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R-3896-6

TECHNICAL MANUAL  
INSTALLATION AND REPAIR  
OF  
THERMAL INSULATION

**F-1 ROCKET ENGINE**

(ROCKETDYNE)

**CHANGE**  
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## INTRODUCTION

This manual is one of seven R-3896-series technical manuals prepared to provide official Rocketdyne field support documentation for the operation and maintenance of the F-1 Rocket Engine, Part Number 104001, Serial Numbers F-2003 through F-2098, and its related ground support equipment, designed and manufactured by Rocketdyne, a division of North American Rockwell Corporation, 6633 Canoga Avenue, Canoga Park, California 91304. The information in these manuals was prepared by Logistics Publications & Training Department of Rocketdyne.

The instructions in the manuals are used to best advantage when each manual is current and complete (see figure 1) and the purpose and scope of each manual is known. The manuals in this series, and the nature of the data each provides, are found in the manuals' contents and support function chart.

### 1. F-1 MANUALS--THEIR SUPPORT FUNCTIONS.

The contents and support function chart lists all F-1 series technical manuals, describes the support function each manual serves, and

lists the section titles of each manual. The chart also explains how the technical data in each manual relates to the support of the engine and its ground support equipment throughout a normal engine flow, as well as during unscheduled maintenance tasks. Information appearing in one manual is not duplicated in another. Thus, information on the description, operation, and maintenance of ground support equipment is in R-3896-5. However, the instructions for servicing the engine using ground support equipment are in R-3896-3 and R-3896-11. Thermal insulation configuration information is in R-5857, Saturn F-1 Configuration Identification & Status Report. Engine serial numbers within this manual are in accordance with Rocketdyne F-1 engine designation. For F-1 engine serial number allocation, refer to the cross-reference index in R-5857.

Manual	Contents and Support Function	Section and Title
R-3896-1 F-1 Rocket Engine Data	This manual contains a physical description of the various F-1 engine systems and the individual engine system components; data pertaining to engine design characteristics including environmental conditions, attitude, mass properties data, turbopump inlet propellant conditions, and interface connections for mating the engine with the S-IC of the Saturn V vehicle; and nominal engine performance characteristics, methods for predicting engine variable characteristics, and other pertinent information that can be used as an aid for analyzing and/or determining specific engine performance. The manual serves to familiarize the reader with the design and operation of the F-1 engine and serves as a training aid document.	I Description and Operation II Interface Design Criteria III Performance

Manual	Contents and Support Function	Section and Title
R-3896-3, Volume I F-1 Rocket Engine Maintenance and Repair	This manual contains general maintenance practices that are peculiar to the engine covered in this volume and to the component repair procedures contained in Volume II of this manual; the use of engine, thrust chamber, and nozzle extension ground support equipment and the tasks necessary to prepare the equipment for maintenance using the applicable pieces of ground support equipment; detailed procedures for component removal, reinstallation, or replacement, and the post-installation test requirements that will verify the integrity of engine systems affected by the removal of individual engine components and lines. This volume and Volume II provide the necessary maintenance and repair data to perform unscheduled maintenance tasks on an uninstalled engine and the required post-maintenance tests to determine that the engine is in an operable condition.	I General Maintenance and Repair
		II Handling
		III Component Removal and Installation
		IV Post-Maintenance Test Requirements
R-3896-3, Volume II F-1 Rocket Engine Maintenance and Repair	This manual contains cleaning, inspecting, repairing, and testing procedures for the individual engine components. This manual provides the data to restore and/or maintain components of the engine in an operable condition for reinstallation on the engine or assignment as a spare.	I Quick-Disconnect
		II Gas Generator
		III Gas Generator Ball Valve
		IV Gas Generator Injector Purge and Pump Seal Purge Check Valve
		V Deleted
		VI Heat Exchanger
		VII Heat Exchanger Check Valve
		VIII Thrust Chamber (Installed)
		IX Thrust Chamber (Uninstalled)
		X Thrust OK Pressure Switch
		XI Inert Prefill Check Valve
		XII Oxidizer Dome Purge Check Valve
		XIII Oxidizer Valve
		XIV Fuel Valve
		XV Turbopump
		XVA Turbine
XVI Bearing Coolant Control Valve		

Manual	Contents and Support Function	Section and Title
R-3896-3, Volume II (cont)		XVII Deleted
		XVIII Electrical Harness
		XIX Hypergol Manifold
		XX Ignition Monitor Valve
		XXI Checkout Valve
		XXII Engine Control Valve
		XXIII Four-Way Solenoid Valve
		XXIV Thrust Chamber Nozzle Extension
		XXV Pressure Transducer
		XXVI Temperature Transducer
		XXVII Flight Instrumentation Junction Boxes
		XXVIII Rigid Ducts, Flexible Lines, and Braided Flex Hoses
		XXIX Redundant Shutdown Valve
		XXX Volumetric Liquid Oxygen Transducer (Oxidizer Flowmeter)
		XXXI Gimbal Boot, Insulation Boot, and Insulation Seal
	R-3896-4 F-1 Rocket Engine Illustrated Parts Breakdown	This manual contains illustrative and columnar listings of all parts of the engine that can be disassembled, reassembled, repaired, replaced, or overhauled. This manual locates and identifies the interrelationship of parts, aids in the requisition of replacement parts, indicates part usage and interchangeability and recommended repair or replacement for the F-1 engine and its individual components and parts.
R-3896-5, Volume I F-1 Rocket Engine Ground Support Equipment Maintenance and Operation	This manual contains safety requirements and general maintenance practices peculiar to the equipment covered in this volume and to equipment and T-tools covered in Volume II of this manual; inspection requirements, physical description, operation, intended usage, operating limitations, periodic maintenance, and parts listings with maintenance-level codes for the F-1 engine ground support equipment covered in this volume. This volume provides data to restore and/or maintain the F-1 rocket engine ground support equipment in an operable condition.	I General Maintenance and Repair II Hydraulic Pumping Unit G2025 III Hydraulic Pumping Unit G2026 IV Accumulator Unit G2027 V Engine Checkout Console G3142 VI Pneumatic Flow Monitors G3130 and G3131 VII Engine Vertical Installer G4049 VIII Engine Rotating Sling G4050 IX Flight Combustion Monitor 703227 X Components Test Console G3141 and Components Adapter Set G3143

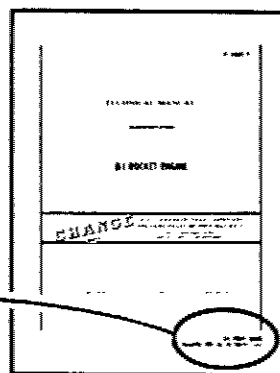
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R-3896-5, Volume II F-1 Rocket Engine Ground Support Equipment Maintenance and Operation	This manual contains inspection requirements, physical description, operation, intended usage, operating limitations, periodic maintenance, and parts listing with maintenance-level codes for the F-1 engine ground support equipment end items that are considered tools (ie, test kits, sets, and tools) and T-tools. This volume provides data necessary to determine that those items of ground support equipment covered by this volume and the F-1 field T-tools are in an operable condition.	I Test Kits, Sets, and Tools II T-Tools III Dummy-Weight T-Tools
R-3896-6 F-1 Rocket Engine Thermal Insulation and Repair	This manual contains a description of the thermal insulation panels, special tools and equipment, installation and removal procedures, access provisions, repair data, and applicable packaging, storage, and handling information. This manual provides information pertinent to the maintenance and repair of F-1 engine thermal insulation.	See detailed table of contents for this manual.
R-3896-9 F-1 Rocket Engine Transportation	This manual contains procedures for preparing the F-1 rocket engine, nozzle extension, thermal insulation, and miscellaneous engine loose equipment for shipment, and procedures for shipping by truck, air, or water. Included are recommended truck-, air-, and water-transport check lists, which may be used to make sure that procedures and in-transit inspection have been performed.	I Preparation for Shipping II Shipping by Truck Transport III Shipping by Air Transport IV Shipping by Water Transport

Manual	Contents and Support Function	Section and Title
R-3896-11 F-1 Rocket Engine Operating Instructions	This manual contains complete, authorized field operating requirements that affect F-1 flight engines F-2029 through F-2098 during normal operational flow from engine receipt at MAF through vehicle launch. Specific and general requirements and procedures for normal F-1 engine activities are provided and include acceptability criteria and limits, special constraints, safety precautions, and correct sequences required to satisfactorily accomplish the activities.	I Operating Requirements II General Requirements III Operating Procedures

## USE YOUR MANUAL ONLY IF CURRENT AND COMPLETE

Manuals that are not current and complete are not authoritative documents and are not to be used. The following outlines the method for determining whether your manual is current and complete.

**A. DETERMINING CURRENCY.** To be sure that yours is the latest issue of the manual, refer to Configuration Identification & Status Report, which is revised monthly and lists the technical manual numbers, titles, unincorporated supplements, and latest change or revision dates. Your manual must have a title page with the same or later date than the date shown in the Configuration Identification & Status Report. Your manual must also include the unincorporated supplements listed in the Configuration Identification & Status Report, or if your manual is later than shown in the report, the unincorporated supplements listed in the Manual Data Supplement Record in your manual. If your title page incorporates two dates as illustrated below, compare the change (lower) date. If your manual is not current, obtain a current copy through your technical manual supply system.



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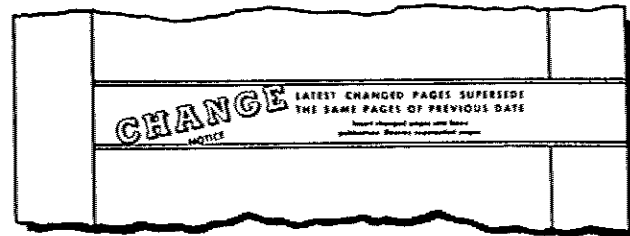
**B. DETERMINING COMPLETENESS.** To be sure that your manual is complete, make a page-by-page comparison of its pages to those listed in the List of Effective Pages. The List of Effective Pages, which shows the change status since the basic issue or last revision, is found on the alphabetically lettered page(s) immediately following the title page. All pages, except supplements, are

listed with their issue dates. Manual pages that are dated must have the same date as that appearing in the List of Effective Pages for that page. Unchanged pages are listed as "original" and are not dated.

## HOW TO KEEP YOUR MANUAL UP-TO-DATE

As design changes are made to the rocket engine and ground support equipment and better methods of maintenance are discovered, your manual is periodically changed, revised, or supplemented. The following steps will help you keep your manual up-to-date:

**A. CHANGES.** Updating by adding to or partially replacing existing pages is defined as a change. Changes can be identified by the change notice on the new title page.



