The SAS is released from the Spacelab pallet by opening the payload retention latches, which capture three trunnions equipped with scuff plates. The extravehicular activity (EVA) crewmembers remove the SAS and position it for soft docking with three capture latches. Next, they hard dock the adapter to the satellite by tightening the 7/16–in. drive screws of nine additional latches using the EVA power tool and EVA torque wrench. A grounding strap is attached to the satellite, and it is docked in the cargo bay by using the payload retention latch assemblies. Two EVA crewmembers are recommended for SAS installation. This is a payload–unique device and is not normally flown.

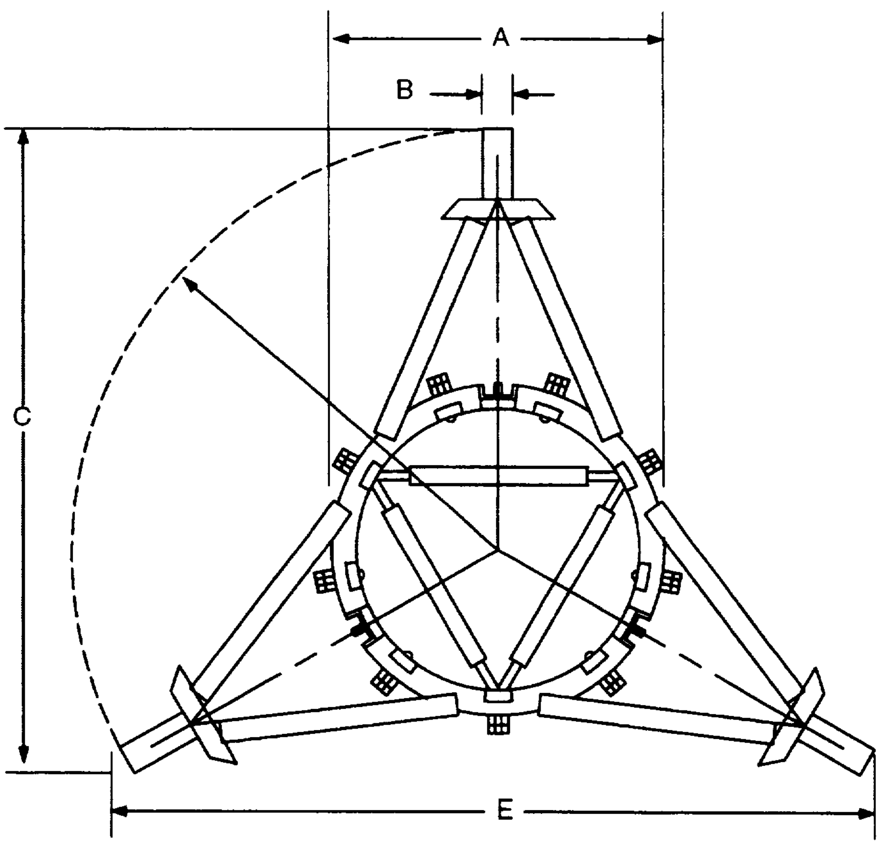
CONTACTS

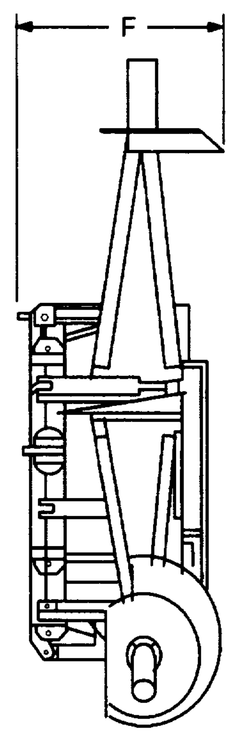
Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: J. Pokras, Hughes Aircraft Co., (213) 648–4291

SPACECRAFT ADAPTER

Technical Information	
Part number	4599883–200
Weight	544.64 lb
Material/ construction	Structure – 7075–T7351 aluminum Surface – Chemglaze A 276 white paint
Load rating	Soft dock – Negligible force Initial installation – 110 in–lb (HI setting on power tool) Final installation – 50 to 60 ft–lb (based on visual indicators)
Temperature range	–40° to 250° F
Quantity flown	**Two for STS 51–A**
Stowage	**Modified Spacelab pallet**
Availability	Reference only

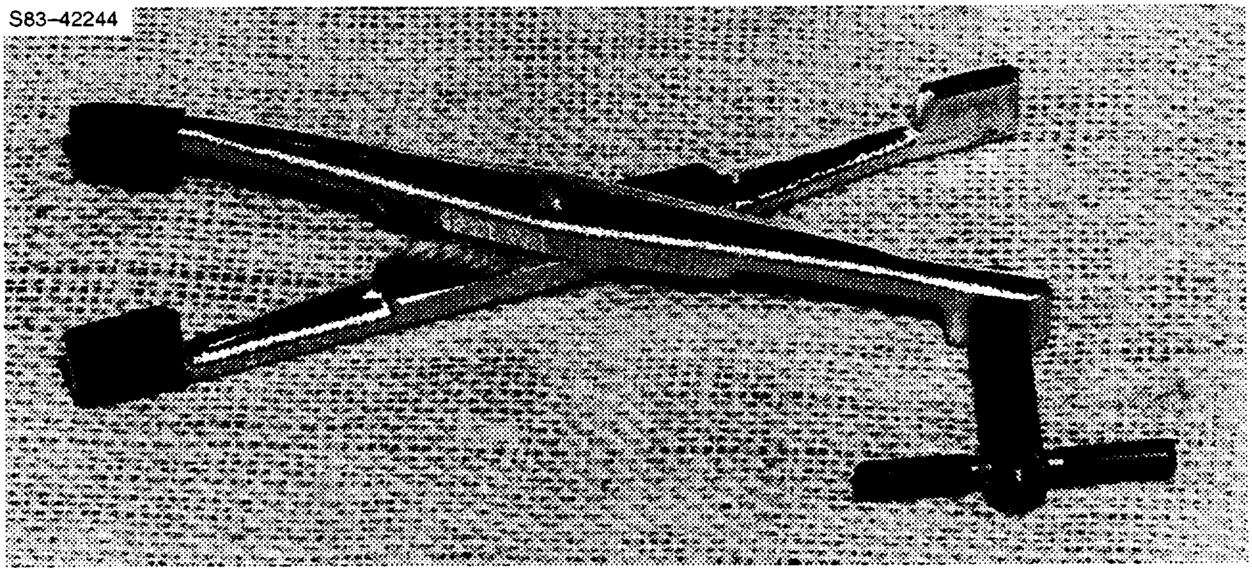
Dimensional Data		
	inches	cm
A	42.0	106.68
B	2.0	5.08
C	81.0	205.74
D	54.0	137.16
E	93.0	236.22
F	26.0	66.04





SPREADER ASSEMBLY

S83–42244



OVERVIEW

The spreader assembly, also known as the extravehicular mobility unit (EMU) waist ring release, was originally designed as a contingency tool for separating the waist ring of the EMU lower torso assembly from that of the hard upper torso. The spreader is now used as a contingency tool to open the type D payload assist module (PAM–D) large sunshield if the sunshield fails to open electrically.

OPERATIONAL COMMENTS

The spreader assembly has rubber tips that are inserted between the two objects that are to be pried apart. Tightening a T–screw in one handle of the scissors–shaped tool against the other handle forces the rubber tips apart and holds them open.

When inserted into the rotary actuator of the large PAM–D sunshield and the intravehicular crewmember display indicates open, the cables can safely be cut and the sunshield opened manually. A tether ring is added to the tool for this use.

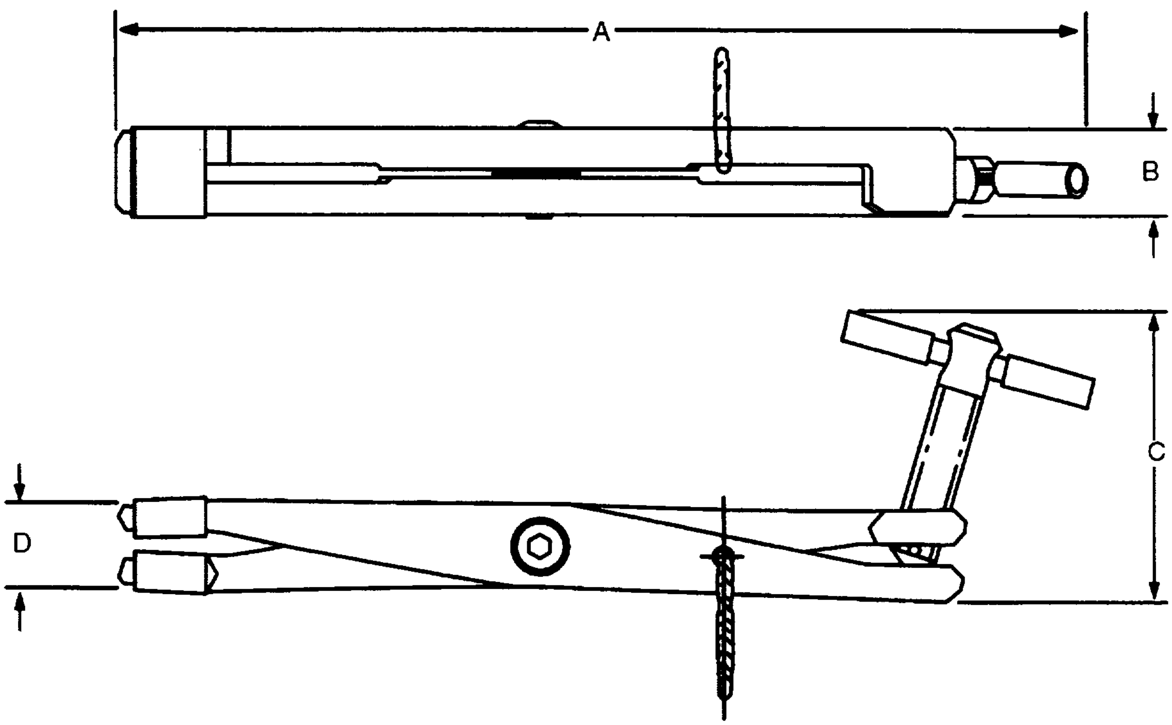
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: R. J. Marak, NASA/EC5, (713) 483–9144

SPREADER ASSEMBLY

Technical Information	
Part number	10108–10021–02
Weight	0.51 lb
Material/ construction	Stainless steel
Load rating	
Temperature range	
Quantity flown	One, as required
Stowage	
Availability	Reference only

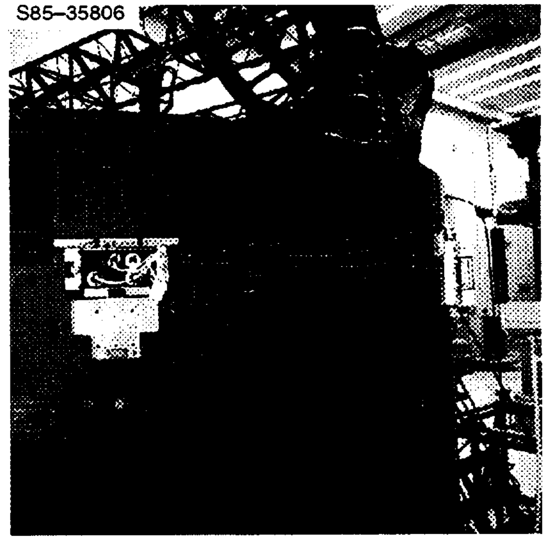
Dimensional Data		
	inches	cm
A	7.69	19.53
B	0.66	1.68
C	2.22	5.64
D	1.35 (max.)	3.43



SPUN BYPASS UNIT

S85–35808

S85–35806



OVERVIEW

The spun bypass unit (SBU) was developed as an extravehicular activity (EVA) crew–installed "hot wire" device to activate several relays and facilitate the remote arm, fire, and stage release of Leasat on STS 51–I. The spacecraft had problems after initial deployment on STS 51–D and required the installation of this device to allow ground commanding for proper operation of the perigee kick motor. One unit was permanently attached to the spacecraft over a test access panel on the solar panel. Two units were flown to ensure mission success. Each had a short EVA handle to aid installation and a bayonet fitting for transport to the worksite. The SBU's were also transported and stored in a flight–unique protective transfer bag during EVA.

OPERATIONAL COMMENTS

The SBU is internally redundant. It received redundant power via a crew–installed wire harness (7 ft long) and electrical connectors mated to spacecraft battery enable plugs. A pair of delayed timers was set to enable the spun relay drive units and the powering of the SBU sequencer logic at 12 and 13 hours, respectively. A continuity verification circuit with green display light was provided to ensure proper mating of a critical harness connector.

Prior to EVA, the crew verified the SBU safety inhibits, performed limited functional testing, and conducted a lamp test of the SBU indicators using a cabin checkout box. This checkout box was basically an enhanced breakout box, consisting of connectors, jumper wire, and tip jacks. It had no active components, electromechanical devices, or indicators. Two units were flown for redundancy. Part of the SBU harness connected to a middeck power outlet; the rest connected to special test ports on each half of the SBU. A standard multimeter was used to check out other SBU functions.

SBU installation involved removing four noncaptive screws and a closeout plate from the spacecraft. Four electrical plugs/caps were removed, a wire harness support fixture was connected, and four connectors were mated to allow SBU checkout before bolting the SBU to a second test access panel. This second panel also had a closeout plate with four noncaptive screws. A single connector was mated here after removing another cap. The first test panel was closed out with a Velcro'ed cover, and the second was closed out by the SBU itself. The last task before activating the timer switches was the removal of the SBU carrying handle to minimize unneeded weight.

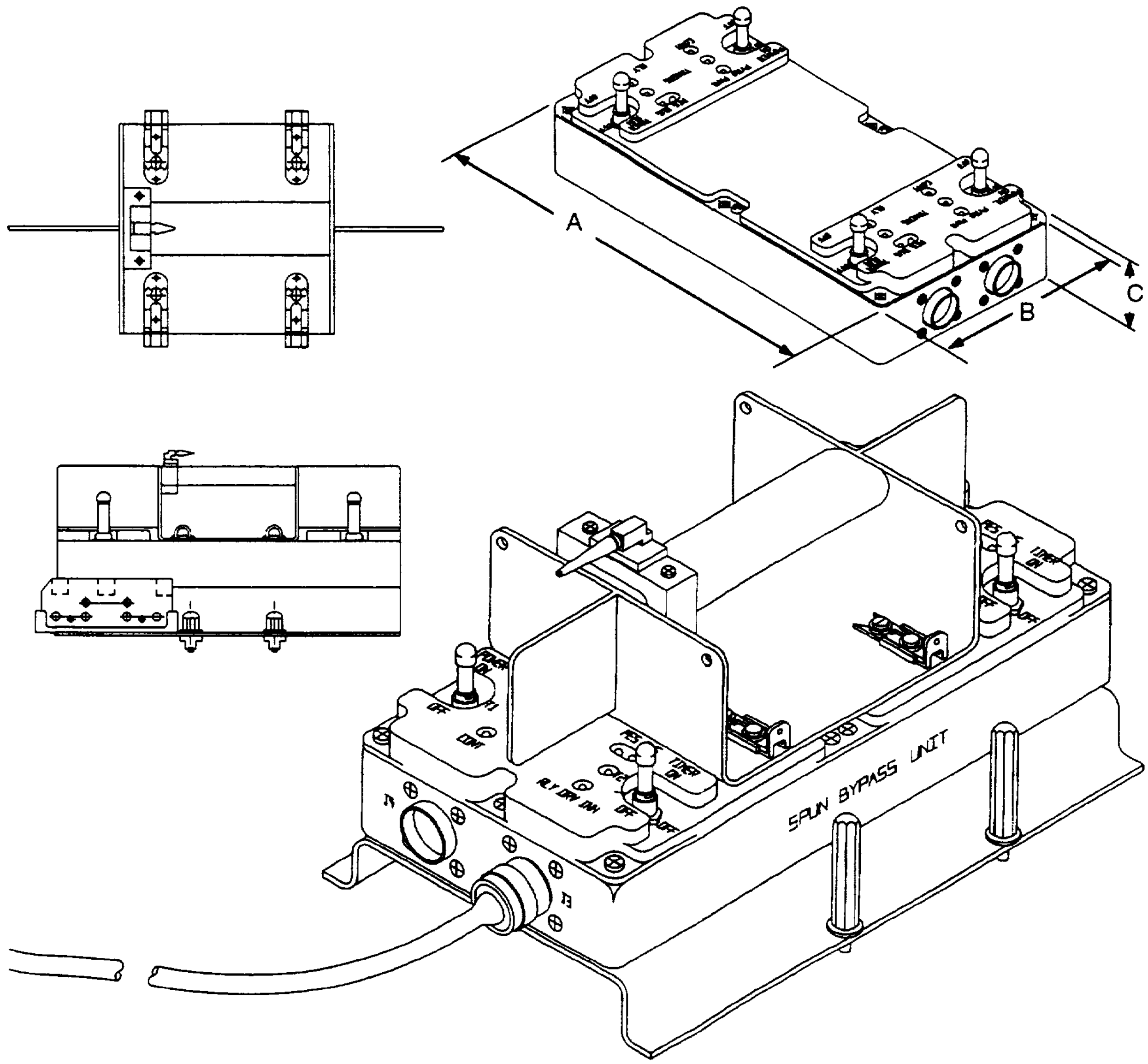
CONTACTS

Operational: R. C. Trevino, NASA JSC/DF42, (713) 483–2597
Technical: **R. Marak, NASA/EC5, (713) 483–9144**

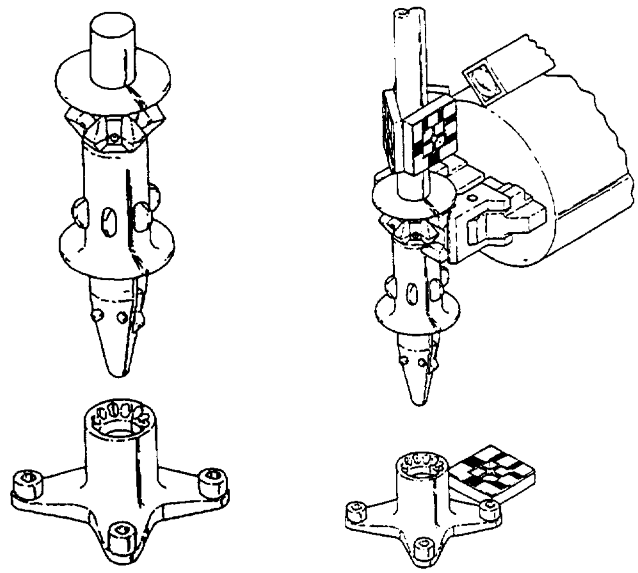
SPUN BYPASS UNIT

Technical Information	
Part number	3649625–100
Weight	12 lb (SBU and wire harness)
Material/ construction	Aluminum housing and handle
Load rating	
Temperature range	–80° to +80° F
Quantity flown	Two on STS 51–I
Stowage	Middeck locker
Availability	Reference only

Dimensional Data		
	inches	cm
A	12.000	30.480
B	6.000	15.240
C	2.330	5.918



SQUID



OVERVIEW

The standard quick release interface device **is referred to as** SQUID. It is a proprietary device developed by Oceaneering Space Systems as a mechanical connector that is both extravehicular activity (EVA) and robotic compatible. It was originally intended as an alternative to **the** robotically incompatible pip pin lock of the standard portable foot restraint (PFR). Gross and fine installation alignment are provided using a pin and cone guidance concept. A soft dock feature holds the two halves together while hard dock is actuated. Rotation of the connection after soft dock and before hard dock is not currently available to simplify attached component reorientation. This fastener has been proposed as a mechanical attachment for the PFR, external lights/cameras, loose tools, or the temporary restraint of on-orbit replaceable units. The SQUID concept should help minimize the overhead and fatigue associated with EVA reconfiguration of loose equipment.

OPERATIONAL COMMENTS

SQUID consists of a passive socket and an engaging probe with lockable detents and a sleeve actuator. The sleeve slides between the locked and unlocked positions. During soft dock, splines on the probe align with slots inside the conical socket before the latching detent pins engage. After soft dock, the sleeve slides 1 in. toward the socket to achieve hard dock. Markings are provided to assist with these various actions. Separate gripping surfaces are provided for the EVA crew and robotic end effectors with parallel gripper jaws. A lock to prevent inadvertent release **(that is also robot compatible)** is still being developed. Early lock concepts required an extra rotation of the sleeve through a J-shaped motion. A contingency release feature is provided to separate the probe from its receptacle.

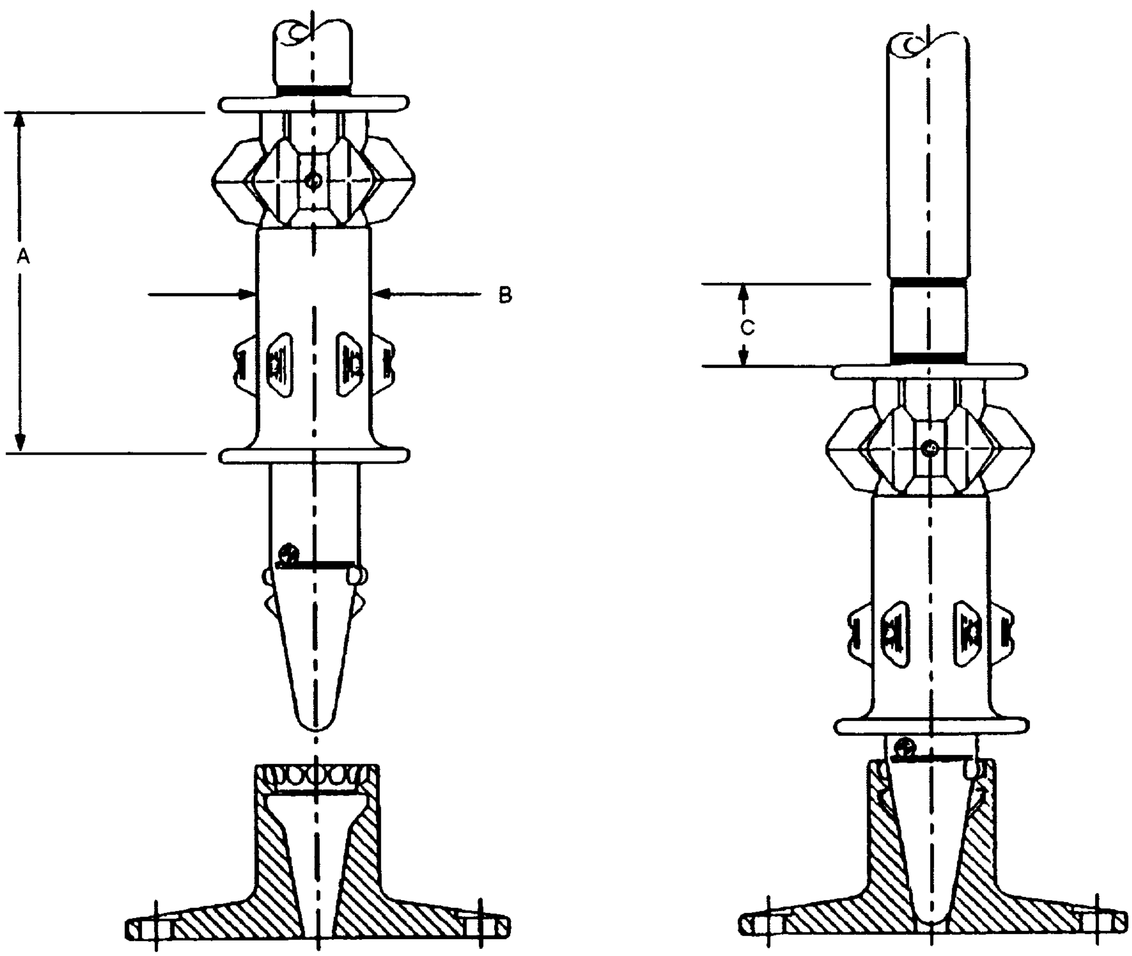
CONTACTS

Operational: R. Trevino, NASA/DF42, (713) 483-2597
Technical: R. Marak, NASA/EC5, (713) 483-9144

SQUID

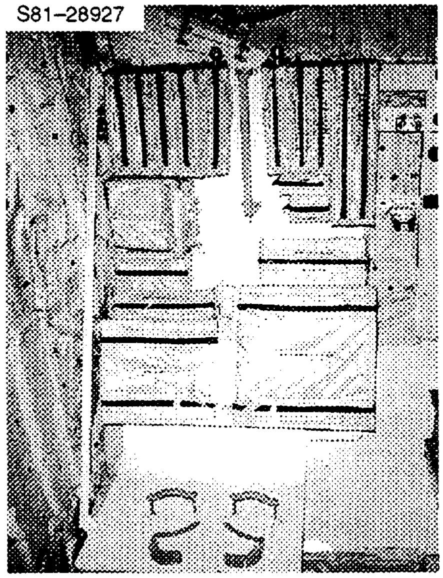
Technical Information	
Part number	
Weight	
Material/ construction	Aluminum, stainless steel
Load rating	5–lb soft dock 585–lb pullout ± 0.75–in. linear misalignment tolerance ± 30° rotational misalignment tolerance
Temperature range	
Quantity flown	
Stowage	
Articulation	12 positions, 30° apart for socket/probe
Availability	Developmental

Dimensional Data		
	inches	cm
A	4.5	11.43
B	1.50	3.81
C	1.0	2.54



STOWAGE ASSEMBLY, MODULAR EQUIPMENT

S81–28927



OVERVIEW

The modular equipment stowage assembly (MESA) is a tool stowage pallet with a dedicated foot restraint that was mounted in the orbiter payload bay on early shuttle missions. It attached to the starboard sill longeron in bay 1. On the first few shuttle flights, the orbiter contingency tools were flown on this pallet in fabric tool bags with internal foam cushions. The bottom of the plate was curved inboard to provide a mounting surface for a foot restraint platform. All the tool bags (20 total) were permanently attached and had zippers to provide access to the tools.

OPERATIONAL COMMENTS

This hardware is no longer available for use on the shuttle, as it was configured only for the early flights to hold tools for payload bay door, radiator, and airlock hatch contingencies. For a while the cargo bay stowage assembly (CBSA) took its place, but now the provisions stowage assembly is flown. The MESA has since been reconfigured for use on STS–37 as the crew loads instrumented pallet. It had extensive structural modifications for this application to make it meet the latest launch loads requirements. The zippers of the tool bags on this pallet were difficult to operate and are no longer recommended for nominal extravehicular activity tool applications.

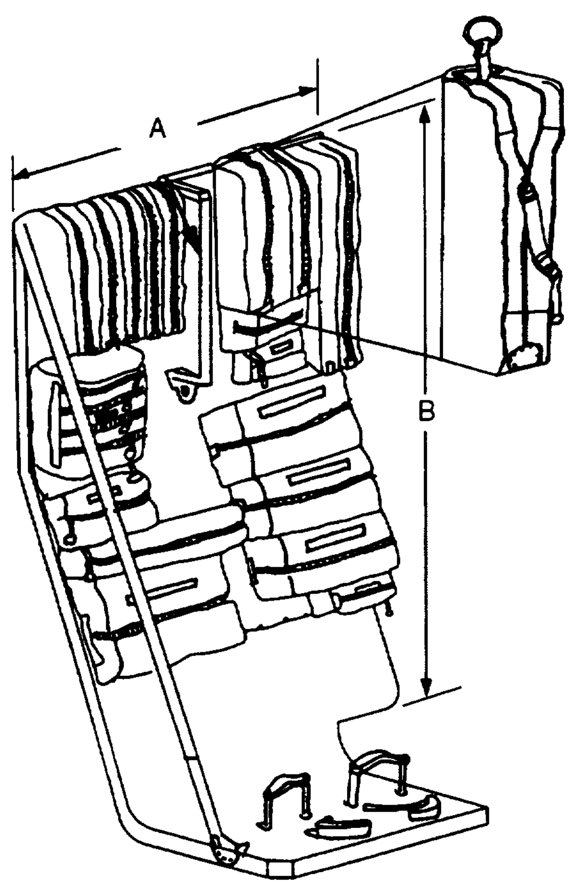
CONTACTS

Operational: B. Adams, JSC DF42, (713) 483–2567
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

STOWAGE ASSEMBLY, MODULAR EQUIPMENT

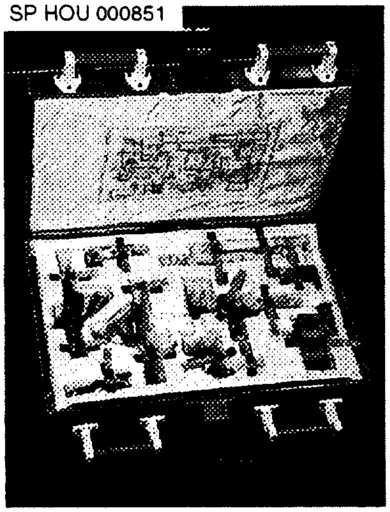
Technical Information	
Part number	V638–650090
Weight	
Material/ construction	Aluminum
Load rating	
Temperature range	
Quantity flown	One
Stowage	Payload bay sill longeron
Availability	Reference only

Dimensional Data		
	inches	cm
A	40.8	103.6
B	58.2	147.8



STOWAGE BOX, NODE

SP HOU 000851



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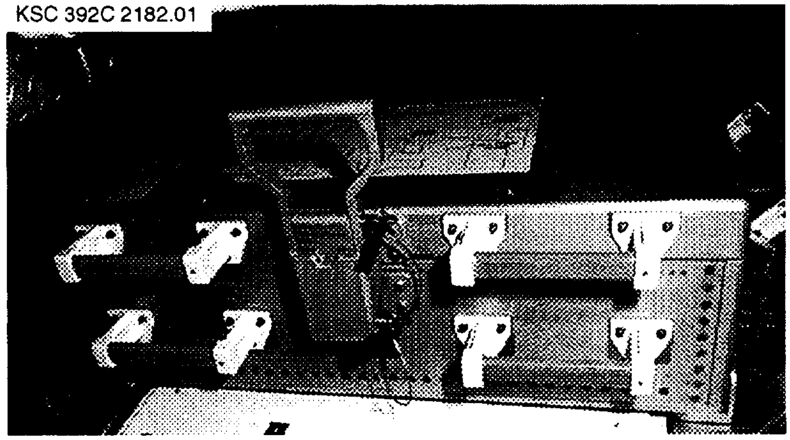


OVERVIEW

The node boxes (also known as node dispensers) were used on STS–49 as part of the assembly of station by extravehicular activity (EVA) methods (ASEM) to store numerous flight–unique components. A pair of boxes were mounted on the top of the ASEM carrier. Each node box contained cushions to protect and support the hardware stowed inside. Velcro straps helped retain each item in the cushion.

The division of contents between each box was determined by proximity to **the** nearest worksite. The port node box contained two port **Y**–fittings, two port truss nodes, two modified 55–ft safety tethers, a **portable foot restraint (PFR)** strut clamp, and a pair of truss joint spanner wrenches and spare pip pins in tool caddies. The starboard box held three starboard nodes and two starboard **Y**–fittings.

OPERATIONAL COMMENTS

Each node dispenser has a hinge on the port side of the box. The lid of the port box was hinged to open outboard for the least interference with ongoing EVA tasks while it is left open. The starboard box had to be hinged near the carrier centerline to support EVA mass handling. A cam–actuated latch, identical to the latch on the strut and leg dispenser bulkheads, secured the node box lids during launch and landing. Two double–acting pip pins secured the latch. A lid stop prevents the lid from opening past the 90° position and includes a Velcro patch to restrain the lid in the open position. The lid was designed with two pry bar notches to provide for contingency opening of the lid.

Decals attached on top of and underneath the lid of each box guided the EVA crew in removal and restowage operations. The node dispensers are vented for launch and landing with cutouts in the cushions and vent holes on the sides of the dispensers.

Each node box has four short handrails located on the latch side, two on the lid and two on the base. A one–piece handrail is located on the hinge side. Noncaptive EVA releasable bolts attached the node dispensers to the carrier to permit jettison if the box could not be resecured for landing.

In the future, all lidded EVA boxes need stable mechanical hinge joints **that** are undisturbed by orbiter jet firings. The Velcro lid holder was inadequate. All Velcro closure straps should open inward **inside** tool boxes so that they do not interfere with box lid closure.

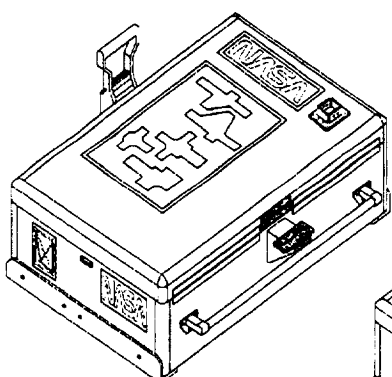
CONTACTS

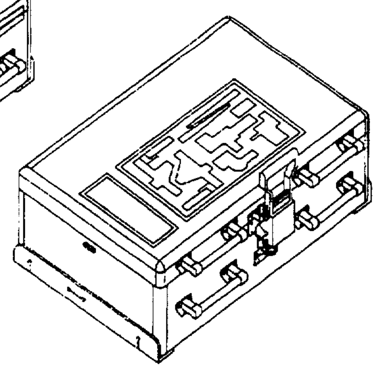
Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. Schwarz, NASA/EC5, (713) 483–2378

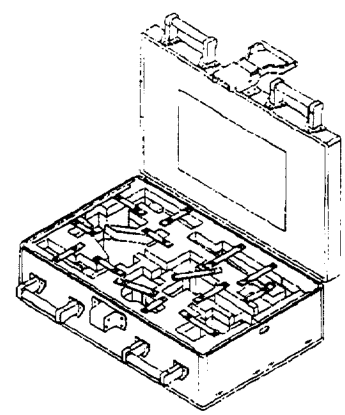
STOWAGE BOX, NODE

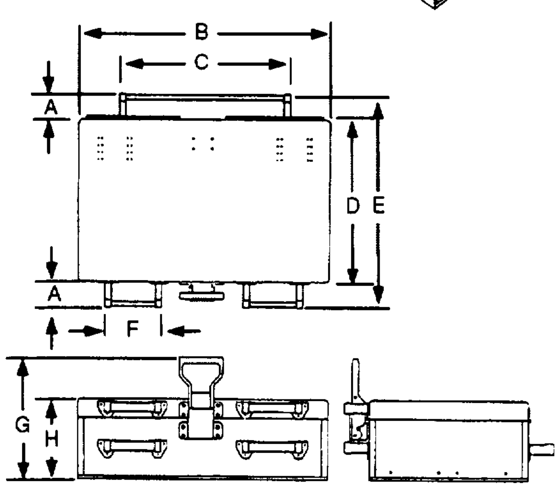
Technical Information	
Part number	1F09502 (port), 1F09540 (stbd) 56777 (pip pins)
Weight	460 lb (combined)
Material/ construction	Aluminum Beta–cloth–covered solimide foam cushions Nomex straps, Molycote pip pin lube
Load rating	187–lb handrails/standoffs 20–lb hold open lid Velcro 25–lb latch actuation
Temperature range	–150° to +160° F (stowage) –30° to +120° F (operational)
Quantity flown	Two on STS–49
Stowage	ASEM carrier in payload bay
Availability	Reference only

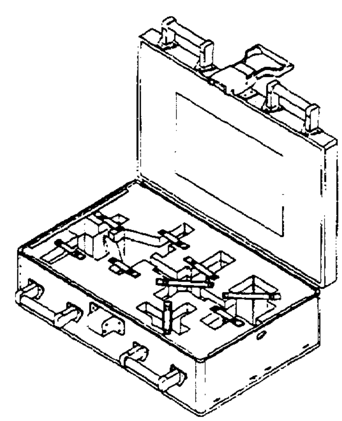
Dimensional Data		
	inches	cm
A	4.1	10.41
B	39.5	100.33
C	21.47	54.53
D	25.5	67.77
E	33.7	85.60
F	9.0	22.86
G	19.16	48.67
H	12.5	31.75





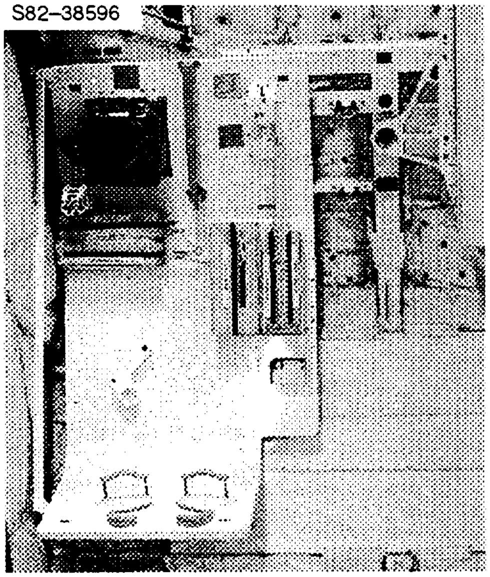




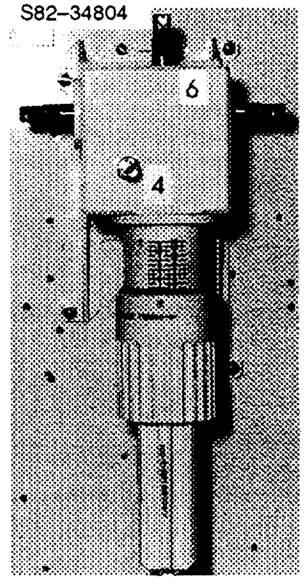


TASK SIMULATOR DEVICE

S82–38596



S82–34804



OVERVIEW

The task simulator device (TSD) was flown on STS–5 as an interface for several orbiter and payload tools/tasks to demonstrate on–orbit shuttle extravehicular activity (EVA) capability. The 7/16–in. hex studs on a pair of torque resistance units allowed the measurement of ratchet wrench force and torque. The adjustable torque unit could be set to resist a range of loads as applied via a torque recorder. Interfaces were also provided for attaching the payload bay door three–point latch tool, forward bulkhead winch **hook,** and payload retention device. An electronic box replacement simulator for the **STS 41–C** Solar Max repair mission was also provided. No data were returned from these devices because the EVA was terminated by suit problems.

OPERATIONAL COMMENTS

For STS–5, this task simulator was mounted in the payload bay on the vertical face of a modified tool stowage pallet. This pallet was a derivative of the modular equipment stowage assembly (MESA) that has since been used as the crew loads instrumented pallet (CLIP) on STS–37. The pallet had a dedicated foot restraint, vertically oriented handrails to aid foot restraint ingress, **and** was attached to the starboard sill longeron in bay 1.

The adjustable torque resistance unit provides a constant drive shaft torque and, therefore, does not accurately represent the variations between breakaway and running torques. Friction clutch disks inside the housing provide the constant torque and are adjusted by rotating the lower spindle relative to a scale marked 0 to 10. The input drive shafts of the fixed and adjustable torque units use **7/16–in.** hex studs and are oriented 90° apart for different drive tool orientations relative to the crewmember. Torque measurements were to have been taken while free floating (handrail restraint only) and while in the foot restraint.