To collate a change, refer to the Filing Instructions sheet issued with the manual and proceed as follows:

1. Remove the pages listed in the "Remove" column of the Filing Instructions sheet from the manual and destroy them. Do not concern yourself with the data on the opposite side of the deleted page since, if this date is not deleted, it is replaced in the change package.
2. Insert all pages listed in the "Insert" column of the Filing Instructions sheet in sequence. Pages with a suffix letter are inserted in alphabetical order following the page with the same basic number; for example, pages 3-14A, 3-14B, etc, follow page 3-14.

GEN-NASA-1A

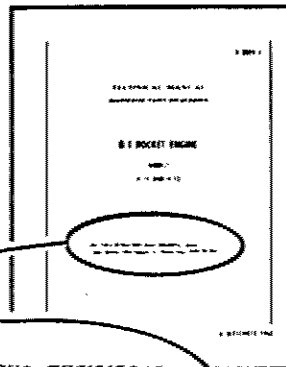
Figure 1. How to Maintain Your Manual (Sheet 1 of 2)

3. If you are unsure of the status of any page or pages, refer to the List of Effective Pages and make sure your manual contains pages (with the corresponding change dates) listed in the List of Effective Pages.
4. Remove manual supplements that have been incorporated.

#### NOTE

Incorporated supplements can be determined by reviewing the newly issued Manual Data Supplement Record.

**B. REVISIONS.** Updating by replacing all the existing pages of a manual is defined as a revision. Revisions can be identified by the replacement notice on the new title page.



To collate a revision, proceed as follows:

1. Remove and destroy all existing pages of your manual except Manual Data Supplements that have not been incorporated.

#### NOTE

Unincorporated supplements can be identified by reviewing the Manual Data Supplement Record supplied in the revision.

2. Insert the new pages in your cover.

**C. SUPPLEMENTS.** Updating that authorizes the addition to, or alteration of, the existing data in your manual is defined as a Manual Data Supplement. Information on how to insert supplements is found in the supplements.

#### HOW TO KEEP ABREAST OF THE LATEST CHANGES TO TECHNICAL DATA

Changes and/or additions to technical data are identified by a vertical bar (change bar) in the margin of the page adjacent to the changed data. A direct comparison between the new (identified by the change bar) and the old data will help you in identifying specific changes made.

GEN-NASA-2

Figure 1. How to Maintain Your Manual (Sheet 2 of 2)



## 2. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

All approved ECPs (Engineering Change Proposals) applicable to the thermal insulation hardware covered in this manual are listed in figure 2. ECP revisions are listed only when they change the manual in a way not required by the original ECP. The date in the last column is the publication date of the manual during which the change made by the ECP was incorporated. When N/A is entered, the ECP does not change the data in the manual.

Approved ECP No.	Incorporated In Manual Dated
F1-265	13 August 1965
F1-266	13 July 1966
F1-349	13 August 1965
F1-397	N/A
F1-413	7 June 1966
F1-425	7 June 1966
F1-463	27 January 1967
F1-475	27 January 1967
F1-479	27 January 1967
F1-481	24 May 1967
F1-488	24 May 1967
F1-489	24 May 1967
F1-516R1	4 March 1968
F1-565	4 March 1968
F1-573R2	4 March 1968
F1-575R3	4 March 1968
F1-588	24 June 1969

Figure 2. Configuration Changes--  
Manual Effectivity

SECTION I  
DESCRIPTION

1-1. SCOPE. This section describes the thermal insulation provided to protect the F-1 engine (figure 1-1) from the extreme temperature environment created by plume radiation and back-flow during clustered engine flight operation.

1-2. DESCRIPTION OF INSULATION.

1-3. Thermal insulators for the engine are of two types, foil-batt and asbestos blanket. They are made of light-weight material and are equipped with various mounting provisions, such as grommets holes, clamps, threaded studs, and lockwire lacing studs. The asbestos and the batting used for insulation are absorbent and, therefore, susceptible to damage by fluids.

1-4. FOIL-BATT INSULATORS.

1-5. Foil-batt insulators are pre-formed segments constructed of random fiber batting secured between two layers of texturized Inconel foil. The thickness of the thrust chamber insulator inner foil is 0.004 inch and of the outer foil is 0.006 inch. Cocoon insulator foils are 0.006 inch thick. The inner foil is vented to prevent ballooning due to expansion of gases trapped between the layers of foil. These segments are used to insulate large flat areas of the thrust chamber and nozzle extension, heat exchanger lines and bellows, customer connect (wrap-around) lines, and the cocoon area (thrust chamber throat to interface panel).

1-6. ASBESTOS BLANKET INSULATORS.

1-7. Asbestos blanket insulators are composed of multiple layers of asbestos cloth reinforced with Inconel lockwire and coated on one side with aluminum. The asbestos blankets are laminates of two, four, or five layers, depending on location on the engine. Asbestos blankets are used on the exit end of the nozzle extension, above the oxidizer dome between the gimbal bearing and interface panel, and below the cocoon between the thrust chamber and turbine manifold.

1-8. SUPPORTING STRUCTURE AND ATTACHING HARDWARE.

1-9. Hardware used to secure the thermal insulation to the engine consists of support structure, screws, self-locking nuts, flat washers, nut clips, bolts, and Inconel lockwire. Support structure (brackets, straps, and supports) is located primarily in the cocoon area. Protruding studs are percussion-welded onto hatbands of the thrust chamber to support and secure insulator panels. Brackets with nut-plates are provided for the nozzle extension for attaching the thermal insulators.

1-10. Proper selection of attaching hardware is required to make sure that components are correctly installed. Attaching hardware is specified in an indented listing following the applicable component.



F1-6-4

Figure 1-1. F-1 Engine (Thermal Insulation Installed)

1-2 Change No. 4 - 13 March 1968

## SECTION II

## SPECIAL TOOLS AND EQUIPMENT

2-1. SCOPE. This section lists the special tools, equipment, and materials required for installation, removal, and repair of thermal insulation brackets and insulation for the F-1 engine. Special tools and equipment required

for installation and removal are in figure 2-1. Special tools and equipment required for repair are in figure 2-2. Materials required for installation and repair are in figure 2-3.

Part No.	Nomenclature	Use
G2035	Thermal Insulation Installation Kit	
9023565	Alinement Clamp	To aline insulator flanges and holes for bending and bolting.
19-9023618	Flange Bending Tool	To bend insulator flange tabs (one-inch maximum height).
9023567	Flange Unbending Tool	To unbend insulator flange tabs (one-inch maximum height).
19-9023621	Flange Offset Bending Tool	To bend insulator flange tabs (1/2-inch maximum height).
9023624	Flange Offset Unbending Tool	To unbend insulator flange tabs (1/2-inch maximum height).
G4084	Thermal Insulation Alinement Fixture	To aline brackets.
G4086	Trunnion Nut Torque Wrench	To remove and install turbopump trunnion nuts.
G4087	Band Clamp Tool	To install insulator clamps.
BR6100 (Anderson Corp)	Brush	To clean nut plate threads.

Figure 2-1. Special Tools and Equipment for Installation and Removal of Thermal Insulation

Part Number	Nomenclature	Use
9026560	Welding Set, 100 watt-sec	To tackweld inconel sheet less than 0.004 inch thick.
9026561	Components Welding Set 10 kva	To spotweld inconel sheet more than 0.004 inch thick.
9026570	Components Welding Set	To replace insulator and thrust chamber attaching studs.
9023569	Stapler Set (Air-Powered)	To repair stapled insulators.
9023570	Grommet Installation Tool Set	To repair insulators using grommets.
BG4000	Electrical-Hydraulic Power Unit (Hi-Shear Corp.)	To install blind nuts in place of inaccessible nutplates in brackets.
BP2500	Gun	
A27-428	Anvil	
C2-12	Chuck	
M3-12	Mandrel	
T-5039534	Holding Fixture	To pull-test percussion welded studs.

Figure 2-2. Special Tools and Equipment for Repair of Thermal Insulation

Identification	Name	Use
AMS5540	Nickel-base alloy; texturized sheet, 0.004 and 0.006 inch thick; flat sheet, 0.010, 0.020, 0.025, and 0.032 inch thick	To repair foil insulators.
AMS5786	Filler wire	To fashion weld studs.
C-5A (Felt Products)	Thread compound	To lubricate fasteners.
Isonate CPR 302-1.5 (The Upjohn Co)(a)	Foam	To repair foam-filled insulators.
MIL-L-25567	Leak-test compound	To coat surfaces for installing percussion welded studs.

(a) Compound has limited shelf life. Refer to age controlled compounds in R-3896-3 for usability test.

Figure 2-3. Materials Specified in This Manual (Sheet 1 of 2)

Identification	Name	Use
MIL-R-5031, Class 5A	Filler wire	To weld repair purge lines.
MIL-S-6721, Type 321	Steel tape (1 x 0.001 inch)	To repair foil insulators.
MS20995N	Inconel lockwire	To safetywire fasteners and lace insulators.
RB0135-001 (Rocketdyne)	Batting	Filler for repairing foil insulators.
RB0135-002, Type II (Rocketdyne)	Asbestos cloth	To repair asbestos insulators.
RD128-3001-0002	Staple	For use with air-powered stapler set.
RTV-102 (General Electric)(a)	White sealant	To repair foam-lined insulators.
RTV-106 (General Electric)(a)	Red sealant	Allowable substitute for RTV-156.
RTV-156 (General Electric)(a)	Red sealant	To repair silicone rubber of glass cloth insulation.
ST0170GB0001-347 (NR, Los Angeles Division)	Filler wire	To fusion weld studs.
TT-I-735 (Federal Specification)	Isopropyl alcohol	To clean material surfaces for welding.
TT-M-261 (Federal Specification)	Methyl-ethyl-ketone	To clean material surfaces for welding.
TT-T-548 (Federal Specification)	Toluene	To thin white sealant RTV-102.
Viton C-328 RTV (Connecticut Hard Rubber Co)(a)	Elastomer	To repair foam-lined insulators.

(a) Compound has limited shelf life. Refer to age controlled compounds in R-3896-3 for usability test.

Figure 2-3. Materials Specified in This Manual (Sheet 2 of 2)

## SECTION III

## INSTALLATION AND REMOVAL (ENGINES F-2003 THROUGH F-2016)

3-1. **SCOPE.** This section contains installation and removal procedures, the sequence in which the thermal insulation should be installed, and safety precautions to be taken during handling of the insulation.

3-2. **SAFETY PRECAUTIONS.**

3-3. Precautionary measures are required to protect personnel against injury and to prevent damage to the equipment. The following precautions shall be observed when handling, installing, and removing thermal insulation:

- a. Wear leather gloves and arm protection to prevent injury from sharp edges and corners or insulators.
- b. Do not force-fit brackets.
- c. Use enough personnel when handling insulators to prevent buckling or distortion of panels.
- d. Use extreme care when handling insulators in windy areas.

**NOTE**

Because of the extreme lightness of insulators, in comparison with their surface area, they should not be placed where winds or drafts could blow them about.

- e. Leave protective packaging on insulators until ready for installation.
- f. Do not stack or pile insulators on work platform.
- g. Use tiedowns to secure insulators; do not use weights.
- h. Protect insulators from punctures or tears when handling near sharp projections or tools.
- i. Do not place equipment against insulators or use them for hand or foot holds.
- j. Do not bend flange tabs of insulators to a sharp radius.
- k. Do not expose insulators to liquids or moisture. The insulation between foil sheets cannot be conveniently dried. Insulation damaged by absorption of fluids other than fuel shall be dried. Insulation damaged by fuel absorption shall be replaced prior to engine firing.

l. Ensure that vent covers on inner foils of cocoon and thrust chamber and nozzle extension insulators are not distorted and are free of obstructions.

m. Insulators shall not be alined with drift pins engaging nutplates of brackets.

n. Do not wear clothing containing sharp objects that may damage engine finishes.

o. Exercise extreme care to prevent damage to engine equipment.

p. Insulators are not rigid components until installed. If misalignment of attaching features occurs due to deformation of insulators from handling, it may be necessary to use hand-force to effect installation. To prevent damage to insulators, apply hand-force to large areas either by pushing or striking with the heel of the hand. Wear gloves to prevent injury to hands.

3-4. **INSTALLATION.**

3-5. Component installation order, identification, and associated hardware are listed in each installation figure. Index numbers in the figures indicate the sequence of installation for the listed parts. Detail and attaching parts are indented in the listing following the indexed assembly. Special instructions occur in a listing in the order of performance. Applicable installation tools are indicated in section II. A numerical list of parts and their shipping box and figure locations is outlined in section VII. The following is a suggested sequence of installation:

- a. Transducer insulators (paragraph 3-7, figure 3-1).
- b. Oxidizer lines (paragraph 3-9, figure 3-2).
- c. Cocoon purge manifold (paragraph 3-11, figure 3-4).
- d. Attach brackets (paragraph 3-13, figure 3-5).

Transducer (Plug Designation)	Transducer Nomenclature	Insulator Part Number
P116	No. 1 Fuel Pump Inlet	19-145113-1
P117	No. 2 Oxidizer Pump Discharge	19-145112-3
P118	Bearing Jet	19-145113-1
P119	Gas Generator Chamber	19-145113-1
P120	No. 2 Fuel Pump Discharge	19-145113-1
P121	No. 2 Fuel Pump Inlet	19-145113-1(b)
P122	Common Hydraulic Return	19-145112-2
P123	Combustion Chamber	19-145113-3
P155	No. 1 Fuel Pump Discharge	19-145113-1
P158	Hydraulic Control Opening	19-145113-1
P159	No. 1 Oxidizer Pump Discharge	19-145112-1
P160	Hydraulic Control Closing	19-145113-1
P162	Oxidizer Seal Cavity	19-145113-4
P161, P163, P164, P165, P166(a)		19-145114

(a) Bank of five transducers.

(b) On engines not incorporating MD31 or MD108 change.

Figure 3-1. Pressure transducer Insulators

d. Attach brackets (paragraph 3-13, figure 3-5).

e. Thrust chamber and nozzle extension (paragraph 3-15, figure 3-6).

f. Cocoon (paragraph 3-17, figure 3-7).

g. Heat exchanger lines (paragraph 3-19, figure 3-8).

h. Wrap-around lines (paragraph 3-21, figure 3-9).

3-6. The following shall be observed where applicable:

a. Engine areas shall be inspected prior to closing out the areas with insulators.

b. CAUTIONS and NOTES shall be observed. These are located following the condition to which they apply, unless they specifically indicate their application to a subsequent condition.

**3-7. INSTALLING PRESSURE TRANSDUCER INSULATORS.**

3-8. Insulators shall be installed on the engine instrumentation transducers as indicated in figure 3-1. The following special instructions apply:

a. Install insulator 19-145114, using 4 screws NAS1100C08-37, 8 washers LD153-0010-0005, and 4 nuts NAS679C08W.

b. Install remaining insulators, using inconel lockwire MS20995N32.

**3-9. INSTALLING OXIDIZER LINES THERMAL INSULATION.**

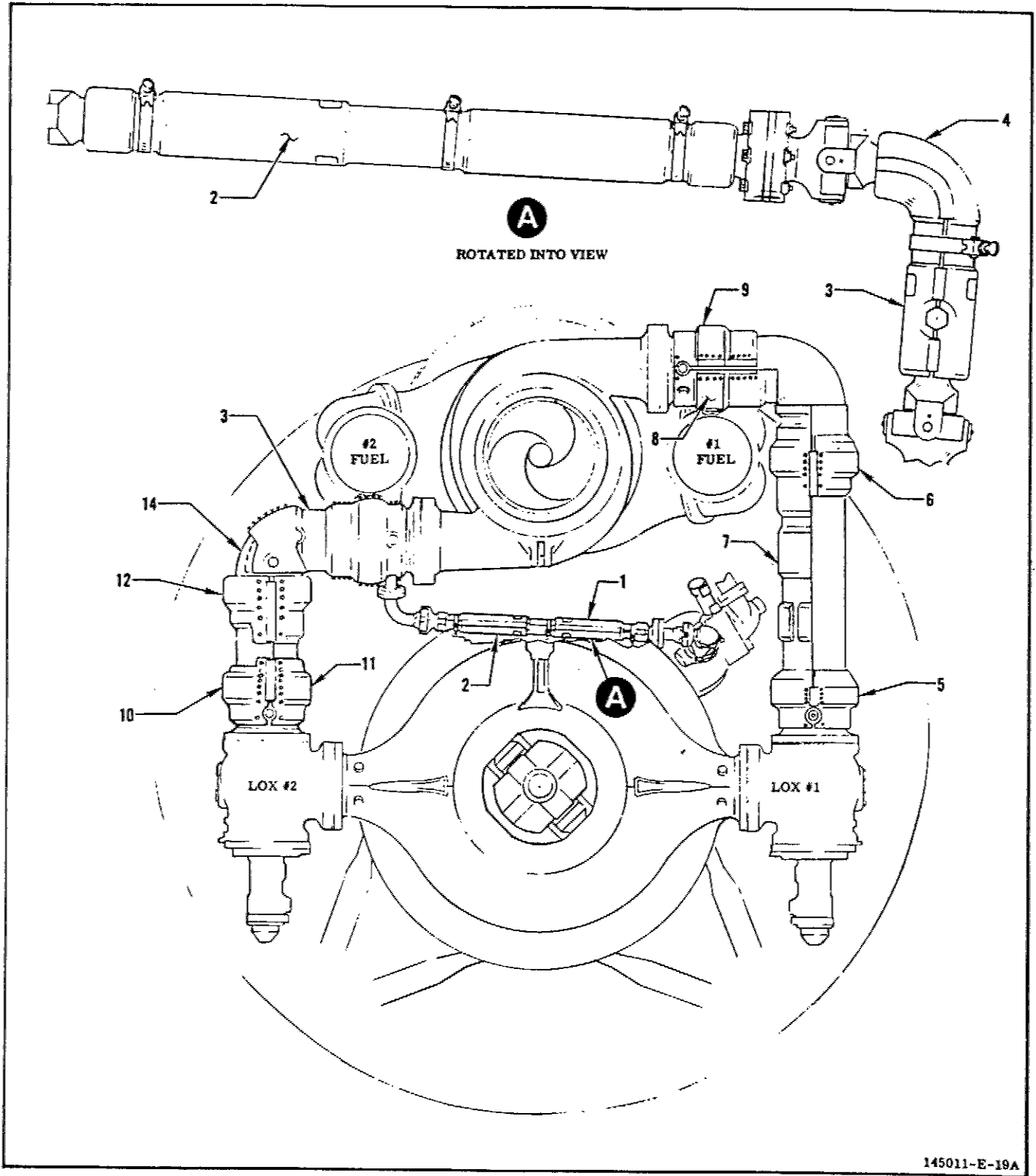
3-10. Oxidizer lines thermal insulation (figure 3-2) is installed on the No. 1 and No. 2 oxidizer lines and the gas generator oxidizer feed line on engines F-2011 through F-2016 only. The bellows protectors on the oxidizer lines shall be removed prior to installing insulators. Insulators shall be installed in the order shown in figure 3-2. Safetywiring methods for lacing studs of insulators are shown in figure 3-3.

**NOTE**

Longitudinal gaps occurring between insulators (5 through 14) shall be equally distributed on either side of the oxidizer outlet lines.

- Parts are supplied by retrofit kit 18-145391-20. Purge manifold parts of the kit are installed as outlined in paragraph 3-11.





145011-E-19A

Figure 3-2. Oxidizer Lines Thermal Insulation (Sheet 1 of 2)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
1	145369	1	Insulator
2	145370	1	Insulator (Clamps 8 ± 2)
3	145371	1	Insulator
4	145372	1	Insulator (Clamps 8 ± 2)
5	145373	1	Insulator
6	145374	1	Insulator
7	145375	1	Insulator
8	145376	1	Insulator
9	145377	1	Insulator
10	145364	1	Insulator
11	145366	1	Insulator
12	145365	1	Insulator
13	145367	1	Insulator
14	145368	1	Insulator

Figure 3-2. Oxidizer Lines Thermal Insulation (Sheet 2 of 2)

3-11. INSTALLING COCOON PURGE MANIFOLD.

3-12. Parts for the cocoon purge manifold are supplied with kit 18-145391-20 for engines F-2003 through F-2016. The cocoon purge manifold is installed in the order indicated in figure 3-4.