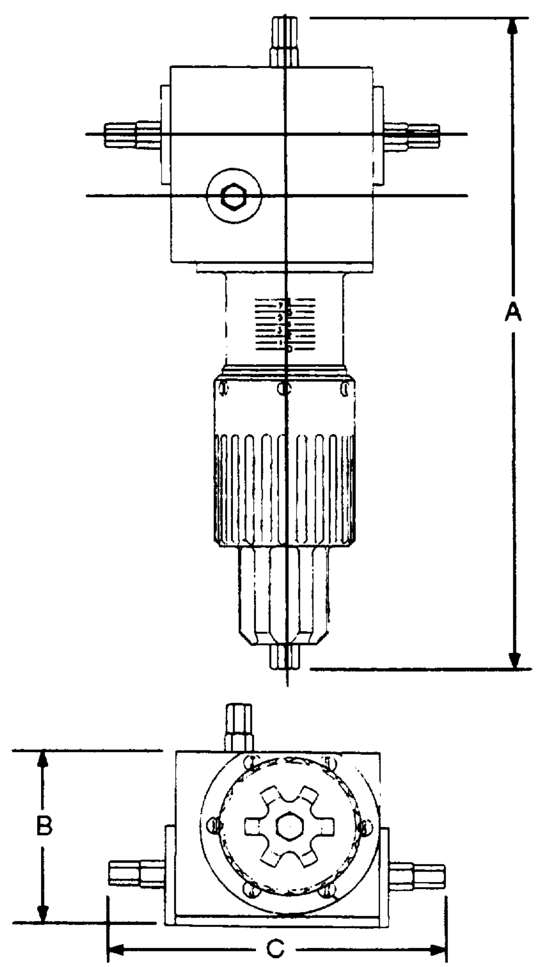
CONTACTS

Operational: B. Adams, JSC/DF42, (713) 483–2567
Technical: R. Marak, NASA/EC5, (713) 483–9144

TASK SIMULATOR DEVICE

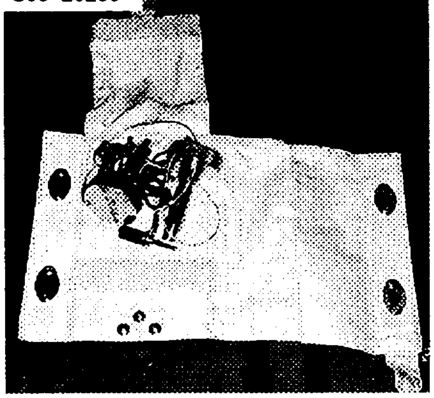
Technical Information	
Part number	SED33102680 (task simulation device) SDD39115351 (adjustable torque resistance unit) SDD39115360 (fixed torque resistance unit)
Weight	
Material/ construction	Aluminum, stainless
Load rating	0 **to** 400 in–lb (operational loads of adjustable torque unit) 1500 in–lb (proof load for fixed torque unit) 1000 in–lb (operating load for fixed torque unit)
Temperature range	
Quantity flown	One on STS–5
Stowage	Payload bay
Availability	Referency only

Dimensional Data		
	inches	cm
A	**15.3**	**39.06**
B	**3.5**	**8.9**
C	**7.5**	**19.1**

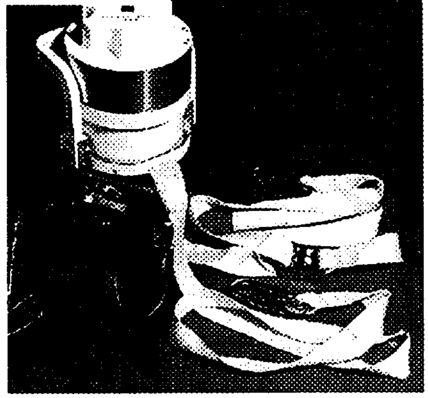


TORQUE MULTIPLIER

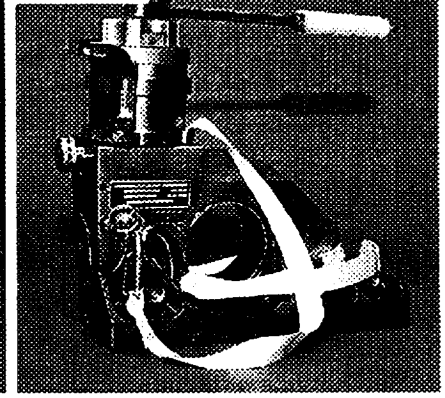
S93–29255



S89–25584



S87–49131



OVERVIEW

The torque multiplier, reaction arm, and latch pin caddy have been developed to be used with the large cable cutter for jettison of a payload that cannot be stowed or secured for reentry. These items are collectively known as the payload jettison hardware.

The torque multiplier is a planetary gear system with a 3/8–in. square drive input and a **1–1/16 in. 12–point socket** output matching the bolts on the payload bay passive latches. The reaction arm aligns the torque multiplier with the passive latch bolt and carries the torque while the bolt is being loosened. The latch pins are used to affix the movable passive latches to their respective mounting points for shuttle reentry when a payload has been jettisoned. All of these items are stowed in the port provisions stowage assembly (PSA).

OPERATIONAL COMMENTS

The knob on the torque multiplier supplies a 3/8–in. square drive input, a sculptured profile for manual operation, and a ratchet mechanism to limit backdrive within the planetary gear train. The **color–coded** ratchet mechanism works only in the loosening mode **(green)**, but the mechanism can be disengaged for free motion in both directions **(red)**. The torque multiplier interfaces with the reaction arm through a set of splines. A captive T–handled knob with a Delrin swivel pad on its end affixes the two together for use. **This knob has a 3/8–in. square drive input for contingency release. The cam–actuated separation lever can be pulled to free the torque multiplier from the reaction fitting.**

Two pin types are stowed in the caddy. One pin, a large shoulder pin with a knurled head, mates with a hole in the passive latch to hold the latch in place; the other, smaller pin threads into a hole and holds the first pin in place.

This version of the shuttle torque multiplier and reaction fitting has been replaced by a simpler one–piece unit.

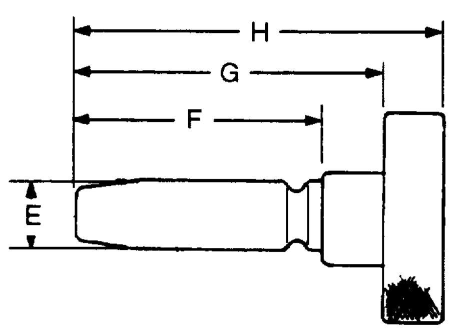
CONTACTS

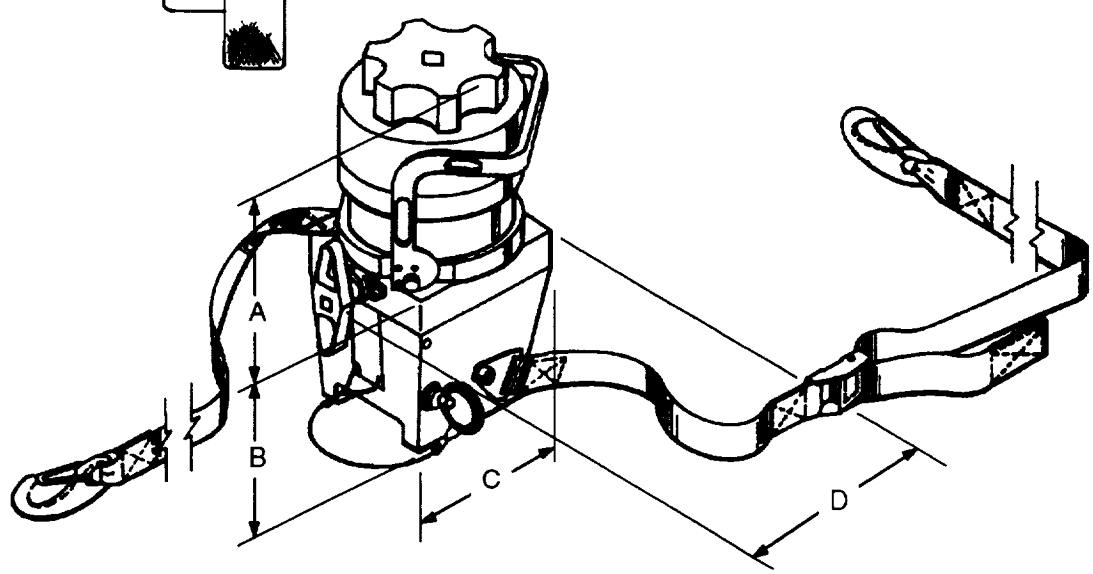
Operational: S. Rainwater, NASA/DF42, (713) 483–1755
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

TORQUE MULTIPLIER

Technical Information	
Part number	10159–10057–01 (payload jettisoning hardware) 10159–20250–01 (torque multiplier) 10159–20260–01 (reaction arm) **SED33104302–301 (latch pin caddy)**
Weight	12.5 lb (torque multiplier), 9.5 lb (reaction fitting)
Material/ construction	Torque multiplier and reaction arm – Stainless steel Latch pin caddy pins – Ortho fabric, stainless steel
Load rating	**Passive latch break out torque 660–707 ft–lb** **Torque ratio 16:1** **Turn ratio 32:1** **Input torque (nominal) 42–45 ft–lb with 15–in. ratchet** **Output torque (max.) 1200 ft–lb (± 5 percent)**
Temperature range	–200° to +250°F (operational), **+ 350° F (stowage)**
Quantity flown	**One**
Stowage	Port PSA
Availability	**Reference only**

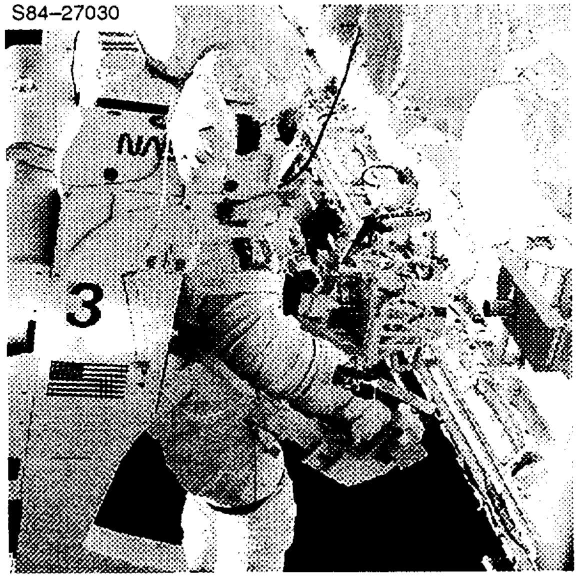
Dimensional Data		
	inches	cm
A	4.880	12.40
B	4.380	11.13
C	3.500	8.89
D	5.380	13.67
E	0.555	1.41
F	2.000	5.08
G	2.500	6.35
H	3.010	7.65





TRUNNION PIN ATTACHMENT DEVICE

S84–27030



OVERVIEW

The trunnion pin attachment device (TPAD), mounted on the manned maneuvering unit (MMU), is used to capture and stabilize a multimission–modular–spacecraft–type satellite. It can also be used to attach a grapple fixture to a satellite for connection to the remote manipulator system (RMS).

OPERATIONAL COMMENTS

The TPAD consists of three parts: the control assembly, the primary assembly, and the secondary assembly. All are attached to the MMU by two brackets held by pip pins. The control assembly provides jaw action and locking control and allows the primary assembly to be detached from the control assembly. The primary assembly attaches the crewmember and MMU to the TPAD satellite for stabilization. A secondary TPAD assembly may be rotated up to take the place of the primary TPAD assembly in case of a primary TPAD failure.

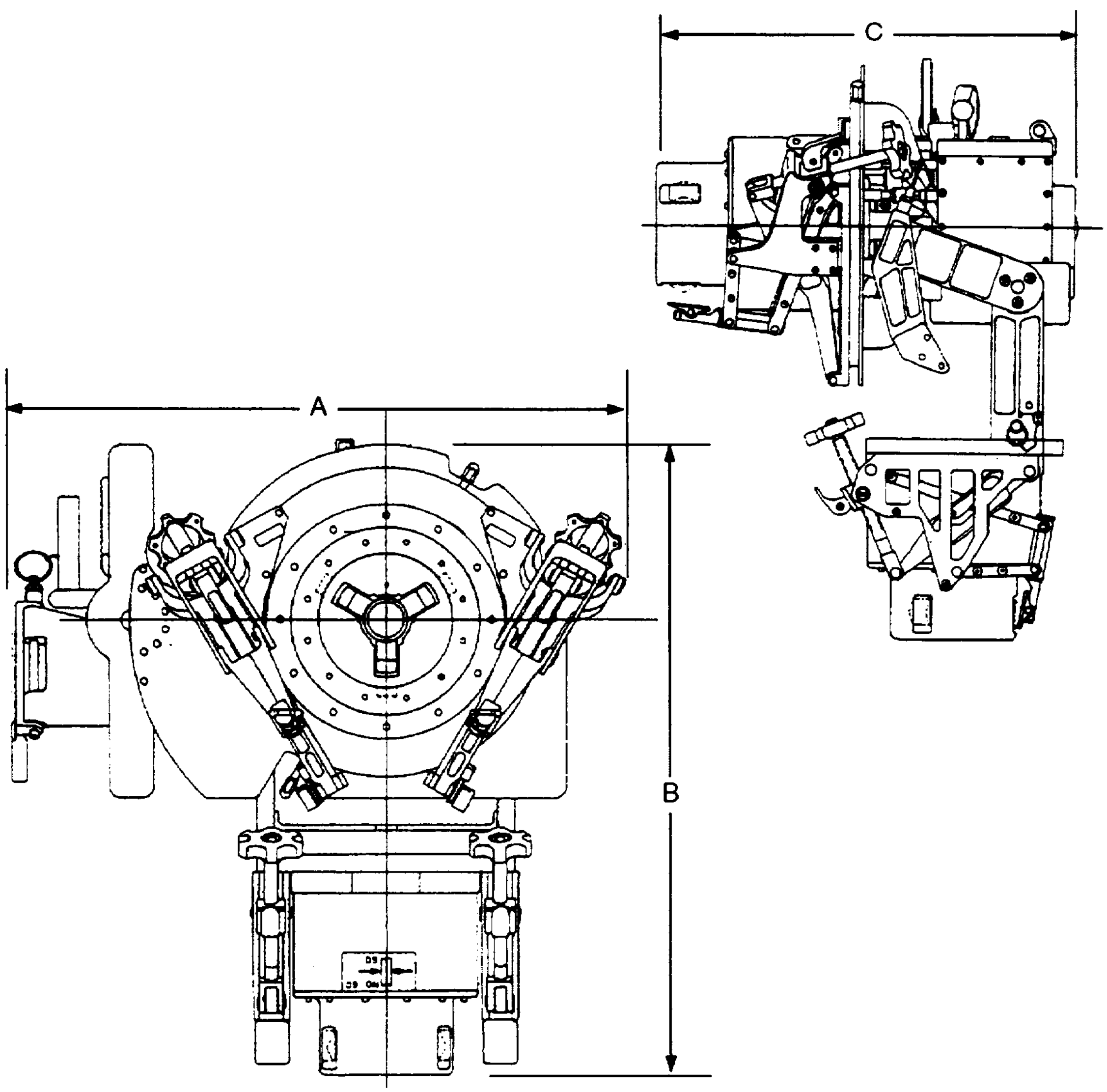
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: R. Marak, NASA/EC5, (713) 483–9144

TRUNNION PIN ATTACHMENT DEVICE

Technical Information	
Part number	10169–10069–01
Weight	106.5 lb
Material/ construction	Aluminum, stainless steel
Load rating	
Temperature range	
Quantity flown	One for STS 41–B and STS 41–C
Stowage	Flight support system locker and special equipment stowage assembly
Availability	Reference only

Dimensional Data		
	inches	cm
A	27.22	69.14
B	28.48	72.34
C	20.78	52.78



WELDER, EVA

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OVERVIEW

The joining of spacecraft structure has typically used mechanical fasteners, adhesives, brazing, and welding. Extravehicular activity (EVA) welding has been proposed as a faster, more reliable means of joining metals in vacuum and under varying thermal conditions. Currently, it is being proposed as a repair technique for sealed fluid/gas lines and to eliminate heavy, unreliable quick disconnects, but may have applications for on–orbit pressure vessels and structural members. It is possible to use the same technology for cutting metal in repair operations. Various organizations have experimented with electron beam welding, gas tungsten arc welding, laser welding, and plasma arc welding. Besides EVA crew operation, robotic use is also anticipated. On–orbit weld inspection is being addressed to ensure quality control. Varying degrees of surface preparation are required for each welding technology.

OPERATIONAL COMMENTS

Most of the proposed electron beam welding units are small, lightweight, battery powered, and have no moving parts. They involve little or no special surface preparation and produce spatter–free welds in just a few minutes. Nondestructive inspection by computer–automated X–ray radiography is anticipated.

Electron beam welding device has been used since 1984 on the Soyuz space station and now on the Mir space station. The latest device was designed by the E. O. Paton Electric Welding Institute in the Ukraine Republic. There has been discussion between the U.S.A. and the Russians concerning a future joint on–orbit welding demonstration.

The electron beam welder being developed in England by Babcock Energy Ltd and The Welding Institute is battery powered and portable. It forms butt or lap welds by bending the beam and focusing it onto the target seam via a computer–controlled electromagnetic deflection field. It has a patented secondary electron beam that scatters X–rays inside welded tubes for on–site computerized inspection. This welder is affixed to tubes with a clamshell, after which the settings are chosen (manually or preprogrammed) for depth, power, tube size, and beam duration. An expert system tracks and inspects the weld seam, with annunciation of positive or negative results. The hands–off weld/inspection process can take 1 to 5 minutes.

NASA involvement in orbital welding technology includes a Skylab experiment in 1972 and sponsorship of university and industry demonstrations with the OAST INSTEP and PATHFINDER programs since 1987. Although neither the Space Shuttle Program nor the Space Station Program has a specific requirement for this technology, welding units continue to be investigated for long range applications like planetary exploration.

CONTACTS

Technical: (English electron beam welder) Martin Peters, Babcock Energy Ltd, London, England, 011–44–1–232–4907
Dr. Alan Sanderson, The Welding Institute, Cambridge, England, 011–44–223–891162
Michael Drews, Automation & Robotics Research Inst., Forth Worth, TX (817) 284–6101
Technical: (Ukrainian electron beam welder) Alexander Zagrebelniz, Paton Electric Welding Institute, Kiev, Ukraine, 227–60–16
Technical: (McDonnell Douglas electron beam welder) Ray Anderson, McDonnell Douglas Aerospace, Huntington Beach, CA (714) 896–9866
Technical: (Rocketdyne gas tungsten arc welder) unknown

WELDER, EVA

Technical Information	
Part number	
Weight	
Material/ construction	
Load rating	
Temperature range	
Quantity flown	
Stowage	
Availability	Developmental

Dimensional Data		
	inches	cm
A		
B		
C		
D		
E		
F		
G		
H		

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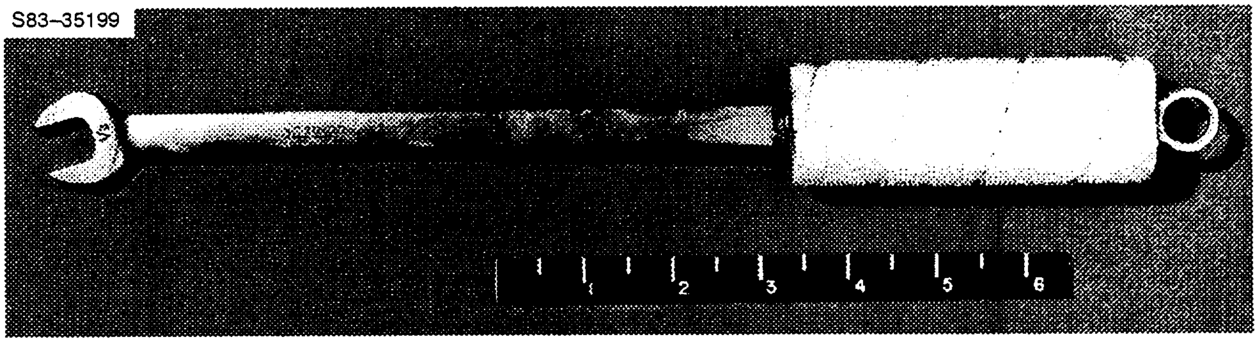
WRENCH, 1/2–INCH OPEN END

S83–35199



OVERVIEW

The 1/2–in. open end wrench is a common tool modified for **contingency** extravehicular activity (EVA) use. The handle is built up and wrapped with Velcro to provide easy gripping by the gloved hand. A tether ring is mounted on the end of the handle for tethering.

OPERATIONAL COMMENTS

The 1/2–in. open end wrench is used to disconnect EVA bolts with a 1/2–in. hex or square head. The wrench is not part of the normally manifested **orbiter** equipment. **Because it is difficult to keep the wrench on the bolts during use, it is not an acceptable design except for infrequent contingency use.**

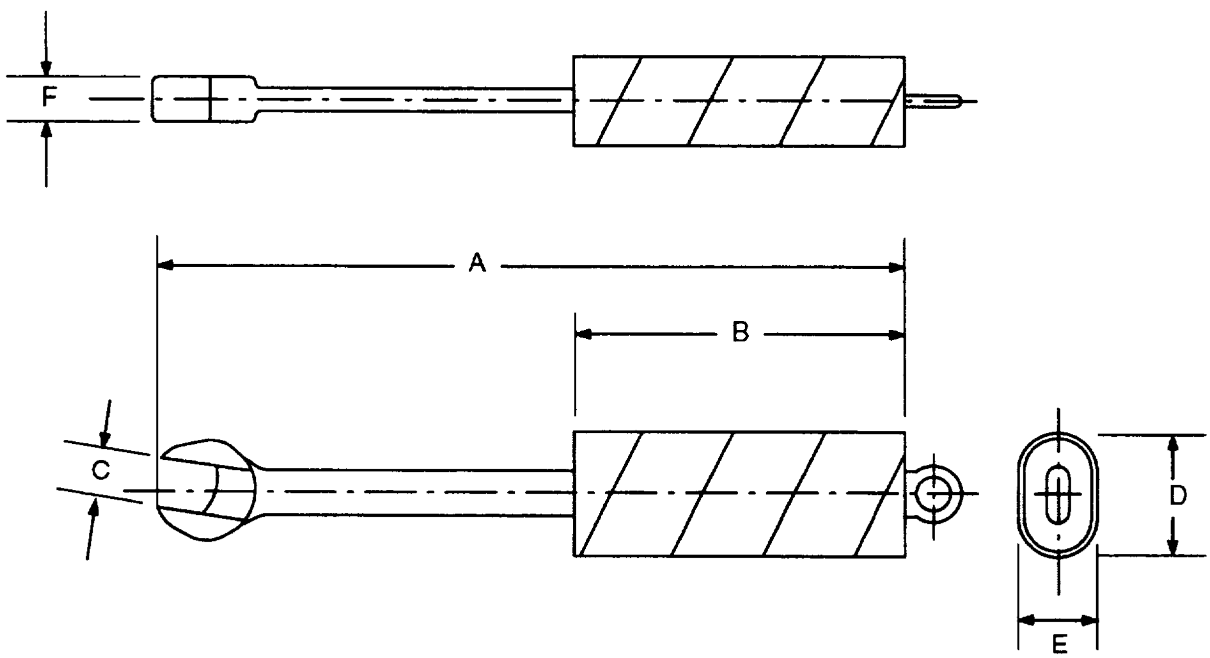
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

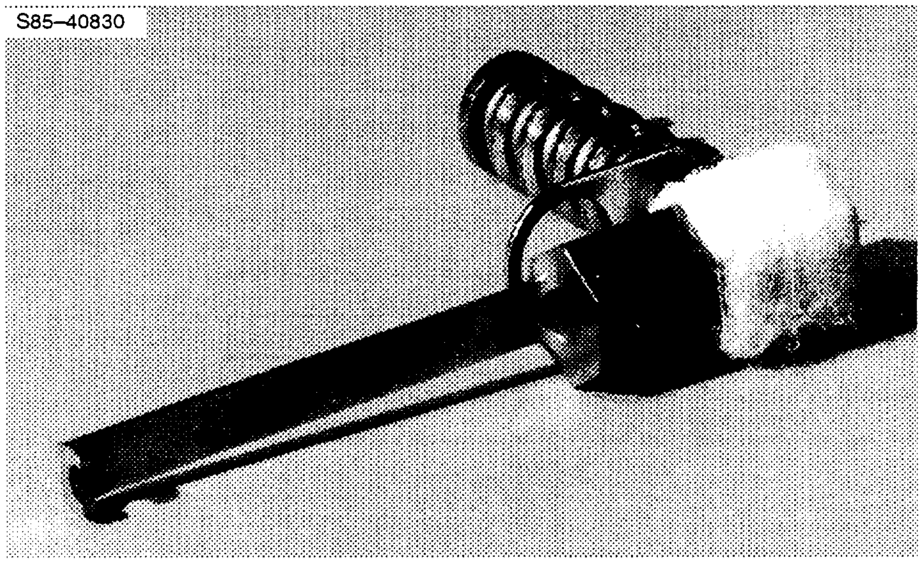
WRENCH, 1/2–INCH OPEN END

Technical Information	
Part number	**V628–650925–005**
Weight	**0.99** lb
Material/ construction	Wrench – AISI 4063 tool steel Wrench extension – AISI 4130 tool steel Handle – polyurethane, Velcro–wrapped, and tether ring
Load rating	**30–lb input**
Temperature range	**–200° to +250° F (operational), +350° F (stowage)**
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	9.00	22.86
B	4.00	10.16
C	0.50	1.27
D	1.25	3.18
E	0.75	1.91
F	0.25	0.64



WRENCH, 1/4-INCH CROW'S FOOT



OVERVIEW

The 1/4–in. crow's foot wrench is a 1/4–in. open–ended hexagonal wrench designed specifically for use during the Solar Maximum Satellite (Solar Max) Repair Mission. A ring is attached to the handle for tethering during extravehicular activity (EVA). Hook Velcro is attached to the upper barrel of the crow's foot wrench to facilitate stowage in a tool caddy.

OPERATIONAL COMMENTS

During the Solar Max Mission, the wrench was used to aid in disassembly of **an EVA incompatible** subminiature D–connector by preventing the movement of a hexagonal standoff post. This tool was developed specifically for use with the shrouded screwdriver extension for Solar Max. The shrouded screwdriver is inserted into the hollow support for the crow's foot, and can be used to tighten or loosen a screw captured by a 1/4–in. nut.

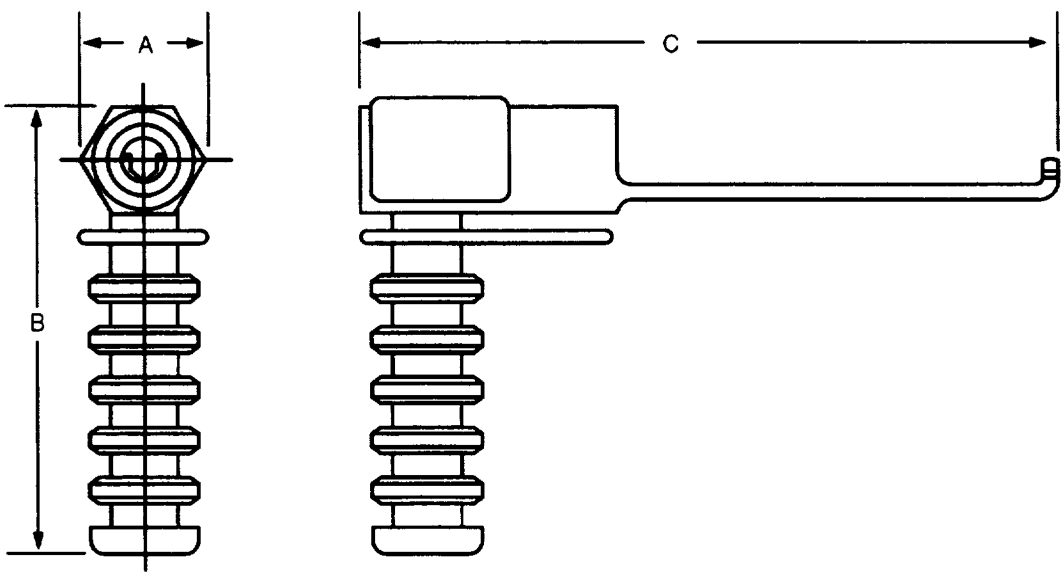
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. J. Marak**, NASA/EC**5**, (713) 483–**9144**

WRENCH, 1/4–INCH CROW'S FOOT

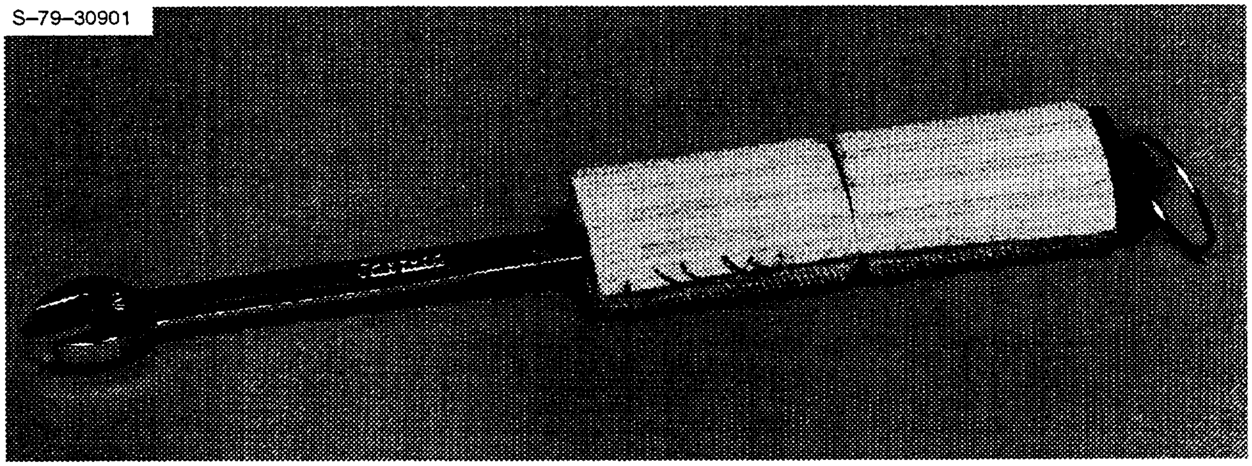
Technical Information	
Part number	SED–33103147–301
Weight	0.40 lb
Material/ construction	Handle – Stainless steel Wrench – Ketos Velcro – Hook
Load rating	
Temperature range	–150° to +280° F **(operational)**
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	0.87	2.21
B	3.25	8.26
C	5.00	12.70



WRENCH, 7/16–INCH OPEN END

S–79–30901



OVERVIEW

The 7/16–in. open end wrench is a common tool modified for **contingency** extravehicular activity (EVA) use. The handle is built up and wrapped with Velcro to provide easy gripping by the gloved hand. A tether ring is mounted on the end of the handle for tethering.

OPERATIONAL COMMENTS

The 7/16–in. open end wrench is a disconnect tool for EVA bolts with a 7/16–in. hex or square head. This tool is no longer part of the normally manifested EVA hardware because other 7/16–in. disconnect tools exist that are easier to operate. **This is not an acceptable EVA design because it is difficult to keep the tool on bolt heads during use.**

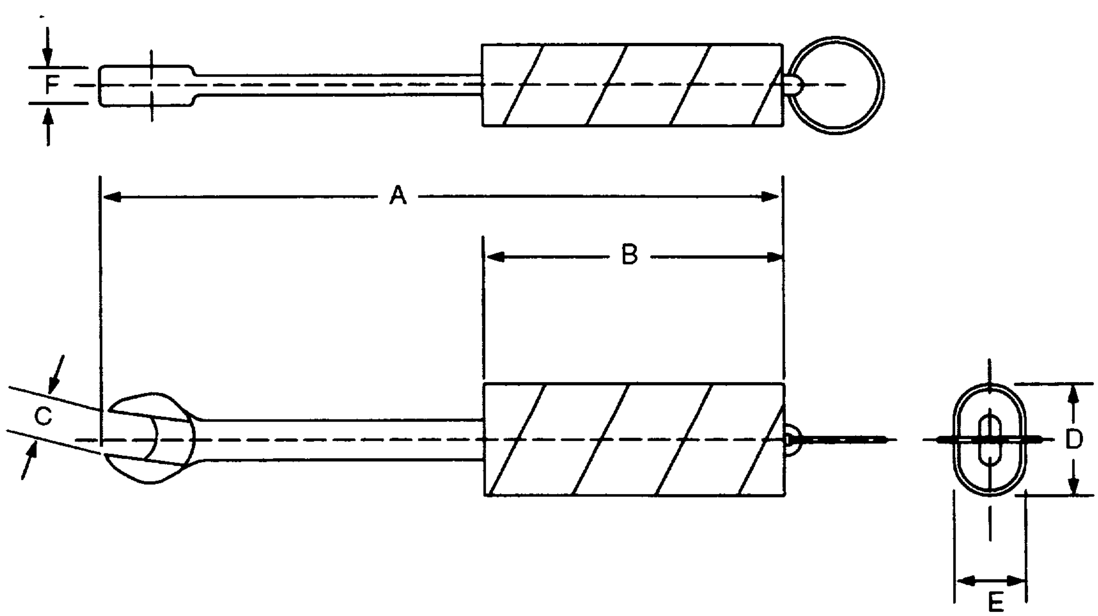
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

WRENCH, 7/16–INCH OPEN END

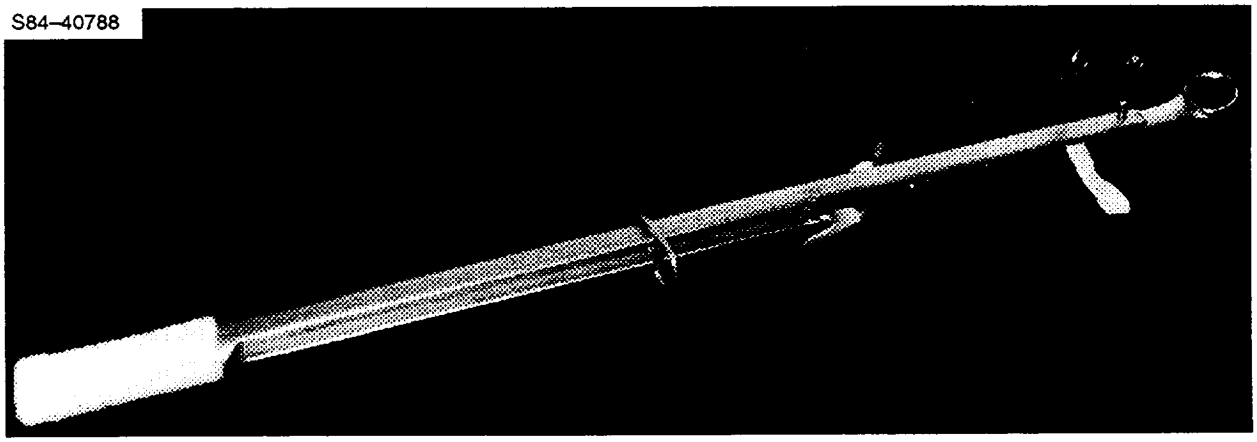
Technical Information	
Part number	V628–650886
Weight	0.8 lb
Material/ construction	Wrench – AISI 4063 tool steel Handle – Polyurethane, Velcro–wrapped, and tether ring
Load rating	
Temperature range	–200° to 250° F (operational) **+350° F (stowage)**
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	9.00	22.86
B	4.00	10.16
C	0.44	1.12
D	1.25	3.17
E	0.75	1.91
F	0.22	0.56



WRENCH, CHEATER BAR AND 15/16–INCH

S84–40788



OVERVIEW

The 15/16–in. wrench with cheater bar is a combination open end/box end wrench with an extension. The wrench is held in place by a T–handled pip pin. The bar has a sliding tether point and a Velcro–wrapped handle. The bar is made of stainless steel, and the wrench is tool steel.

OPERATIONAL COMMENTS

The 15/16–in. wrench with cheater bar has a moment arm of 28.5 in. for extra leverage on tight bolts. The cheater bar was used to break loose remote engagement mechanism bolts on **early versions of the** Spartan satellite. A different size wrench could easily be modified to fit into the cheater bar. This tool is not normally manifested, **nor is it an acceptable tool for other than infrequent contingency use. It has been replaced by a ratchet with a long telescoping handle.**

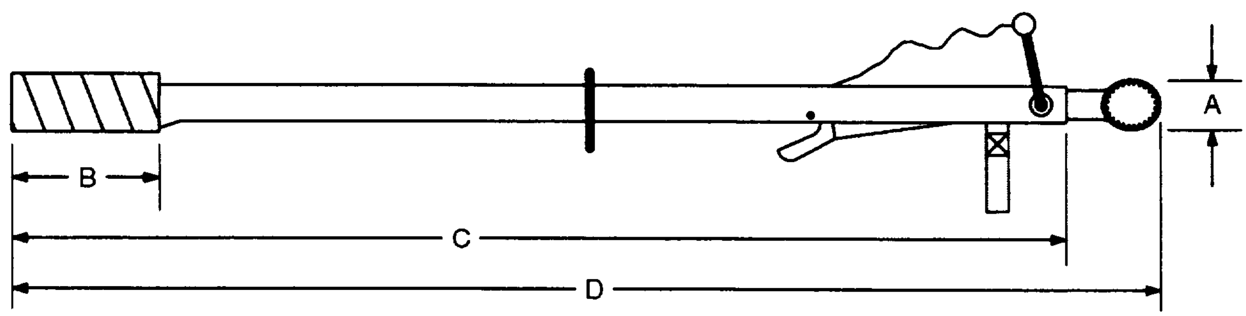
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: R. Scott, NASA/GSFC, (301) 286–2210

WRENCH, CHEATER BAR AND 15/16–INCH

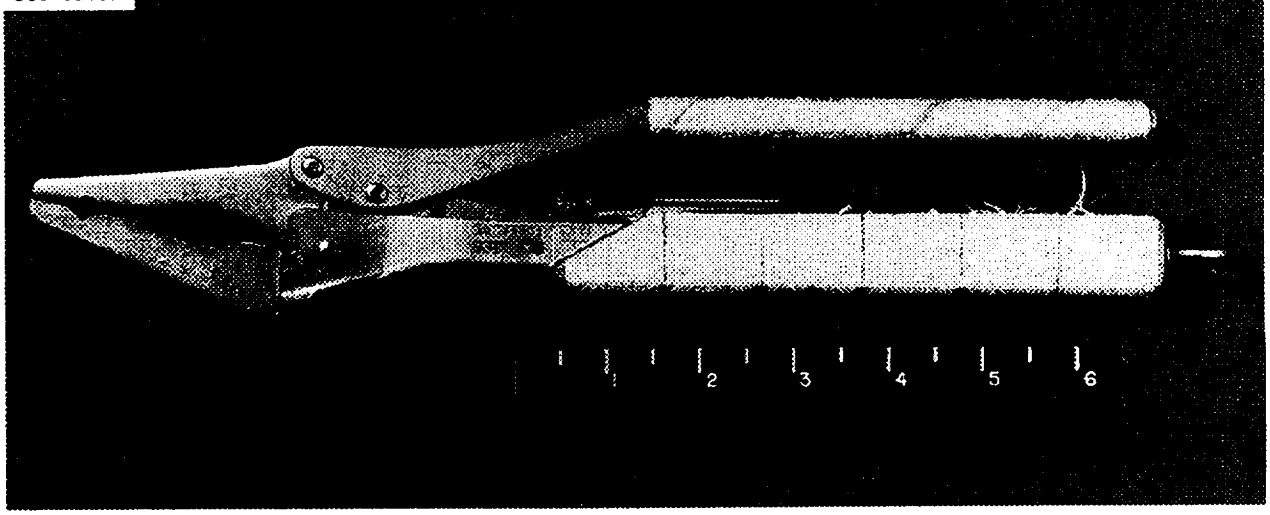
Technical Information	
Part number	10159–10065–01
Weight	3.2 lb
Material/ construction	Stainless steel bar, tool steel wrench, Velcro–wrapped handle
Load rating	1000 in–lb max with extension
Temperature range	–130° to 150° F
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	1.3	3.30
B	4.0	10.16
C	25.0	63.00
D	28.5	72.39



WRENCH, LEVER

S83–35197



OVERVIEW

The lever wrench is self–adjusting Vise–Grip pliers with a clamping–jaws design that includes a size and force adjustment screw on the handle. Force placed on the nut by the wrench can be set with the adjusting screw. An astro ring is fixed to one of the handles for tether attachment. Both handles are wrapped with Velcro.