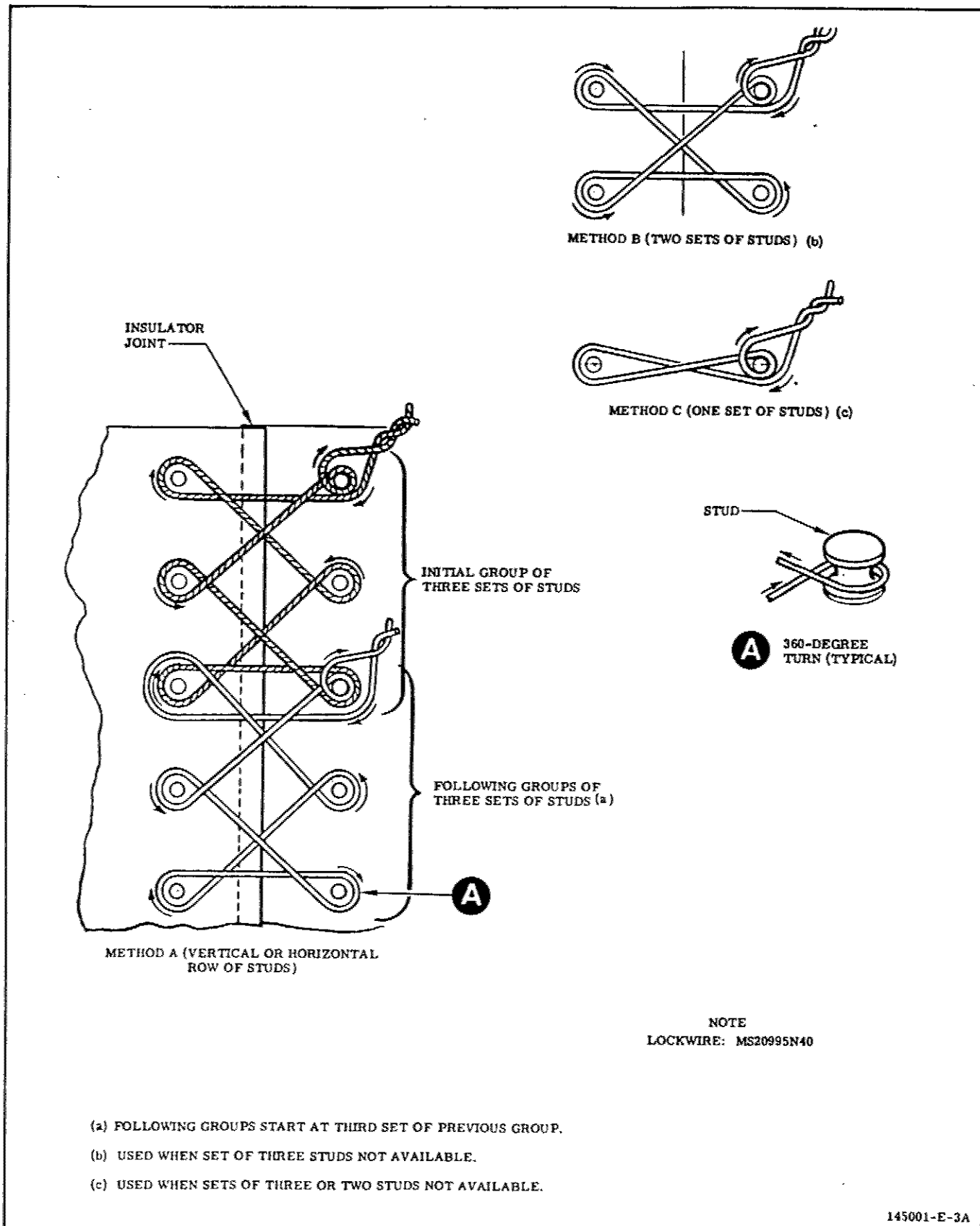
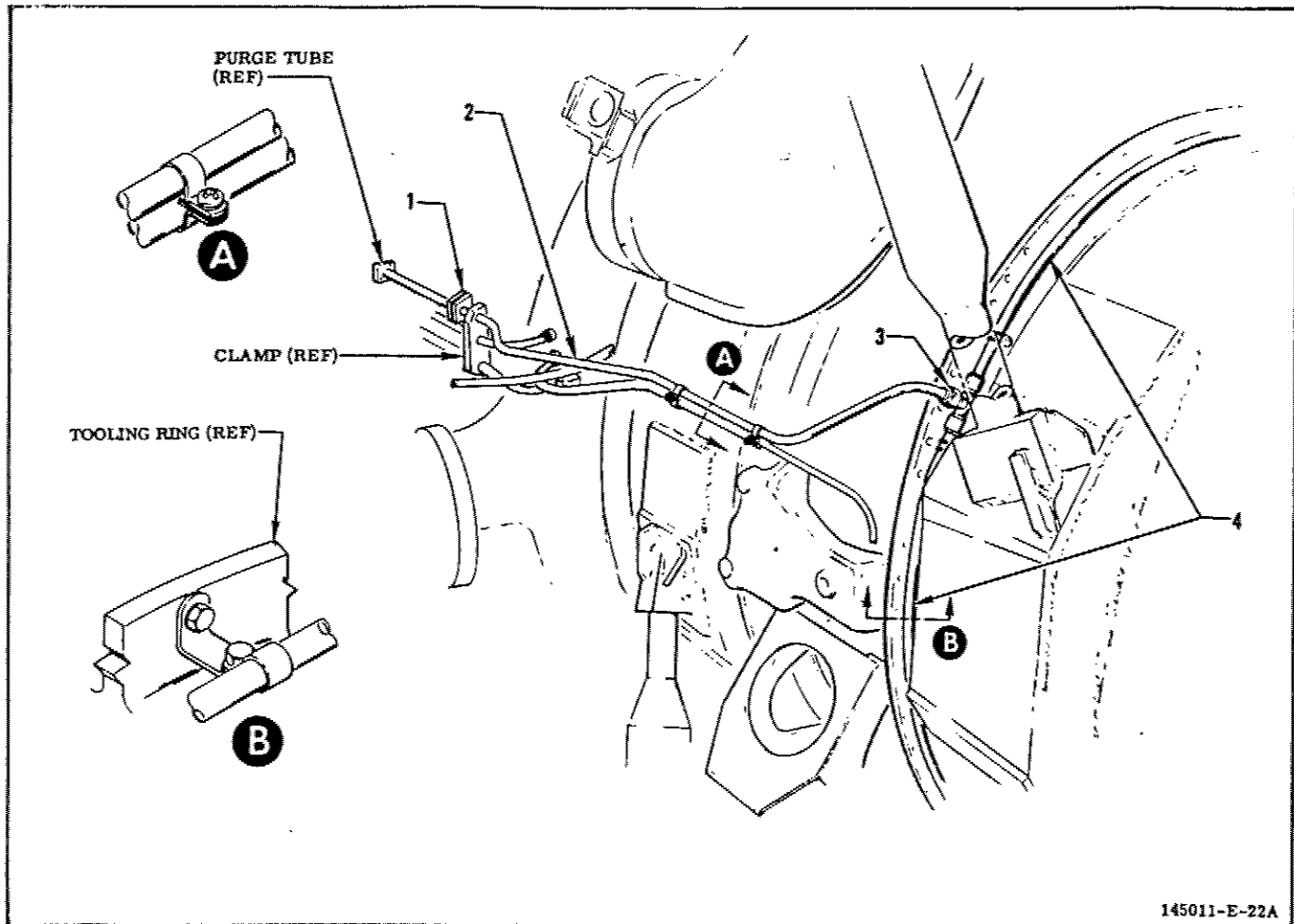


Figure 3-3. Safetywiring Methods for Thermal Insulation



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
1	RD251-4084-0020	1	Orifice	3	AN824-10C	1	Tee
	NOTE				NOTE		
	Diameter of pilot hole of orifice is 0.020 inch. Actual required orifice size is 0.272 inch with customer fluid input of 5 ± 0.25 lbs/min of gaseous nitrogen at 250 ± 15° F.				Torque coupling nuts of tubes (2, 4) as follows: Record maximum running torque. Continue to torque to 700-800 inch-pounds above recorded torque.		
2	145523 Attaches		Tube to tee (3).	4	145388 Attaches	2	Tube to tee (3).
	RD111-1010-6425	1	Bolt		NOTE		
	RD153-5004-0004	4	Washer		The following parts attach tube (2) to existing parallel tube. (See sheet 1, detail A.)		
	LD153-0010-0007	4	Washer		RE127-2001-0006	4	Clamp
	RD114-8003-2004	4	Nut 35-41				

Figure 3-4. Cocoon Purge Manifold (Sheet 1 of 2)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	NAS1003-3A	2	Bolt
	LD153-0010-0007	2	Washer
	RD153-5004-0003	2	Washer
	RD114-8003-2003	2	Nut 24-30

## NOTE

The following parts attach at tooling ring holes 4, 11, 14, 20, 31, 40, 42, 58, 66, and 69. (See sheet 1, detail B.)

MS9104-14	10	Bracket
NAS1005-8A	10	Bolt
LD153-0010-0011	10	Washer
RD153-5004-0005	10	Washer
RD114-8003-2005	10	Nut 90 ±10

## NOTE

The following parts attach tubes (4) to brackets at tooling ring holes.

RE127-2001-0006	10	Clamp
NAS1003-3A	10	Bolt
LD153-0010-0007	10	Washer
RD153-5004-0003	10	Washer
RD114-8003-2003	10	Nut 27 ±3

Figure 3-4. Cocoon Purge Manifold (Sheet 2 of 2)

### 3-13. INSTALLING THERMAL INSULATION ATTACH BRACKETS.

3-14. Thermal insulation attach bracket assemblies may be installed in any desired sequence. A suggested order of installation is indicated by the index number order listed in figure 3-5. Engine alinement shall be completed prior to the installation of brackets in the dome area of the engine. Threaded fasteners provided with drilled holes for lockwire shall be safetywired with inconel lockwire following final torquing. If a bolt replacement is necessary, but is not locally available, a substitute bolt of identical callout except one or two dash numbers longer may be used. A maximum of three washers LD153-0013 may be installed under the attaching nut to prevent the nut from engaging the imperfect bolt threads. A maximum of two washers is used when a serrated washer is specified as part of the installation.

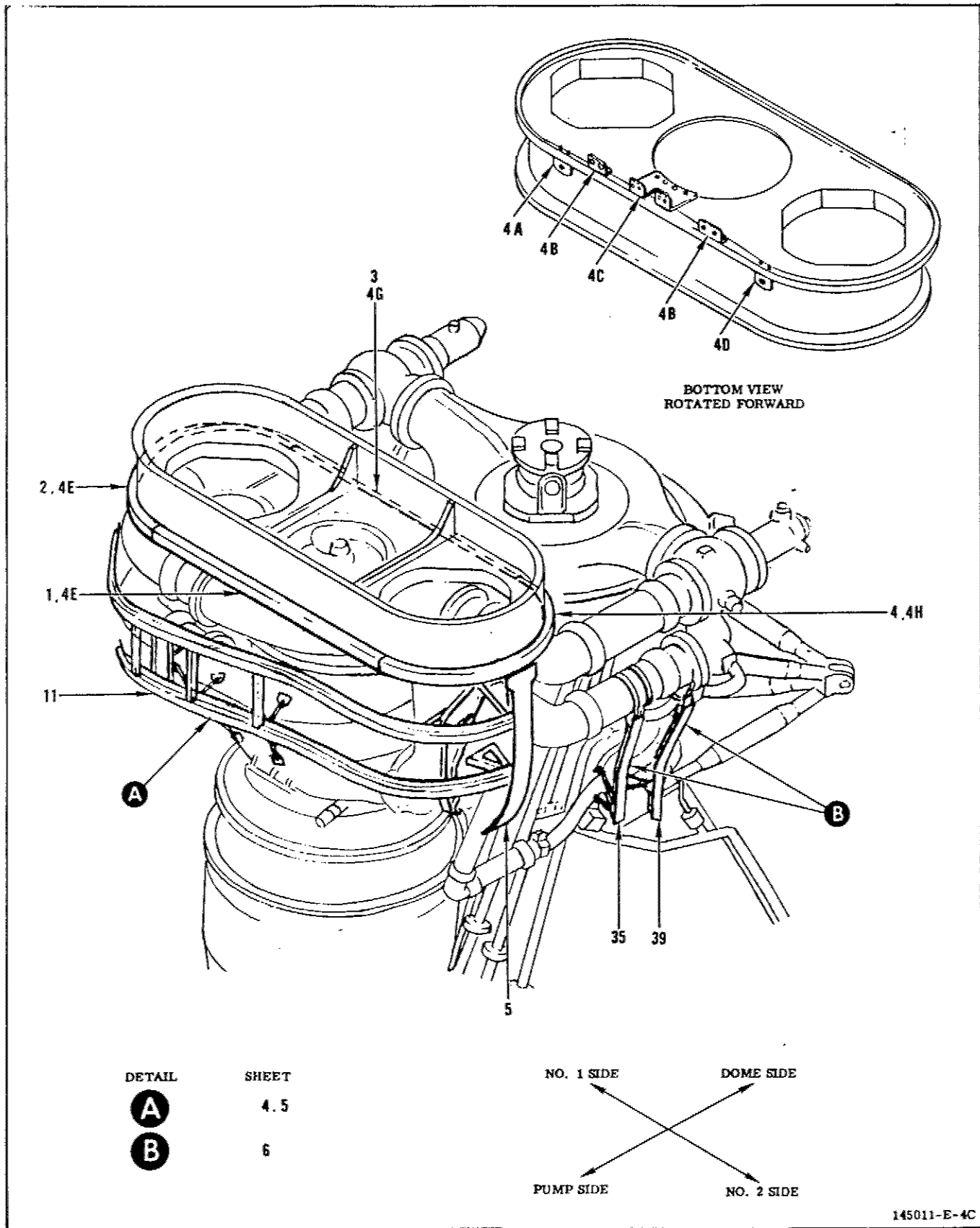
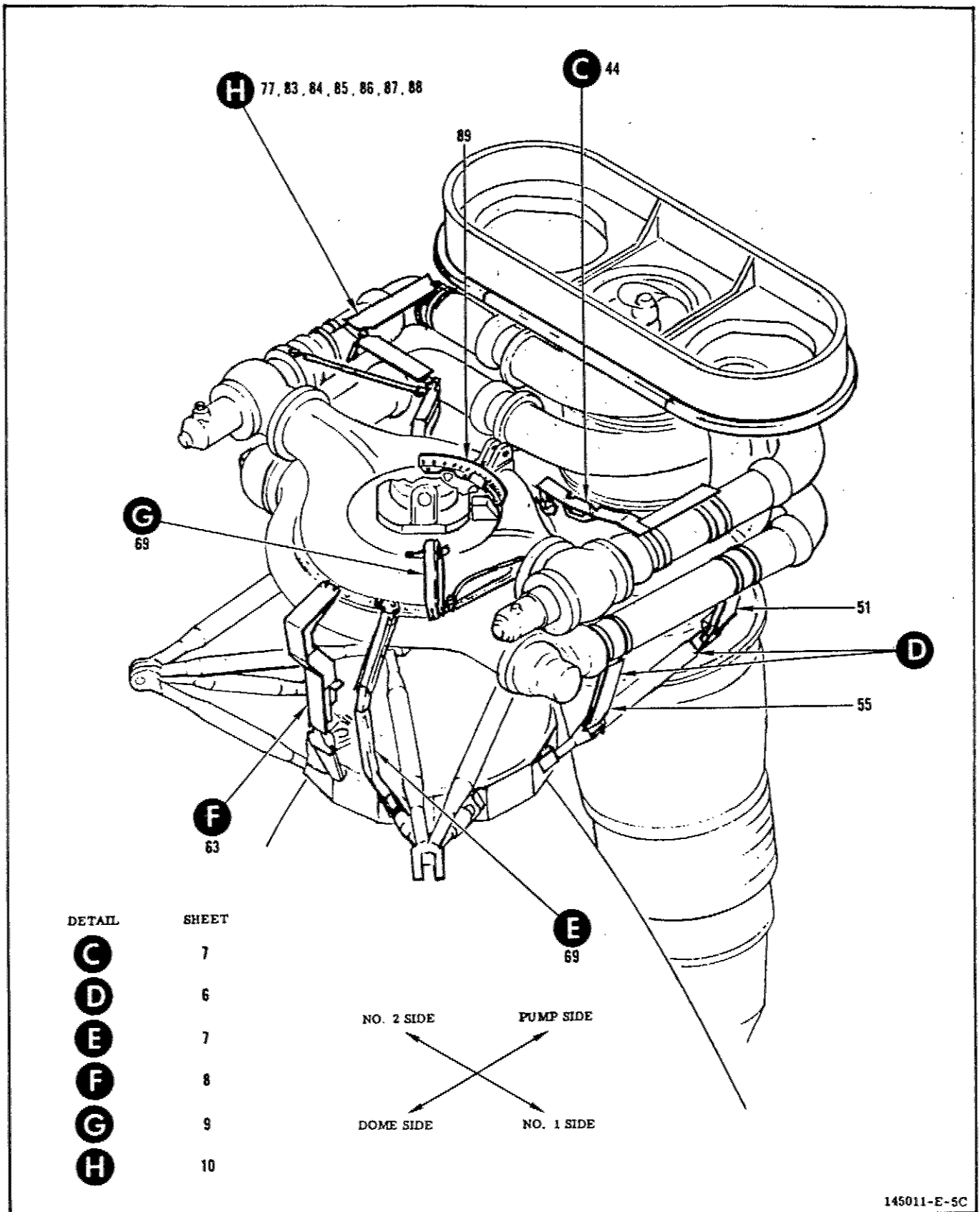


Figure 3-5. Thermal Insulation Attach Brackets (Sheet 1 of 23)



145011-E-5C

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 2 of 23)

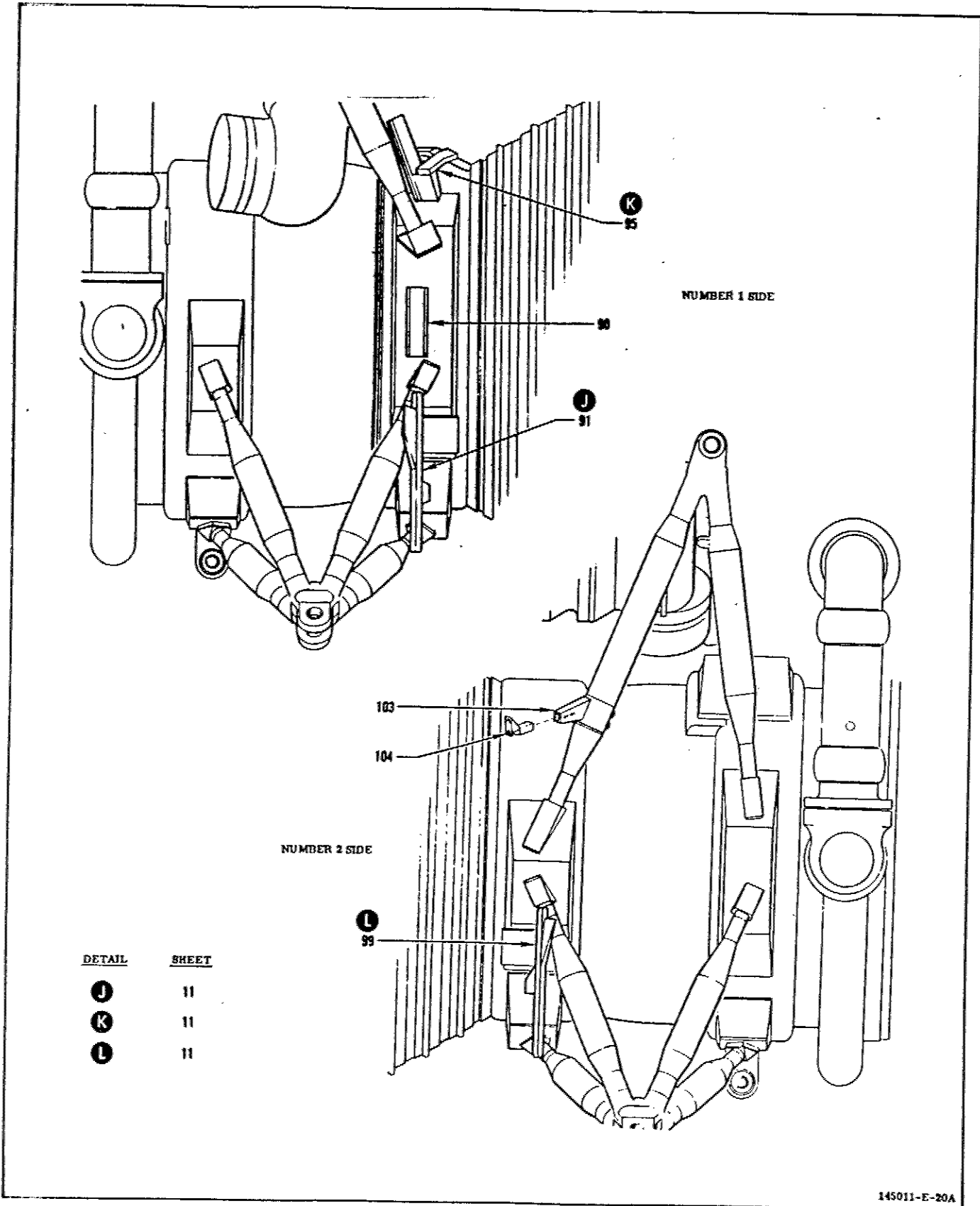


Figure 3-5. Thermal Insulation Attach Brackets (Sheet 3 of 23)