OPERATIONAL COMMENTS

The lever wrench is a **contingency** disconnect and jam removal tool used to grasp the nut during nut and bolt removals. In order to use the self–adjusting feature, the handles must first be fully opened, the fixed jaw placed against the nut, and the handles then closed. The wrench has a maximum opening of 1–5/16 in. Normally, the force adjustment screw will be pre–set before stowage so that no adjustment will be required. **The Vise–Grip pliers long ago replaced this tool, since the Vise–Grips were found to be superior overall.**

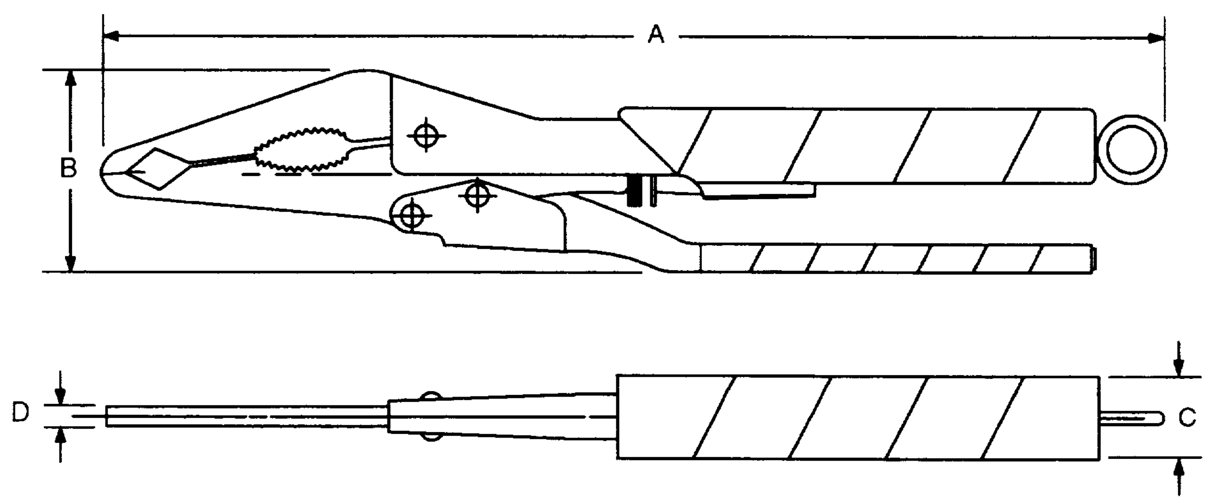
CONTACTS

Operational: R. McDaniel, NASA/DF4, (713) 483–2570
Technical: W. B. Wood, NASA/EC5, (713) 483–9247

WRENCH, LEVER

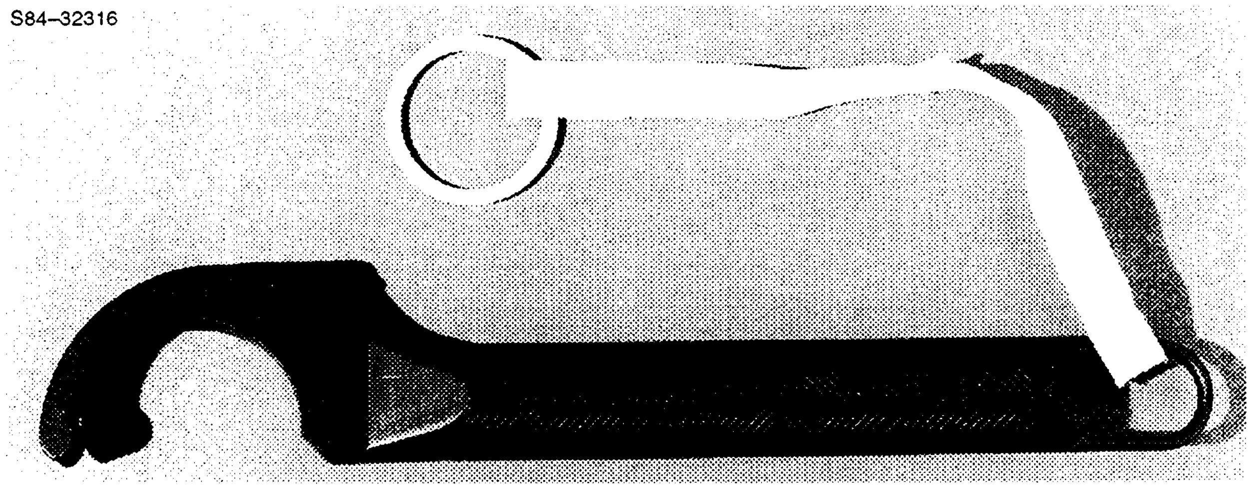
Technical Information	
Part number	V628–650878–003
Weight	1.65 lb
Material/ construction	Tool steel Handles – Wrapped with Velcro, tether ring on large handle Jaws – Notched, serrated
Load rating	
Temperature range	**–200° to +250° F (operational)** **+350° F (stowage)**
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	12.900	32.77
B	2.400	6.10
C	0.800	2.03
D	0.188	0.48



WRENCH, SPANNER

S84–32316



OVERVIEW

This spanner wrench is part of the hydrazine servicing tool set **of** the orbital refueling system. **It was used on STS 41–G to demonstrate on–orbit satellite refueling** from the orbiter. This tool has a large hook–shaped opening at one end, a headless pin behind the large opening, and a tether ring attached to the other end.

OPERATIONAL COMMENTS

The spanner wrench large opening is used to tighten and/or loosen the silver knob of the seal verification tool. The pin is used to tighten or loosen the multipurpose tool fitting connection.

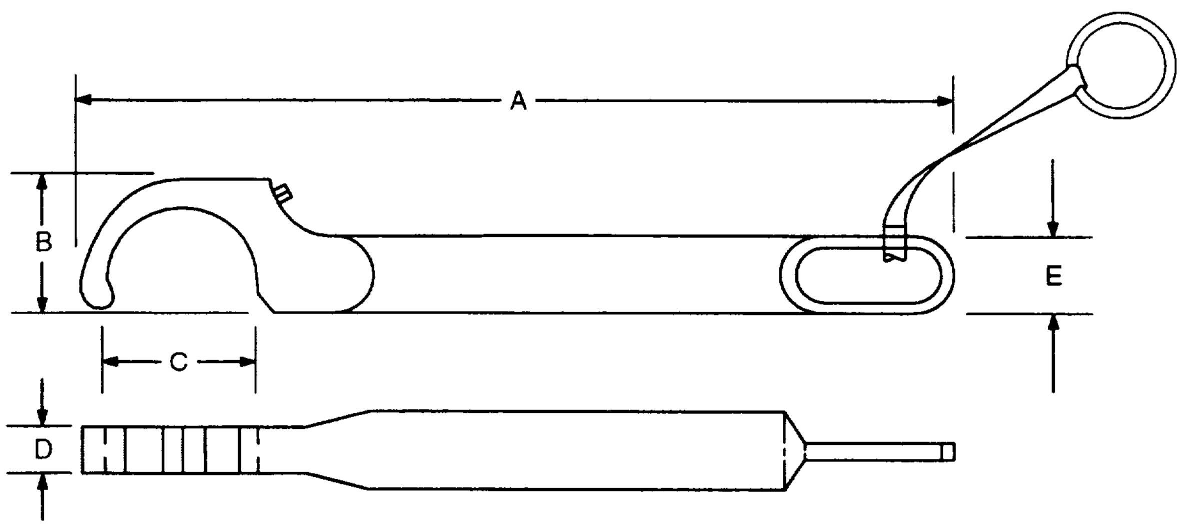
CONTACTS

Operational: R. C. Trevino, NASA/DF42, (713) 483–2597
Technical: **R. Marak**, NASA/EC5, (713) 483–9144

WRENCH, SPANNER

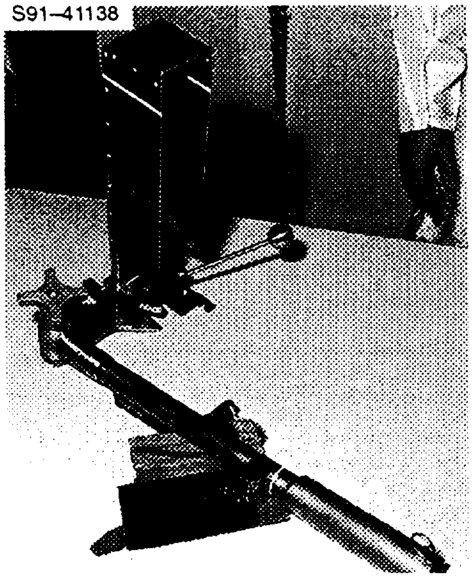
Technical Information	
Part number	SED 39116524–301
Weight	0.54 lb
Material/ construction	Anodized aluminum
Load rating	Rotate multipurpose tool – 105 ± 50 in–lb maximum
Temperature range	35° to 150° F
Quantity flown	
Stowage	
Availability	Reference only

Dimensional Data		
	inches	cm
A	10.25	26.04
B	1.75	4.45
C	2.01	5.11
D	0.50	1.27
E	1.00	2.54

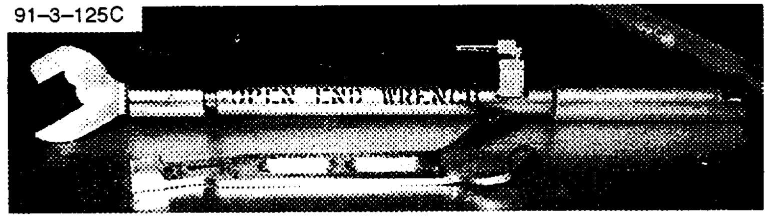


WRENCH, TENSIONED BOLT RELEASE

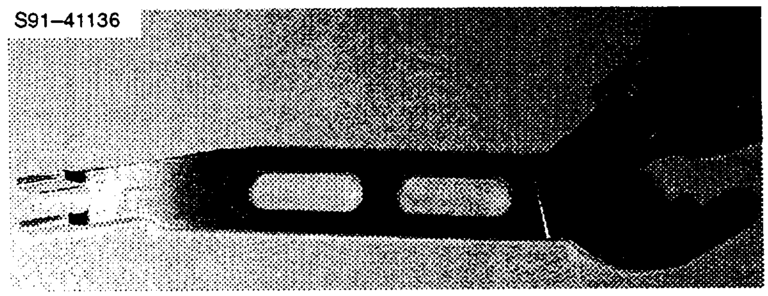
S91-41138



91-3-125C



S91-41136



OVERVIEW

This item is actually a collection of several tools assembled during extravehicular activity (EVA) to allow the safe release of high-tension bolts that hold a solar array in place for launch. These tools are used if the normal release mechanism fails. They were specifically designed for use with the upper atmosphere research satellite (UARS). The components that make up this tool assembly include a bolt shroud to protect the crew from unsafe rapid bolt release and a pair of wrenches that together act like hedge clippers to free the bolt.

OPERATIONAL COMMENTS

Before an attempt is made to release the launch restraint bolts, rope is used with alignment guides to restrain the solar array. This keeps the solar array secure until all bolts are released, after which the rope can be carefully loosened for array deployment.

The bolt shroud is the first component to be installed. This involves rotating the shroud from its stowed position to an upright use position using a pip pin to hold it fixed in each orientation. The fixed wrench is then attached by engaging it in a groove located on the retention bolt assembly and locking it in place by rotating an antirotation tab. A "gate" jaw is rotated down to hold the retention bolt while its preload nut is released. This nut is freed using an open-end wrench rotated clockwise. A visual cue on the nut will indicate when this has been completed. The gate jaw is next rotated upward so that the retention bolt can be released with 11.5 counterclockwise turns by a retention bolt lifting tool. A GO/NO-GO gauge on the opposite end of this lifting tool is inserted between the bolt and its separation nut to verify disengagement. When the bolt is fully disengaged, the lifting tool is used to slide the bolt upward to a fully retracted position marked on the protective shroud. Both the fixed and the open-end wrenches feature telescoping handles that can be adjusted by the EVA crew for extra mechanical advantage. All items stow in the UARS tool box when not in use.

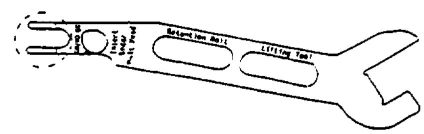
CONTACTS

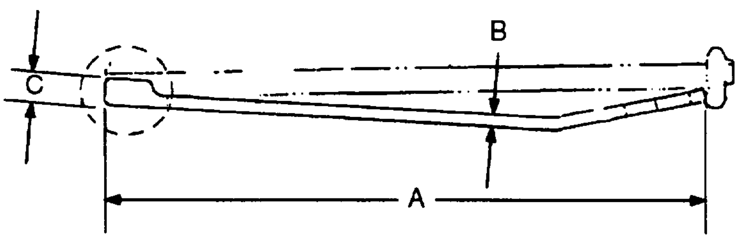
Operational: R. McDaniel, NASA/DF42, (713) 483-2570
Technical: R. Rashford, GSFC, (301) 286-7183

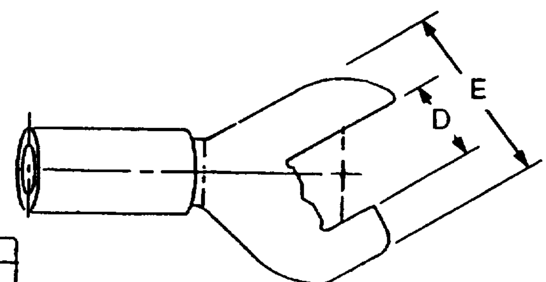
WRENCH, TENSIONED BOLT RELEASE

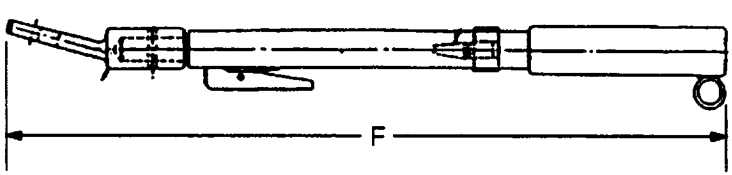
Technical Information	
Part number	47–284511–**G**1 (fixed wrench) 47–281312**P**1 (lifting tool) 47–2845**26G2** (open–**end** wrench)
Weight	14.0 lb (fixed wrench) **1.02 lb (lifting tool)** 8.78 lb (open–end wrench)
Material/ construction	Fixed wrench – Aluminum, CRES Open–end wrench – Alloy steel, CRES Lifting tool – CRES
Load rating	25–lb working load 50 ft–lb output torque
Temperature range	–130° to +194° F (stowage)
Quantity flown	One
Stowage	UARS tool box
Availability	Reference only

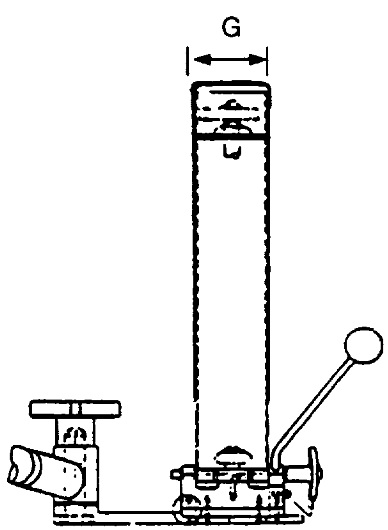
Dimensional Data		
	inches	cm
A	11.76	29.87
B	0.25	0.635
C	0.563	1.43
D	1.262	3.21
E	2.75	6.99
F	22.0 – 33.8	55.88 – 85.85
G	2.71	6.88
H	3.44	8.74
I	14.60	37.08

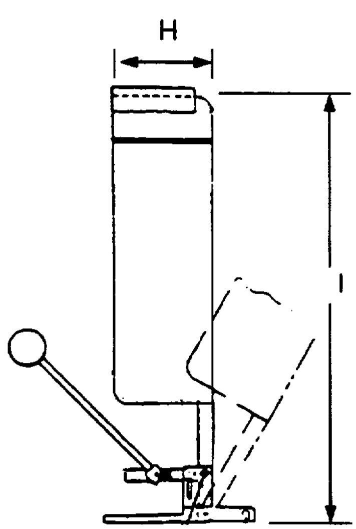




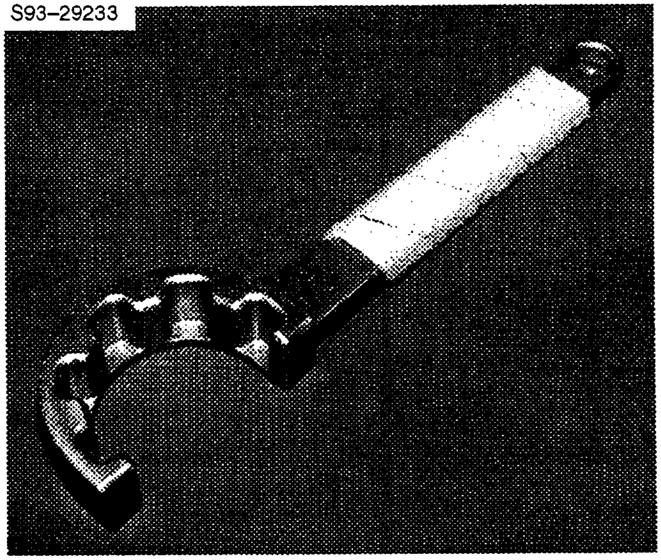








WRENCH, TRUSS JOINT SPANNER

S93–29233


OVERVIEW

This spanner wrench is a simple tool designed to provide additional leverage, if needed, to connect or disconnect the Langley Research Center (LaRC) extravehicular activity (EVA) truss joints. It was used on STS–49 as part of the assembly of station by EVA methods (ASEM). A tether loop is located on the end of the wrench handle and the handle is wrapped with Velcro for attachment to a tool caddy. Each of the two spanner wrenches was wrapped in a tool caddy and both were stowed in the ASEM port node box for launch and landing.

OPERATIONAL COMMENTS

The spanner wrench is attached around the dog ears on the LaRC joint, using alignment markings on the spanner wrench to aid in a one–handed operation. The other hand holds the strut for restraint. The semicircular part of the tool that engages the LaRC joint has notches at 45° intervals. One side of the spanner wrench has notches that are open for LaRC joint installation and the other side is closed to restrain the dog ears inside the wrench. The crewmember applies a counterclockwise force on the handle to release the joint. To lock the joint, the EVA crewmember applies a clockwise, rotating force.

Flight experience shows that spanner wrenches are definitely required for joint operation when multiple mate/demate cycles are required. They also help with troublesome single joints.

This tool and the structural joint to which it attaches were designed before changing the station to a preintegrated truss construction. Although some struts will exist on the station, the current preintegrated truss design uses primarily I–beam segments.

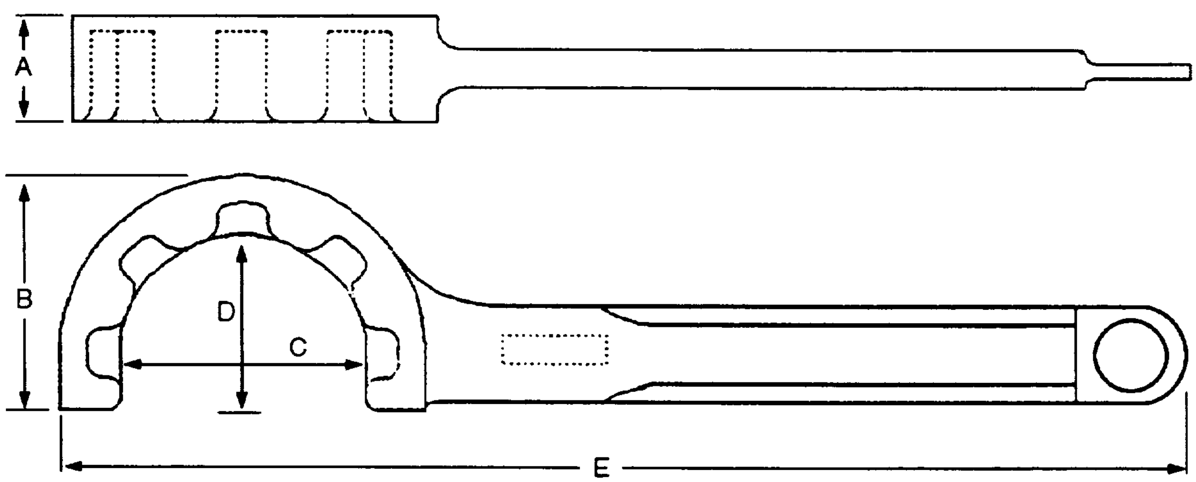
CONTACTS

Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. Schwarz, NASA/EC5, (713) 483–2378

WRENCH, TRUSS JOINT SPANNER

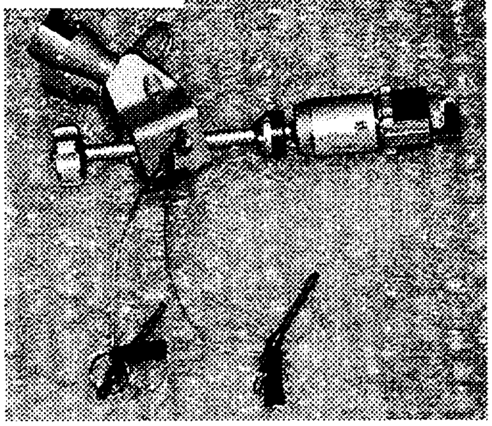
Technical Information	
Part number	1F02632
Weight	1.0 lb
Material/ construction	Aluminum
Load rating	
Temperature range	–150° to +160° F (stowage) –30° to +120° F (operational)
Quantity flown	Two on STS–49
Stowage	ASEM port node box
Availability	Reference only

Dimensional Data		
	inches	cm
A	0.85	2.16
B	2.11	5.36
C	2.0	5.08
D	1.4	3.56
E	11.0	27.94

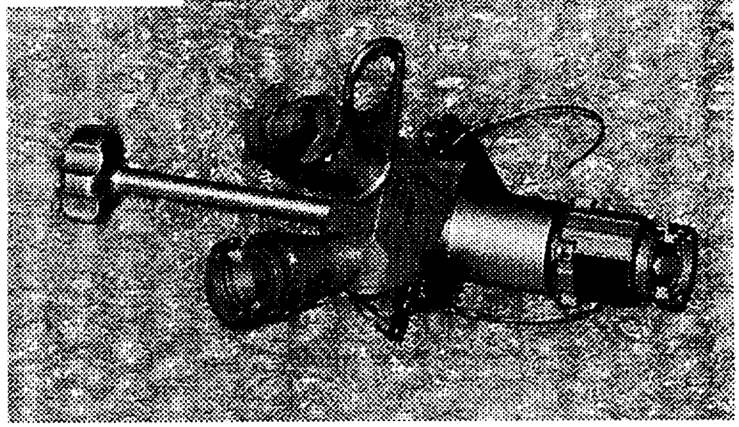


Y–FITTING/BERTHING ADAPTER

SP HOU 000804



SP HOU 000805



OVERVIEW

A primary objective of the assembly of station by extravehicular actvity (EVA) methods (ASEM) on STS–49 was to attach a large volume/mass to a fixed structure by joint EVA and robotic operations. These EVA operations required the EVA crew to provide verbal guidance to the robot operator for rough positioning and then complete the attachment using the compliance provided by a mechanical fitting. The Y–fitting, or berthing adapter, supplied this compliance using Langley joints/stubs and a releasable shaft/plunger assembly. Four fittings were used to mate the four forward corners of the assembled ASEM truss to eight struts/legs attached to the ASEM carrier.

OPERATIONAL COMMENTS

Tethered double–acting pip pins lock the berthing adapter plunger in place. These pins are released during EVA operations to allow the EVA crew to adjust the compliance on orbit. With the removal of two pip pins, the Y–fittings provide up to 7 in. of translation in the X–direction and 0.5 in. of translation in the Y– and Z–directions. Rotation of 360° about the X–axis and up to 20° of rotation about the Y– and Z–axes can be achieved with the pip pins removed. With the pins installed and the knob preload released, 0.25 in. of X–direction compliance is provided. Alignment stripes located on the Y–fitting body and shaft simplify resetting the assembly for multiple mating attempts. Each Y–fitting was also labeled according to its installed location (port, starboard, etc.) and to match the attached struts/legs (1–8).

The Y–fitting shaft/plunger has an EVA knob that is used to tighten the assembly after the pip pins have been inserted. On the end opposite the knob, the plunger has threads that screw into the Langley joint adapter and can be used to tighten the Langley joint against the conical stop in the berthing adapter. The threads have a single snap ring that restrains the plunger from loosening out of the Langley joint. The knob has a 7/16–in. double–height hex that allows the crewmember to loosen the Y–fitting plunger for contingency operations. Equipment tether points are provided and are not crew safety rated.

Based upon on–orbit experience, the Y–fittings could use even more compliance. The half–inch of Y and Z compliance is insufficient. This caused excessive robotic fine repositioning of the ASEM carrier before attachment was feasible. This fitting was designed prior to the latest SSF concept for attaching pressurized modules to the preintegrated truss. The baseline SSF mechanism has more compliance on each side of the mating interfaces and uses a powered, threaded shaft to make up alignment mismatch.

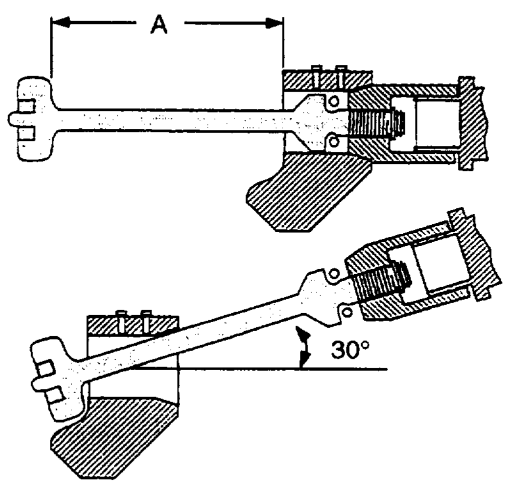
CONTACTS

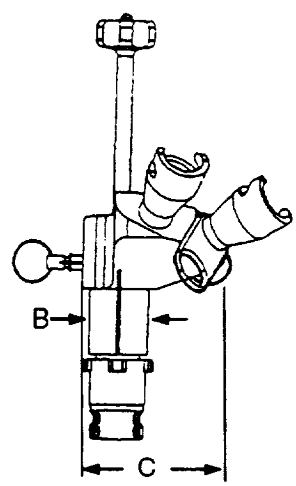
Operational: R. K. Fullerton, NASA/DF42, (713) 483–2589
Technical: R. Schwarz, NASA/EC5, (713) 483–2378

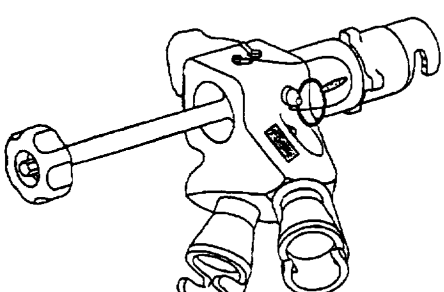
Y–FITTING/BERTHING ADAPTER

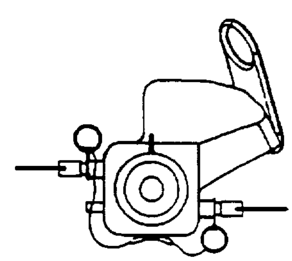
Technical Information	
Part number	1F02676 56777 (pip pins)
Weight	**22.3** lb
Material/ construction	Aluminum, Molycote pip pin lube
Load rating	30–lb tether point
Temperature range	–150° to 160° F (stowage) **–30° to 120° F (operational)**
Quantity flown	Four on STS–49
Stowage	ASEM node box in payload bay
Availability	Reference only

Dimensional Data		
	inches	cm
A	7.0	17.78
B	2.35	5.97
C	5.61	14.25









SPACE STATION

Currently, the Space Station Program is being reorganized and redesigned. A joint U.S./Russian/International Partners Space Station is likely. There will be many changes to the list of extravehicular activity (EVA) tools and equipment for the space station. It is emphasized that space station EVA designers and planners use this information for preliminary purposes.

The purpose of this section is to describe Space Station EVA equipment as it stands at the time of publication of this document. Due to the dynamic nature of space station EVA design and requirements definition, this section will be outdated well before the first station flight. Still, the data presented here is made available so station mission planners and the designers of other programs have some idea of the progress made to date. This data captures the corporate knowledge gained through numerous design reviews.

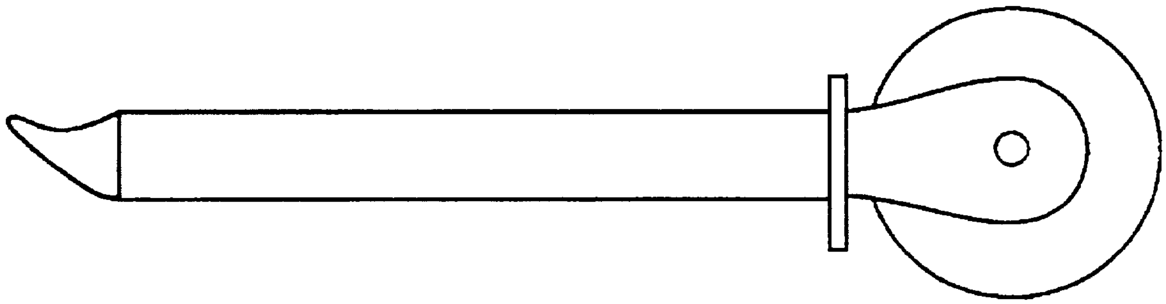
Space Station EVA equipment will be provided from several sources. Much of the station–unique hardware will be delivered by McDonnell Douglas and Lockheed through Work package (WP2). Other unique equipment is being driven by requirements from WP1 and WP4. Government furnished equipment (GFE) is being utilized where possible to maintain commonality with proven STS hardware and to minimize costs. This part of the catalog concentrates on the unique new hardware from WP2. It merely lists the name, part number, quantity and mission launch of the other hardware.

Though new superceding documents are pending, the EVAS ACD (SSP–30256) is the official controlling document for station EVA tools and takes precedence over this catalog. To minimize redundancy and promote tool commonality, this catalog will be the repository for detailed descriptions of all station EVA equipment in the long term. The ACD will eventually only list the top level tool requirements and vital statistics (e.g. name, part number, quantity, manifest date, etc.).

	HARDWARE TITLE	PROVIDER/STATUS	PART #	MISSION	QUANTITY	PAGE #
1	Airlock Hatch Seal Tool	UNDEFINED PROVIDER/DESIGN	TBD	MB–7	1	AAA–1
2	Airlock, SSF	WP2 PROVIDED	MDC–6496	MB–7	1	AAA–3
3	Bag, Airlock Tool Stowage	UNDEFINED PROVIDER/DESIGN	TBD	TBD	1	TBD
4	Bag, Large Trash	GFE	10176–20157–XX	MB–1 and subs	2	B–11
5	Bag, Small Trash	GFE	10165–10065–XX	MB–1 and subs	2	B–17
6	Battery Carrier, Large	UNDEFINED PROVIDER/DESIGN	TBD	MB–1 and subs	2	TBD
7	Battery, High Torque Power Tool	WP2 PROVIDED	5832388	MB–1 and subs	TBD	BBB–1
8	CETA Cart	WP2 PROVIDED	5835510	MB–4	2	CCC–1
9	CETA Tether Shuttle	WP2 PROVIDED	5835522	MB–2	2	CCC–3
10	Connector Pin Straightener, Multisize	GFE W/ MOD FOR SSF PINS	10181–10015–XX	MB–1 and subs	2	C–29
11	Connector, EVA Fluid (SSF)	WP2 PROVIDED	TBD	ALL	TBD	TBD
12	Connector, Zero–G Electrical	WP2 PROVIDED	40M39580	ALL	TBD	CCC–5
13	Cuff Checklist, Electronic	GFE	SK–ECC–XX	TBD	TBD	CC–29
14	Cutter, Compound Cable	GFE	SED33104404–XXX	MB–7	2	CC–31
15	Cutter, Large Cable	GFE	10159–10056–XX	MB–7	2	C–5
16	Drive, Right Angle	GFE	10176–20150–XX	TBD	2	D–13
17	EMU Thermal Mittens	GFE	10106–84628–XX	MB–7	2 PAIR	E–3
18	Hammer	GFE	V628–650875–XXX	MB–7	2	H–1
19	Handle, Micrometeoroid/Orbital Debris Shield	UNDEFINED PROVIDER/DESIGN	TBD	MB–7	2	HHH–1
20	Handles, ORU	UNDEFINED PROVIDER/DESIGN	TBD	MB–7	2	HHH–3
21	Handrail/Handhold, Ground Installed	WP2 PROVIDED	SEE WRITEUP	MB–1 and subs	TBD	HHH–5
22	Handrail, On–Orbit Installed	WP2 PROVIDED	5844339	MB–X	TBD	HHH–7
23	Hydrazine Brush	GFE	SEB39115185–XXX	MB–1 and subs	2	H–27
24	Hydrazine Monitor	GFE	SDD46015994–XXX	MB–1 and subs	2	HH–27
25	Light, Helmet Flood	GFE	TBD	MB–1 and subs	2	TBD
26	Light, Portable External	WP2 PROVIDED	5832351	MB–1 and subs	2	LLL–1
27	Mechanical Finger	GFE	10181–10018–XX	MB–7	2	M–7
28	Mini Workstation	GFE	10150–10050–XX	MB–7	2	M–9
29	Mirror, Wrist	GFE	10108–10012–XX	MB–7	2	M–13
30	ORU Transfer Device	WP2 PROVIDED	5844327	MB–7	2	000–1
31	Payload Retention Device	GFE	10163–10063–XX	MB–7	2	P–5
32	PFR Worksite Interface	WP2 PROVIDED	TBD	MB–1 and subs	TBD	PPP–1
33	PFR Workstation Stanchion (SSF)	WP2 PROVIDED	5832355	MB–1	2	PPP–3
34	Pliers, Needle Nose	GFE	V628–650865–XXX	MB–7	2	P–37
35	Pliers, Vise–Grip	GFE	V628–650876–XXX	MB–7	2	P–39
36	Portable Contamination/Leak Detector	GFE	TBD	TBD	TBD	TBD
37	Portable Foot Restraint, Articulating	WP2 PROVIDED	5825282	MB–1, 4 AND 7	2	PPP–5
38	Portable Work Platform	WP2 PROVIDED	TBD	MB–4	2	PPP–7
39	Portable Work Platform Stowage Device Kit	WP2 PROVIDED	TBD	TBD	TBD	PPP–9
40	Power Tool, High Torque	WP2 PROVIDED	5832387	MB–1 and subs	2	PPP–11
41	Probe	GFE	V628–650879–XXX	MB–7	2	P–63
42	Pry Bar	GFE	V628–650990–XXX	MB–7	2	P–65
43	Ratchet Wrench Cheater Bar	GFE	10159–10065–XX	TBD	2	R–1
44	Ratchet, 3/8–Inch Drive McTether	GFE	10181–10023–XX	MB–1 and subs	2	R–7
45	Ratchet, 3/8–Inch Drive With 7/16 Inch Socket	GFE	V628–650860–XXX	TBD	TBD	R–9
46	Repair Kit, Fluid Line	WP2 PROVIDED/NO DESIGN	TBD	MB–7	2	TBD
47	Repair Kit, Pressurized Module	WP1 PROVIDED/NO DESIGN	TBD	MB–7	2	TBD
48	Robotic/EVA Interfaces	WP2/4 PROVIDED	SEE WRITEUP	MB–1 and subs	TBD	RRR–1
49	Scissors, Modified	GFE	10159–20076–XX	MB–7	2	S–3
50	Slidewire (SSF)	WP2 PROVIDED	5839276	TBD	TBD	SSS–1
51	Socket Set, 5/16–Inch	GFE	TBD	TBD	2	TBD
52	Socket Set, 7/16–Inch	GFE	TBD	MB–1 and subs	2	TBD
53	Stowage Container, EVA Support Equip and Tools	WP2 PROVIDED	TBD	MB–7	2	SSS–3
54	Stowage Device, EVA Tool	WP2 PROVIDED	5825269	MB–1, MB–4	2	SSS–5
55	Tape/Velcro Caddy	GFE	SED33104207–XXX	MB–7	2	T–3
56	Temporary Equipment Restraint Aid	WP2 PROVIDED	TBD	MB–4	2	TTT–1
57	Tether Loop	WP2 PROVIDED	5835757	TBD	TBD	TTT–3
58	Tether, Adjustable Equipment	GFE	10159–20005–XX	MB–1 & SUBS	TBD	T–13
59	Tether, Adjustable Equipment (HST)	GFE	10181–10016–XX	MB–1 & SUBS	TBD	T–15
60	Tether, Retractable Equipment	GFE	SED33105307–XXX	MB–1 & SUBS	TBD	T–21
61	Tether, Rigidizing	GFE	TBD	MB–1 & SUBS	2	TTT–5
62	Tether, Safety	GFE	10162–10062–XX	MB–1 & SUBS	TBD	T–23
63	Tether, Waist	GFE	10151–20040–XX	MB–1 & SUBS	TBD	T–27
64	Tether, Wrist	GFE	10151–20041–XX	MB–1 & SUBS	TBD	T–29
65	Tool Board	WP2 PROVIDED	TBD	MB–1 & 7	TBD	TBD
66	Tool Caddy, McCaddy and Ratchet	GFE	10181–10017/45–XX	MB–1 & SUBS	TBD	T–39
67	Tool Caddy, Soft	GFE	SED33104089–XX	MB–1 & SUBS	TBD	T–41
68	Torque Multiplier	WP2 PROVIDED	5841939	MB–1	2	TTT–7
69	Vent Tool, Heat Exchanger Nitrogen	WP2 PROVIDED/NO DESIGN	TBD	TBD	2	TBD
70	Wrench, Adjustable	GFE	V628–650892–XXX	MB–7	2	W–13

NOTE : ALL INFORMATION LISTED ABOVE IS SUBJECT TO CHANGE. VERIFY BEFORE USING FOR ANY PURPOSE.

AIRLOCK HATCH SEAL TOOL



OVERVIEW

The airlock hatch seal tool is designed as an aid for extravehicular activity crew removal and replacement of the large seals associated with the Space Station Freedom airlock hatches. One end of the tool is used to pry out a portion of the seal for removal. The other end has a rolling wheel to assist in forcing the seal back into its groove during reinstallation. A tether point will be added to the final design.

OPERATIONAL COMMENTS

There are two redundant seals for each airlock hatch that may require periodic replacement due to usage wear, accidental damage, or long term environmental degradation. This tool can be used to pry a portion of the seal out and then the seal can be fully removed by simply pulling on the loose end. Proper seal reinstallation requires full seating back into the groove and elimination of any tendency of the seal to stretch for nonuniform distribution in the groove. This tool should ensure correct seal installation. The seal itself will have an internal cord to minimize seal stretch and make this task a little easier. This tool will be stowed inside the airlock.

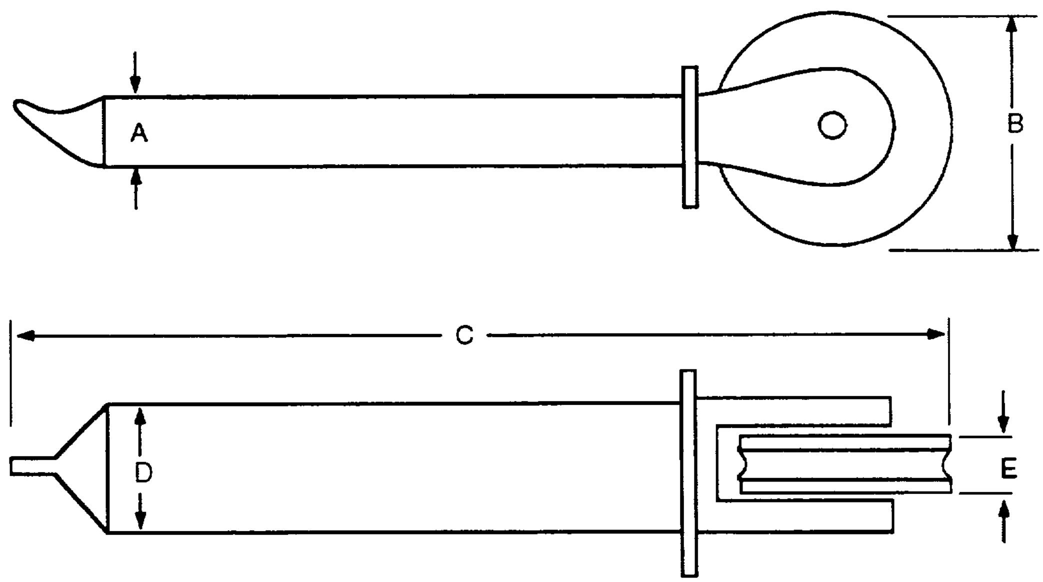
CONTACTS

Operational: Richard Fullerton, NASA/DF42, (713) 483–2589
Technical: Phil West, NASA/EC5, (713) 483–9236

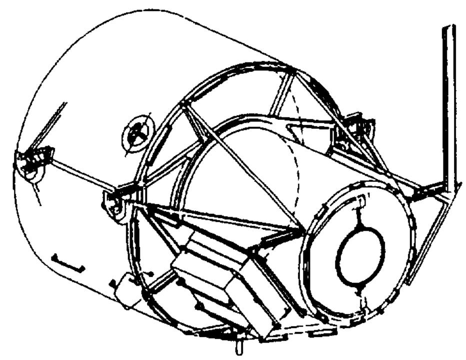
AIRLOCK HATCH SEAL TOOL

Technical Information	
Part number	TBD
Weight	1 lb (approx)
Material/ construction	Limited life items – TBD Lubricants – TBD Metallics – Aluminum alloy Nonmetallics – TBD
Load rating	TBD
Temperature range	–65° to +180° F
Quantity flown	One on MB7
Stowage	Airlock interior locker
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	0.75	1.91
B	2.50	6.35
C	9.40	23.88
D	1.38	3.51
E	0.62	1.57



AIRLOCK, SSF



OVERVIEW

The Space Station Freedom (SSF) airlock is a dual–chamber pressure vessel that can be isolated from the rest of the crew cabin to allow the extravehicular activity (EVA) crew to reach the external environment for assembly and maintenance tasks. It attaches to the zenith port of node 1 for improved thermal performance. Unlike the orbiter airlock, which has only one small chamber, the large dual chambers of this airlock can be used to conserve depress gas for large equipment transfer, and for true hyperbaric treatment. The large chamber is known as the equipment lock; the small chamber is called the crew lock. By pumping the gas normally vented overboard back into the equipment lock or into node 1, resupply of oxygen and nitrogen to support EVA is minimized. Both chambers can be depressed so that a pair of EVA crewmembers and a large orbital replaceable unit (ORU) can ingress and egress together. If EVA crewmembers are afflicted with decompression sickness, they can be treated by pressurizing the crew lock to 2.8 atmospheres. This airlock will be used instead of the orbiter airlock as soon as possible, since joint EVA and SSF robotic operations can be conducted only if the intravehicular activity crew has unrestricted access to the SSF modules. With the orbiter airlock at vacuum, any SSF crew would be isolated from the orbiter in an emergency.

OPERATIONAL COMMENTS

In terms of EVA support, this airlock has the following features:

- Mounting provisions for two extravehicular mobility units (EMU's) on the equipment lock wall for don/doff and prebreathe activities. A spare third EMU can be stowed in an overhead locker.
- A pair of umbilicals in the equipment lock for EMU servicing, including cooling water, high pressure oxygen, battery recharge, hardline communication, and EMU operations power. A second pair of umbilicals provides life support while isolated inside the crew lock. Radio frequency communication is not available in the crew lock.
- Depress/repress valves on each side of the airlock bulkheads. The gas recycling pump will be installed after MB–7 as a developmental cost savings.
- Hyperbaric chamber pressurization is controlled in the equipment lock and the operator can look through windows into the crew lock during treatment. Crew lock atmosphere is cooled and scrubbed of CO_2 and humidity by an airlock–unique environmental unit that has its own condensing heat exchangers and CO_2 molecular sieve. Hyperbaric systems have been deferred until after MB–7 as a cost savings.
- A small transfer lock on the hatch between the crew and equipment locks allows equipment to be passed through during hyperbaric treatment or if needed during EVA.
- Externally mounted tool boxes to hold assembly and maintenance equipment. The battery recharge station is located inside the equipment lock for power tool servicing.
- The entire airlock can be used in a "campout" mode for overnight prebreathe at a reduced cabin pressure while isolated from the rest of the station.

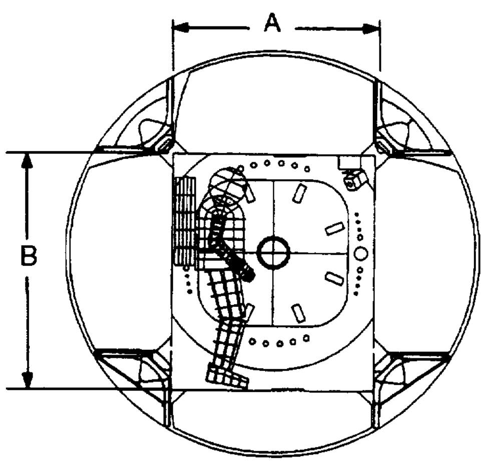
CONTACTS

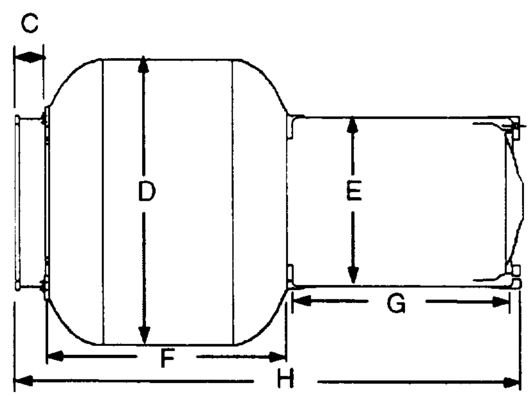
Operational: R. Fullerton, NASA/DF42, (713) 483–2589
Technical: J. Marmolejo, NASA/EC5, (713) 483–9233

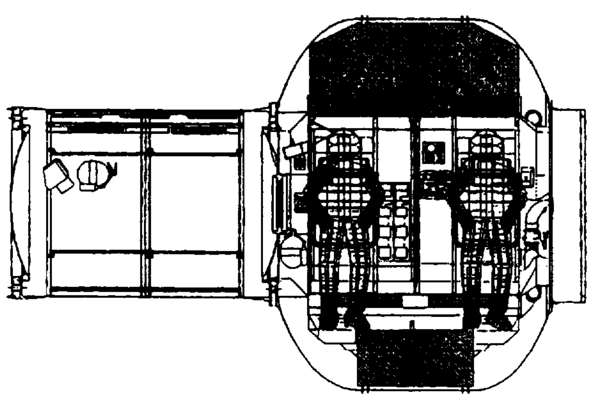
AIRLOCK, SSF

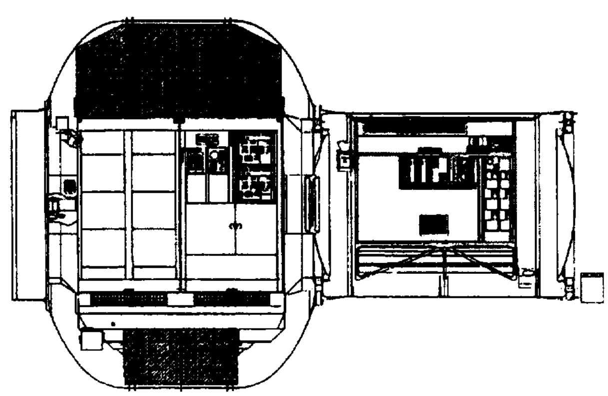
Technical Information	
Part number	MDC–6496 (drawing tree)
Weight	
Material/ construction	Machined/welded aluminum pressure vessels
Load rating	187–lb internal handrail tubes and standoffs 200–lb internal crew safety tether loops 200–lb external handrail standoff tether points
Temperature range	
Internal volume	947 ft^3 (two EMU's, equipment lock) 225 ft^3 (two EMU's, crew lock)
Quantity flown	One on MB–7
Stowage	Zenith port of SSF node 1
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	72.0	182.88
B	86.0	218.44
C	11.40	28.96
D	148.0	375.92
E	74.70	189.74
F	109.27	277.55
G	98.66	250.60
H	229.87	583.87

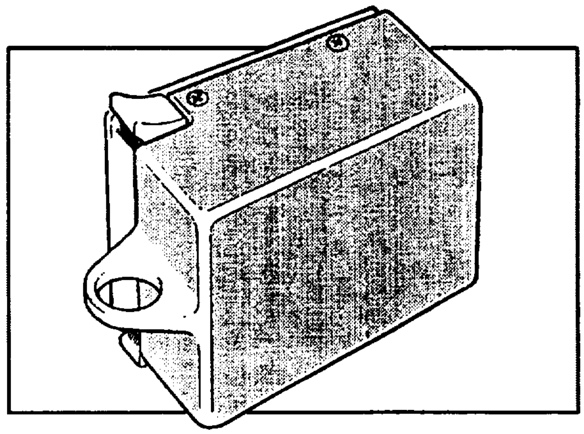








BATTERY, HIGH TORQUE POWER TOOL



OVERVIEW

This battery is designed to be common to the high torque power tool and the external portable floodlight. To conserve battery power and minimize battery–related extravehicular activity (EVA) overhead, these two tools can also be plugged into external power outlets. All batteries are recharged inside the airlock, and a set of batteries can be transported to and from each worksite in a special transfer container. Each battery also has its own tether ring.

OPERATIONAL COMMENTS

To reduce launch weight impacts, the battery is rechargeable. It uses NiCd technology to produce 28.8 V dc and has a 31.1 W–hr capacity. Twenty–four cells connected in series with nickel alloy tabs form the battery pack interior. Enough insulation is designed into the battery for trouble–free transport to worksites. External electrolyte leakage is prevented with a layer of Goretex. The battery is fuse protected for external shorts and has microcircuit temperature sensing and a pair of thermal cutoff switches to stop cell pack overheating.

Battery recharge is performed inside the airlock. This reduces EVA time associated with battery maintenance and allows pre–EVA battery/tool checkout. Because of thermal constraints, the battery is not designed for long–term stowage outside the airlock.

Dual latch mechanisms secure the battery to each powered device. Each latch has a green indicator to aid in verifying full installation. A 6–lb installation force is required. Both latches must be depressed to remove the battery.

The power tool's motor controller features an undervoltage lockout, a current limiter, and a thermal shutdown for tool and battery protection. The power tool also has a battery installation switch that prevents tool activation before full battery insertion. Low battery–charge level is indicated by an LED on the power tool. For battery independence, a detachable power cord is available.

The floodlight has an auto off function that uses an ambient light sensor to conserve battery power. Like the power tool, it has a detachable power cord. Low battery charge is indicated by a blinking light.

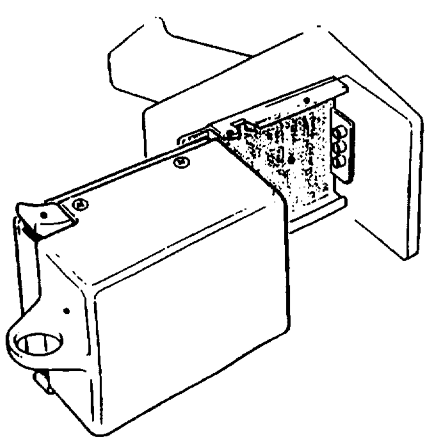
CONTACTS

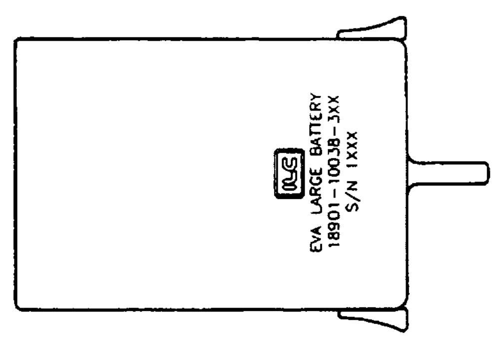
Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

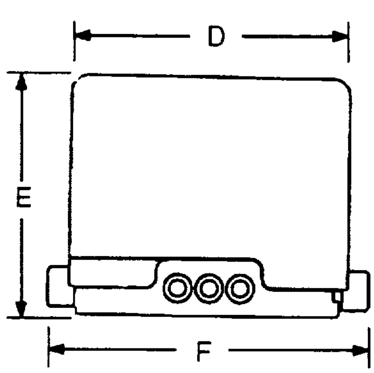
BATTERY, HIGH TORQUE POWER TOOL

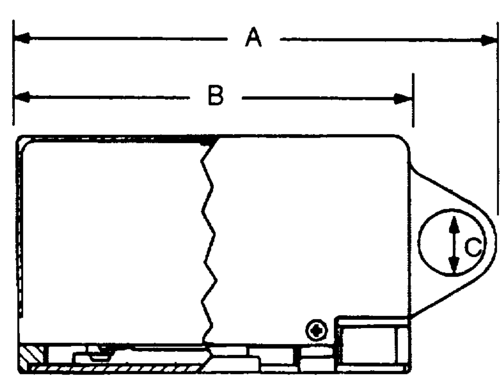
Technical Information	
Part number	5832388–501 18901–10038–301
Weight	3.2 lb
Material/ construction	Limited life items – Nylon cell separators (250 cycles, 5 yr) Lubricants – None Metallics – Aluminum receiver/case Nonmetallics – Vespel latch, Chemglaze paint, Beta cloth aluminized Mylar, Scrim insulation layers
Load rating	28.8 V dc 31.1 W–hr (min) 1.08 A–hr 40.8 V dc charge voltage 30 min/battery or 3 hr/6 batteries for floodlight 36 min/battery for power tool (34 min at 30% load)
Temperature range	–172° to +156° F
Quantity flown	Four minimum (MB1 and subs)
Stowage	Shuttle middeck (MB1 – MB6)
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	5.45	13.84
B	4.47	11.35
C	0.75	1.91
D	3.10	7.87
E	2.70	6.86
F	3.58	9.09

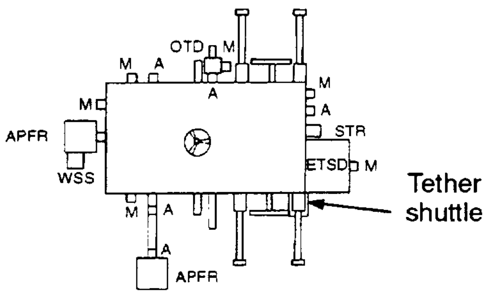








CETA CART



M	Microconical I/F
A	Articulating socket
STR	Safety tether reel
OTD	ORU transfer device
WSS	Workstation stanchion
APFR	Articulating portable foot restraint
ETSD	EVA tool stowage device

OVERVIEW

The crew and equipment translation aid (CETA) provides rapid transport of the extravehicular activity (EVA) crew, orbital replacement units (ORU's), and support tools for Space Station Freedom (SSF) assembly and maintenance. The CETA cart is a manually propelled, wheeled vehicle that rides the mobile transporter (MT) rails. After the rails of the rotating solar array joint are aligned, the cart can access all truss segments. CETA serves as a work platform for tasks on the three nearby faces of the SSF truss. CETA can be used for emergency return of an incapacitated crewmember to the airlock. A tether shuttle complements the CETA cart for single crew transport to and from each cart. The ORU transfer device (OTD), articulating portable foot restraint (APFR), and EVA tool stowage device (ETSD) are also used with the cart. CETA is normally stowed coupled to the space station remote manipulator system (SSRMS) MT between EVA's. Two carts are baselined for SSF to allow parallel tasks by independent EVA crews.

OPERATIONAL COMMENTS

Based on STS–37 evaluations, the SSF CETA was selected to be manually propelled as opposed to using electrical or mechanical drive systems. It has a large flat bed to hold ORU(s) volumes up to 50 by 45 by 84 in. and masses up to 2200 lb (including crew and tools). The ORU is attached to CETA with a square rod and grid system on the cart and a passive/active ORU carrier latch. A pair of fixed foot restraints with EVA–releasable heel/toe bars is built in for cart movement in either direction along the MT rails. Several APFR sockets are mounted on the sides of the cart for use with a foot restraint to access ORU's on the adjacent truss faces. These sockets also provide options for mounting the OTD. One of the sockets is attached to an extendable horizontal pole so the APFR can be used as a tool box restraint. An integral safety tether reel on the cart reduces tether swap overhead. Illumination for CETA translation and use as a worksite will be provided by a portable floodlight set up by the EVA crew.

The cart can be stopped using a dynamic brake system (nominal), a parking brake system, or an energy absorber (e.g., if brakes fail). The dynamic brake uses a mechanical linkage and cable system that is pull handle actuated. The handle articulates in pitch and yaw and its actuation force is crew adjustable. The parking brake is independent of the dynamic brake and is shaft driven through a similar brake handle. It is releasable only by a foot pedal. The energy absorber acts as an emergency stop at the end of the MT rails. It uses a friction diaphragm made up of belleville springs and is resettable after impact.

Since the couplers between the CETA cart, tether shuttle, and MT are totally manual, the carts are left attached to the MT between EVA's. This gives the MT freedom to travel the rails for robotic tasks. The lower roller of each wheel unit can be disassembled to remove the cart from the rails for replacement, relocation, or maintenance. An extravehicular–installable grapple fixture permits robotic relocation of the cart around the MT. All CETA components have been thermally hardened for long term exposure at worksites to reduce EVA overhead.

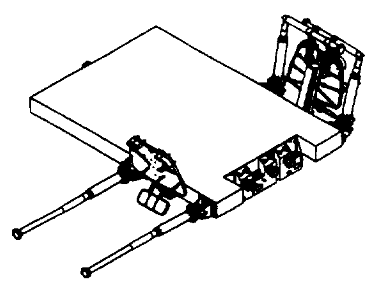
CONTACTS

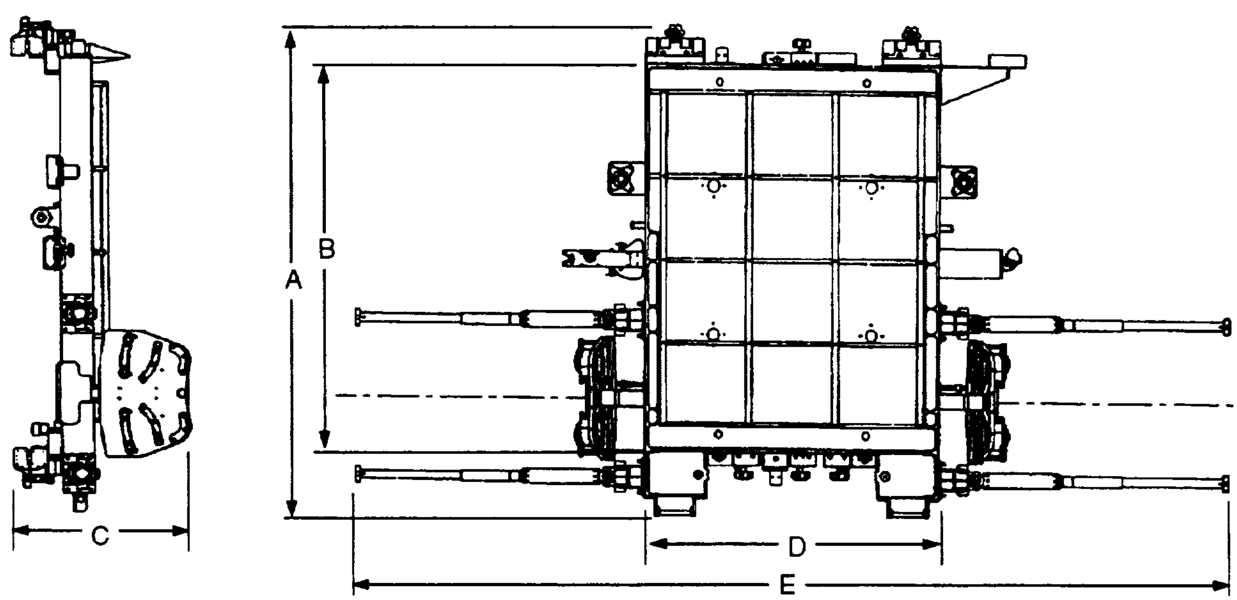
Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

CETA CART

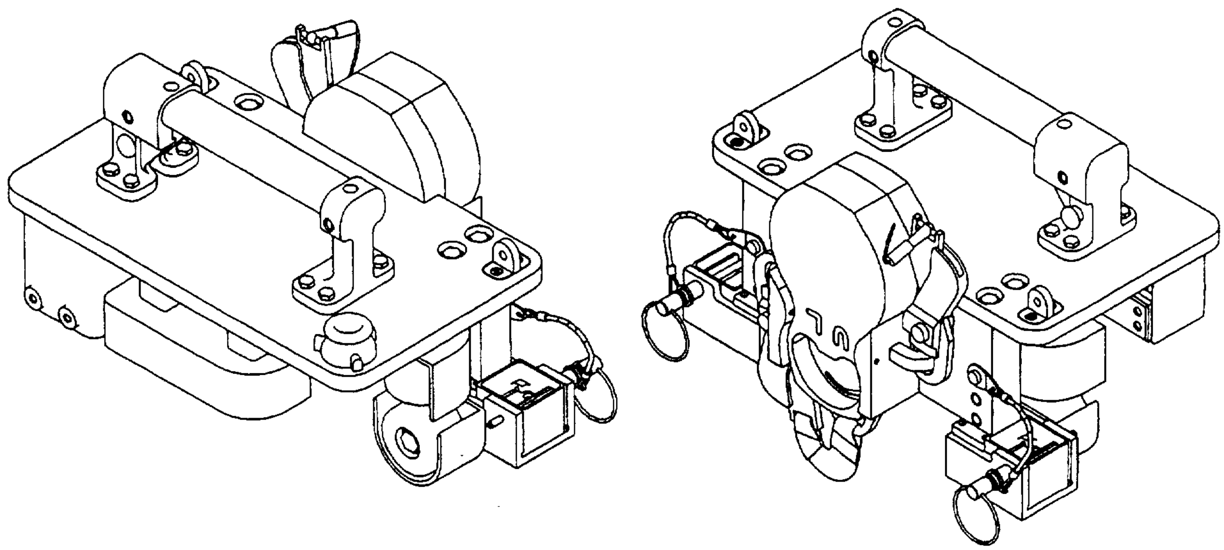
Technical Information	
Part number	5835510–501
Weight	569.5 lb (unloaded) 2200–lb cargo capacity(crew and ORU's)
Material/ construction	Limited–life items – Wheels, brake pads, energy absorber (10 yr) Lubricants – TBD Metallics – Anodized aluminum alloys, stainless, CRES, beryllium copper coil springs, titanium belleville springs Nonmetallics – Rulon bushings/bearings, Vespel brake handle lining
Load rating	45–lb parking brake hold capacity 3 ft/sec translation and impact rate 0.5 ft/sec, 10–lb mechanical coupler impact limit 20–lb dynamic brake actuation force 200–lb tether–point strength 187–lb handrail strength 100–lb, 4200 in–lb OTD/APFR/ETSD socket strength 600–lb deceleration force of energy absorber with fully loaded cart at 3 ft/sec (8–in. energy absorber stroke)
Temperature range	–65° to +180° F
Quantity flown	Two on MB4
Stowage	Mated to SSRMS mobile transporter
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	80.69	204.95
B	63.26	160.68
C	28.00	71.12
D	48.00	121.92
E	142.78	362.66





CETA TETHER SHUTTLE



032.F

OVERVIEW

The tether shuttle is considered a component of the crew and equipment translation aid (CETA). It provides a tethered continuous translation capability similar to a slidewire. Like the CETA cart, it is manually propelled with wheels that ride the mobile transporter (MT) rails. Unlike the CETA cart, the tether shuttle is not guaranteed to reach the outboard solar array truss segments. This is because of an incompatibility between the shuttle's tighter wheel alignment tolerance and the potential maximum rail gap at the truss joint. The shuttles are normally stowed detached from the MT rail near the airlock and must be attached to the rail for each extravehicular activity (EVA). This allows the space station remote manipulator system (SSRMS) MT to roam the rails freely between EVA's for robotic tasks. Stowage near the airlock provides the crew with a means to translate to the CETA carts, which are stored coupled to the MT. Two shuttles are baselined for SSF to allow parallel tasks by independent EVA crew. They are launched on brackets attached to the truss structure.

OPERATIONAL COMMENTS

The Space Station Freedom (SSF) tether shuttle was derived from the design demonstrated on STS–37. It has an integral safety tether for attachment of a waist safety tether. Instead of the knob used on the STS–37 design, the SSF shuttle has a short handrail section for body restraint during translation. For parking purposes, the shuttle can be manually coupled to the CETA cart or tethered anywhere along the MT rail. It has a soft dock feature for free float installation and stowage that can act as an integral parking brake like the STS–37 design. The crewmember's gloved hand acts as the brake during translations. Illumination for shuttle translation will be provided by nearby fixed floodlights and the extravehicular mobility unit (EMU) helmet lights.

The shuttle is removable from the rails to accommodate replacement, relocation, or maintenance. This is accomplished by disassembly of the lower roller of each wheel unit. All CETA components have been thermally hardened for long term exposure at worksites to reduce EVA overhead.

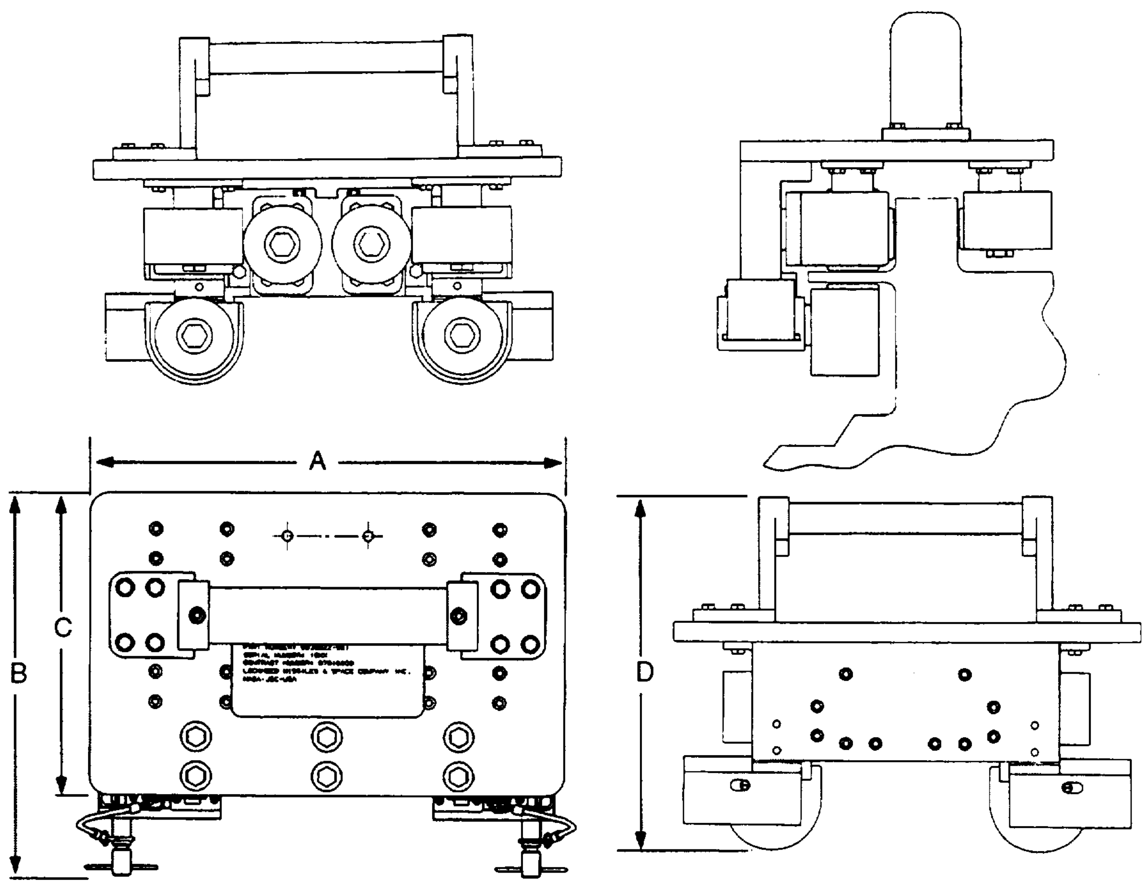
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

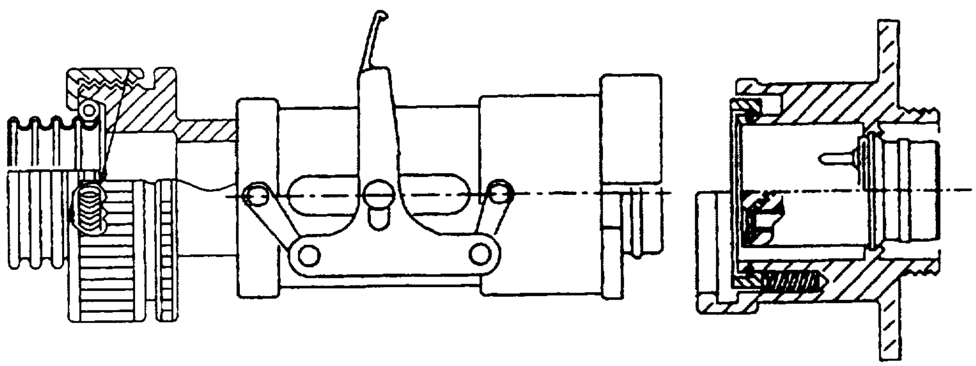
CETA TETHER SHUTTLE

Technical Information	
Part number	5835522–501
Weight	27.6 lb
Material/ construction	Limited–life items – Wheels (10 yr) Lubricants – MoS2 solid film lube Metallics – Aluminum alloys, CRES Nonmetallics – Rulon bushings/bearings
Load rating	3–ft/sec. translation and impact rate 0.5–ft/sec., 10–lb mechanical coupler impact limit 187–lb handrail strength
Temperature range	65° to +180° F
Quantity flown	Two on MB2
Stowage	Mated to CETA/SSRMS MT or beside MT rail near airlock
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	11.1	28.19
B	9.1	23.11
C	7.25	18.42
D	8.45	21.46



CONNECTOR, ZERO–G ELECTRICAL



OVERVIEW

The zero–g electrical connector has been selected as the primary connector for Space Station Freedom (SSF) extravehicular activity (EVA) applications. It was jointly developed by NASA MSFC, MDSSC–SSD, and Bendix. It was originally conceived for an orbital workshop (a modified LH_2–fueled Saturn SIV–B stage). This program evolved into Skylab, where the connector was first used. It was also used for the Apollo lunar rover TV camera. As opposed to the majority of connectors that mate with a circular rotation, this connector has a linear actuated lock lever. For SSF applications, the connector will house standard pin–socket interfaces as well as fiber–optic fittings.

OPERATIONAL COMMENTS

The connector is a cylindrical scoop–proof unit with inserts and contacts based on MIL–C–38999 and MIL–C–39029. It has multiple shell sizes, and it accommodates wire and cable from AWG 26 to AWG 8, coax, twinax, and fiber–optics. The coupling mechanism is lever actuated, providing pin engagement after shell soft dock and pin disengagement before shell disengagement. This feature, along with a sealed piston action, contains arcing and sparking if the connector has not been safed by powerdown. Soft dock is provided by a spring–loaded ring in the receptacle shell mating face. The lock lever has a 2.8–in. axial travel and provides a visual and tactile position status. The lever concept is attractive because it reduces the need for fine finger grasp forces and, therefore, should be less fatiguing to a pressurized gloved hand. Alignment/keying is obvious and inherent to the matching mating surfaces. Clearance between adjacent zero–g connectors is 1.5 in. but has the potential to be reduced due to the linear engagement design versus rotating wing tab–type connectors.

Improvements being incorporated for current applications include latch/lever robotic enhancements, a firmer soft dock, increased axial and roll on mating capability, development of controlled leakage bulkhead feedthrough receptacles, creation of sealing plugs, addition of electromagnetic interference/remote frequency interference (EMI/RFI) grounding fingers, shield grounding backshells, and visual markings.

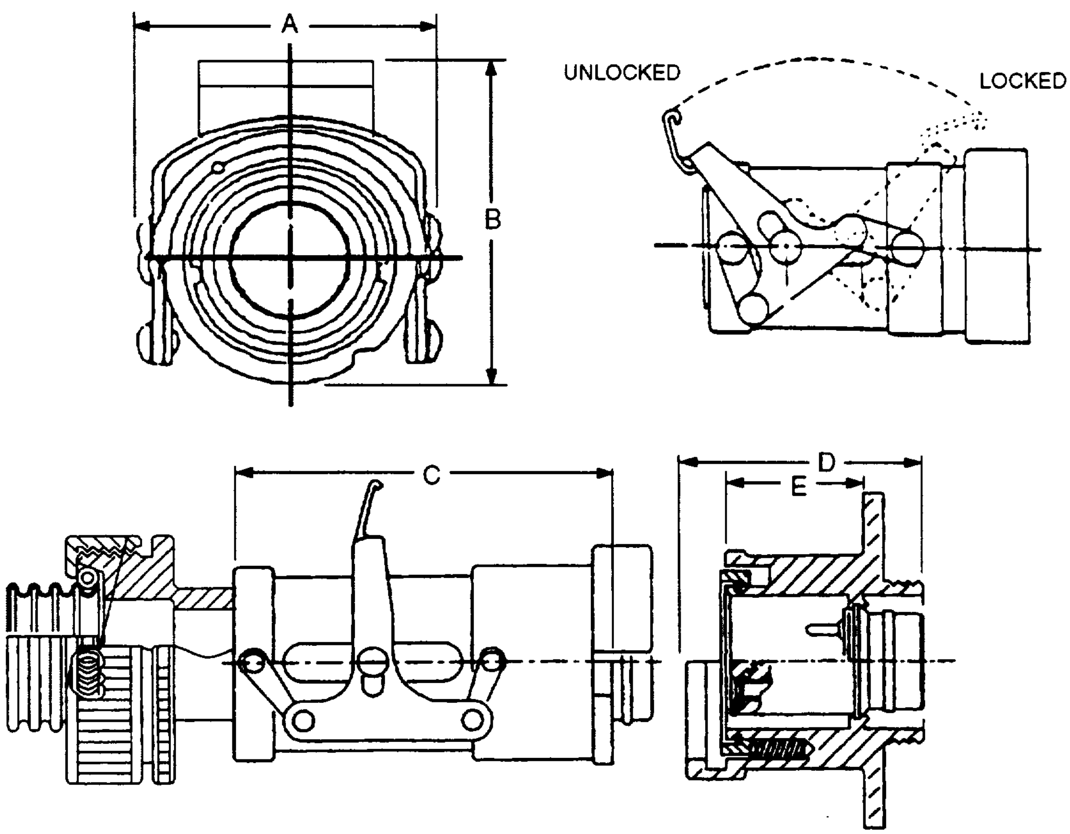
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Gordon Rysavy, NASA/KA, (713) 483–8164

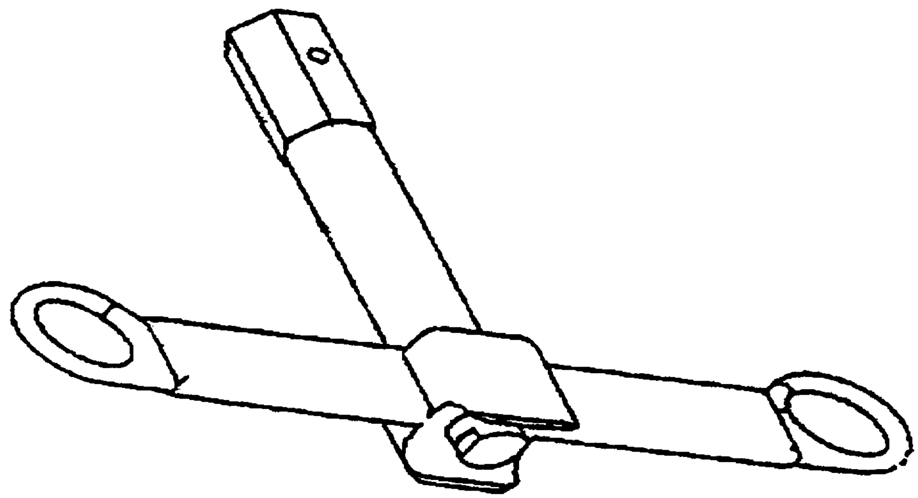
CONNECTOR, ZERO–G ELECTRICAL

Technical Information	
Part number	40M39580
Weight	1.4 lb
Material/ construction	Limited life items – TBD Lubricants – TBD Metallics – Aluminum alloy backshell Nonmetallics – Composite backshell, silicone elastomer seal
Load rating	TBD lb soft dock TBD lb axial lock
Temperature range	TBD
Quantity flown	Numerous on each SSF flight
Stowage	SSF external utility trays, internal bulkheads, truss–mounted EVA utility ports, SSRMS base utility ports, PWP utility ports, external portable floodlight, high torque power tool
Availability	Being refined for SSF

Dimensional Data		
	inches	cm
A	1.8 shell size 15 1.9 shell size 17 2.1 shell size 21 2.4 shell size 25	4.57 4.83 5.33 6.10
B	2.1 shell size 15 2.2 shell size 17 2.4 shell size 21 2.7 shell size 25	5.33 5.59 6.10 6.86
C	2.816 unmated 2.165 mated	7.15 5.50
D	1.725	4.38
E	0.79	2.01



HANDLE, MICROMETEOROID/ORBITAL DEBRIS SHIELD



OVERVIEW

The micrometeoroid/orbital debris (MM/OD) shield handle is designed for use during maintenance of the space station MMOD panels. The handle provides the EVA crew with a means to manipulate and tether the panels after their release. Design of this handle is derived from a similar item used on STS 51–I.

OPERATIONAL COMMENTS

The MMOD handle mates with a receptacle on the panel and is installed and removed after pushing a safety button. A safety lock should prevent accidental disengagement while transporting the MMOD panel. The number of handle interfaces per panel is unknown at this time. The volume and mass of each panel is similarly indeterminate.

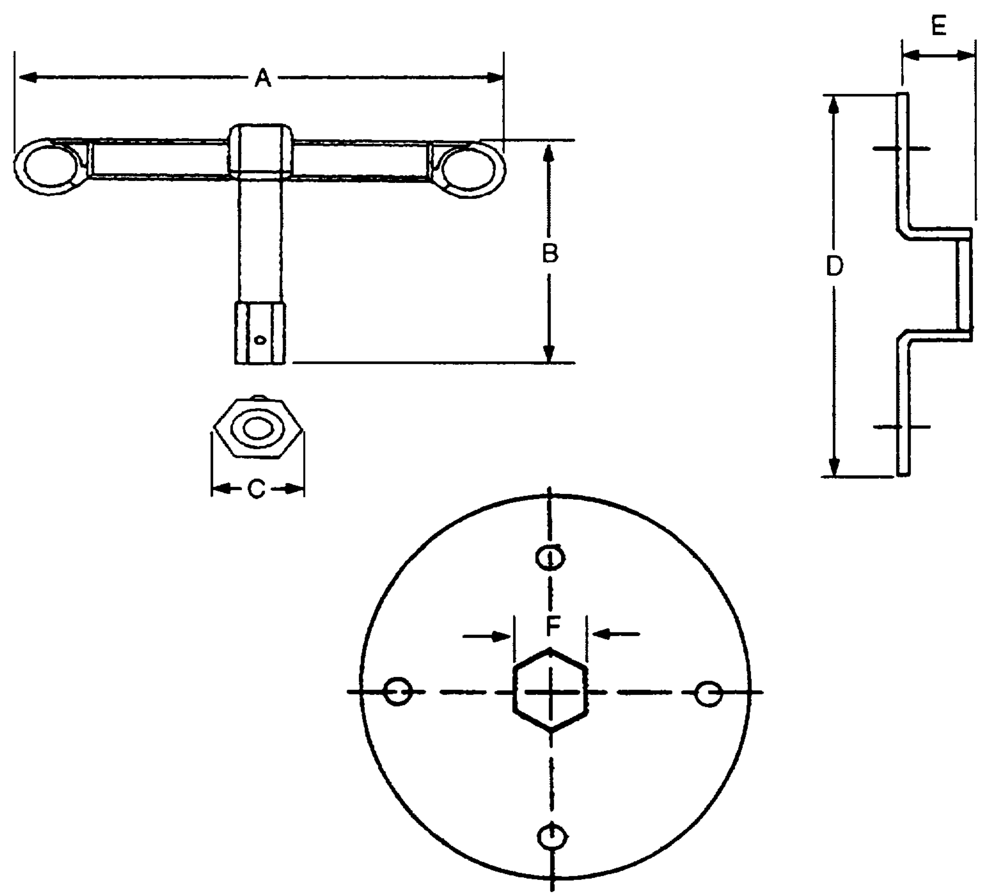
CONTACTS

Operational: Robert Trevino, JSC/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

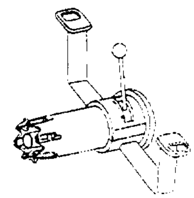
HANDLE, MICROMETEOROID/ORBITAL DEBRIS SHIELD

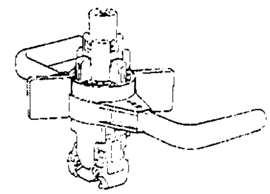
Technical Information	
Part number	
Weight	
Material/ construction	
Load rating	
Temperature range	
Quantity flown	
Stowage	
Availability	In development for SSF

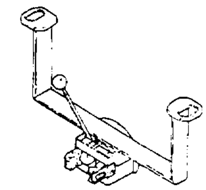
Dimensional Data		
	inches	cm
A	5.88	14.94
B	3.62	9.19
C	0.566	1.44
D	2.57	6.53
E	0.875	2.22
F	0.50	1.27



HANDLES, ORU







OVERVIEW

This family of orbital replacement unit (ORU) handles attaches to the various fittings that have been proposed as force/torque reaction interfaces for both robotic and extravehicular activity (EVA) equipment. The handles and their fittings are intended for Space Station Freedom (SSF) applications, but could be used on any spacecraft. The small size and weight of the fittings permit robotic and EVA handling of equipment being replaced on orbit while minimizing the weight associated with permanently fixed structure like large grapple fixtures. Several interfaces are being developed as proposed standards and all serve the same basic functions. SPAR is developing the H–handle and the micro fittings. Oceaneering Space Systems (OSS) is working on the conical and the microconical interfaces. Handles have been developed for the each of these fittings.

Two handles are baselined for SSF to allow parallel tasks by independent EVA crew. The crew and equipment translation aid (CETA) cart tool box has stowage fittings on its exterior to accommodate these handling aids when not in use. One will normally be stowed on each CETA cart. Both the handle arrangement and ORU fittings are designed to preclude clearance interference with adjacent ORU's. All handle components will be thermally hardened for long term exposure at worksites to reduce EVA overhead.

OPERATIONAL COMMENTS

One of the handles developed by SPAR attaches to both the micro and H–handle fittings. A control lever drives grippers to engage the ORU fittings. The lever rotates counterclockwise to lock and clockwise to unlock. Soft dock is provided in the unlocked lever position. Immediate hard dock is feasible when the lever is left in the locked position. The attached handles can be freely rotated about the interface and locked in the preferred orientation. Tether points are located at the end of each hand grip. A second handling aid from SPAR is commonly called the "ice cream scoop" because of its similarity to the common household utensil. It has a single handgrip and an actuating tab that releases and engages locking fingers. These fingers fit over the SPAR microfitting.