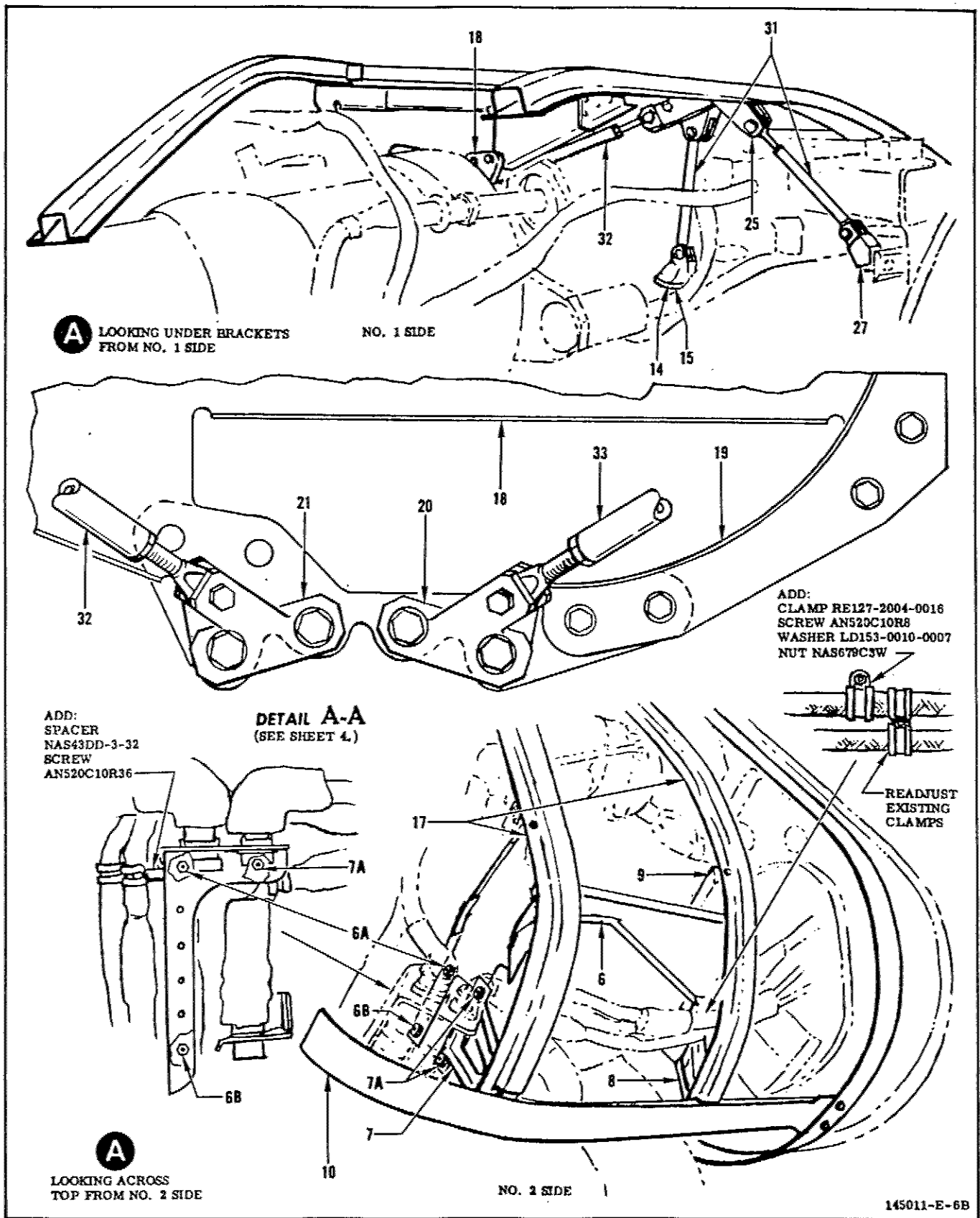


Figure 3-5. Thermal Insulation Attach Brackets (Sheet 4 of 23)

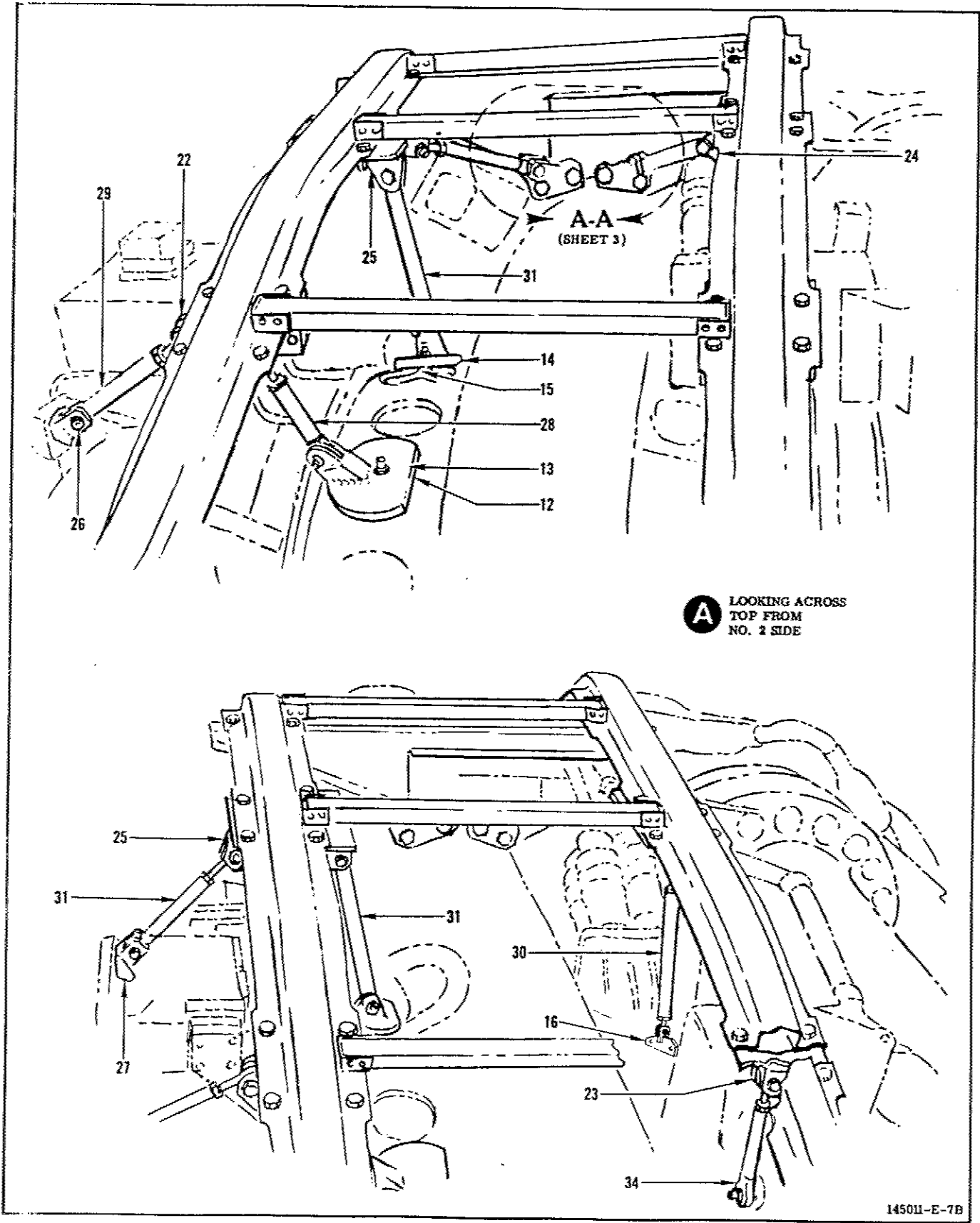
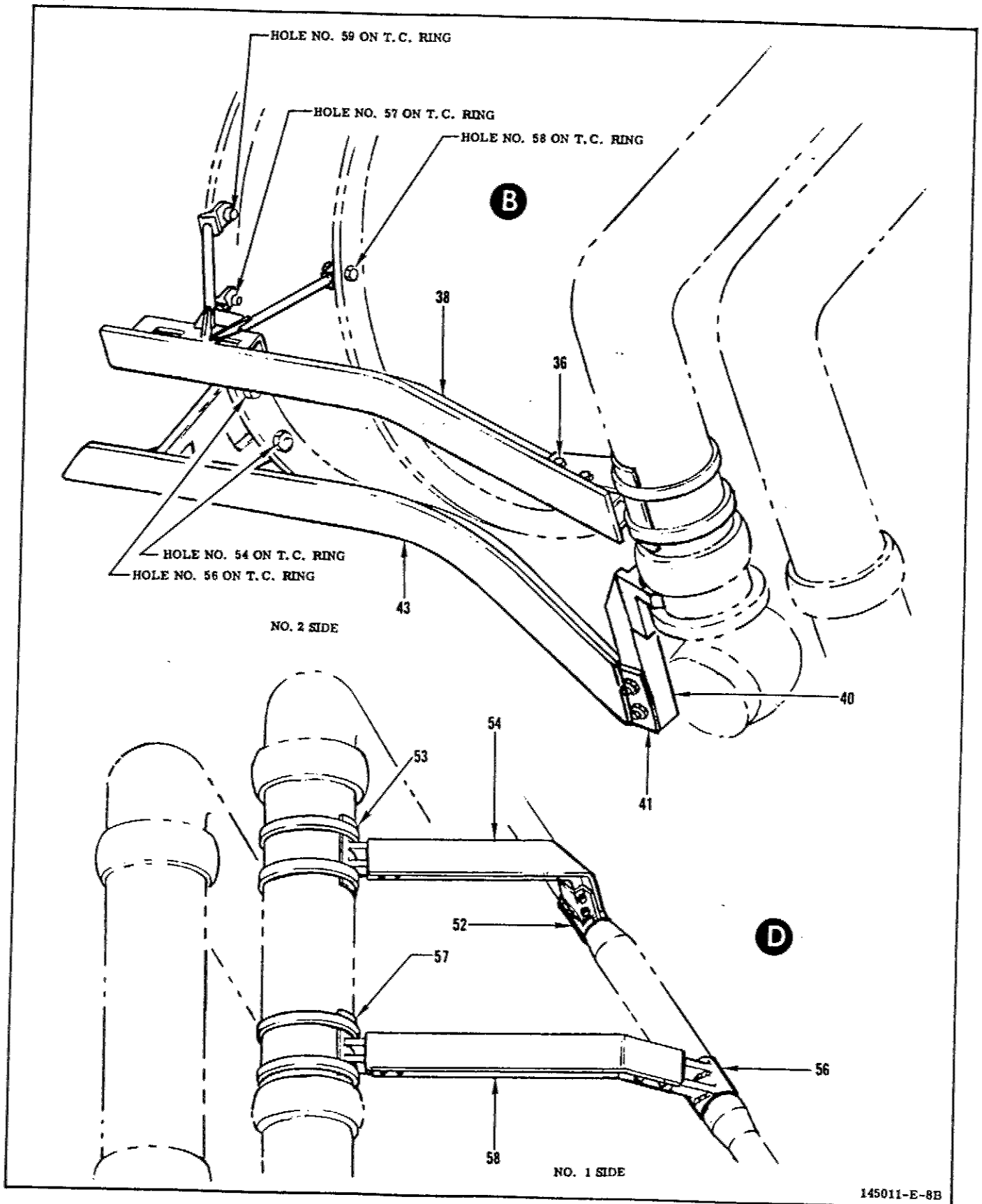