OSS has developed another handle that also attaches to both the micro and the H–handle fittings and uses a control lever to drive grippers for ORU fitting engagement. In the lever's intermediate position, soft dock is possible. The lever is rotated clockwise for hard dock and fully counterclockwise for ORU release. A different set of hard/soft dock settings is used for the two types of ORU interfaces. These handgrips are fixed in one orientation. Tether points are located at the end of each hand grip. OSS has developed a similar handling aid for the **microconical** fittings. The actuating lever and handles are nearly identical in function to the other OSS ORU handle.

These handles generally accommodate two–handed installation with soft dock and linear/angular misalignment tolerance functions, but further work is needed in several areas. Single–handed manipulation with a non–slip handle at the ORU/handle center of gravity should be provided. A redundant lock should be added for hard dock to preclude inadvertent ORU release. Better clearance is needed between the handles and ORU fasteners. In addition, rigid restraint of the ORU and handle to the crewmember must be addressed to ensure minimal interference with two–handed free translation.

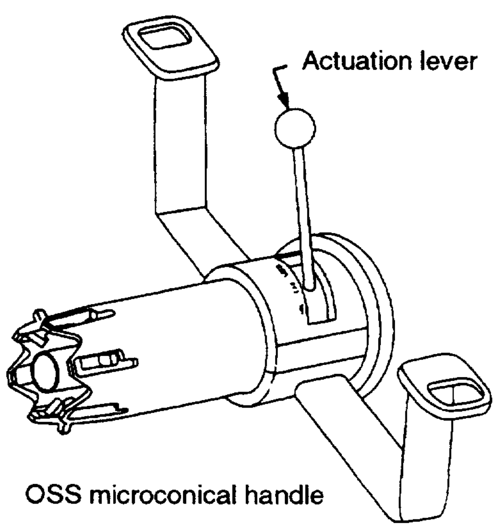
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

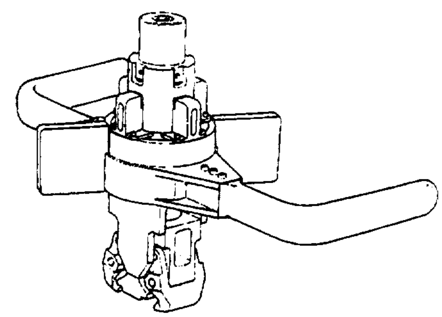
HANDLES, ORU

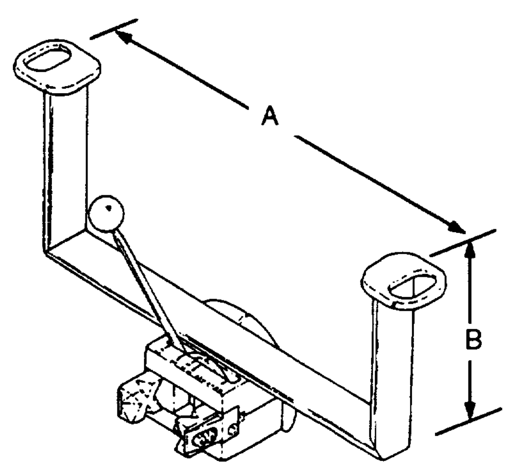
Technical Information	
Part number	
Weight	5 lb (approx)
Material/ construction	Limited–life terms – TBD Lubricants – TBD Metallics – Aluminum, stainless steel Nonmetallics – TBD
Load rating	1200 lb ORU (max., reduced performance) 45– by 50– by 84–in. ORU (max.)
Temperature range	–65° to +180° F
Quantity flown	Two on MB–7
Stowage	CETA cart tool box
Misalignment tolerance	± 0.50 in. linear, ± 15° (SPAR H–handle) ± 0.25 in. linear, ± 10° (SPAR micro) ± 0.25 in. linear, ± 15° rotation, ± 7° angular (OSS microconical)
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	13.8	35.0
B	5.3	13.5



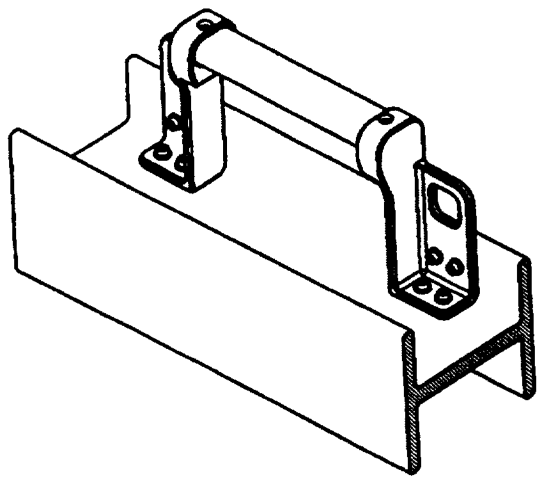
OSS microconical handle

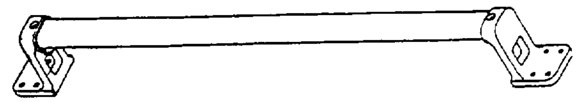

SPAR micro and H–fixture handle

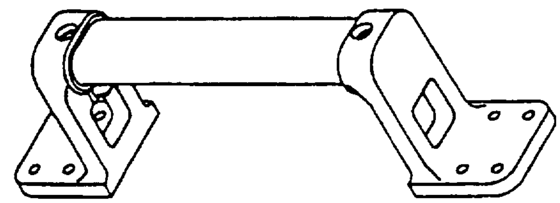


OSS micro and H–fixture handle

HANDRAIL/HANDHOLD, GROUND INSTALLED







OVERVIEW

Ground–installed handholds and handrails are identical except for length. Both are used as translation aids and as body/equipment restraints. They are located along planned translation routes and at worksites. Where clearances with the orbiter payload bay envelope are adequate, these ground–installed units are preinstalled. An on–orbit installed version is required when the clearances are too tight. Each unit consists of a pair of standoffs and a length of handrail tubing. Special side–mounted units have been designed for attachment to the inside channels of the various preintegrated truss beams.

OPERATIONAL COMMENTS

Each standoff is attached by four bolts. Crew–induced tether load is limited to 200 lb and relies upon a load–alleviating waist tether. The oval cross–section tube is baselined for these handrails. Each assembly is anodized yellow to indicate its rating as a crew safety tether point and to ensure limited color fading with time. The extravehicular mobility unit (EMU) mini–workstation end effector is commonly attached to tether points like this as an added aid for free floating body restraint. Small and large wrist and waist tether hooks are accommodated by the tether point design. Small and large french hook attachment is also accommodated. Spacing between handrails along translation paths is set at a maximum of 24 in., but should be continuous along frequently used routes.

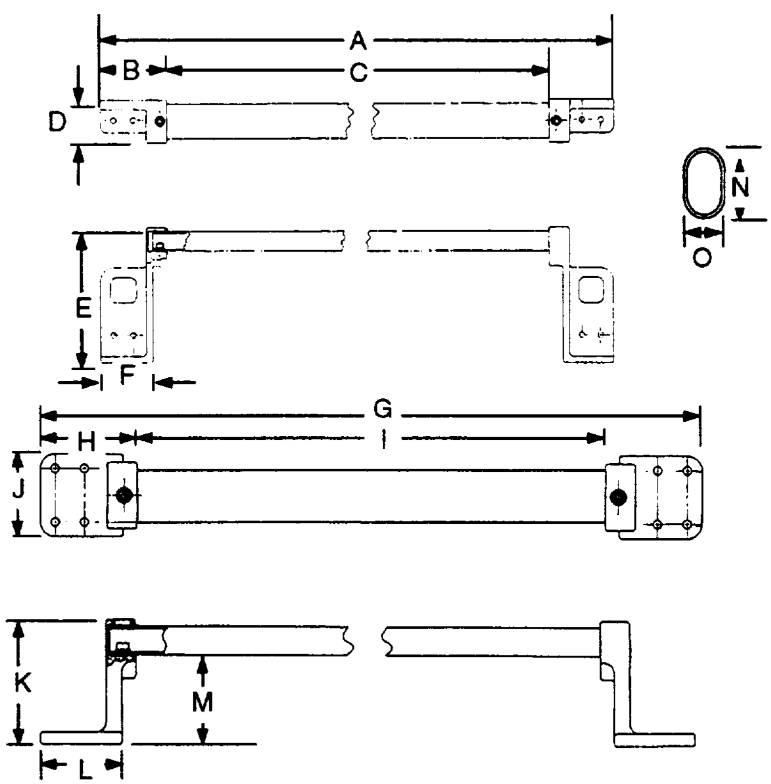
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

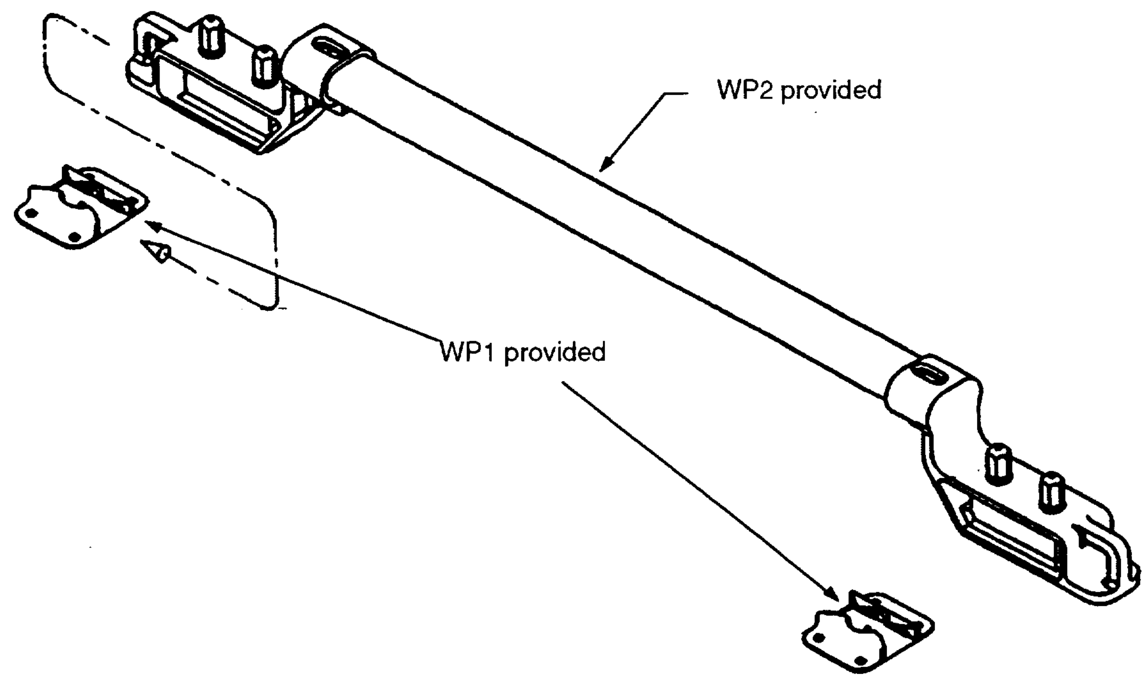
HANDRAIL/HANDHOLD, GROUND INSTALLED

Technical Information	
Part number	5835755–501 (handhold, top mounted) 5835754–501 (handrail, top mounted) 5848233–501 (handhold, tall side mounted) 5848232–501 (handrail, tall side mounted) 5848233–503 (handhold, short side mounted) 5848232–503 (handrail, short side mounted)
Weight	0.76 lb (handhold, top mounted) 1.15 lb (handrail, top mounted) 1.33 lb (handhold, tall side mounted) 1.71 lb (handrail, tall side mounted) 1.19 lb (handhold, short side mounted) 1.56 lb (handrail, short side mounted)
Material/ construction	Limited–life items – None Lubricants – None Metallics – Aluminum alloy, CRES fasteners Nonmetallics – Vibratite
Load rating	187–lb handrail tube 200–lb tether point plus factor of safety of 4.0 One 450–lb crew with 150 lb equipment at 4 fps
Temperature range	–65° to +180° F
Quantity flown	503 sites starting with MB1 (handholds) 710 sites starting with MB1 (handrails)
Stowage	N/A
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	28.03 H/R 11.03 H/H	71.20 28.02
B	2.562	6.507
C	22.906 H/R 5.906 H/H	58.181 15.001
D	1.700	4.318
E	5.950 tall 5.250 short	15.113 13.335
F	2.00	5.08
G	27.775 H/R 14.382 H/H	70.549 36.530
H	2.438	6.193
I	22.899 H/R 5.899 H/H	58.163 14.983
J	2.125	5.398
K	3.170	8.052
L	2.088	5.305
M	2.25	5.72
N	1.380	3.505
O	0.740	1.880



HANDRAIL, ON–ORBIT INSTALLED



OVERVIEW

Like other types of handrails, this handrail is used as a translation aid and as a body/equipment restraint. It is located along planned pressurized module translation routes and worksites. Where clearances with the orbiter payload bay envelope are adequate, ground–installed units are preattached. This on–orbit installed version is required when the clearances are too tight. Each unit consists of a pair of standoffs and a length of handrail tubing. WP1 provides the seat track and debris shield clearance for attachment to pressurized modules.

OPERATIONAL COMMENTS

Each standoff is attached by two 7/16–in. EVA–compatible captive bolts. Crew–induced tether load is limited to 200 lb and relies upon a load–alleviating waist tether. The oval cross–section tube is baselined for these handrails. Each assembly is anodized yellow to indicate their rating as a crew safety tether point and to ensure limited color fading with time. The EMU mini–workstation end effector is commonly attached to tether points like this as an added aid for free–floating body restraint. Small and large wrist and waist tether hooks are accommodated by the tether point design. Small and large french hook attachment is also accommodated. Restraint during transport to the installation site is TBD.

Installation is supported by several design aids. An arrow on the underside of the handrail indicates the proper engagement direction. The quick shoe fitting of the leading standoff has a tongue for easier initial engagement. Final alignment is assisted by a detent between each standoff and the preattached quick mount.

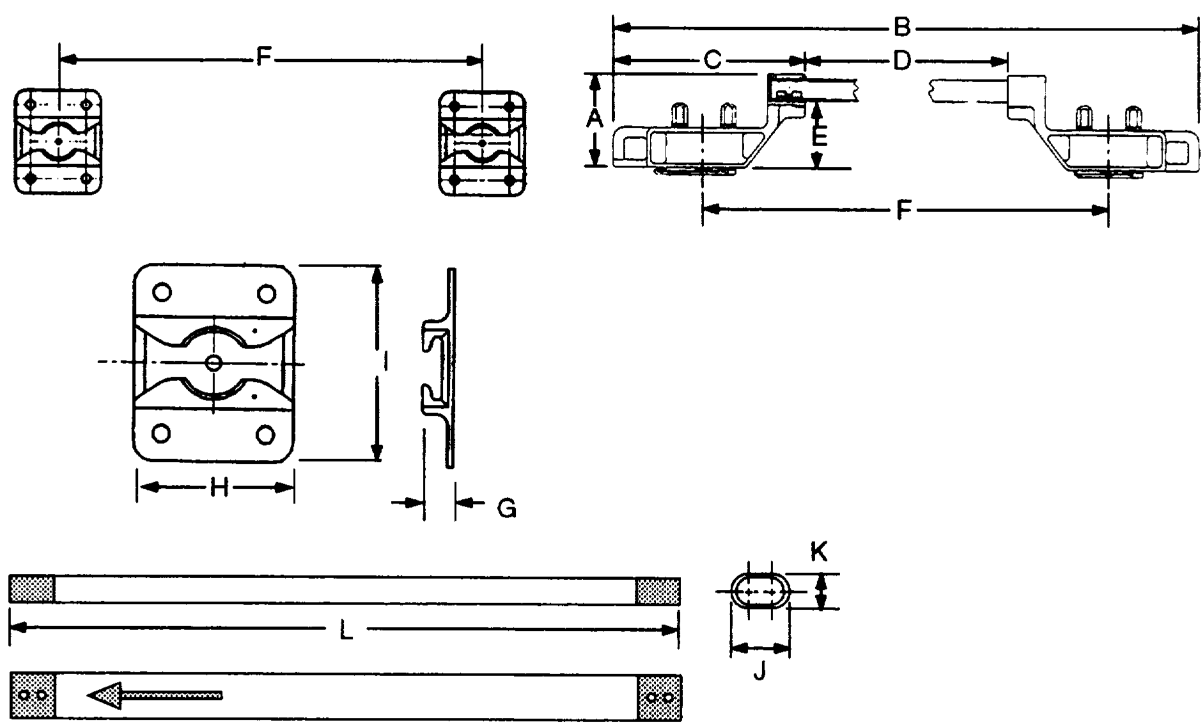
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

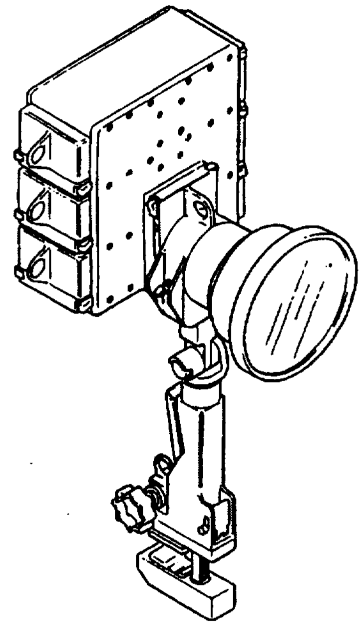
HANDRAIL, ON–ORBIT INSTALLED

Technical Information	
Part number	5844339–501 (handrail) F375166 (WP1 seat track)
Weight	2.24 lb
Material/ construction	Limited life items – None Lubricants – None Metallics – Anodized aluminum alloy, CRES fasteners Nonmetallics – Vibratite
Load rating	187–lb handrail tube 200–lb tether point plus factor of safety of 4.0 One 450–lb crew with 150–lb equipment at 4 fps 5–lb installation force 75–in–lb fastener torque
Temperature range	–65° to +180° F
Quantity flown	TBD sites starting with MB5
Stowage	TBD
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	3.20	8.13
B	29.76	75.59
C	6.375	16.19
D	17.01	43.21
E	2.28	5.79
F	24.000	60.96
G	0.380	0.965
H	2.000	5.08
I	2.500	6.35
J	1.380	3.505
K	0.750	1.91
L	19.510	49.56



LIGHT, PORTABLE EXTERNAL



OVERVIEW

The external portable light provides localized illumination during extravehicular activity (EVA) assembly and maintenance tasks. It also lights up the crew and equipment translation aid (CETA) translation corridor when mounted on the cart. It's design is based upon the Hubble Space Telescope (HST) floodlight. Power for the incandescent lamp comes from up to six large battery packs (common to the high torque power tool) or from external utility outlets via an 8–ft long detachable power cord. There are four external outlets distributed over the Space Station Freedom (SSF) truss and another three on the portable work platform (PWP) temporary equipment restraint. The light features an adjustable clamping jaw with a positive open/close mechanism for attachment to a wide variety of structures. Only a tether ring is provided for light restraint during crew transport.

OPERATIONAL COMMENTS

The floodlight has a manual on/off switch as well as an auto on/off function that works using an ambient light sensor to conserve battery power. Like the power tool, it has a detachable power cord with integrated 120 – 28 V dc converter. Low battery charge (26.4 V dc) is indicated by an intermittent blinking light. An automatic low voltage cutoff switch deactivates the light at 19.2 V dc. Multiple installed batteries are discharged in parallel. The batteries cannot be charged while still installed on the light. A battery installation switch prevents light activation before full battery insertion. Battery recharge and battery module stowage are accommodated only inside the orbiter middeck or the SSF airlock. This reduces EVA time associated with battery maintenance and allows pre–EVA battery checkout. Power consumption is 55 W at 28 V dc.

The clamping jaws are actuated by a squeeze lever and lock button. They are adjustable from 1/8 in. to 3.7 in. Clamp force is adjustable by a knob. An elastomer covers the jaws to protect the clamped surfaces. The lamp head tilts from –45° to +90° and pans a full 360°. The head is separable from its handle via a pushbutton quick disconnect. Stowage accommodations are provided in the airlock external tool box and in the CETA tool box. Because of thermal constraints, the light is not designed for long–term stowage outside the various tool boxes, unless it is protected by its multilayer insulation bag. Two lights are baselined to allow parallel tasks by independent EVA crew.

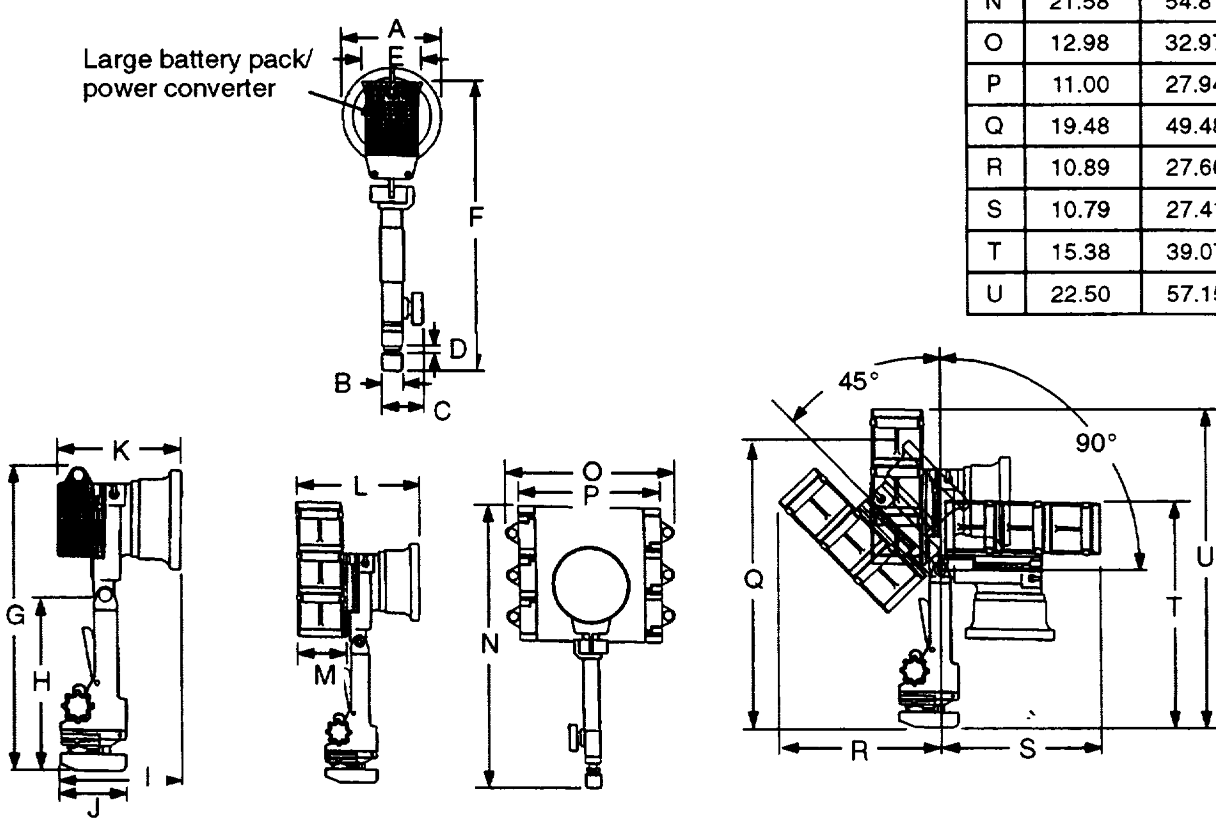
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

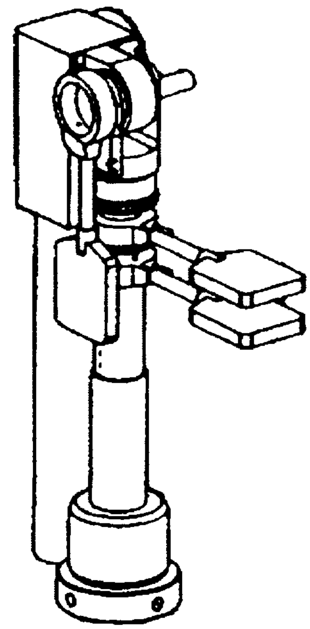
LIGHT, PORTABLE EXTERNAL

Technical Information	
Part number	5832351–501 18901–10006–301
Weight	13 lb (without battery module and cable) 17.1 lb (with empty battery module and no cable) 30 lb (with full battery load and no cable) 31 lb (with full battery load and attached cable)
Material/ construction	Limited life items – Sealed lamp (400 hr, 2.5 yr min) Lubricants – TBD Metallics – Aluminum alloy Nonmetallics – Lexan lens
Load rating	28 V dc 55 W 30 min/battery or 3 hr/6 batteries 4 fps lens impact rating 120° F max. touch temperature 13–26 lb clamp force (adjustable) 30 ft–candle illumination at 10 ft at center of 60° pattern
Temperature range	–65° to +180° F
Quantity flown	2 (MB1) no power cord 2 (MB7) with power cord
Stowage	UBA/CETA tool box or airlock exterior tool box
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	6.00	15.24
B	1.20	3.05
C	2.42	6.15
D	3.70	9.40
E	3.60	9.14
F	18.47 22.17	47.22 56.31
G	18.59 22.29	47.22 56.31
H	10.75 14.45	27.31 36.70
I	7.40	18.80
J	4.00	10.16
K	7.56	19.20
L	9.25	23.50
M	3.75	9.53
N	21.58	54.81
O	12.98	32.97
P	11.00	27.94
Q	19.48	49.48
R	10.89	27.66
S	10.79	27.41
T	15.38	39.07
U	22.50	57.15



ORU TRANSFER DEVICE



OVERVIEW

The orbital replacement unit (ORU) transfer device (OTD) enables the relocation of objects between worksites. It is intended to avoid the need for robotic or multiple crewmember transport of large ORU's. It has a manually extendable mechanical boom. The OTD can be installed in any standard portable foot restraint (PFR) socket on the truss, the crew and equipment translation aid (CETA) cart, the unpressurized logistics carrier (ULC), or other suitable sites. It is sized to hold large ORU's (up to 1200 lb and the size of a telephone booth). One will normally be stowed on each CETA cart. Two are baselined for Space Station Freedom (SSF) to allow parallel tasks by independent extravehicular activity (EVA) crew.

OPERATIONAL COMMENTS

Due to its large size (mass and volume), manual transport of the OTD itself between worksites or setup/teardown at worksites or stowage sites can be performed only by two crewmembers. Space station remote manipulator system transport will be the preferred method to maintain crew independence for unassisted maintenance tasks in parallel. Since the OTD is not designed for unaided robotic stowage and deployment, the EVA crew will have to provide this assistance. The OTD has a built–in load alleviation device to protect the SSF structure from anticipated EVA crew and ORU loads during operation as well as while stowed during SSF reboost. The mounting interface uses a standard 1.0–in. hex probe and is therefore compatible with normal PFR sockets. The OTD carries its own PFR socket pip pin to reduce socket–related weight. A rotating pitch joint on each CETA cart gives the OTD an extra reach toward difficult–to–access faces of the truss.

When the OTD is installed with an attached object to relocate, a single crewmember has control over independent yaw and pitch levers for guidance to the intended destination. A boom extension crank deploys the boom linearly from 44 to 186 in. Larger masses must be deployed more slowly. The exact ORU interface at the end of the boom has not yet been determined. All OTD components have been thermally hardened for long–term exposure at worksites to reduce EVA overhead.

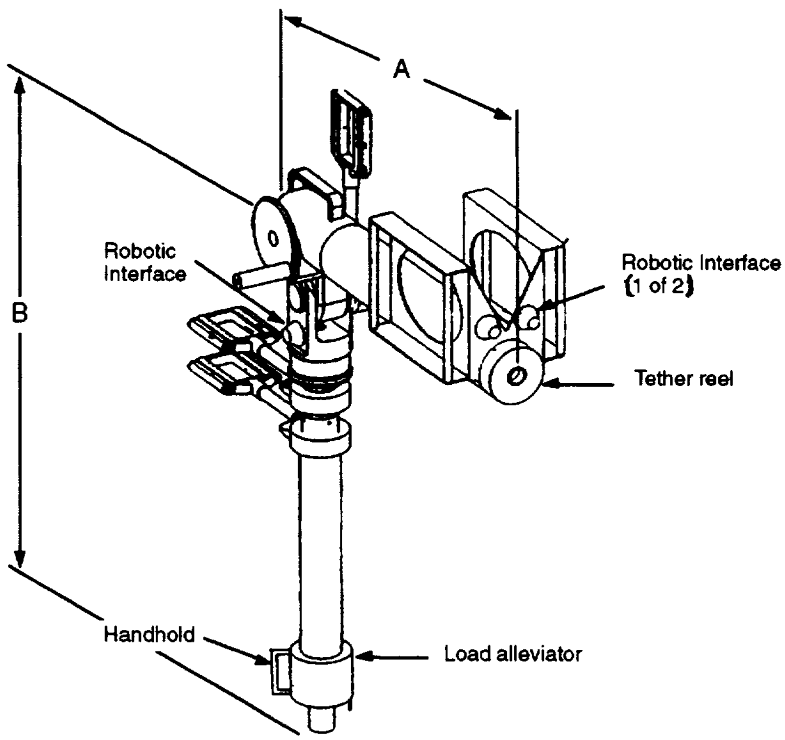
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

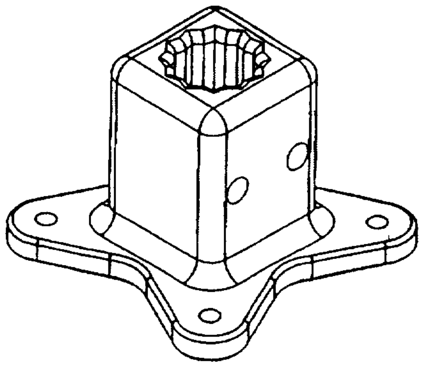
ORU TRANSFER DEVICE

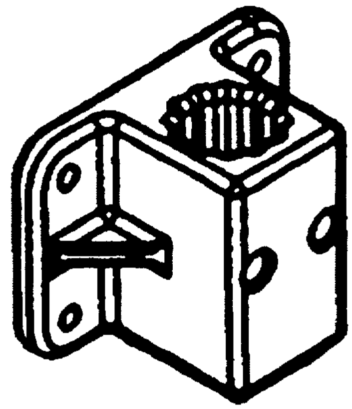
Technical Information	
Part number	5844327-501
Weight	188.9 lbs
Material/ construction	Limited life items – TBD Lubricants – TBD Metallics – Aluminum alloys, CRES Nonmetallics – TBD
Load rating	600 lb ORU (nominal) 1200 lb ORU (max., reduced performance) 45 X 50 X 84 in. ORU (max.)
Temperature range	–65° to +180° F
Quantity flown	2 on MB7
Stowage	CETA cart
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	44.0 186.0	111.76 472.44
B	60.0	152.40



PFR WORKSITE INTERFACE





OVERVIEW

The portable foot restraint (PFR) worksite interface has a 12–point socket that secures a variety of extravehicular activity (EVA) devices to the Space Station Freedom (SSF) structure. The sockets are located along planned translation routes and at worksites. Where clearances with the orbiter payload bay envelope are adequate, ground–installed units are used. An on–orbit–installed version is required when the clearances are too tight. Each socket has redundant holes for a 3/8–in.–diameter pip pin provided by the mating device. This saves on socket–related weight. The sockets are commonly used at the airlock, at each unpressurized logistics carrier (ULC), on the crew and equipment translation aid (CETA) cart, on the space station remote manipulator system end effector, and at local assembly and maintenance worksites. A special side mounted unit has been designed for attachment to the inside channels of the preintegrated truss beams.

OPERATIONAL COMMENTS

The articulating PFR (APFR), the ORU transfer device (OTD), the CETA cart EVA tool stowage device, and the orbiter PFR all mate with this 1.0–in. socket. Crew–induced load is limited to 100 lb shear and 4200 in–lb torsion and relies upon a load alleviator built into the APFR. Each assembly is anodized white for easy crew recognition and to ensure limited color fading with time. Each socket is attached by four bolts. The on–orbit installed units have captive 7/16–in. EVA bolts and thread into 1/4–in. Zip nuts. Because of higher loads, a larger version of this socket (1.5–in. receptacle) is required by the portable work platform (PWP) temporary equipment restraint aid and PWP workstation stanchion and is provided by the APFR and the PWP stowage device kit. To ensure electrical grounding of large attached foot restraints and stanchions, a leaf spring contact is built into the base of each socket.

An improved design that will use the same bolt hole mounting pattern is in work. This new design is intended to replace the hex probe and socket with a more EVA friendly interface. It should reduce crew overhead by having better insertion alignment, a soft–dock feature, more rigid hard dock, and robotic compatibility. The vehicle–mounted half will be passive while the active mechanisms are on the APFR.

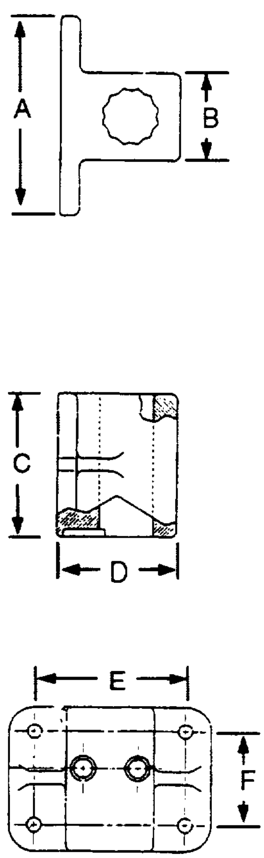
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

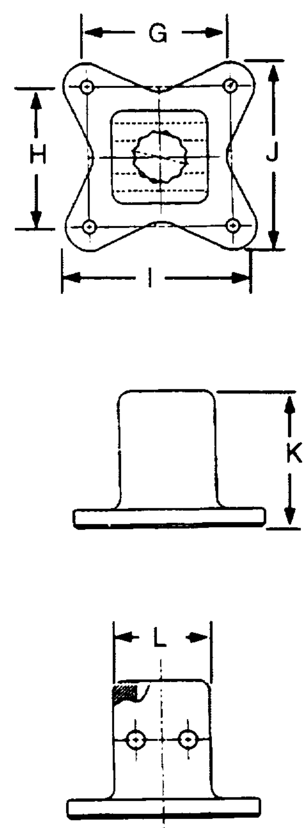
PFR WORKSITE INTERFACE

Technical Information	
Part number	5835758–501 (ground installed, top mounted) 5848234–501 (ground installed, side mounted) 58XXXXX–501 (on–orbit installed)
Weight	1.15 lb (ground installed, top mounted) 1.22 lb (ground installed, side mounted) 1.XX lb (on–orbit installed)
Material/ construction	Limited–life items – None Lubricants – None Metallics – Anodized aluminum alloy castings, CRES fasteners, CRES leaf spring grounding Nonmetallics – Vibratite
Load rating	100 lb shear and 4200 in–lb torsion/bending
Temperature range	–65° to +180° F
Quantity flown	498 sites starting with MB1 (ground installed) TBD sites starting with MB1 (on–orbit installed)
Stowage	N/A
Availability	In development for SSF, major redesign in progress

Dimensional Data		
	inches	cm
A	4.000	10.16
B	1.75	4.45
C	2.875	7.303
D	2.375	6.033
E	3.000	7.62
F	1.875	4.763
G	3.000	7.62
H	3.00	7.62
I	4.00	10.16
J	4.00	10.16
K	2.875	7.303
L	2.00	5.08

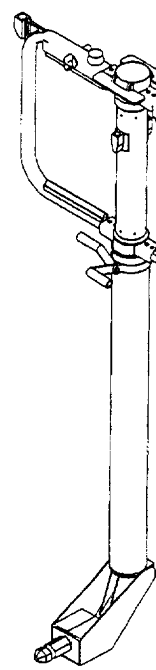


5848234



5835758

PFR WORKSTATION STANCHION (SSF)



OVERVIEW

The portable foot restraint (PFR) workstation stanchion is a component of the portable work platform (PWP). It serves as an ingress and egress aid. It holds up to four single–sided tool boards or two double–sided boards. Several small equipment receptacles are mounted on the stanchion. When in use, it will be plugged into the base of the articulating portable foot restraint (APFR). When not in use, the stanchion is either stowed on the APFR or in the load–alleviating socket of the PWP stowage kit. These precautions are required to protect Space Station Freedom (SSF) structure. Two stanchions are baselined for SSF.

OPERATIONAL COMMENTS

Because of the large size (mass and volume) of the stanchion, manual transport between worksites or setup/teardown at worksites or stowage sites is reliant upon a semirigid tether for a single crewmember. The second crewmember may have to assist if this aid or the space station remote manipulator system (SSRMS) is not available. The stanchion is not currently robotically compatible for worksite setup/teardown. It will commonly be used at each unpressurized logistics carrier (ULC), on the crew equipment translation aid (CETA) cart, on the SSRMS, or at local oribtal replacement unit (ORU) worksites. The stanchion has a larger than normal 1.5–in. hex probe for interface with the APFR and the PWP stowage kit. Larger probes are required because of expected high crew/equipment loads. The stanchion carries its own PFR socket pip pin to reduce socket–related weight.

Like the STS manipulator foot restraint stanchion, pitch and yaw of the stanchion about the foot restraint platform is controlled by a pair of levers. The tool carrier also rotates about the stanchion and is controlled by depressing bars on top of the stanchion. A pair of handholds are provided to aid in stanchion installation and removal from a socket. Four bayonet receptacles and two microconical fittings provide small equipment retention. All stanchion components have been thermally hardened for long–term exposure at worksites to reduce extravehicular activity overhead.

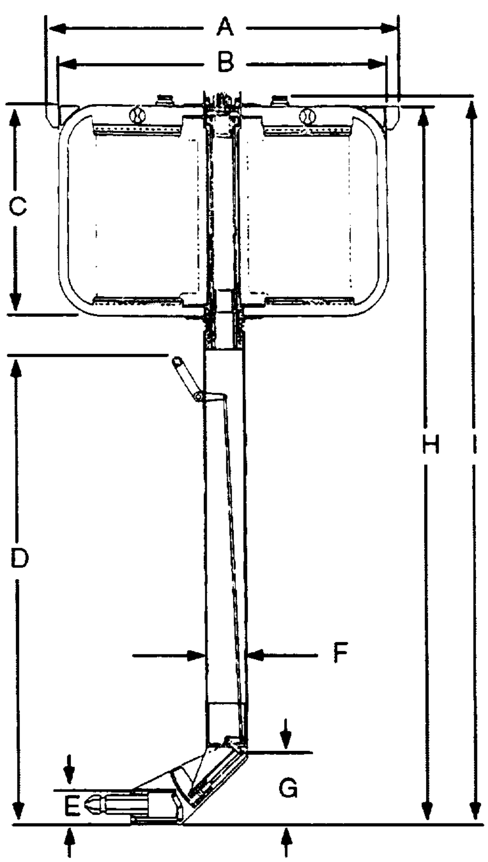
CONTACTS

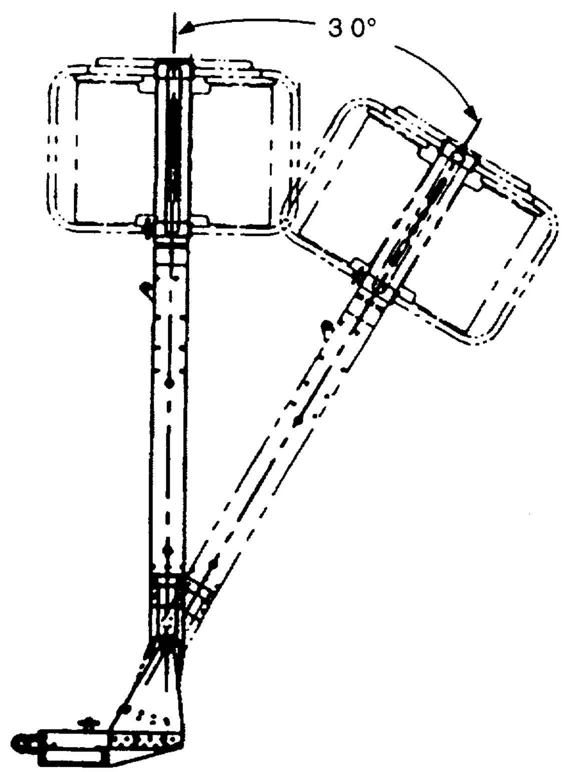
Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

PFR WORKSTATION STANCHION (SSF)

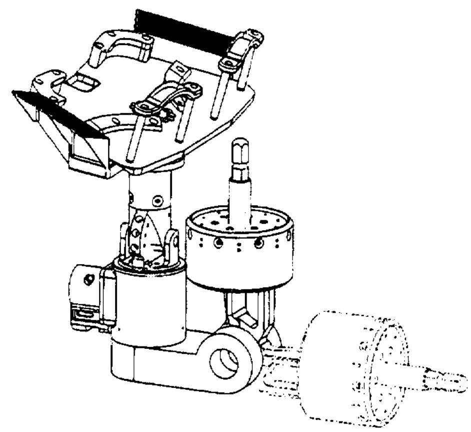
Technical Information	
Part number	5832355–501
Weight	39 lb (unloaded)
Material/ construction	Limited life items – None Lubricants – TBD Metallics – Aluminum alloys, CRES
Load rating	125–lb kickload applied at top of the stanchion
Temperature range	–65° to +180° F
Quantity flown	2 on MB1
Stowage	SSRMS base; attached to APFR on CETA, ULC or truss
Articulation	Yaw: ±360°, 8 pos, 45° increments (right lever) Pitch: 30°, 5 pos, 6° increments (left lever) Roll: ±360°, 8 pos, 45° increments
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	28.1	71.37
B	26.1	66.29
C	17.1	43.43
D	37.2	94.49
E	2.8	7.11
F	3.2	8.13
G	5.8	14.73
H	58.0	147.32
I	59.3	150.62





PORTABLE FOOT RESTRAINT, ARTICULATING



OVERVIEW

The articulating portable foot restraint (APFR) is a component of the portable work platform (PWP). When integrated into the PWP, the APFR is used as an adjustable foot restraint and is the core for attachment of equipment stanchions. The APFR attaches to any standard PFR socket, to the space station remote manipulator system (SSRMS) via the temporary equipment restraint aid (TERA), or directly to end effector's built-in PFR socket. Adjustment mechanisms are provided for foot plate yaw, pitch, and roll as well as work stanchion yaw about the foot plate. The pitch joint folds up to minimize the APFR's transport volume. A load-alleviation device protects Space Station Freedom (SSF) structure from crew and equipment loads. Eight APFR's are baselined for SSF. Two will be dedicated for PWP use.

OPERATIONAL COMMENTS

Because of the large size (mass and volume) of the APFR, manual transport between worksites or setup/teardown at worksites or stowage sites is reliant upon a semirigid tether for a single crewmember. The second crewmember may have to assist if this aid or the SSRMS is not available. The APFR is not currently robotically compatible for worksite setup/teardown. The APFR will commonly be used at each unpressurized logistics carrier (ULC), on the crew equipment translation aid (CETA) cart, on the SSRMS end effector socket, on the SSRMS via the TERA, or at local ORU worksites. The APFR has a normal 1.0–in. hex probe for interface with all standard PFR sockets and carries its own PFR socket pip pin to reduce socket related weight. It accepts the larger 1.5–in. hex probe of the PWP workstanchion. This larger socket is required because of expected high crew/equipment loads. The 1.0 inch hex probe is being replaced with a TBD extravehicular activity (EVA)/robot friendly interface.

Like the Hubble Space Telescope PFR, the crew must remove one boot from the foot restraint to actuate the foot platform roll and yaw controls. Pitch adjustments can be performed only by hand before foot restraint ingress. A locking device prevents the left boot from slipping out during yaw repositioning. The attachable workstanchion has its own controls for pitch, yaw, and rotation, which are operable while still in the foot restraint. A pair of integral handholds is provided to aid in APFR installation and removal from a socket. Ingress and egress aids are supplied by handrails at local worksites or by the PWP stanchions. Releasable toe bars and heel clips hold the suited crew's boots. The front of the foot plate has been removed to reduce transport volume and weight. All APFR components have been thermally hardened for long term exposure at worksites to reduce EVA overhead.

With full actuation, the load–alleviation device will translate the crew 8 to 17 in. away from or toward its attachment point. It will bend up to 10° under full load. Loads higher than 50 lb applied at the chest should be avoided.

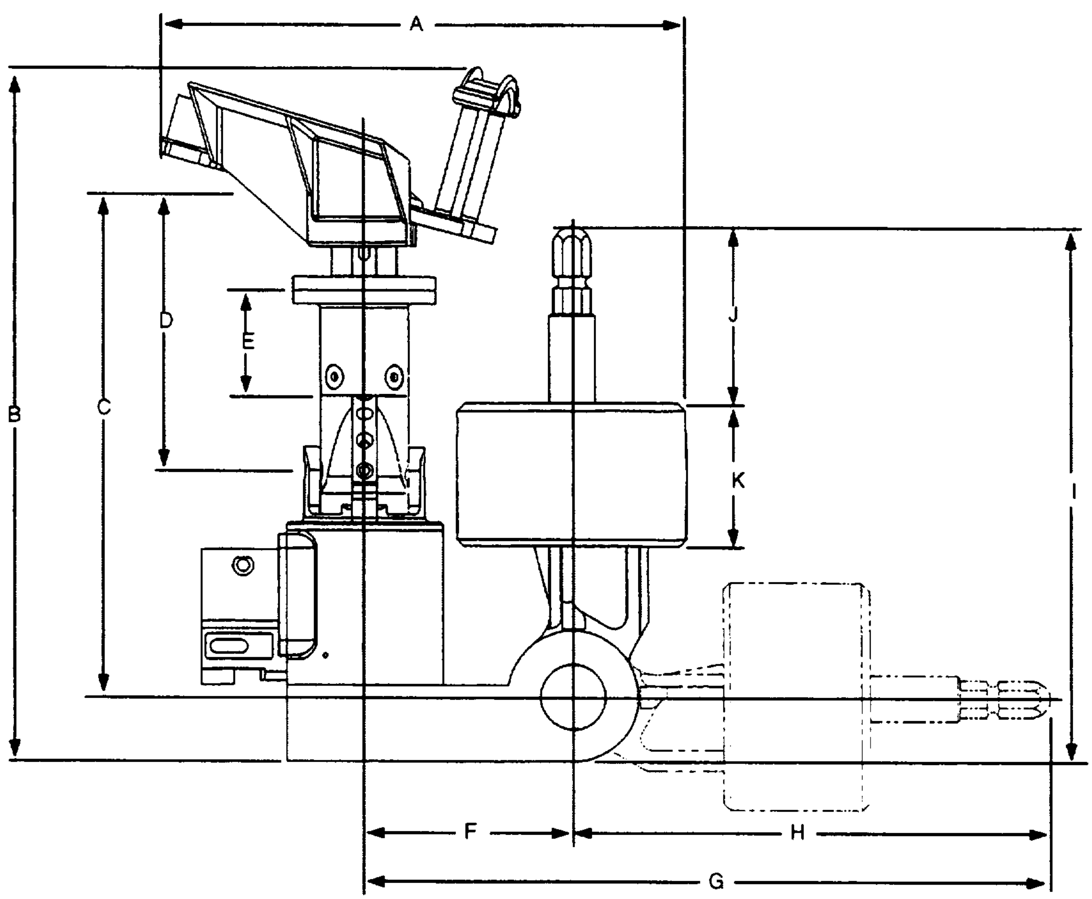
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

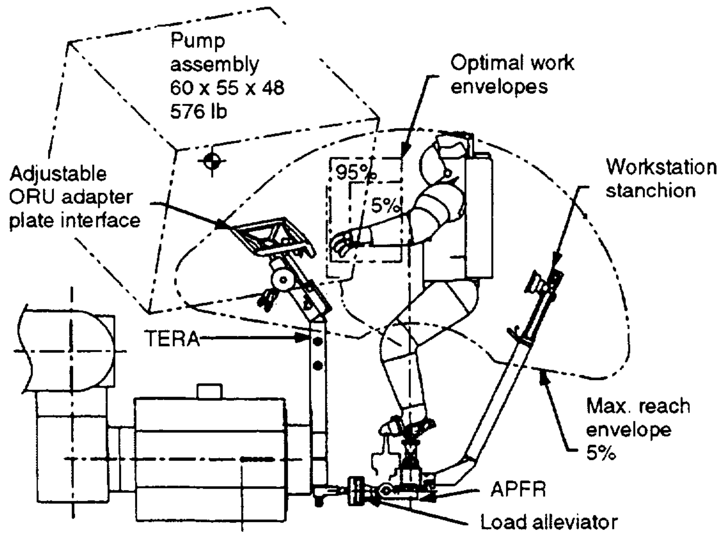
PFR, ARTICULATING

Technical Information	
Part number	5825282–501
Weight	50 lb
Material/ construction	Limited life items – Load alleviator (10 yr) Lubricants – TBD Metallics – Aluminum alloys, CRES
Load rating	50–lb load applied at chest height for load–alleviator slip 4000 in–lb bending load for ±10° deflection 4200 in–lb torsion load
Temperature range	–65° to +180° F
Quantity flown	Two on MB1 Two on MB4 Two on MB7
Stowage	SSRMS base, ULC, CETA, or truss using any std socket
Articulation	Yaw: ± 360°, 12 pos, 30° increments (right pedal) Pitch: ± 135°, 30 pos, 9° increments (manual) Roll: ± 60°, 6 pos, 20° increments (left pedal)
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	16.00	40.64
B	21.62	54.91
C	15.5	39.37
D	8.50	21.59
E	3.28	8.33
F	6.35	16.13
G	20.97	53.26
H	14.62	37.13
I	16.0	40.64
J	5.50	13.97
K	4.50	11.43



PORTABLE WORK PLATFORM



OVERVIEW

The portable work platform (PWP) is an assembly of several separate items that together form a work platform for an extravehicular activity (EVA) crewmember. It is made up of the temporary equipment restraint aid (TERA), the articulating portable foot restraint (APFR) and the portable foot restraint (PFR) workstation stanchion. The PWP restrains the crew via foot restraints for hands–free operations and holds tools and orbital replacement units (ORU's) from a pair of stanchions. The space station remote manipulator system (SSRMS) can grapple the PWP for worksite positioning and translation between worksites. Power to run lights and tools is also available from the SSRMS. Enough components are baselined to allow the assembly of two complete PWP's. One will be dedicated for SSRMS use.

OPERATIONAL COMMENTS

Because of the large size (mass and volume) of the PWP, manual transport between worksites or setup/teardown at worksites or stowage sites can be performed only by two crewmembers. SSRMS transport will be the preferred method to maintain crew independence for unassisted maintenance tasks in parallel. Since the PWP is not designed for unaided robotic stowage and deployment, the EVA crew will have to provide this assistance. When the PWP is not mated to the SSRMS, it must be mated to the load–alleviation features of the PWP stowage kit to protect the SSF structure from anticipated EVA crew loads and vehicle reboost.

The TERA stanchion is sized to accommodate one large ORU. The ORU being replaced must be temporarily stowed elsewhere while the new unit from the TERA is installed. There are two tether hooks on retractable cables for temporary restraint between TERA and the ORU installation location. The three utility outlets provide 120 V dc when powered through the power/data grapple fixture (PDGF) of the SSRMS.

The workstation stanchion serves as an ingress and egress aid and holds up to four single–sided tool boards or two double–sided boards. Two tool caddy bayonet receptacles are mounted below the tool board carrier.

All PWP components have been thermally hardened for long term exposure at worksites to reduce EVA overhead.

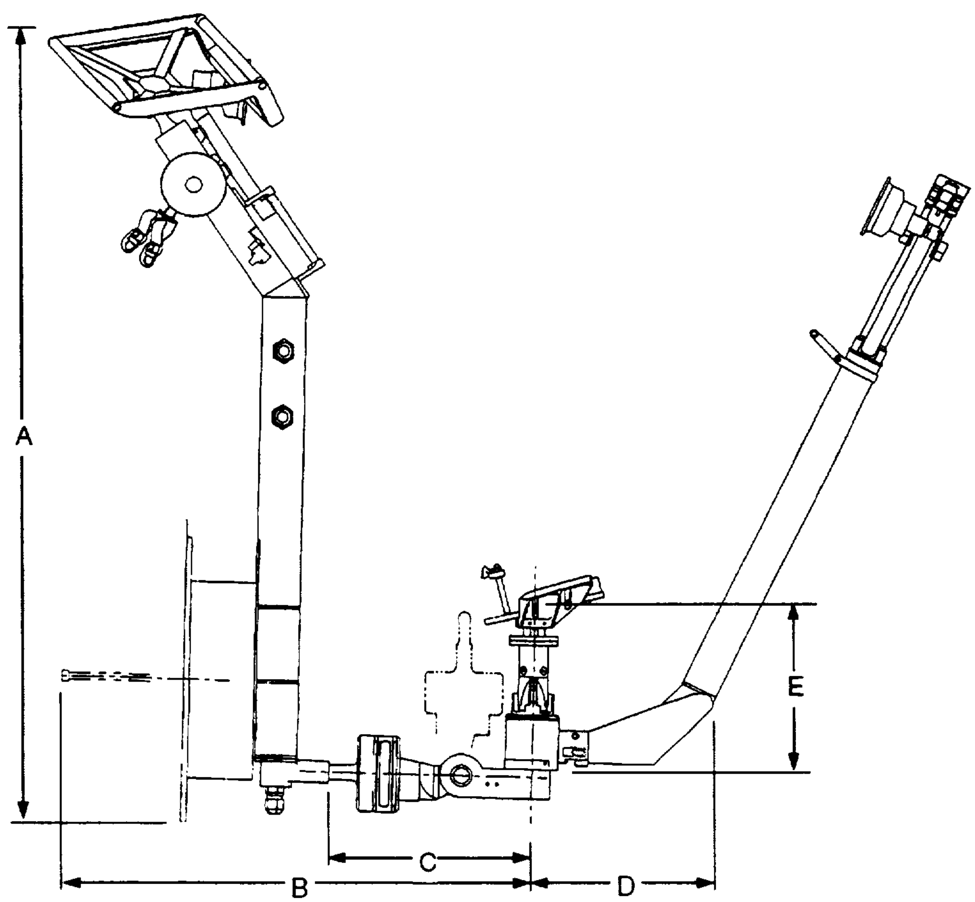
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

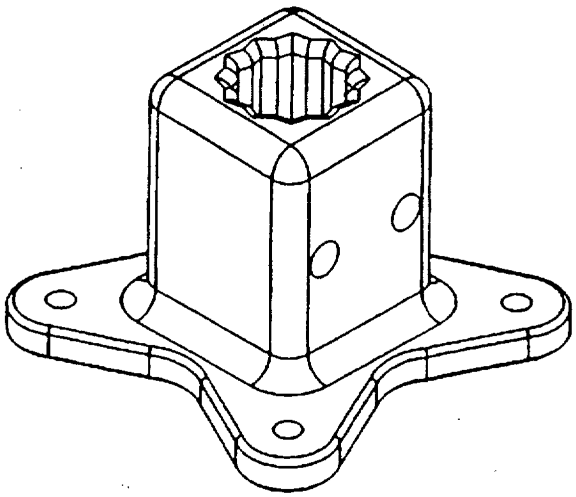
PORTABLE WORK PLATFORM

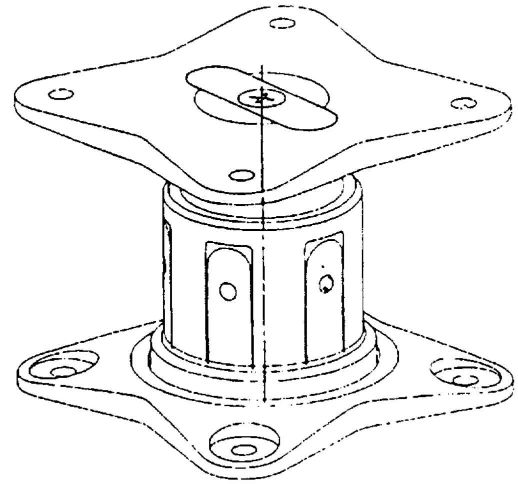
Technical Information	
Part number	
Weight	134 lb without PDGF (TERA, APFR, stanchion) 182 lb with PDGF (TERA, APFR, stanchion)
Material/ construction	Limited life items – Retractable tethers, power cable, load alleviator (10 yr) Lubricants – TBD Metallics – Aluminum alloys, CRES
Load rating	50–lb load applied at chest height for load alleviator slip 50 lb applied at top of the stanchion 600 lb ORU
Temperature range	–65° to +180° F
Quantity flown	Two on MB4
Stowage	SSRMS, SSRMS base, CETA cart, ULC, or truss
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	72.2	183.39
B	42.7	108.46
C	18.3	46.48
D	16.3	41.40
E	15.5	39.37



PORTABLE WORK PLATFORM STOWAGE DEVICE KIT





OVERVIEW

The PWP stowage device kit (PDSK) is a component of the portable work platform (PWP). To protect the Space Station Freedom (SSF) structure from extravehicular activity (EVA) crew or vehicle reboost loads applied to stowed PWP components, the kit features a special load–alleviating socket. This socket includes a spherical ball that slips under excessive load. A large portable foot restraint (PFR) socket is mated to the load–alleviation ball to accommodate the 1.5–in. hex probe of the PWP stanchions. No special protection is needed when the PWP is used with the space station remote manipulator system (SSRMS).

OPERATIONAL COMMENTS

These stowage sockets will be located where the PWP components are commonly stowed (e.g., the SSRMS base, unpressurized logistics carriers (ULC's), and crew and equipment translation aid (CETA) cart). Pip pins for securing PWP components to the sockets will be provided by each component. Compared to orbiter sockets, which each have a pin, this minimizes the number and weight of pins. These sockets are designed only for on–orbit crew and reboost loads and not for launch.

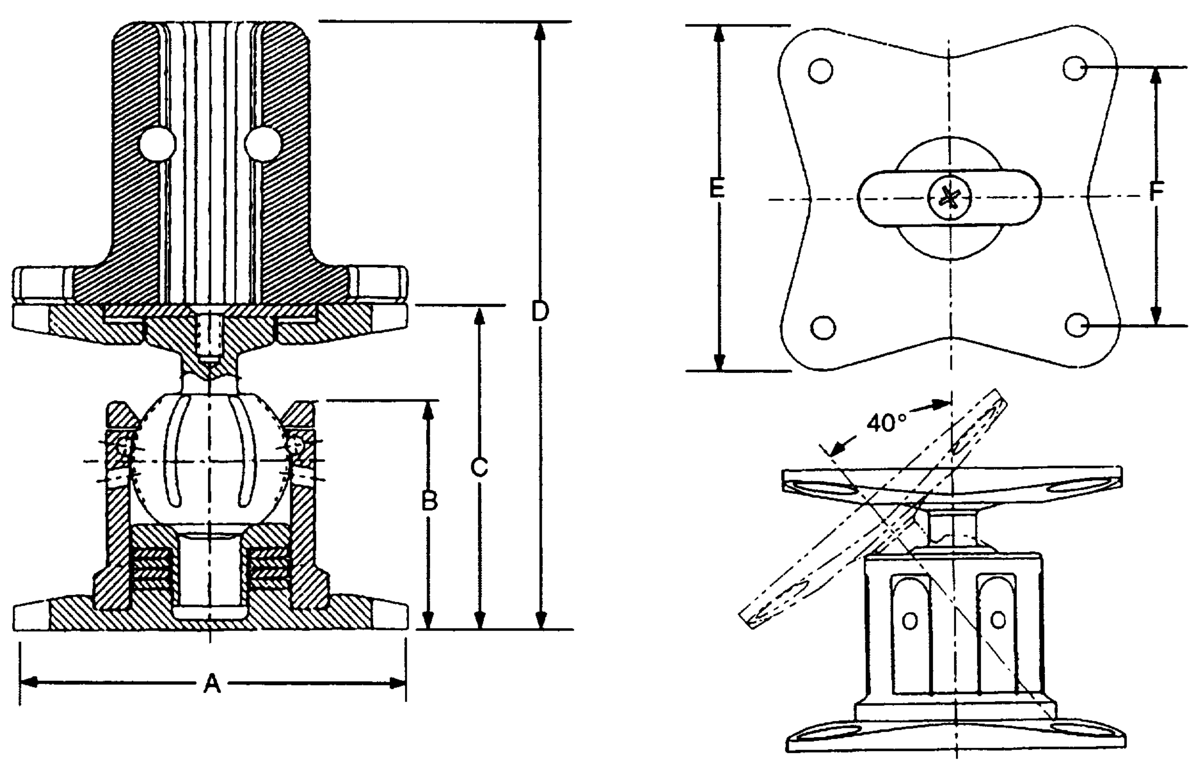
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

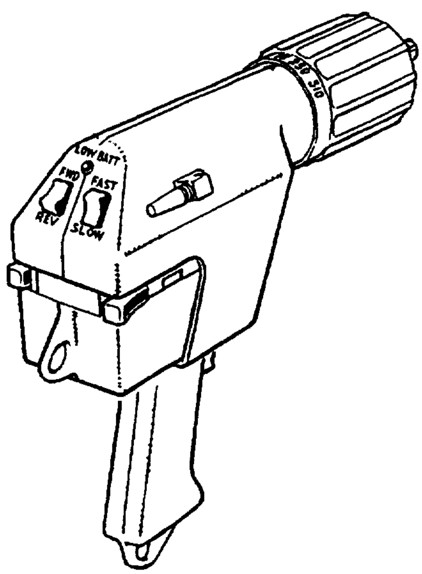
PORTABLE WORK PLATFORM STOWAGE DEVICE KIT

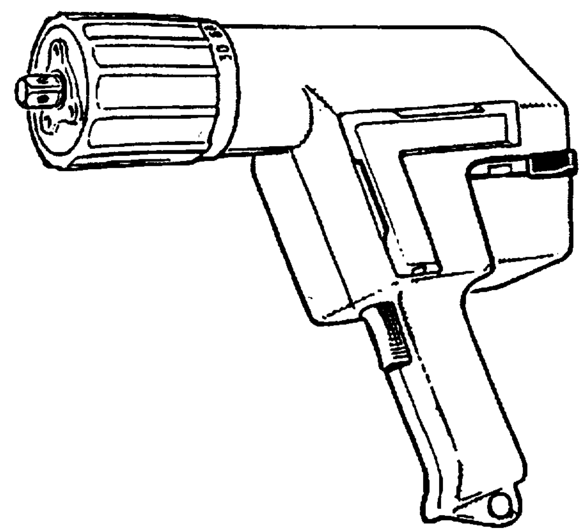
Technical Information	
Part number	
Weight	14.2 lb (each load–alleviating ball/socket)
Material/ construction	Limited–life items – None Lubricants – TBD Metallics – Aluminum alloys, stainless
Load rating	100 lb shear, 4200 in–lb torsion from crew loads 1207 in–lb bending with 0.3g acceleration during SSF reboost
Temperature range	–65° to +180° F
Quantity flown	TBD
Stowage	ULC's, SSRMS base, truss, CETA cart
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	4.000	10.16
B	2.294	5.827
C	3.276	8.321
D	6.156	15.636
E	4.000	10.16
F	3.000	7.62



POWER TOOL, HIGH TORQUE





OVERVIEW

The high torque power tool utilizes a brushless dc motor with an electronic control system to provide speed, torque, and direction control. It operates in two modes, from the Space Station Freedom (SSF) utility outlets with a detachable power cord or from a removable battery pack. Torque output is selected with a serrated and indented mechanical clutch adjustment ring. Torque accuracy is ±10 percent as a design goal and can be selected from 2.5 to 25.8 ft–lb with eight major discrete settings and incremental intermediate positions. Forward and reverse drive direction is switch selectable. No–load speeds of 20 and 50 rpm are also switch selectable. The tool has a drop–proof tether interface for 3/8–in. square drive extensions. It has a pistol grip handle and trigger with a serially actuated lockout button to prevent accidental operation. A bayonet fitting and retractable tether hook are provided for tool transport and restraint..

OPERATIONAL COMMENTS

This tool can drive the SSF torque multiplier to achieve higher output torques. The motor controller features Hall–effect speed sensors, an undervoltage lockout, a 12–amp current limiter, and a thermal shutdown for tool protection. The **removable** and rechargeable 28 V dc NiCd battery that runs this tool also powers the portable floodlight. A battery installation switch prevents tool activation before full battery insertion. Low battery–charge level of 25 V dc is indicated by a light–emitting diode. Battery recharge is performed inside the airlock. This reduces extravehicular activity (EVA) time associated with battery maintenance and allows pre–EVA battery/tool checkout. For battery independence, an 8–ft–long detachable power cord with an integrated 120 – 28 V dc–dc converter is available. It can be plugged into the portable work platform (PWP) outlets or the four EVA outlets located on the truss. Power consumption is 125 W at 28 V dc. Stowage accommodations are provided in the airlock tool box, in the crew equipment and translation aid (CETA) tool box, and in the airlock. Because of thermal constraints (e.g., lubricants), the tool is not designed for long term stowage outside the airlock or the various tool boxes. Two tools are baselined for SSF to allow parallel tasks by independent EVA crew.

CONTACTS

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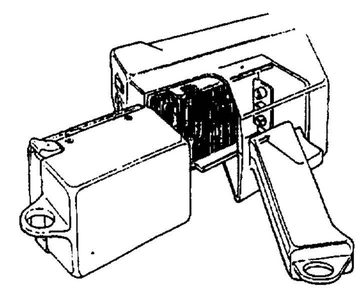
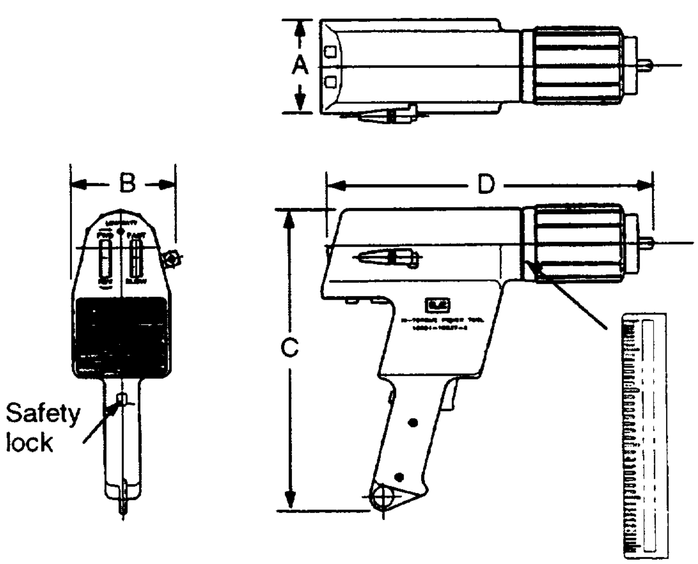
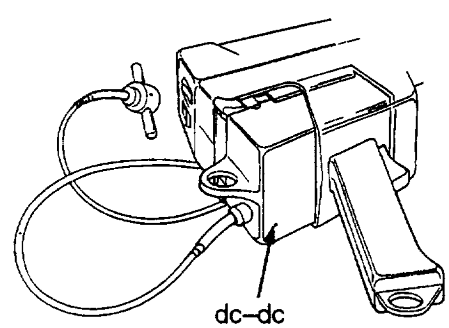
POWER TOOL, HIGH TORQUE

Technical Information	
Part number	5832387–501 18901–20037–301
Weight	8.80 lb (without battery and cable) 12.00 lb (with battery, without cable) 13.00 lb (with battery and cable)
Material/ construction	Limited–life items – TBD Lubricants – Braycoat grease Metallics – Aluminum alloy, aluminum bronze, CRES Nonmetallics – Chemglaze paint, Loctite
Load rating	±10% torque accuracy (design goal) 20 and 50 rpm (no load) 10 rpm (full load) Setting — Torque (ft–lb) 1 — 2.5 2 — 5.0 3 — 7.5 4 — 10.8 5 — 13.3 6 — 16.7 7 — 20.8 8 — 25.8
Temperature range	–65° to +180° F
Quantity flown	Two on MB1 (power cord with dc–dc converter on MB7)
Stowage	Airlock interior, CETA tool box, or airlock exterior tool box
Duty cycle/ single battery	60 half–in. long (1/4)–28 fasteners with 30 in.–lb runup and 9 in.–lb final torque 36 min (10% of 6–hr EVA) 34 min at 30% load 2 min at 100% load
Availability	In development for SSF

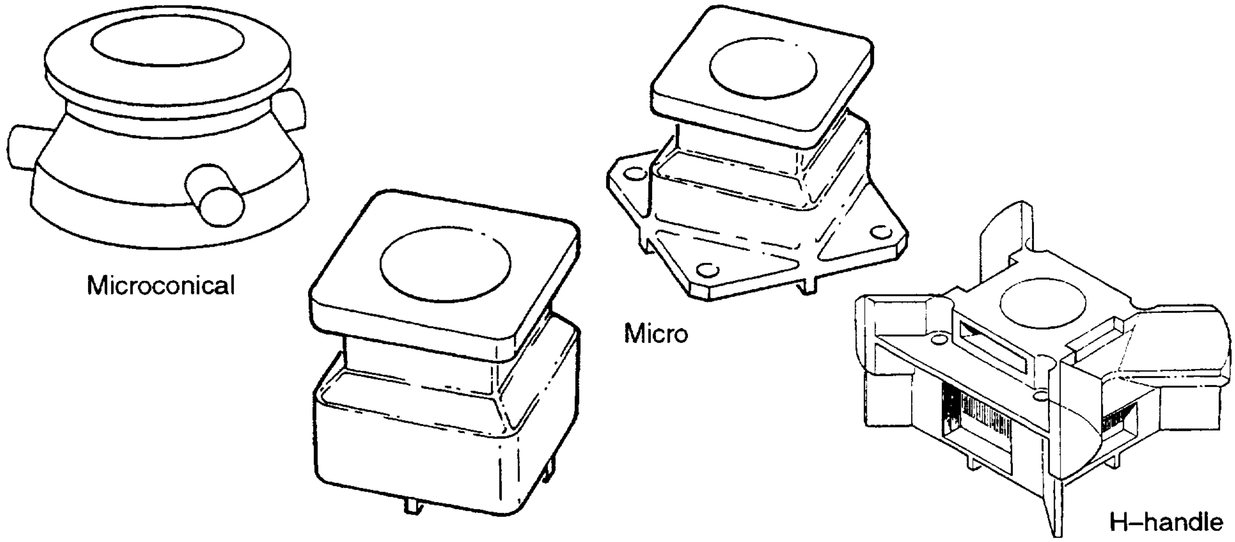
Dimensional Data		
	inches	cm
A	3.4	8.64
B	3.87	9.83
C	11.0	27.94
D	12.0	30.48







ROBOTIC/EVA INTERFACES



OVERVIEW

This discussion covers a family of designs that serve as force/torque reaction interfaces for both robotic and extravehicular activity (EVA) equipment. They have been proposed primarily for applications on Space Station Freedom (SSF) but could be used on any spacecraft. To permit the robotic handling of equipment being replaced on orbit while minimizing the weight associated with permanently affixed structure, several small fittings have been designed that can also be used by the EVA crew. Four interfaces are at present being developed as proposed standards and all serve the same basic functions. SPAR is developing the H–handle and the microfittings. Oceaneering Space Systems (OSS) is working on the conical and the microconical interfaces.

OPERATIONAL COMMENTS

When mounted over the head of a bolt, these fittings can be used by robotic grippers or EVA tools for torque reaction interfaces. They are particularly suited for the installation of an EVA torque multiplier when high torques are involved. The SSF torque multiplier is being designed to interface with the OSS microconical and SPAR microfittings. An early version of the H–handle was first used on STS 41–C as a load–reacting interface between the modular servicing tool and the housing of the attitude control system of the solar maximum satellite. The conical interface has been incorporated into the OSS SQUID mechanical connection.

These fittings can be used for EVA–installed handling aids where the weight and volume of a permanently installed handhold is prohibitive. SPAR has developed installable handles for the micro– and H–handle fittings. The micro handle is commonly called the “ice cream scoop” since it looks and functions much the same. OSS has created handles which attach to the SPAR H–handle and the OSS microconical fittings. Work package 2 EVA equipment uses the microconical fitting extensively on equipment like the semirigid tether, foot restraint stanchion, crew equipment translation aid (CETA) cart platform, orbital replaceable unit (ORU) transfer device, and the exterior of the CETA tool box. Work package 4 is using the SPAR micro throughout the components of the Space Station remote manipulator system.

CONTACTS

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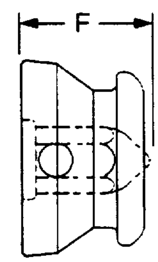
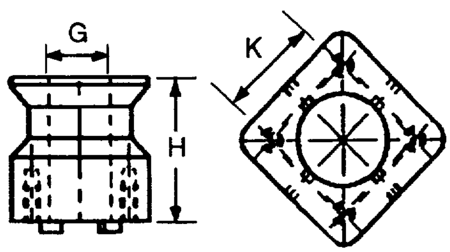
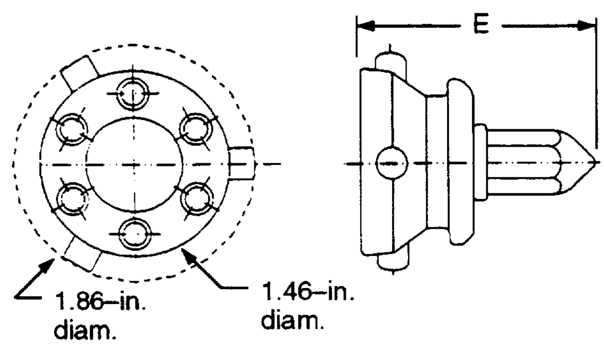
ROBOTIC/EVA INTERFACES

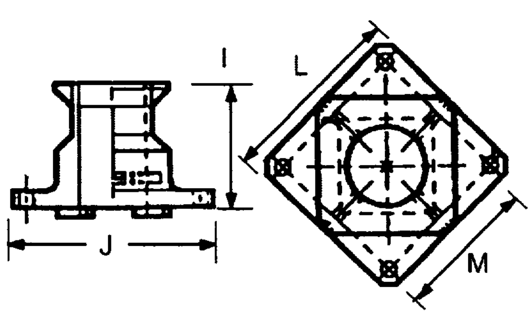
Technical Information	
Part number	41624F2002 (H–handle) 41624F2001–1 **(micro surface mount)** **41624F2001–2 (micro recessed mount)**
Weight	0.529 lb (H–handle) 0.227 lb (SPAR micro) 0.863 lb (OSS conical) 0.15 lb (OSS microconical)
Material/ construction	Limited life items – TBD Lubricants – None Metallics – Aluminum, stainless steel, titanium Nonmetallics – None
Load rating	0–1320 lb ORU, 500 ft–lb (SPAR H–handle) 0–500 lb ORU, TBD ft–lb (SPAR micro) 0–1200 lb ORU, 500 ft–lb (OSS conical) 0–1320 lb ORU, 50 ft–lb (OSS microconical)
Temperature range	–150° to +200° F (H–handle/micro)
Quantity flown	
Stowage	
Misalignment tolerance	± 0.50 in. linear, ± **10°** (SPAR H–handle) ± 0.25 in. linear, ± 10° (SPAR micro) ± 0.75 in. linear, ± 15° rotation, ± 30° angular (OSS conical) ± 0.25 in. linear, ± 15° rotation, ± 7° angular (OSS microconical)
Availability	Developmental

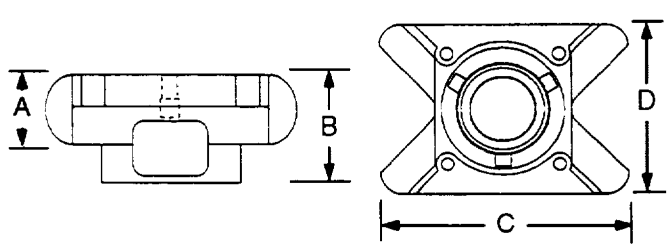
Dimensional Data		
	inches	cm
A	1.10	2.79
B	1.71	4.34
C	3.91	9.93
D	2.70	6.86
E	1.83	4.65
F	0.94	2.39
G	0.950	2.413
H	0.81	2.06
I	1.81	4.60
J	2.85	7.24
K	1.062	2.697
L	2.14	5.44
M	1.750	4.445



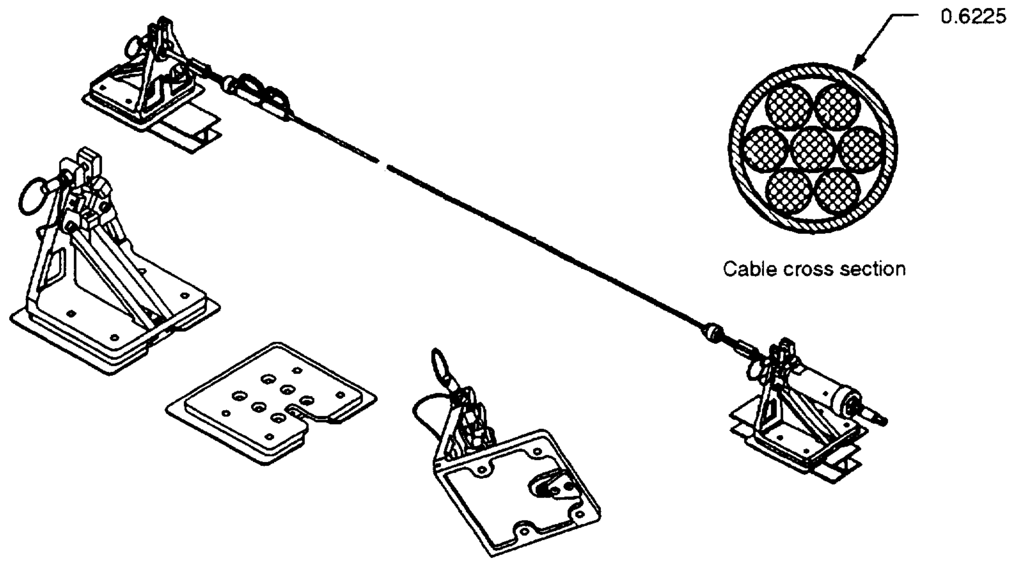








SLIDEWIRE (SSF)



OVERVIEW

The slidewire provides a sliding tether point rated for crew safety loads. Slidewires are located along planned translation routes and between high–use worksites. For Space Station Freedom (SSF) applications, all slidewires are mounted to pressurized crew modules. The mobile transporter does not have a slidewire. Because of tight clearances with the orbiter payload bay envelope, most slidewires will have to be extravehicular activity (EVA)–installed. Each slidewire consists of a pair of standoffs with integral tether points, a length of cable, and two sliding tether points. The design permits crew to translate at up to 4 ft/sec.

OPERATIONAL COMMENTS

Each slidewire standoff is attached by four 7/16–in. hex headed captive bolts. A soft–dock spring plunger and alignment guides aid in EVA installation of each standoff. A pip pin holds the tension adjustment end of the cable to its standoff. The cable tension is adjustable (clockwise to tighten), and color–coded indicators (green, yellow, red) flag when proper preload of 100 lb is achieved. A hard stop is built into the tensioner to prevent damage due to overtightening. A self–locking thread insert prevents loss of tension. A power tool or ratchet wrench with a 7/16–in. socket will drive the tension adjustment nut. Crew–induced tether load is limited to 200 lb and relies upon a load–alleviating waist tether. The cable assembly is considered an orbital replacement unit and should be periodically checked for proper tension and cable integrity. The sliders are restrained near the standoffs by TBD means. The slidewire cable has a white Teflon coating, and the sliders are anodized yellow to indicate their rating as a crew safety tether point. Anodizing should limit color fading with time. The means for slidewire restraint during transport to each installation site is TBD.