Figure 3-5. Thermal Insulation Attach Brackets (Sheet 5 of 23)



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Figure 3-5. Thermal Insulation Attach Brackets (Sheet 6 of 23)

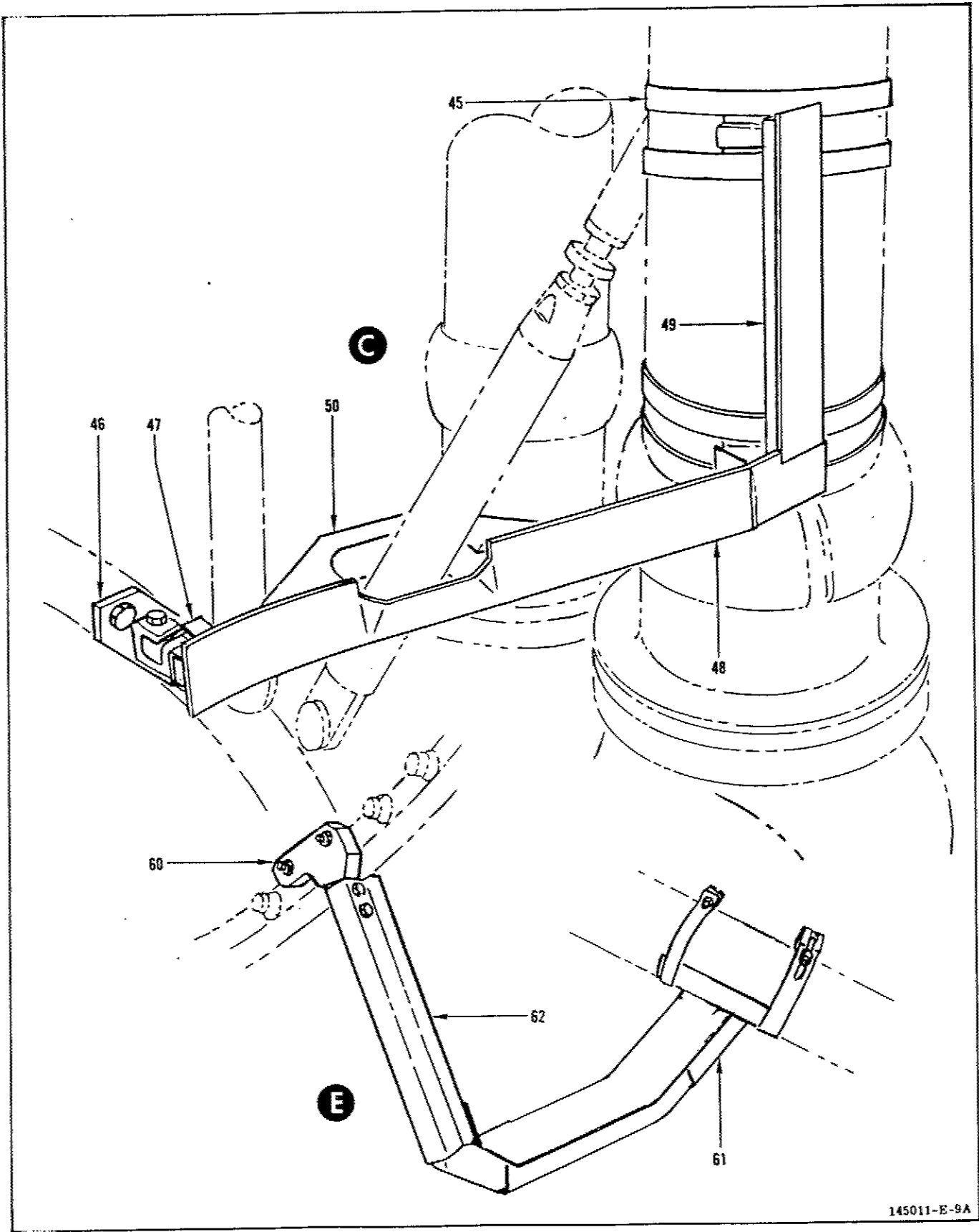


Figure 3-5. Thermal Insulation Attach Brackets (Sheet 7 of 23)

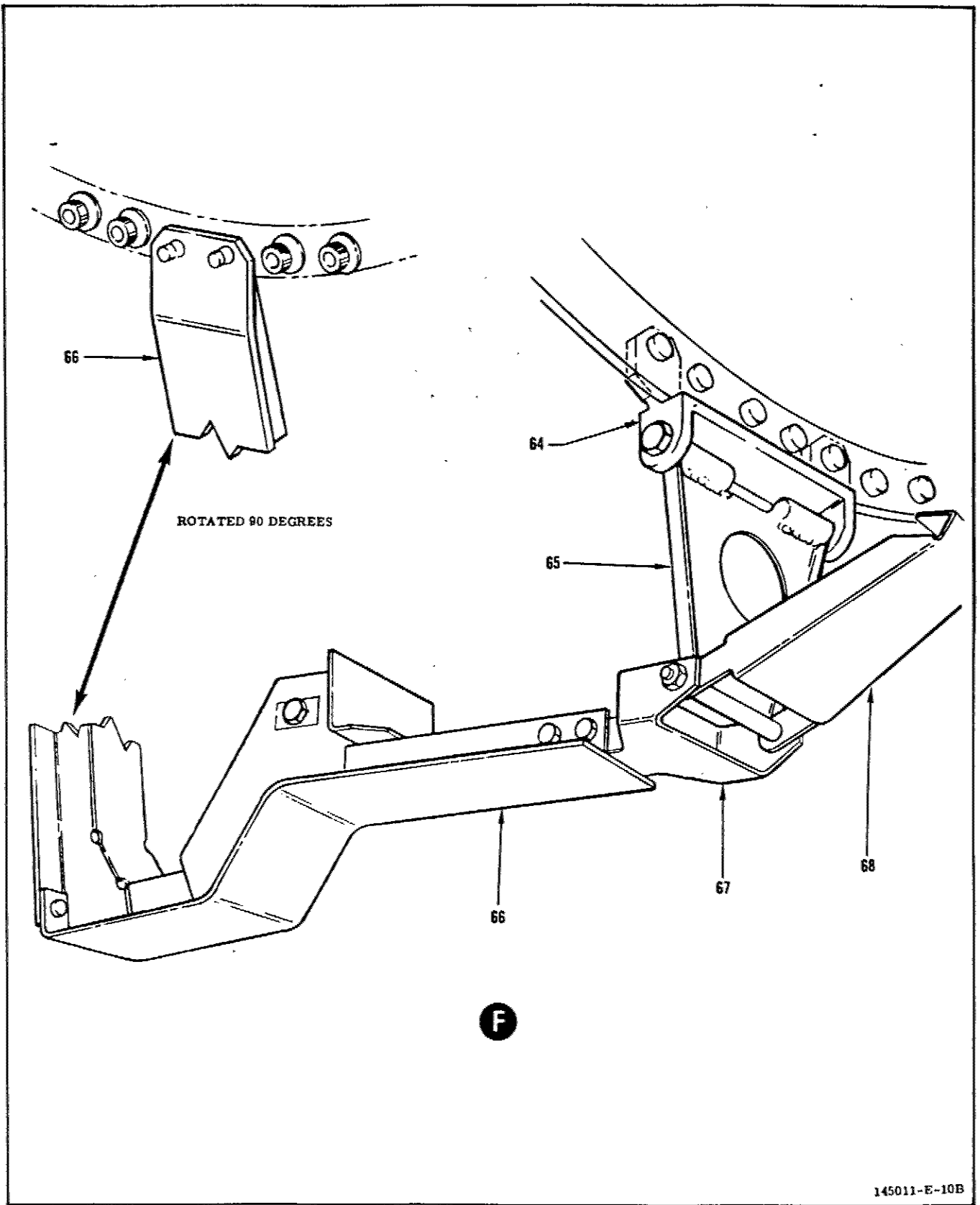
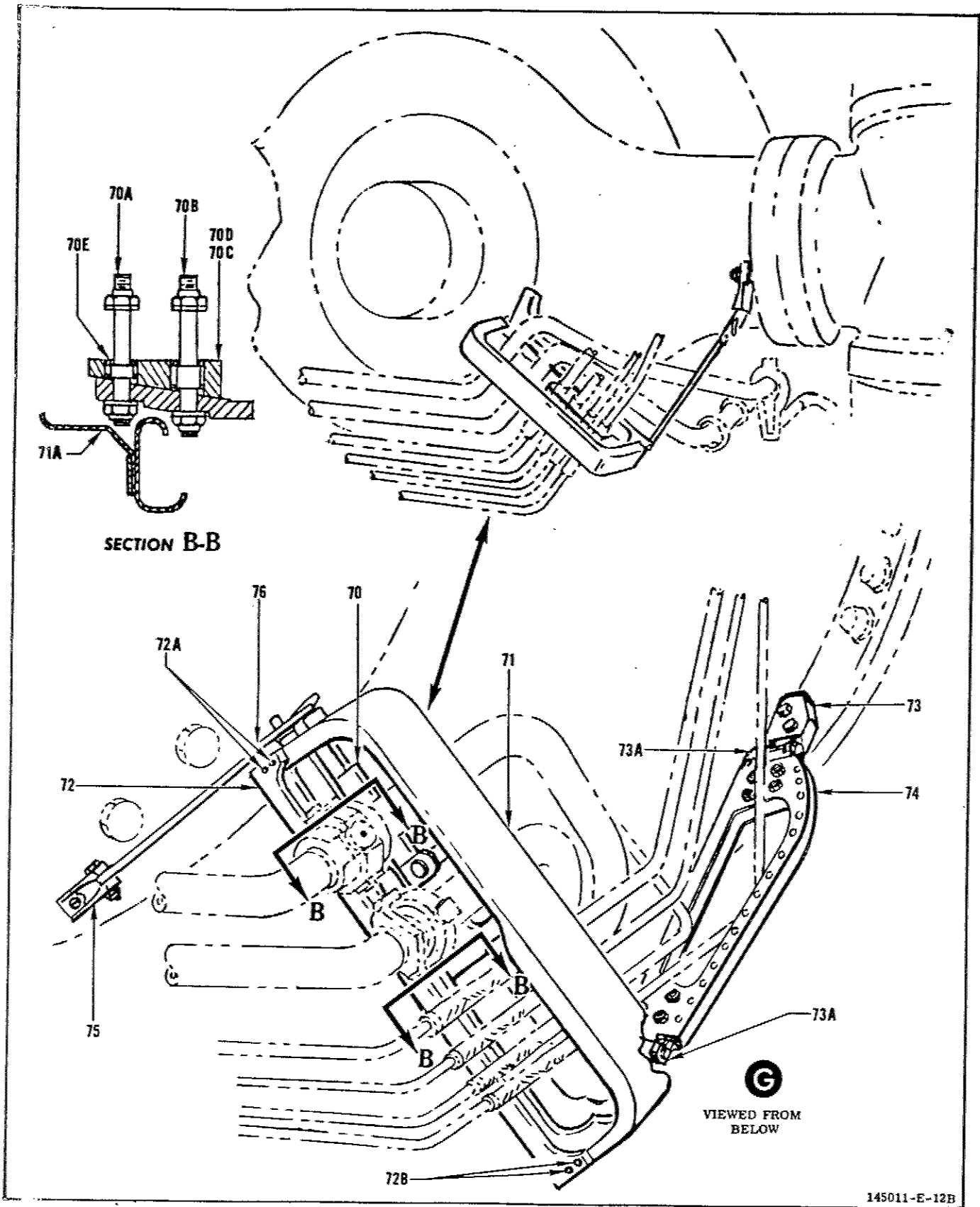
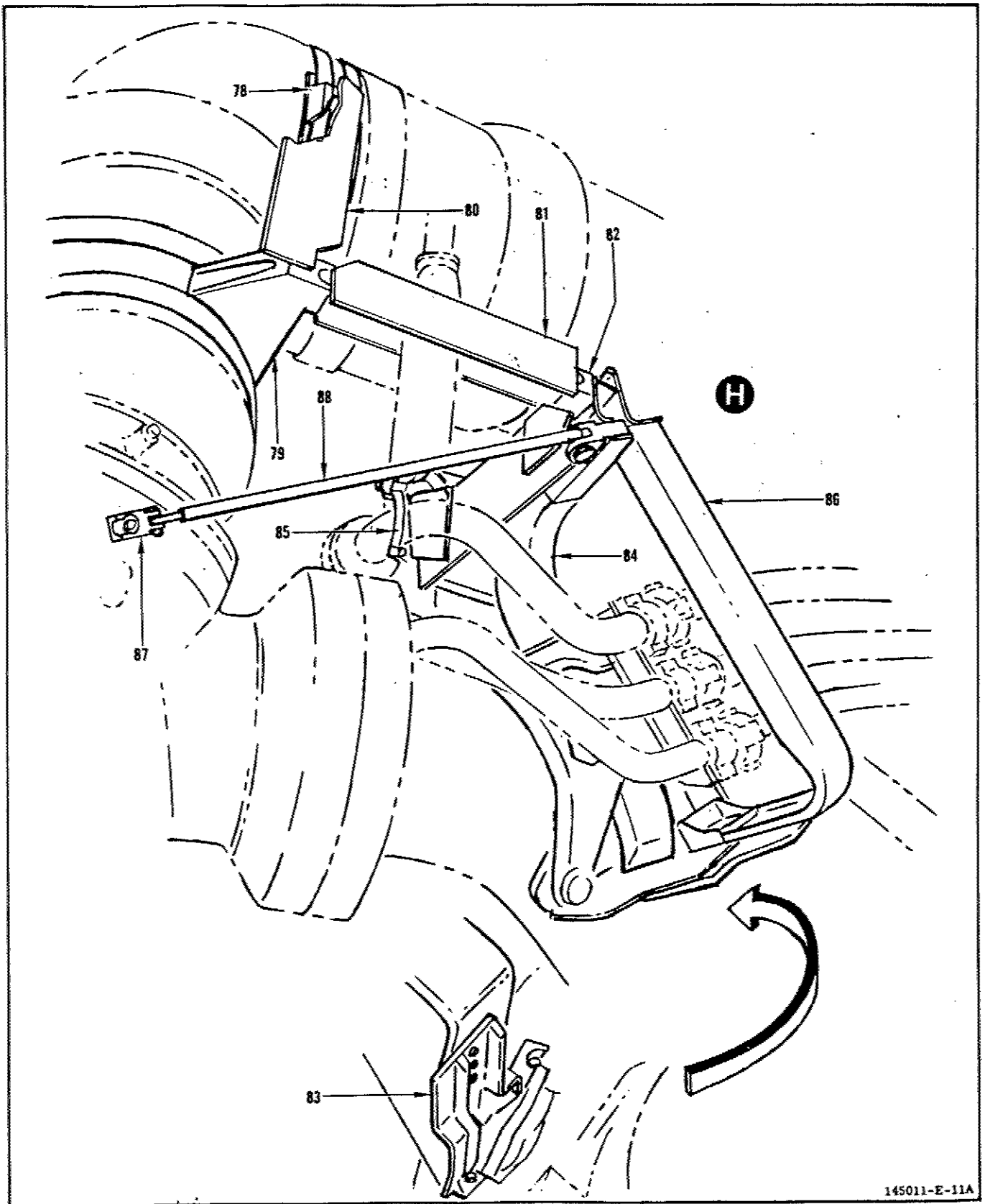