CONTACTS

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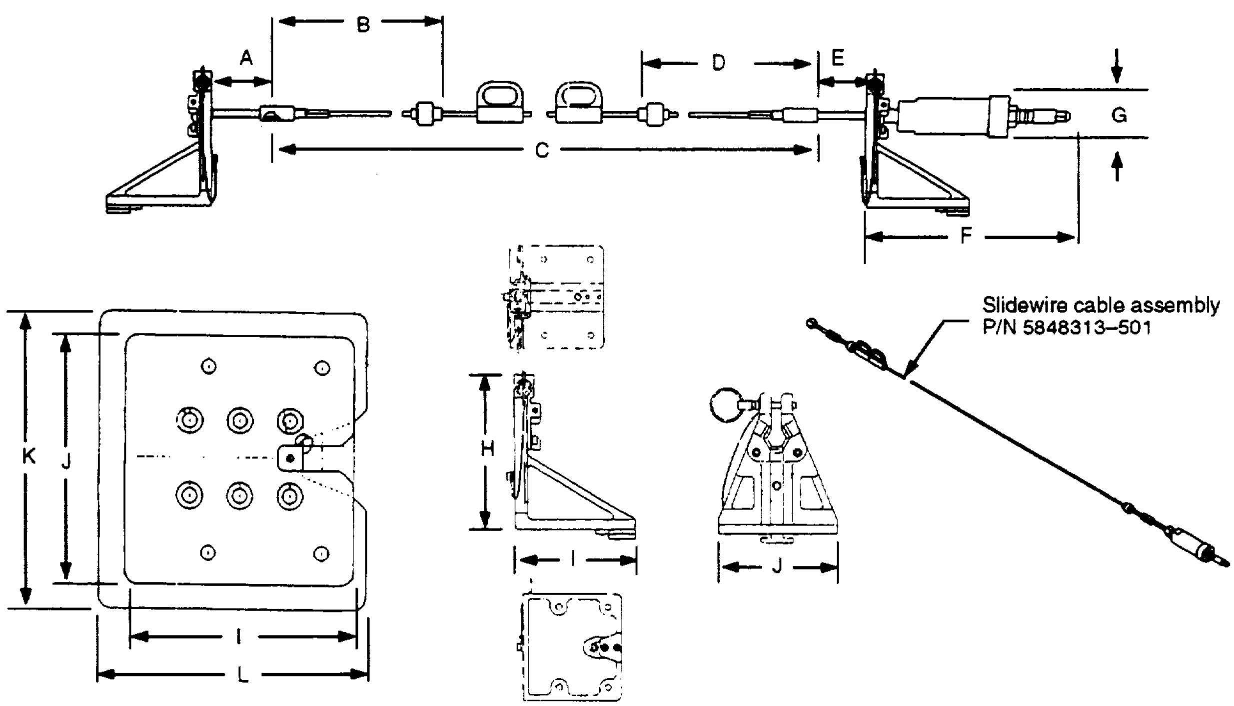
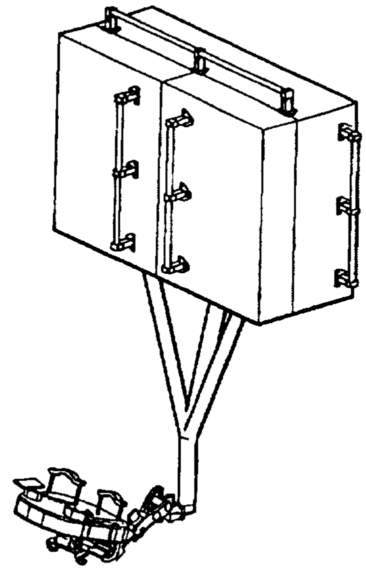
SLIDEWIRE (SSF)

Technical Information	
Part number	5839276–501 (integrated assembly) 5847950–501 (standoff) 5848313–501 (cable assembly, seven lengths) F375165 (docking plate)
Weight	0.09 lb/ft of cable 8.26 lb (8 ft) 9.68 lb (24 ft) 10.74 lb (36 ft) 8.70 lb (13 ft) 9.94 lb (27 ft) 9.12 lb (17.7 ft) 10.38 lb (32 ft)
Material/ construction	Limited life items – Cable tension spring (15 yrs) Lubricants – TBD Metallics – Aluminum, 3/16–in.–dia CRES cable and fasteners Nonmetallics – Teflon cable jacket
Load rating	<5–lb installation force 200–lb cable pull plus factor of safety of 4.0 One 450–lb crew with 150 lb equipment at 4 ft/sec Two 450–lb crew with no equipment at 4 ft/sec
Temperature range	–65° to +180° F
Quantity flown	Thirteen sites starting with MB1 (seven different lengths from 8 to 36 ft)
Stowage	N/A
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	2.27	5.766
B	8.0	20.320
C	88.75 (–501) 148.75 (–503) 205.15 (–505) 280.75 (–507) 316.75 (–509) 376.75 (–511) 424.75 (–513)	225.425 377.825 521.081 713.105 804.545 956.945 1078.865
D	8.0	20.320
E	2.27	5.766
F	8.66	21.996
G	1.88	4.775
H	5.875	14.923
I	4.531	11.509
J	5.0	12.700
K	6.0	15.240
L	5.281	13.414



STOWAGE CONTAINER, EVA SUPPORT EQUIPMENT AND TOOLS



OVERVIEW

The extravehicular activity (EVA) support equipment and tools (ESE&T) stowage container holds a large number of the tools needed for Space Station Freedom (SSF) assembly and maintenance. Two are launched on the SSF airlock exterior on MB7. Supplemental tool stowage nearer worksites is provided by a smaller EVA tool stowage device (ETSD) mounted on each crew and equipment translation aid (CETA) cart. The ETSD provides tool stowage prior to MB7. Each ESE&T box is built with a machined frame strengthened and closed out by a sheet metal skin. Tool boards restrain most of the smaller stowed equipment, but some items attach directly to quick release fittings.

OPERATIONAL COMMENTS

The ESE&T box provides 27 ft^3 of useful tool stowage and has a 20 percent reserve volume for growth. Internal stowage features can be reconfigured on orbit to accommodate varying tool needs. Tools are accessed by releasing each hinged door latch from the lock to the open position. Handrails on the top, front, and sides of the box serve as body restraints and door opening grips. A dedicated foot restraint is provided with each box. Each door has a multiple–position, hold–open mechanism to ease tool retrieval without worrying about inadvertent closure. The internal tool restraints include single sided tool boards captured by slotted holders, large 1/4–turn fasteners, bayonet fittings, sliding clips, and retractable 6–ft tether reels. The tool boards can be installed on the tool carrier of the STS manipulator foot restraint and the SSF portable work platform workstation stanchion.

CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
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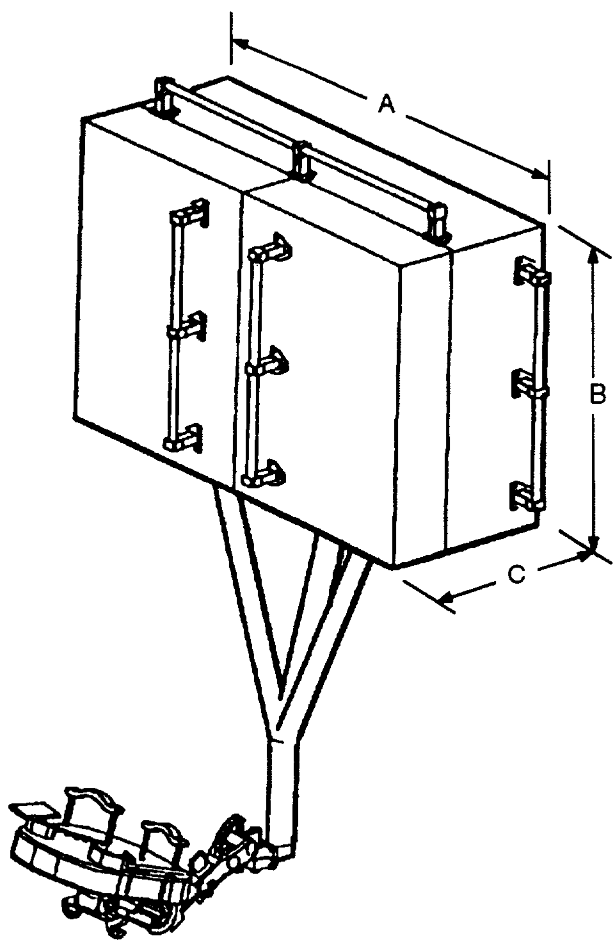
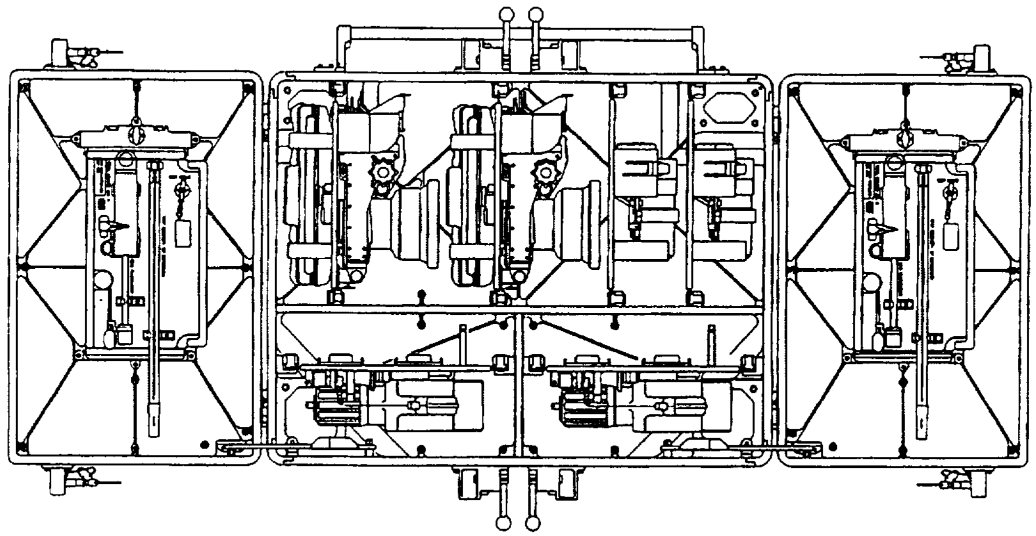
STOWAGE CONTAINER, EVA SUPPORT EQUIPMENT AND TOOLS

Technical Information	
Part number	SKESEB006 ?
Weight	364 lb (empty) XXX lb (full)
Material/ construction	Limited–life items – TBD Lubricants – TBD Metallics – Aluminum alloys, CRES Nonmetallics – Delrin, Vespel
Load rating	187 lb handrail/pushoff
Temperature range	–65° to +180° F (cert)
Quantity flown	2 (MB7)
Stowage	Airlock exterior
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	54.61	138.71
B	36.11	91.72
C	21.11	53.62



STOWAGE DEVICE, EVA TOOL



OVERVIEW

The extravehicular activity (EVA) tool stowage device (ETSD) holds a selection of the tools needed for Space Station Freedom (SSF) assembly from mission build (MB)1 through MB6. It is launched and remains on the unpressurized berthing adapter (UBA) for use during the first four flights. A second is flown on MB4. When the crew and equipment translation aid (CETA) cart becomes operational on MB4, both boxes will be relocated to CETA to make the tools more readily accessible. A pair of larger tool boxes and more tools will be delivered on a flight after man–tended capability. Each ETSD is designed to hold two of each tool needed for early assembly tasks. The ETSD is built much like the Hubble Space Telescope tool box, with a machined frame strengthened and closed out by a sheet metal skin. Tool boards with quick–release fittings restrain the stowed EVA equipment. There are provisions on the exterior of each box for attaching additional equipment. In principle, the box is portable, but because of its large size, two crewmembers will be required to relocate it if robotic assistance is not available.

OPERATIONAL COMMENTS

The ETSD provides 6 ft^3 of useful tool stowage. On–orbit reconfiguration of internal stowage features to accommodate varying tool needs is TBD. Tools are accessed by releasing each hinged door's latch from the lock to the open position. Handrails on the top and front of the box serve as body restraints, door opening grips, and box handling aids. A foot restraint is available only with the box attached to CETA, not on the UBA. Each door has a 125° hold–open mechanism to ease tool retrieval without worrying about inadvertent closure. In case of a jammed door, the hinges, latches, and hold–open mechanisms have EVA–releasable bolts as a workaround. The internal tool restraints include single–sided tool boards captured by slotted holders, large 1/4–turn fasteners, bayonet fittings, sliding clips, and retractable 6–ft tether reels. The tool boards can be installed on the tool carrier of the orbiter manipulator foot restraint and the SSF portable work platform workstation stanchion. Orbital replacement unit (ORU) handling aids and tool caddies can be stowed on the exterior of the box.

Attachment mounts for the ETSD differ between the UBA and the CETA cart. Sixteen bolts are used for the UBA. For the CETA cart, only eight bolts are required. Alignment guides and soft–dock features are TBD for installation on CETA.

CONTACTS

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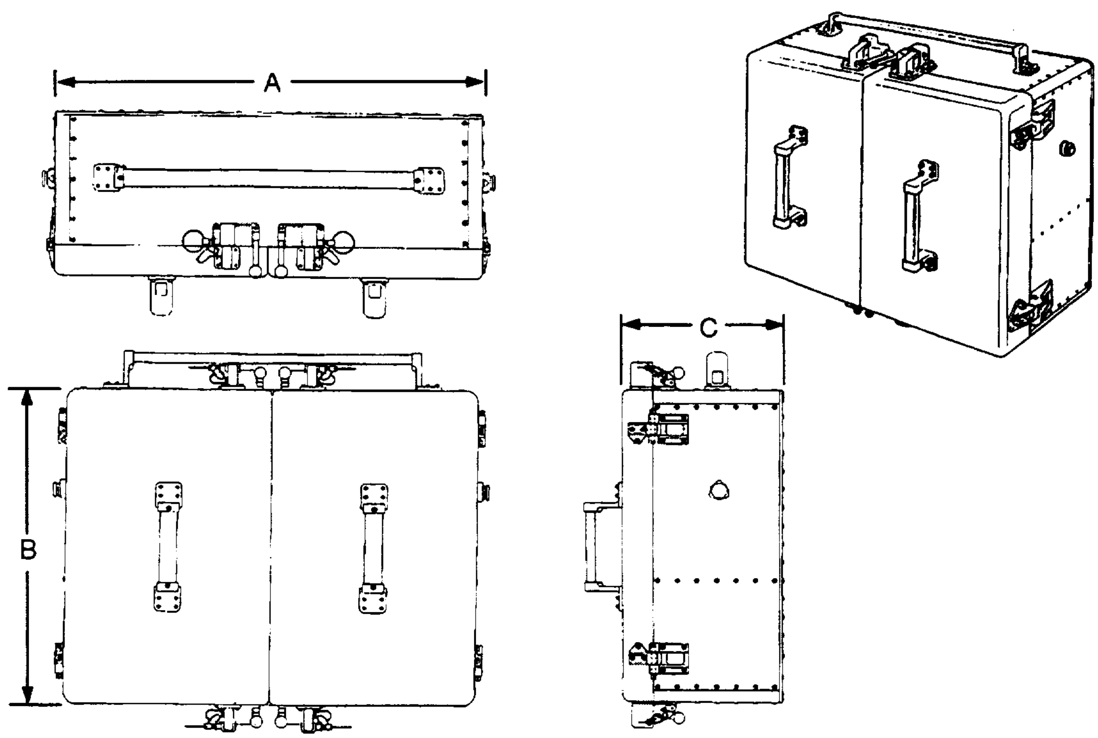
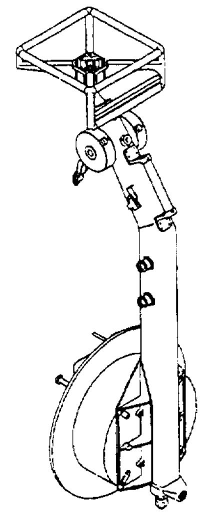
STOWAGE DEVICE, EVA TOOL

Technical Information	
Part number	5825269–501 18901–10080–301 (empty box)
Weight	81.1 lb (empty with passive insulation) 173.4 lb (with MB1 tools)
Material/ construction	Limited–life items – TBD Lubricants – TBD Metallics – Aluminum alloys, CRES Nonmetallics – Delrin, Vespel, multilayer insulation, Loctite
Load rating	187–lb handrail/pushoff 200–lb handrail tether points (plus 4.0 factor of safety)
Temperature range	–65° to +180° F (cert) 0° to +65° F (nominal)
Quantity flown	1 (MB1) 1 (MB4)
Stowage	Unpressurized berthing adapter (MB1 – MB4) Transferred to CETA carts on MB4
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	**33.75**	**85.73**
B	**26.26**	**66.70**
C	**13.17**	**33.45**



TEMPORARY EQUIPMENT RESTRAINT AID



OVERVIEW

The temporary equipment restraint aid (TERA) is a component of the portable work platform (PWP). When integrated into the PWP, TERA serves as an extravehicular activity (EVA) crewmember's workstation and foot restraint. It is designed to restrain one large orbital replaceable unit (ORU) for EVA maintenance tasks. It has electrical outlets to extend the life of battery powered EVA tools. The EVA portable floodlight can be attached for general worksite illumination. TERA can be attached to the space station remote manipulation system (SSRMS) for robotic positioning of the crew and attached equipment, or it can be stowed at a fixed location. TERA features a power and data grapple fixture (PDGF) for mechanical and electrical connection to the SSRMS. TERA will mate to the 1.0–in. hex probe socket on the articulating portable foot restraint (APFR). It can be stowed without the APFR by insertion into the special load–alleviating socket of the PWP stowage kit. Two TERA's built into full PWP's are baselined for Space Station Freedom (SSF). One is planned to be dedicated to the SSRMS.

OPERATIONAL COMMENTS

Because of the large size (mass and volume) of the TERA and PWP, manual transport between worksites or setup/teardown at worksites or stowage sites can be performed only by two crewmembers. SSRMS transport will be the preferred method to maintain crew independence for unassisted maintenance tasks in parallel. Since the PWP and TERA are not designed for unaided robotic stowage and deployment, the EVA crew will have to provide this assistance. When TERA is not mated to the SSRMS, it must be mated to the load–alleviation features of the PWP stowage kit to protect the SSF structure from anticipated EVA crew loads and vehicle reboost. TERA has an oversized 1.5–in. hex probe for added strength (compared to the standard orbiter PFR probe) and is, therefore, not compatible with normal PFR sockets. TERA carries its own PFR socket pip pin to reduce socket related weight.

The TERA stanchion is sized to accommodate one large ORU using the crew and equipment translations aid (CETA) cart's square rod and grid system. There are two tether hooks on retractable cables for temporary restraint between TERA and the ORU installation location (<30–lb retraction force). The three utility outlets provide 120 V dc when powered through the PDGF of the SSRMS and can be used to run portable lights or power tools. A pair of bayonet receptacles and microconical fittings on the stanchion permit small equipment restraint. All PWP components have been thermally hardened for long term exposure at worksites to reduce EVA overhead.

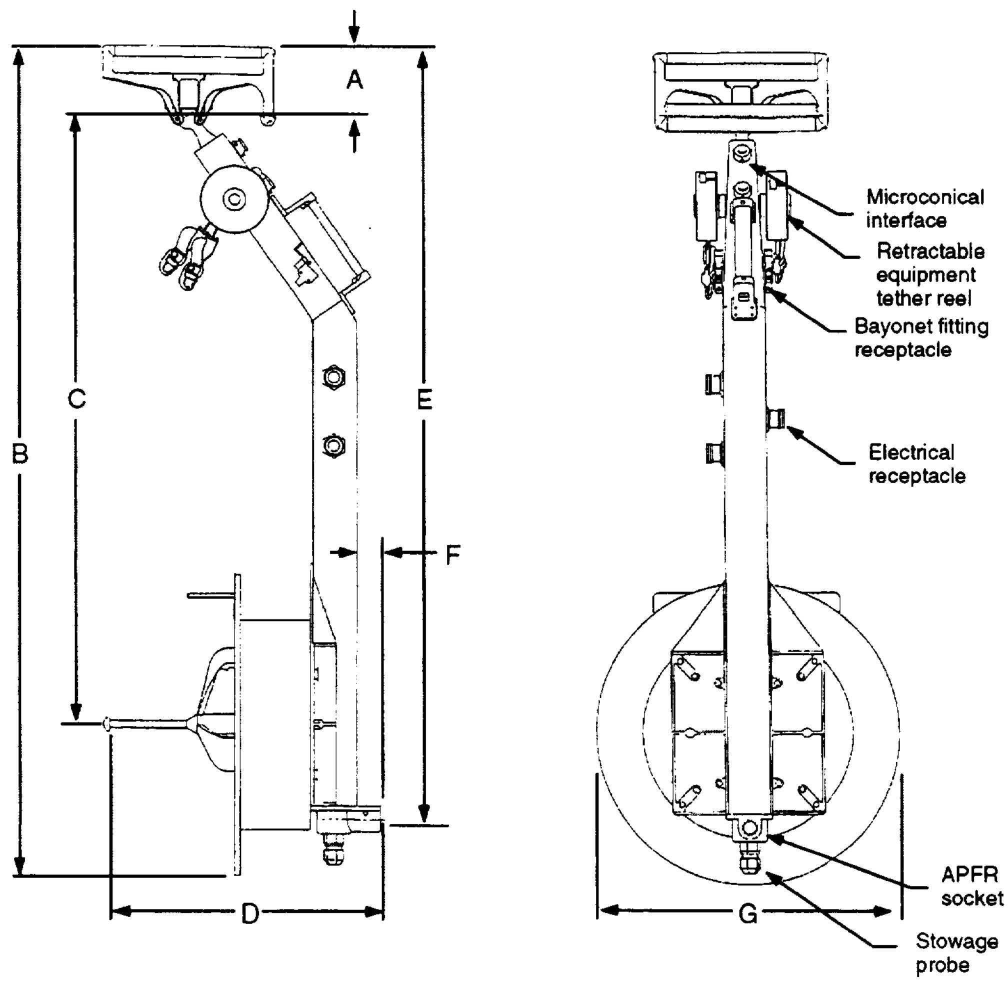
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

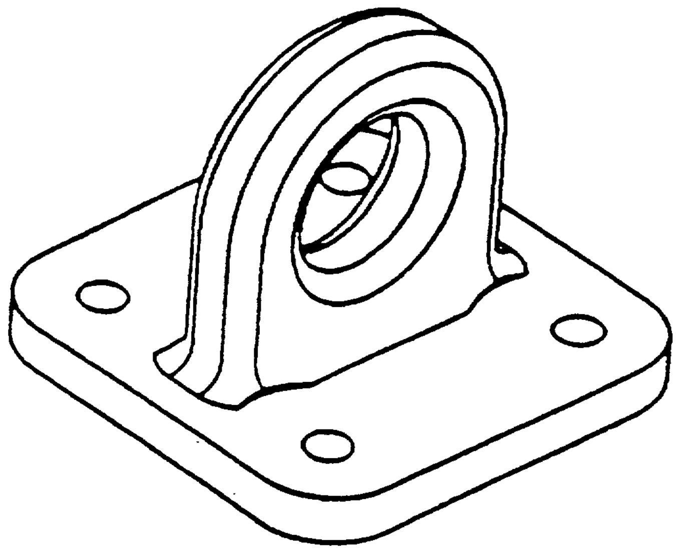
TEMPORARY EQUIPMENT RESTRAINT AID

Technical Information	
Part number	
Weight	45.0 lb without PDGF 94.5 lb with PDGF
Material/ construction	Limited–life items – Retractable tethers, power cable (10 yr) Lubricants – Brayco 602, bonded MoS_2 film Metallics – Aluminum alloys, CRES
Load rating	125–lb kickload applied at top of the stanchion 600 lb ORU
Temperature range	–65° to +180° F
Quantity flown	Two on MB4
Stowage	SSRMS or PWP stowage kit
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	6.1	15.49
B	72.2	183.39
C	53.2	135.13
D	24.0	60.96
E	67.4	171.20
F	2.0	5.08
G	26.0	66.04



TETHER LOOP



OVERVIEW

The tether loop provides a fixed tether point rated for crew safety loads. It can also be used for equipment or orbital replacement unit (ORU) restraint. The loops are generally located along planned translation routes and at selected worksites.

OPERATIONAL COMMENTS

Each tether loop is attached by four bolts. All loops are ground installed. Crew–induced tether load is limited to 200 lb and relies upon a load–alleviating waist tether. The loops are anodized yellow to indicate their rating as a crew safety–tether point and to ensure limited color fading with time. The extravehicular mobility unit (EMU) mini workstation end effector is commonly attached to tether points like this as an added aid for free floating body restraint. Small and large wrist and waist tether hooks are accommodated by the tether point design. Small and large french hook attachment is also accommodated.

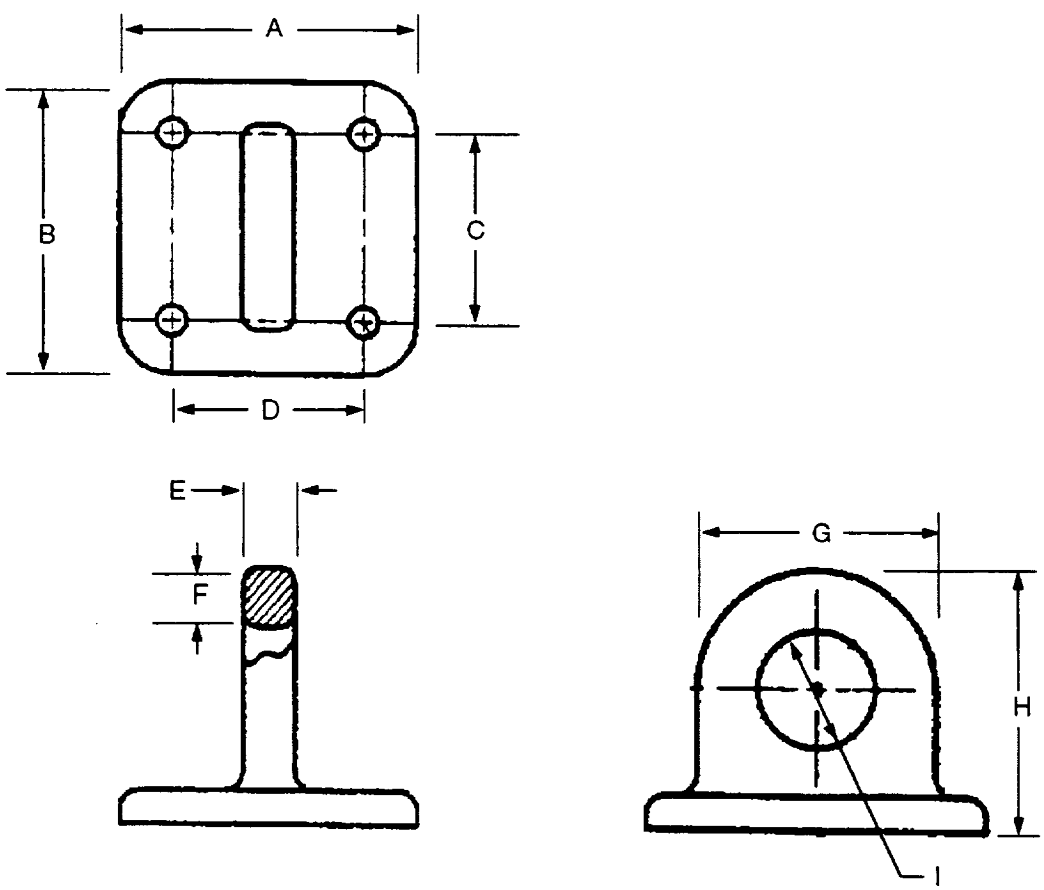
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

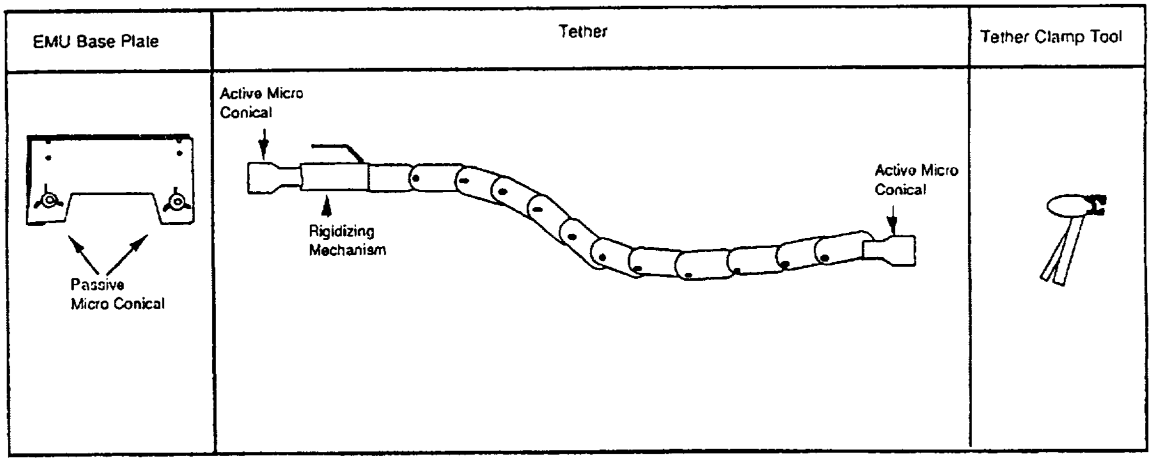
TETHER LOOP

Technical Information	
Part number	5835757–501
Weight	0.16 lb
Material/ construction	Limited–life items – None Lubricants – None Metallics – Aluminum alloy, CRES fasteners
Load rating	200–lb pull plus factor of safety of 4.0 One 450–lb crew with 150–lb equipment at 4 fps
Temperature range	–65° to +180° F
Quantity flown	TBD
Stowage	N/A
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	2.125	5.398
B	2.125	5.398
C	1.375	3.493
D	1.375	3.493
E	0.375	0.953
F	0.375	0.953
G	1.500	3.81
H	1.65	4.19
I	0.750	1.905



TETHER, RIGIDIZING



OVERVIEW

Based upon in–flight experience with the manual transport of masses, the HST semi–rigid tether is being used as the basis upon which a Space Station tether will be developed. This should make unassisted transport of foot restraints, tools and orbital replacement units (ORUs) feasible and more time efficient to reduce EVA overhead. This tether will provide a third hand so the the crew can dedicate both hands to controlled manual translations. It will help restrain equipment at each worksite. Items being transported and surrounding vehicle structure will be protected from inadvertant impact damage.

OPERATIONAL COMMENTS

This tether has three major components. A special adapter plate attaches to the EMU mini workstation fittings and is the mounting surface for the tether. The mini workstation will still be able to mount to this plate, though it will be shifted slightly more forward into the crew's work volume. The tether has two operating modes: flexible and relatively rigid. Attached items are oriented as desired when the tether is flexible, while they are transported (or kept stationary at a worksite) in the rigid mode. A lever type mechanism is anticipated as the rigidizing device for the tether. Each end of the tether may have a robotic style attachment interface (e.g. microconical). More than one receptacle can be selected on the EMU adapter plate to suit the crew's left or right–handed preference or to allow multiple tether attachment. A clamping tool can be attached to the free end of the tether and will hold a variety of objects via their tether points. Use of this tether as a limited form of body restraint is TBD.

CONTACTS

Operational: Robert Trevino, JSC/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

TETHER, RIGIDIZING

Technical Information	
Part number	
Weight	
Material/ construction	
Load rating	10 lb applied to free end before significant deflection 50 lb object carrying limit
Temperature range	
Quantity flown	
Stowage	
Availability	In development for SSF

Dimensional Data		
	inches	cm
A		
B		
C		

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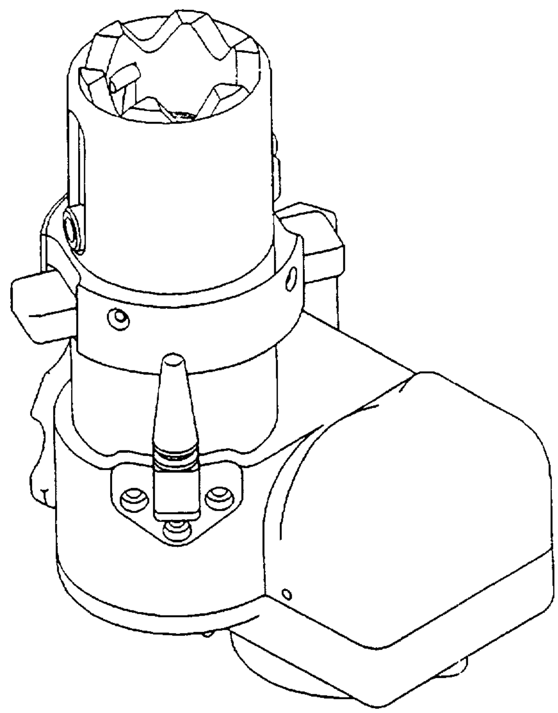
TORQUE MULTIPLIER (SSF)



OVERVIEW

The torque multiplier is used to deliver amplified torque when driven by the high–torque power tool or an extravehicular activity (EVA) ratchet wrench. Certain orbital replaceable units (ORU's) and assembly interfaces are beyond the capability of these tools and require torques up to 100 ft–lb. Many of the ORU's require the high torques only for launch and may not need to be reapplied after ORU replacement. Given an effective gear ratio of 4.8:1, the power tool maximum torque of 25.8 ft–lb and ±10 percent accuracy, the torque multiplier can deliver up to 124 ft–lb. A tether attach point and bayonet fitting are provided for tool transport and restraint. Stowage accommodations are provided in the airlock tool box and in the unpressurized berthing adapter (UBA)/crew and equipment translation aid (CETA) tool box. Two tools are baselined to allow parallel tasks by independent EVA crew.

OPERATIONAL COMMENTS

This tool is designed to transmit torque equally well to remove and install fasteners. It is nominally used with the power tool's second highest torque setting (20.8 ft–lb) to achieve up to 100 ft–lb output. The highest power tool setting (25.8 ft–lb) is reserved to remove cold–welded bolts up to 124 ft–lb. Internal gears provide two input drive options (one parallel to output and one perpendicular to output). Each input is through a 3/8–in. square drive and output is through a pushbutton–selectable 7/16– or 3/4–in. socket driven by a 1/2–in. square drive. There are no McTether tool fittings on either drive input because of a safety concern for gloved hand injury after accidentally grasping the unused rotating McTether. Torque transfer to attached structure is compatible with microconical and SPAR micro interfaces. Docking latches hold the torque multiplier in place and take a push force of 5 lb to engage. The output socket allows up to 7/8 in. of bolt travel.

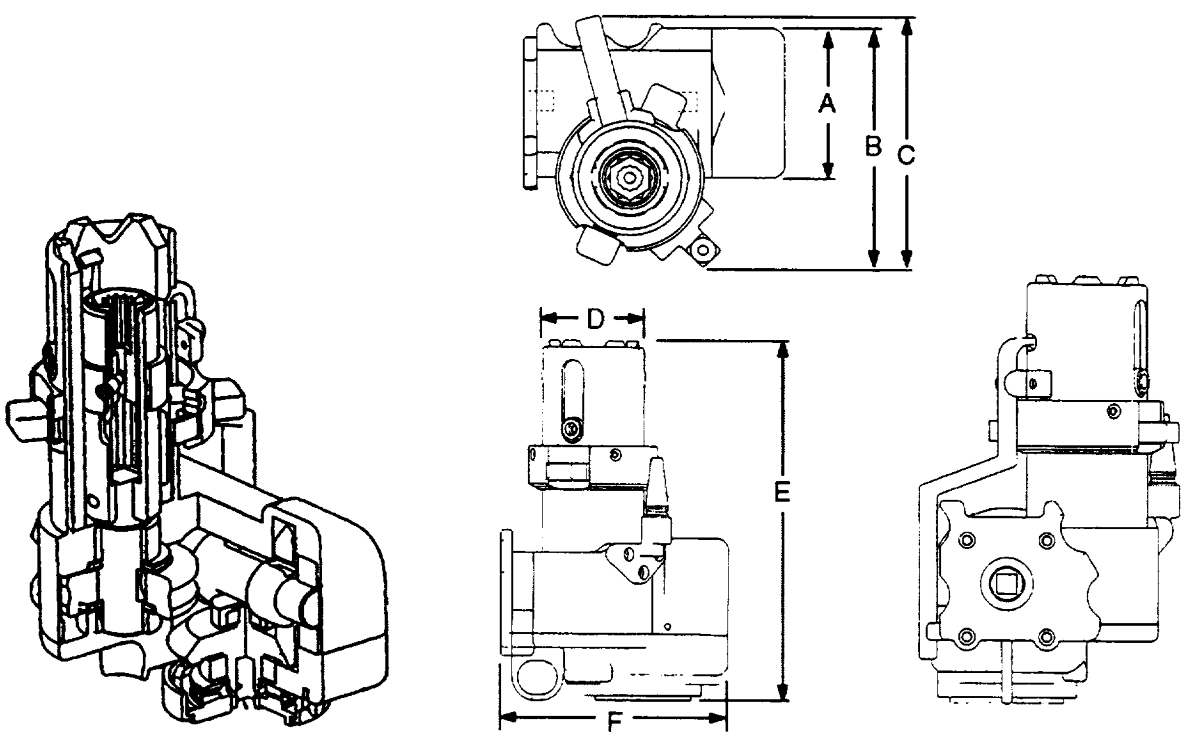
CONTACTS

Operational: Robert Trevino, NASA/DF42, (713) 483–2597
Technical: Phil West, NASA/EC5, (713) 483–9236

TORQUE MULTIPLIER (SSF)

Technical Information	
Part number	5841939–501
Weight	9.75 lb
Material/ construction	Limited–life items – TBD Lubricants – TBD Metallics – Aluminum, stainless Nonmetallics – Teflon bearing seal
Load rating	6.67:1 gear ratio (theoretical) 28% gear friction loss (est.) 4.8:1 output gear ratio (min.) Power tool setting/torque (ft–lb) — Torque multiplier output (ft–lb) 1/5.0 — 12 2/5.0 — 24 3/7.5 — 36 4/10.8 — 52 5/13.3 — 64 6/16.7 — 80 7/20.8 — 100 8/25.8 — 124
Temperature range	–65° to +180° F
Quantity flown	Two on MB1
Stowage	UBA/CETA tool box or airlock exterior tool box
Drive interface	Microconical torque reaction fitting 3/8–in. square drive input 1/2–in. square drive output 7/16– or 3/4–in. 12–point socket output
Availability	In development for SSF

Dimensional Data		
	inches	cm
A	2.926	7.432
B	4.66	11.84
C	4.898	12.441
D	2.250	5.715
E	8.065	20.485
F	5.070	12.878



034.B

APPENDIX A
USER QUESTIONNAIRE

Name ______________ **Org** ____________ **Mail code** ____________

Return to: Richard Fullerton, NASA JSC, DF42, FAX (713) 483–5074

GENERIC QUESTIONS

How often do you use the catalog?

☐ Daily ☐ Weekly ☐ Monthly ☐ Other ____________

What do you use the catalog for?

Rate the usefulness of the following:

Photographs	:	Not useful	1	2	3	4	5	Very useful
Text description	:	Not useful	1	2	3	4	5	Very useful
Operational contact	:	Not useful	1	2	3	4	5	Very useful
Technical contact	:	Not useful	1	2	3	4	5	Very useful
Technical information table	:	Not useful	1	2	3	4	5	Very useful
Technical drawings	:	Not useful	1	2	3	4	5	Very useful
Dimensional data table	:	Not useful	1	2	3	4	5	Very useful
Flight manifest history	:	Not useful	1	2	3	4	5	Very useful
Reference listing	:	Not useful	1	2	3	4	5	Very useful

Should we limit the catalog to shuttle items or expand it to include previous and future programs?

Gemini, Apollo, Skylab	:	Not useful	1	2	3	4	5	Very useful
Space station	:	Not useful	1	2	3	4	5	Very useful

Do you have any comments on the format of the existing catalog?

Sorted alphabetically	:	Not useful	1	2	3	4	5	Very useful
Sorted by availability	:	Not useful	1	2	3	4	5	Very useful
Indexed by hardware type	:	Not useful	1	2	3	4	5	Very useful
Indexed by major payload	:	Not useful	1	2	3	4	5	Very useful
Indexed alphabetically	:	Not useful	1	2	3	4	5	Very useful

ELECTRONIC VS. PAPER

How often would you use the computer version of the catalog?

☐ Daily ☐ Weekly ☐ Monthly ☐ Other ____________

Which catalog version would you tend to use? ☐ Electronic ☐ Paper ☐ Both

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APPENDIX B
INSTRUCTIONS ON ACCESS TO COMPUTERIZED CATALOG

This capability is still in development. Further information will be provided at a later date.

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APPENDIX C
WORKSHEET FOR NEW WRITEUPS

Use this form as a guideline when adding a new item to the catalog. Also, refer to existing writeups for specific examples.

TITLE – Should be simple and descriptive of the tool in a generic sense. Avoid payload–unique titles and extraneous words like "EVA" or "Assembly." Put a common key word in the front of each title to make each item easier to locate. For example, "tether, waist" and "wrench, adjustable" are preferred over "waist tether" and "adjustable wrench".

PHOTO – Provide 8 X 10 color or black and white photo(s) (preferably black and white) with a traceable photo number. Try to include a ruler or scale near each object for dimensional perspective. Photos of the item in use or alone are acceptable. Three–D isometric drawings are suitable for items still in development. The images should complement the dimensioned views on the back of each writeup without being repetitive (e.g., show markings and user interfaces).

OVERVIEW – Discuss the "big picture" aspects of what it is, where it is used, purpose, theory of how it works, and which significant components are included in its assembly.

OPERATIONAL – Discuss the details of how it is operated, subtle operational techniques, stowage provisions, alternate applications, and on–orbit use experience.

CONTACTS – Provide name, organization, and phone number
- OPERATIONAL – JSC Mission Operations Directorate personnel (DF42)
- TECHNICAL – NASA subsystem manager

TECHNICAL INFORMATION TABLE
- PART NUMBER – Complete assembly and significant individual pieces
- WEIGHT – Complete assembly and significant individual pieces
- MATERIAL/CONSTRUCTION – Metallics, nonmetallics, lubricants, and limited life items
- LOAD RATING – Forces, torques, velocity, etc.
- TEMPERATURE RATING – Operational, stowage
- QUANTITY FLOWN – How many manifested on previous or current flights and the flight designation (STS–XX)
- STOWAGE – Where manifested on previous or current flights (in–cabin, payload bay, tool box name)
- AVAILABILITY – Standard, flight specific (reserved for single payload?), reference only, developmental, SSF
- MISCELLANEOUS – Tool specific data not covered above (e.g., power source, socket depth, articulating joint settings/ranges)

SCHEMATIC – Provide line drawings of top, bottom, and side views. Include views showing stowage, interfaces with related hardware, or 3–D images.

DIMENSIONAL DATA TABLE – List schematic labels and dimensions in English and metric units. Include stowage dimensions of maximum length, width, and depth. List dimensions of key operational interfaces (e.g., extendable length).

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APPENDIX D
TOOL LOCATOR SORTED BY EQUIPMENT TYPE

The large number of items described in this reference book makes it difficult to easily locate a single tool description. Besides splitting the document into sections based upon availability, appendixes with the equipment titles sorted by various common document are also provided. The titles and page numbers listed here should help users find items of interest more readily. This particular sort groups the hardware into generalized categories by equipment types. The following classifications are used in this index:

TYPE	EXAMPLES
Body Restraint	Handrails, foot restraints, PFR sockets, PFR ingress aids
Body/Equip Restraint	Workstations, tethers
Cutter	Saws, wire cutters, tube cutters, clippers, scissors
Drive	Manual drive ratchets, torque multiplier, torque wrench
Electrical	Connectors, pin tools, connector tools, cables, switches
Equip Restraint	Equipment/crew tethers, fasteners, rope, tape, Velcro, hooks
Fluid Transfer	Spacecraft propellant/cooling servicing and cleanup
Lever	Pry bars, bolt pullers, spreaders
Photo/Lights	Cameras, TV's, lighting
Power	Batteries, power tools, power packages
Socket	Allen extensions, hex sockets, screwdriver extensions
Stowage	Lockers, bags, containers
Wrench	Pliers, open–end wrenches, ratcheting wrenches
Other	MMU, EMU, EVA docking adapters, miscellaneous items

	HARDWARE TITLE	TYPE	PAGE
1	Astrorope	BODY RESTRAINT	AA-7
2	CETA Tether Shuttle	BODY RESTRAINT	CCC-3
3	CETA Tether Shuttle (EDFE)	BODY RESTRAINT	CC-13
4	Crew Propulsive Device	BODY RESTRAINT	CC-33
5	Handrail, GFE	BODY RESTRAINT	H-11
6	Handrail, Oval	BODY RESTRAINT	H-13
7	Handrail/Handhold, Ground Installed	BODY RESTRAINT	HHH-5
8	Handrail, On-Orbit Installed	BODY RESTRAINT	HHH-7
9	Knob, EVA	BODY RESTRAINT	K-1
10	PFR Articulating Socket	BODY RESTRAINT	PP-7
11	PFR Articulating Socket, Push Button	BODY RESTRAINT	P-9
12	PFR Attachment Device, RMS	BODY RESTRAINT	P-11
13	PFR Centerline Clamp Assembly	BODY RESTRAINT	PP-9
14	PFR Extender	BODY RESTRAINT	P-13
15	PFR Ingress Aid	BODY RESTRAINT	P-15
16	PFR Probe Extension	BODY RESTRAINT	P-17
17	PFR Socket (HST)	BODY RESTRAINT	P-19
18	PFR Socket (STS)	BODY RESTRAINT	P-21
19	PFR Socket Converter, 90o	BODY RESTRAINT	P-23
20	PFR Socket, Bridge Fitting	BODY RESTRAINT	P-25
21	PFR Socket, Sill Longeron	BODY RESTRAINT	PP-13
22	PFR Strut Clamp	BODY RESTRAINT	PP-15
23	PFR Worksite Interface	BODY RESTRAINT	PPP-1
24	Pole, Leavy	BODY RESTRAINT	P-37
25	Portable Foot Restraint	BODY RESTRAINT	P-41
26	Portable Foot Restraint (HST)	BODY RESTRAINT	P-43
27	Portable Foot Restraint, Articulating	BODY RESTRAINT	PPP-5
28	Portable Foot Restraint, Push Button	BODY RESTRAINT	P-45
29	Simplified Aid For EVA Rescue	BODY RESTRAINT	SS-5
30	Slidewire (SSF)	BODY RESTRAINT	SSS-1
31	Slidewire (STS)	BODY RESTRAINT	S-11
32	Telescoping Boom	BODY RESTRAINT	T-5
33	CETA Cart	BODY/EQUIP RESTRAINT	CCC-1
34	CETA Electrical Cart (EDFE)	BODY/EQUIP RESTRAINT	CC-7
35	CETA Manual Cart (EDFE)	BODY/EQUIP RESTRAINT	CC-9
36	CETA Mechanical Cart (EDFE)	BODY/EQUIP RESTRAINT	CC-11
37	CETA Track (EDFE)	BODY/EQUIP RESTRAINT	CC-15
38	CETA Truck (EDFE)	BODY/EQUIP RESTRAINT	CC-17
39	Crew Loads Instrumented Pallet	BODY/EQUIP RESTRAINT	C-39
40	Manipulator Foot Restraint	BODY/EQUIP RESTRAINT	M-1
41	Manned Maneuvering Unit	BODY/EQUIP RESTRAINT	M-3
42	Mini Workstation	BODY/EQUIP RESTRAINT	M-9
43	PFR Workstation Stanchion	BODY/EQUIP RESTRAINT	P-27
44	PFR Workstation Stanchion (SSF)	BODY/EQUIP RESTRAINT	PPP-3
45	Pole, Bistem	BODY/EQUIP RESTRAINT	PP-23

46	Pole, Inflatable	BODY/EQUIP RESTRAINT	PP–25
47	Pole,Telescoping	BODY/EQUIP RESTRAINT	PP–27
48	Portable Work Platform	BODY/EQUIP RESTRAINT	PPP–7
49	Portable Work Platform Stowage Device Kit	BODY/EQUIP RESTRAINT	PPP–9
50	SQUID	BODY/EQUIP RESTRAINT	SS–17
51	Task Simulator Device	BODY/EQUIP RESTRAINT	TT–1
52	Temporary Equipment Restraint Aid	BODY/EQUIP RESTRAINT	TTT–1
53	Tether Loop	BODY/EQUIP RESTRAINT	TTT–3
54	Tether Point	BODY/EQUIP RESTRAINT	T–9
55	Tether, Safety	BODY/EQUIP RESTRAINT	T–23
56	Tether, Waist	BODY/EQUIP RESTRAINT	T–27
57	Translation Aid	BODY/EQUIP RESTRAINT	T–53
58	Cutter, Antenna	CUTTER	C–43
59	Cutter, Cable	CUTTER	C–45
60	Cutter, Compound Cable	CUTTER	CC–37
61	Cutter, High Tension Cable	CUTTER	C–47
62	Cutter, Large Cable	CUTTER	C–49
63	Cutter, Right Angle	CUTTER	C–51
64	Cutter, Safety Wire	CUTTER	C–53
65	Cutter, Tube	CUTTER	C–55
66	Cutters, Diagonal	CUTTER	C–57
67	Saw	CUTTER	SS–1
68	Scissors, EMU	CUTTER	S–1
69	Scissors, Modified	CUTTER	S–3
70	Door Latch Tool	DRIVE	DD–1
71	Door Latch Tool, External Tank	DRIVE	D–1
72	Drive Unit Preload Tool	DRIVE	D–13
73	Dust Cap Removal Tool	DRIVE	DD–3
74	Force Measurement Tool	DRIVE	F–5
75	Hammer	DRIVE	H–1
76	Payload Clamp Assembly Driver	DRIVE	PP–3
77	Payload Clamp Assembly Torque Limited Driver	DRIVE	PP–5
78	Pin Puller/Socket	DRIVE	PP–17
79	Ratchet With 15/16–Inch Socket	DRIVE	RR–1
80	Ratchet With Telescoping 15/16–Inch Socket	DRIVE	RR–3
81	Ratchet Wrench Cheater Bar	DRIVE	R–1
82	Ratchet, 1/2–Inch Drive	DRIVE	RR–5
83	Ratchet, 3/4–Inch Drive	DRIVE	RR–7
84	Ratchet, 3/8–Inch Drive	DRIVE	R–3
85	Ratchet, 3/8–Inch Drive (EVA)	DRIVE	R–5
86	Ratchet, 3/8–Inch Drive (SAL)	DRIVE	RR–9
87	Ratchet, 3/8–Inch Drive McTether	DRIVE	R–7
88	Ratchet, 3/8–Inch Drive, With 7/16–Inch Socket	DRIVE	R–9
89	Ratchet, 3/8–Inch Drive, With 7/16–Inch Socket (EVA)	DRIVE	R–11
90	Ratchet, 3/8–Inch Drive, With 7/16–Inch Socket and Extension	DRIVE	R–13
91	Ratchet, MMU FSS Contingency	DRIVE	R–15

92	Ratchet, MST Manual Backup	DRIVE	RR-11
93	Ratchet/Socket System	DRIVE	RR-13
94	Torque Multiplier	DRIVE	TT-3
95	Torque Multiplier (SSF)	DRIVE	TTT-7
96	Torque Multiplier, Modified	DRIVE	T-49
97	Torque Recorder	DRIVE	T-51
98	Wrench, L-Handle with Number 10 Allen	DRIVE	W-25
99	Wrench, Small Torque	DRIVE	W-31
100	Wrench, Torque	DRIVE	W-33
101	Cable , Jumper	ELECTRICAL	CC-1
102	Connector and Cap, Wing Tab	ELECTRICAL	C-19
103	Connector Demate Tool, D	ELECTRICAL	C-21
104	Connector Installation Tool, D	ELECTRICAL	CC-19
105	Connector Mate Tool, D	ELECTRICAL	C-23
106	Connector Pin Straightener	ELECTRICAL	CC-21
107	Connector Pin Straightener, Multisize	ELECTRICAL	C-25
108	Connector Removal Tool, D	ELECTRICAL	CC-23
109	Connector Tool, Basin Wrench Electrical	ELECTRICAL	CC-25
110	Connector Tool, Circular	ELECTRICAL	C-27
111	Connector Tool, Circular (HST)	ELECTRICAL	C-29
112	Connector Tool, Coax	ELECTRICAL	C-31
113	Connector Tool, Locking Electrical	ELECTRICAL	C-33
114	Connector Tool, Round Coax	ELECTRICAL	C-35
115	Connector, Zero-G Electrical	ELECTRICAL	CCC-5
116	Portable Data Aquisition Package	ELECTRICAL	P-39
117	Remote Power Unit	ELECTRICAL	RR-15
118	Shorting Plug	ELECTRICAL	SS-3
119	Spun Bypass Unit	ELECTRICAL	SS-15
120	Switch, EMU	ELECTRICAL	S-49
121	Switch, EVA	ELECTRICAL	S-51
122	Antenna Bridge Structure	EQUIP RESTRAINT	AA-3
123	Apogee Kick Modor Capture Device	EQUIP RESTRAINT	AA-5
124	Bar, Capture	EQUIP RESTRAINT	BB-3
125	Bar, Grapple	EQUIP RESTRAINT	BB-5
126	Bar, Handling	EQUIP RESTRAINT	BB-7
127	Bar, INTELSAT Capture	EQUIP RESTRAINT	BB-9
128	Bar, Spin-Up	EQUIP RESTRAINT	BB-11
129	Battery Transfer Strap, MMU	EQUIP RESTRAINT	B-29
130	Bayonet Fitting	EQUIP RESTRAINT	B-43
131	Bolt and Socket, EVA Standard	EQUIP RESTRAINT	B-45
132	Bolts, EVA Captive	EQUIP RESTRAINT	B-49
133	Carryout Bracket	EQUIP RESTRAINT	CC-5
134	Door Latch, 1/4 Turn	EQUIP RESTRAINT	D-3
135	Door Stay, Adjustable, SSM	EQUIP RESTRAINT	D-5
136	Door Stay, OTA	EQUIP RESTRAINT	D-7
137	Door Support Bracket	EQUIP RESTRAINT	D-9

138	Fastener, 1/4 Turn	EQUIP RESTRAINT	F–1
139	Grapple Fixture, Portable Flight Releasable	EQUIP RESTRAINT	G–3
140	Handle, Electrical Connector Cap T	EQUIP RESTRAINT	H–3
141	Handle, Jettison/Transfer	EQUIP RESTRAINT	H–5
142	Handle, Large Portable ORU	EQUIP RESTRAINT	HH–1
143	Handle, Micrometeoroid/Orbital Debris Shield	EQUIP RESTRAINT	HHH–1
144	Handle, Primary Deployment Mechanism	EQUIP RESTRAINT	H–7
145	Handle, Small Portable ORU	EQUIP RESTRAINT	HH–3
146	Handle, T	EQUIP RESTRAINT	H–9
147	Handles, ORU	EQUIP RESTRAINT	HHH–3
148	Handling Aid, Magnetic	EQUIP RESTRAINT	HH–5
149	Harpoon, EASE Truss Node	EQUIP RESTRAINT	H–15
150	Harpoon, Modified	EQUIP RESTRAINT	HH–7
151	Hook, French	EQUIP RESTRAINT	H–17
152	Hook, Grapple	EQUIP RESTRAINT	HH–9
153	Hook, J	EQUIP RESTRAINT	H–19
154	Hook, One–Handed Tether	EQUIP RESTRAINT	HH–11
155	Hook, Quick Attach Tether	EQUIP RESTRAINT	HH–13
156	Hook, Radial Squeeze	EQUIP RESTRAINT	HH–15
157	Hook, Skylab	EQUIP RESTRAINT	HH–17
158	Hook, Swivel	EQUIP RESTRAINT	HH–19
159	Hook, Truss Strut	EQUIP RESTRAINT	HH–21
160	Hook, Universal Tether	EQUIP RESTRAINT	H–21
161	Joint, Truss	EQUIP RESTRAINT	JJ–1
162	Magnetic Panel Attachment Device	EQUIP RESTRAINT	MM–1
163	Manual Aft Frame Tilt Actuator	EQUIP RESTRAINT	M–5
164	Mechanical Finger	EQUIP RESTRAINT	M–7
165	ORU Transfer Device	EQUIP RESTRAINT	OOO–1
166	Payload Interface Mechanism	EQUIP RESTRAINT	P–1
167	Payload Interface Mechanism Adapter	EQUIP RESTRAINT	P–3
168	Payload Retention Device	EQUIP RESTRAINT	P–5
169	Payload Retention Strap	EQUIP RESTRAINT	P–7
170	Pin, Safing	EQUIP RESTRAINT	PP–19
171	Pip–Pin	EQUIP RESTRAINT	P–29
172	Pip–Pin, Lock–Lock	EQUIP RESTRAINT	P–31
173	Power Tool Retaining Mechanism	EQUIP RESTRAINT	PP–29
174	Robotic/EVA Interfaces	EQUIP RESTRAINT	RRR–1
175	Rope Reel, RMS	EQUIP RESTRAINT	R–19
176	Snatch Block	EQUIP RESTRAINT	S–13
177	Spacecraft Adapter	EQUIP RESTRAINT	SS–11
178	Steering Wheel	EQUIP RESTRAINT	S–29
179	Tape Caddy, Kapton	EQUIP RESTRAINT	T–1
180	Tape/Velcro Caddy	EQUIP RESTRAINT	T–3
181	Tensioning Buckle	EQUIP RESTRAINT	T–7
182	Tether, Adjustable Equipment	EQUIP RESTRAINT	T–13
183	Tether, Adjustable Equipment (HST)	EQUIP RESTRAINT	T–15

184	Tether, Drop–Proof	EQUIP RESTRAINT	T–17
185	Tether, Retractable	EQUIP RESTRAINT	T–19
186	Tether, Retractable Equipment	EQUIP RESTRAINT	T–21
187	Tether, Rigidizing	EQUIP RESTRAINT	TTT–5
188	Tether, Semirigid	EQUIP RESTRAINT	T–23
189	Tether, Wrist	EQUIP RESTRAINT	T–25
190	Tie Wrap	EQUIP RESTRAINT	T–33
191	Tool Board	EQUIP RESTRAINT	T–35
192	Tool Board, Cushioned	EQUIP RESTRAINT	T–37
193	Tool Caddy, McCaddy and Ratchet	EQUIP RESTRAINT	T–39
194	Tool Caddy, Soft	EQUIP RESTRAINT	T–41
195	Trunnion Pin Attachment Device	EQUIP RESTRAINT	TT–5
196	Velcro Caddy	EQUIP RESTRAINT	V–1
197	Winch	EQUIP RESTRAINT	W–1
198	Y–Fitting/Berthing Adapter	EQUIP RESTRAINT	YY–1
199	Zip Nut	EQUIP RESTRAINT	Z–1
200	Connector, EVA Fluid	FLUID XFER	C–37
201	Connector, Helium II Resupply	FLUID XFER	CC–27
202	Hydrazine Analyzer	FLUID XFER	HH–23
203	Hydrazine Ball Valve Housing	FLUID XFER	HH–25
204	Hydrazine Brush	FLUID XFER	H–23
205	Hydrazine Cap Retainer Assembly	FLUID XFER	HH–27
206	Hydrazine Detector	FLUID XFER	H–25
207	Hydrazine Dust Cap Remover	FLUID XFER	HH–29
208	Hydrazine Monitor	FLUID XFER	HH–31
209	Hydrazine Multipurpose Tool	FLUID XFER	HH–33
210	Hydrazine Nut Retainer Assembly	FLUID XFER	HH–35
211	Hydrazine Removal Canister	FLUID XFER	H–27
212	Hydrazine Retrieval Tool	FLUID XFER	HH–37
213	Hydrazine Seal Verification Tool	FLUID XFER	HH–39
214	Airlock Hatch Seal Tool	LEVER	AAA–1
215	Bolt Puller	LEVER	B–47
216	Loop Pin Extractor	LEVER	L–5
217	PAM–D Wedge	LEVER	PP–1
218	Power Drive Unit Disconnect	LEVER	P–47
219	Probe	LEVER	P–61
220	Pry Bar	LEVER	P–63
221	RMS Shoulder Brace Release Tool	LEVER	R–17
222	Spreader Assembly	LEVER	SS–13
223	Airlock	OTHER	A–1
224	Airlock, External	OTHER	AA–1
225	Airlock, SSF	OTHER	AAA–3
226	Centerline Latch Bypass Tool	OTHER	C–17
227	Cover, Apogee Kick Motor Nozzle	OTHER	CC–29
228	Cover, Large Soft Environmental	OTHER	CC–31
229	Cuff Checklist	OTHER	C–41

230	Cuff Checklist, Electronic	OTHER	CC-35
231	EMU Helmet Mounted Display	OTHER	EE-1
232	EMU Thermal Mittens	OTHER	E-3
233	EMU Watch	OTHER	E-5
234	Extravehicular Mobility Unit	OTHER	E-7
235	Extravehicular Mobility Unit, Advanced	OTHER	EE-3
236	Go/No-Go Gauges	OTHER	G-1
237	Mirror, Donning	OTHER	MM-3
238	Mirror, Inspection	OTHER	M-11
239	Mirror, Wrist	OTHER	M-13
240	MMU Range Finder	OTHER	MM-5
241	MMU Thruster Cue Light Extender	OTHER	M-17
242	PFR Probe Bolt Head	OTHER	P-11
243	Three-Point Latch Tool	OTHER	T-31
244	Welder, EVA	OTHER	WW-1
245	Battery, EMU Lights	PHOTO/LTS	B-33
246	Battery, EMU TV	PHOTO/LTS	B-35
247	Camera Actuator and Cable, MMU 35-MM	PHOTO/LTS	C-1
248	Camera Cover, 35-MM	PHOTO/LTS	C-3
249	Camera Cover, MMU 35-MM	PHOTO/LTS	C-5
250	Camera Mount, 35-MM	PHOTO/LTS	C-7
251	Camera Mount, Macro	PHOTO/LTS	CC-3
252	Camera Mount, MMU 35-MM	PHOTO/LTS	C-9
253	Camera Receiver and Video Processor, EMU Television	PHOTO/LTS	C-11
254	Camera, 35-MM	PHOTO/LTS	C-13
255	Camera, EMU Television	PHOTO/LTS	C-15
256	Flashlight	PHOTO/LTS	F-3
257	Light, Portable External	PHOTO/LTS	LLL-1
258	Light, Portable Flood	PHOTO/LTS	L-1
259	Lights, EMU	PHOTO/LTS	L-3
260	Battery Charger, EMU Middeck	POWER	B-25
261	Battery Recharge Cable, MMU	POWER	B-27
262	Battery, EMU	POWER	B-31
263	Battery, EVA Power Tool	POWER	B-37
264	Battery, High Torque Power Tool	POWER	BBB-1
265	Battery, Mini Power Tool	POWER	B-39
266	Battery, MMU	POWER	B-41
267	Module Servicing Tool	POWER	M-19
268	Power Package, EVA	POWER	P-49
269	Power Ratchet Tool	POWER	P-51
270	Power Tool, EVA	POWER	P-53
271	Power Tool, EVA (HST)	POWER	P-55
272	Power Tool, High Torque	POWER	PPP-11
273	Power Tool, Rotary Impact	POWER	P-57
274	Power Tool, Mini	POWER	P-59
275	Power Tool, Smart	POWER	PP-31

276	Drill, 1/4–Inch	SOCKET	D–11
277	Drive, Right Angle	SOCKET	D–15
278	Screwdriver, Extension with Shrouded	SOCKET	S–5
279	Screwdriver, Shrouded Flex	SOCKET	S–7
280	Screwdriver, Shrouded Rigid	SOCKET	S–9
281	Socket, 1–1/16 inch	SOCKET	SS–7
282	Socket, 11/32 and 3/16 Inch	SOCKET	SS–9
283	Socket, 5/16–Inch	SOCKET	S–15
284	Socket, 5/16–Inch (HST)	SOCKET	S–17
285	Socket, 7/16 Inch Adjustable	SOCKET	S–19
286	Socket, 7/16–Inch	SOCKET	S–21
287	Socket, 7/16–Inch (HST)	SOCKET	S–23
288	Socket, 7/16–Inch GFE	SOCKET	S–25
289	Socket, Extension and 7/16–Inch (HST)	SOCKET	S–27
290	Torq–Set Tip Extension	SOCKET	T–43
291	Torq–Set Tip Extension (HST)	SOCKET	T–45
292	Torque Limiter, Multisetting	SOCKET	T–47
293	Wrench, 1/2–Inch Allen	SOCKET	W–3
294	Wrench, Extension and 1/4–Inch Allen	SOCKET	W–17
295	Wrench, Extension and 1/4–Inch Allen (IPS)	SOCKET	W–19
296	Wrench, Extension with 3/16–Inch Allen	SOCKET	W–21
297	Wrench, Extension with Number 10 Allen	SOCKET	W–23
298	Bag, Airlock Stowage	STOWAGE	B–1
299	Bag, Centerline Latch Tool	STOWAGE	B–3
300	Bag, EVA	STOWAGE	B–5
301	Bag, EVA Power Tool Battery	STOWAGE	B–7
302	Bag, HST Tool	STOWAGE	B–9
303	Bag, Large Trash	STOWAGE	B–11
304	Bag, MMU Battery Transfer	STOWAGE	B–13
305	Bag, PSA Tool Stowage	STOWAGE	B–15
306	Bag, Small Trash	STOWAGE	B–17
307	Bag, Three–Point Latch Tool	STOWAGE	B–19
308	Bag, Tool Stowage	STOWAGE	B–21
309	Bag, Transfer	STOWAGE	B–23
310	Bar Stowage Assembly	STOWAGE	BB–1
311	EMU Helmet Holding Fixture	STOWAGE	E–1
312	Fuse Transfer Container	STOWAGE	F–9
313	MMU Flight Support Station	STOWAGE	M–15
314	Stowage Assembly, Cargo Bay	STOWAGE	S–31
315	Stowage Assembly, LEASAT Equipment	STOWAGE	S–33
316	Stowage Assembly, Modular Equipment	STOWAGE	SS–19
317	Stowage Assembly, Provisions	STOWAGE	S–35
318	Stowage Assembly, Special Equipment	STOWAGE	S–37
319	Stowage Assembly, Tool Container	STOWAGE	S–39
320	Stowage Box, HST Tool	STOWAGE	S–41
321	Stowage Box, Node	STOWAGE	SS–21

322	Stowage Box, UARS Tool	STOWAGE	S-43
323	Stowage Box, Umbilical	STOWAGE	S-45
324	Stowage Container, EVA Support Equipment and Tools	STOWAGE	SSS-3
325	Stowage Device, EVA Tool	STOWAGE	SSS-5
326	Stowage Locker, Flight Support System	STOWAGE	S-47
327	Tether Reel Box	STOWAGE	T-11
328	Forceps	WRENCH	F-7
329	Pliers, Needle Nose	WRENCH	P-33
330	Pliers, One-handed Vise-Grip	WRENCH	PP-21
331	Pliers, Vise-Grip	WRENCH	P-35
332	Wrench, 1/2-Inch Open End	WRENCH	WW-3
333	Wrench, 1/2-Inch Ratcheting Box End	WRENCH	W-5
334	Wrench, 1/4-Inch Crow's Foot	WRENCH	WW-5
335	Wrench, 5/16-Inch Ratcheting Box End	WRENCH	W-7
336	Wrench, 7/16-Inch and 1/2-Inch Box End	WRENCH	W-9
337	Wrench, 7/16-Inch Open End	WRENCH	WW-7
338	Wrench, 7/16-Inch Ratcheting Open End	WRENCH	W-11
339	Wrench, Adjustable	WRENCH	W-13
340	Wrench, Cheater Bar and 15/16-Inch	WRENCH	WW-9
341	Wrench, Contingency Strut	WRENCH	W-15
342	Wrench, Lever	WRENCH	WW-11
343	Wrench, RMS MPM	WRENCH	W-27
344	Wrench, Shuttle Umbilical Retraction System	WRENCH	W-29
345	Wrench, Spanner	WRENCH	WW-13
346	Wrench, Tensioned Bolt Release	WRENCH	WW-15
347	Wrench, Truss Joint Spanner	WRENCH	WW-17

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APPENDIX E
TOOL LOCATOR SORTED BY MAJOR PAYLOAD

The large number of items described in this reference book makes it difficult to easily locate a single tool description. Besides splitting the document into sections based upon availability, appendixes with the equipment titles sorted by various common document are also provided. The titles and page numbers listed here should help users find items of interest more readily. This particular sort groups the hardware into generalized categories by major payload. This index does not include all the hardware for each of these payloads. Additional generic equipment is also often used. The items listed here were originally unique to these payloads. The following classifications are used in this index:

ACTS/TOS
ASEM
EDFE
EURECA
GRO
HST
INTELSAT
IPS
IUS
LEASAT
MMU
ORFEUS/SPAS
ORS
PAM
SAL
SMRM
SPARTAN
TSS
UARS
WESTAR/PALAPA

	HARDWARE TITLE	PAYLOAD	PAGE
1	Dust Cap Removal Tool	ACTS/TOS	DD–3
2	Pin Puller/Socket	ACTS/TOS	PP–17
3	Ratchet, 3/4 Inch Drive	ACTS/TOS	RR–7
4	Astrorope	ASEM	AA–7
5	Crew Propulsive Device	ASEM	CC–33
6	Hook, Grapple	ASEM	HH–9
7	Joint, Truss	ASEM	JJ–1
8	PFR Strut Clamp	ASEM	PP–15
9	Pole, Bistem	ASEM	PP–23
10	Pole, Inflatable	ASEM	PP–25
11	Pole,Telescoping	ASEM	PP–27
12	Stowage Box, Node	ASEM	SS–21
13	Translation Aid	ASEM	T–53
14	Wrench, Truss Joint Spanner	ASEM	WW–17
15	Y–Fitting/Berthing Adapter	ASEM	YY–1
16	CETA Electrical Cart (EDFE)	EDFE	CC–7
17	CETA Manual Cart (EDFE)	EDFE	CC–9
18	CETA Mechanical Cart (EDFE)	EDFE	CC–11
19	CETA Tether Shuttle (EDFE)	EDFE	CC–13
20	CETA Track (EDFE)	EDFE	CC–15
21	CETA Truck (EDFE)	EDFE	CC–17
22	Crew Loads Instrumented Pallet	EDFE	C–39
23	Portable Data Aquisition Package	EDFE	P–39
24	Cutter, High Tension Cable	EURECA	C–47
25	Connector, EVA Fluid	GRO	C–37
26	Ratchet Wrench Cheater Bar	GRO	R–1
27	Socket, 7/16–Inch GFE	GRO	S–25
28	Wrench, Shuttle Umbilical Retraction System	GRO	W–29
29	Bag, HST Tool	HST	B–9
30	Bolts, EVA Captive	HST	B–49
31	Connector Demate Tool, D	HST	C–21
32	Connector Mate Tool, D	HST	C–23
33	Connector Pin Straightener, Multisize	HST	C–25
34	Connector Tool, Circular (HST)	HST	C–29
35	Connector Tool, Coax	HST	C–31
36	Connector Tool, Locking Electrical	HST	C–33
37	Connector Tool, Round Coax	HST	C–35
38	Door Stay, Adjustable, SSM	HST	D–5
39	Door Stay, OTA	HST	D–7
40	Drive Unit Preload Tool	HST	D–13
41	Fuse Transfer Container	HST	F–9
42	Grapple Fixture, Portable Flight Releasable	HST	G–3
43	Handle, Jettison/Transfer	HST	H–5
44	Handle, Large Portable ORU	HST	HH–1
45	Handle, Primary Deployment Mechanism	HST	H–7

46	Handle, Small Portable ORU	HST	HH–3
47	Hook, J	HST	H–19
48	Light, Portable Flood	HST	L–1
49	Mechanical Finger	HST	M–7
50	PFR Extender	HST	P–13
51	PFR Ingress Aid	HST	P–15
52	PFR Socket (HST)	HST	P–19
53	PFR Socket Converter, 90o	HST	P–23
54	Portable Foot Restraint (HST)	HST	P–43
55	Power Ratchet Tool	HST	P–51
56	Power Tool, EVA (HST)	HST	P–55
57	Power Tool, Rotary Impact	HST	P–57
58	Ratchet, 3/8–Inch Drive McTether	HST	R–7
59	Screwdriver, Shrouded Flex	HST	S–7
60	Screwdriver, Shrouded Rigid	HST	S–9
61	Socket, 5/16–Inch (HST)	HST	S–17
62	Socket, 7/16 Inch Adjustable	HST	S–19
63	Socket, 7/16–Inch (HST)	HST	S–23
64	Socket, Extension and 7/16–Inch (HST)	HST	S–27
65	Stowage Box, HST Tool	HST	S–41
66	Tether, Adjustable Equipment (HST)	HST	T–15
67	Tether, Semirigid	HST	T–25
68	Tool Board, Cushioned	HST	T–37
69	Tool Caddy, McCaddy and Ratchet	HST	T–39
70	Torq–Set Tip Extension (HST)	HST	T–45
71	Torque Limiter, Multisetting	HST	T–47
72	Wrench, 7/16–Inch and 1/2–Inch Box End	HST	W–9
73	Zip Nut	HST	Z–1
74	Bar, INTELSAT Capture	INTELSAT	BB–9
75	Camera Mount, Macro	INTELSAT	CC–3
76	Cover, Large Soft Environmental	INTELSAT	CC–31
77	Mirror, Inspection	INTELSAT	M–11
78	Steering Wheel	INTELSAT	S–29
79	Socket, 7/16–Inch GFE	INTELSAT/ASEM	S–25
80	Payload Clamp Assembly Driver	IPS	PP–3
81	Payload Clamp Assembly Torque Limited Driver	IPS	PP–5
82	Wrench, Contingency Strut	IPS	W–15
83	Wrench, Extension and 1/4–Inch Allen (IPS)	IPS	W–19
84	Cutter, Large Cable	IUS	C–49
85	Manual Aft Frame Tilt Actuator	IUS	M–5
86	Ratchet, 3/8–Inch Drive, With 7/16–Inch Socket (EVA)	IUS	R–11
87	Ratchet, 3/8–Inch Drive, With 7/16–Inch Socket and Extension	IUS	R–13
88	Telescoping Boom	IUS	T–5
89	Torque Multiplier	IUS	TT–3
90	Torque Multiplier, Modified	IUS	T–49
91	Wrench, 1/2–Inch Allen	IUS	W–3

92	Bag, Transfer	LEASAT	B–23
93	Bar Stowage Assembly	LEASAT	BB–1
94	Bar, Capture	LEASAT	BB–3
95	Bar, Grapple	LEASAT	BB–5
96	Bar, Handling	LEASAT	BB–7
97	Bar, Spin–Up	LEASAT	BB–11
98	Connector Tool, Circular	LEASAT	C–27
99	Drive, Right Angle	LEASAT	D–15
100	Handle, Electrical Connector Cap T	LEASAT	H–3
101	Handle, T	LEASAT	H–9
102	Pin, Safing	LEASAT	PP–19
103	Remote Power Unit	LEASAT	RR–15
104	Shorting Plug	LEASAT	SS–3
105	Spun Bypass Unit	LEASAT	SS–15
106	Stowage Assembly, LEASAT Equipment	LEASAT	S–33
107	Stowage Assembly, Tool Container	LEASAT	S–39
108	Torq–Set Tip Extension	LEASAT	T–43
109	Bag, MMU Battery Transfer	MMU	B–13
110	Battery Recharge Cable, MMU	MMU	B–27
111	Battery Transfer Strap, MMU	MMU	B–29
112	Battery, MMU	MMU	B–41
113	Camera Actuator and Cable, MMU 35–MM	MMU	C–1
114	Camera Cover, MMU 35–MM	MMU	C–5
115	Camera Mount, MMU 35–MM	MMU	C–9
116	Magnetic Panel Attachment Device	MMU	MM–1
117	Manned Maneuvering Unit	MMU	M–3
118	MMU Flight Support Station	MMU	M–15
119	MMU Range Finder	MMU	MM–5
120	MMU Thruster Cue Light Extender	MMU	M–17
121	Ratchet, MMU FSS Contingency	MMU	R–15
122	Socket, 5/16–Inch	MMU	S–15
123	Door Latch Tool	ORFEUS/SPAS	DD–1
124	Cutter, Right Angle	ORS	C–51
125	Cutter, Safety Wire	ORS	C–53
126	Hydrazine Ball Valve Housing	ORS	HH–25
127	Hydrazine Cap Retainer Assembly	ORS	HH–27
128	Hydrazine Dust Cap Remover	ORS	HH–29
129	Hydrazine Multipurpose Tool	ORS	HH–33
130	Hydrazine Nut Retainer Assembly	ORS	HH–35
131	Hydrazine Retrieval Tool	ORS	HH–37
132	Hydrazine Seal Verification Tool	ORS	HH–39
133	Wrench, Spanner	ORS	WW–13
134	PAM–D Wedge	PAM	PP–1
135	Spreader Assembly	PAM	SS–13
136	Power Package, EVA	PAM, TSS	P–49
137	Carryout Bracket	SAL	CC–5

138	Ratchet, 1/2–Inch Drive	SAL	RR–5
139	Ratchet, 3/8–Inch Drive (SAL)	SAL	RR–9
140	Bag, Large Trash	SMRM	B–11
141	Cable , Jumper	SMRM	CC–1
142	Connector Installation Tool, D	SMRM	CC–19
143	Connector Pin Straightener	SMRM	CC–21
144	Connector Removal Tool, D	SMRM	CC–23
145	Door Support Bracket	SMRM	D–9
146	Drill, 1/4–Inch	SMRM	D–11
147	Module Servicing Tool	SMRM	M–19
148	Ratchet, 3/8–Inch Drive (EVA)	SMRM	R–5
149	Ratchet, MST Manual Backup	SMRM	RR–11
150	Scissors, Modified	SMRM	S–3
151	Screwdriver, Extension with Shrouded	SMRM	S–5
152	Socket, 7/16–Inch	SMRM	S–21
153	Stowage Locker, Flight Support System	SMRM	S–47
154	Trunnion Pin Attachment Device	SMRM	TT–5
155	Wrench, 1/4–Inch Crow's Foot	SMRM	WW–5
156	Wrench, 7/16–Inch Ratcheting Open End	SMRM, HST	W–11
157	Wrench, Extension with Number 10 Allen	SMRM	W–23
158	Ratchet With 15/16 Inch Socket	SPARTAN	RR–1
159	Ratchet With Telescoping 15/16 Inch Socket	SPARTAN	RR–3
160	Wrench, Cheater Bar and 15/16–Inch	SPARTAN	WW–9
161	Wrench, 5/16–Inch Ratcheting Box End	TSS	W–7
162	Wrench, Extension with 3/16–Inch Allen	TSS	W–21
163	PFR Probe Extension	UARS	P–17
164	Pole, Leavy	UARS	P–37
165	Socket, 11/32 and 3/16 Inch	UARS	SS–9
166	Stowage Box, Umbilical	UARS	S–43
167	Stowage Box, UARS Tool	UARS	S–45
168	Wrench, Tensioned Bolt Release	UARS	WW–15
169	Antenna Bridge Structure	WESTAR/PALAPA	AA–3
170	Apogee Kick Modor Capture Device	WESTAR/PALAPA	AA–5
171	Bag, Tool Stowage	WESTAR/PALAPA	B–21
172	Cover, Apogee Kick Motor Nozzle	WESTAR/PALAPA	CC–29
173	Cutter, Antenna	WESTAR/PALAPA	C–43
174	Spacecraft Adapter	WESTAR/PALAPA	SS–11
175	Wrench, L–Handle with Number 10 Allen	WESTAR/PALAPA	W–25
176	Wrench, Small Torque	WESTAR/PALAPA	W–31
177	Wrench, Torque	WESTAR/PALAPA	W–33

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APPENDIX F
TOOL LOCATOR SORTED ALPHABETICALLY BY TITLE

The large number of items described in this reference book makes it difficult to easily locate a single tool description. Besides splitting the document into sections based upon availability, appendixes with the equipment titles sorted by various common categories are also provided. The titles and page numbers listed here should help users find items of interest more readily. This particular sort groups the entire reference book alphabetically by title.

92	Door Latch Tool, External Tank	D–1
93	Door Latch, 1/4 Turn	D–3
94	Door Stay, Adjustable, SSM	D–5
95	Door Stay, OTA	D–7
96	Door Support Bracket	D–9
97	Drill, 1/4–Inch	D–11
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APPENDIX H
ACRONYMS

AAH	automatic attitude hold
ABS	antenna bridge structure
ACD	apogee kick motor capture device
	architecture control document
ACTS/TOS	advanced communications technology satellite/transfer orbit stage
AKM	apogee kick motor
APC	adaptive payload carrier
APFR	articulating PFR
AR	astrorope
ASEM	assembly of station by EVA methods
BP	bistem pole
CBSA	cargo bay stowage assembly
CETA	crew and equipment translation aid
CLIP	crew loads instrumented pallet
CPD	crew propulsive device
CRT	cathode–ray tube
CSR	crew self rescue
CTSD	Crew and Thermal Systems Division
DCM	display and control module
DDL	door drive linkage
DTO	detailed test objective
EDFE	EVA development flight experiment
EMU	extravehicular mobility unit
EPP	EVA power package
ESE&T	EVA support equipment and tools
ET	external tank
ETSD	EVA tool stowage device
EV	extravehicular
EVA	extravehicular activity
EVAS	extravehicular activity system
FSS	flight support station
	flight support system
GAS	get–away special
GFE	government–furnished equipment
GRO	Gamma Ray Observatory
HHMU	handheld maneuvering unit
HMD	helmet mounted display

HST	Hubble Space Telescope
	hydrazine servicing tool
IP	inflatable pole
IPS	instrument pointing system
IUS	inertial upper stage
IV	intravehicular
IVA	intravehicular activity
LCD	liquid crystal display
LED	light–emitting diode
LESA	Leasat equipment stowage assembly
LSM	Leasat salvage mission
MB	mission build
MEB	main electronics box
MESA	modular equipment stowage assembly
MFR	manipulator foot restraint
MLI	multilayer insulation
MMS	multimission modular spacecraft
MMU	manned maneuvering unit
MPESS	mission peculiar equipment support structure
MPM	manipulator positioning mechanism
MST	module servicing tool
MT	mobile transporter
MWS	mini work station
N/A	not applicable
ORS	orbital refueling system
ORU	orbital replaceable unit
OTD	ORU transfer device
PAD	PFR attachment device
PAM	payload assist module
PCA	payload clamp assembly
PDAP	portable data acquisition package
PDGP	power/data grapple fixture
PDU	power drive unit
PFR	portable foot restraint
PIM	payload interface mechanism
PLSS	primary life support system
PRD	payload retention device
PRT	power ratchet tool
PSA	provisions stowage assembly
PWP	portable work platform
REM	remote engagement mechanism

RMS	remote manipulator system
RPU	remote power unit
SAFER	simplified aid for EVA rescue
SAL	scientific airlock
SAS	spacecraft adapter structure
SBU	spun bypass unit
SESA	special equipment stowage assembly
SIP	standard interface panel
SMM	Solar Maximum mission
SMRM	Solar Maximum repair mission
SPAS	Shuttle pallet satellite
SQUID	Standard quick release interface device
SRL	satellite restraint latch
SRM	satellite retrieval mission
SRT	semirigid tether
SSF	Space Station Freedom
SSRMS	space station RMS
STS	Space Transportation System
SURS	Shuttle umbilical retraction system
TA	translation aid
TCA	tool container assembly
TERA	temporary equipment restraint aid
TP	telescoping pole
TPAD	trunnion pin attachment device
TSD	task simulator device
TSS	tethered satellite system
UARS	upper atmosphere research satellite
ULC	unpressurized logistics carrier
VPU	video processing unit
WFPC	wide field planetary camera
WP	work package

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