Figure 3-5. Thermal Insulation Attach Brackets (Sheet 8 of 23)



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Figure 3-5. Thermal Insulation Attach Brackets (Sheet 9 of 23)



145011-E-11A

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 10 of 23)

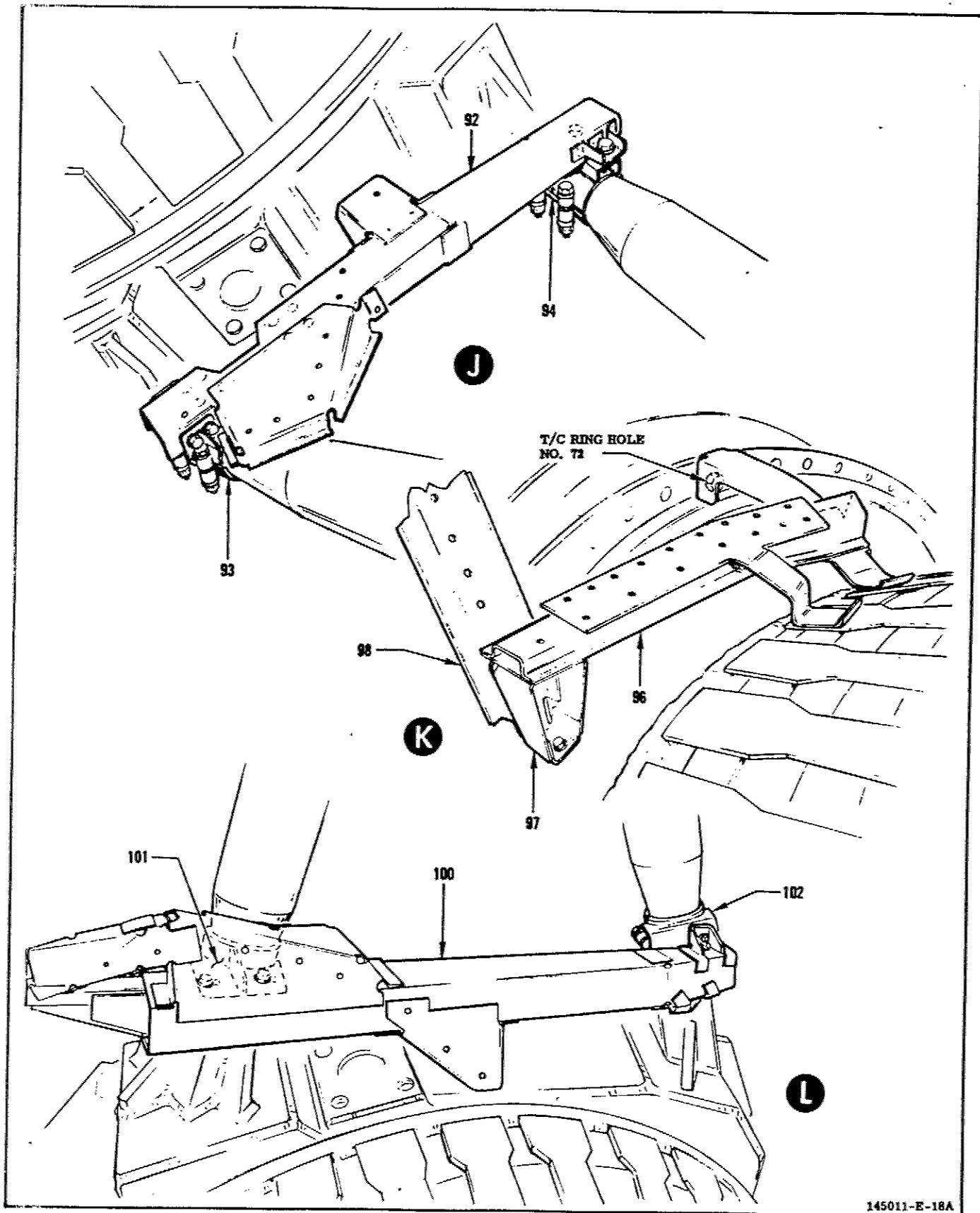


Figure 3-5. Thermal Insulation Attach Brackets (Sheet 11 of 23)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
NOTE							
Steps a through h install collars (1 through 4) for engines F-2003 through F-2010.							
a. Install collars (1 through 4) but do not tighten bolts at collar overlaps or apply torques.							
b. With adjusting lugs at No. 2 side collar (4) butted to lugs of collars (1, 3), install bolts 145396, and torque nuts to 100 ± 5 inch-pounds.							
c. Install bolts 145396 at adjusting lugs for collar (2) to serrated lugs of collars (1, 3) and alternately torque nuts to 100 ± 5 inch-pounds in 25 inch-pounds increments.							
d. Using existing bolts and washers at serrated lugs of collars (1, 3) install serrated adjusting blocks 145190 at serrated lugs, with ends of blocks against lugs of collar (2). Torque bolts for blocks to 93 ± 3 inch-pounds.							
e. Alternately final-torque nuts of bolts 145396 at collar (4) lugs to 350 ± 5 inch-pounds in 50 inch-pounds increments.							
f. Torque bolts NAS1100C4-14 and RD111-1010-6413 at overlaps of collar (2) to collar (1) to 65 ± 5 inch-pounds and collar (3) to 150 ± 5 inch-pounds.							
g. Safetywire bolts for serrated adjusting blocks.							
h. Torque bolts NAS1100C4-14 and RD111-1010-6413 at overlaps of collar (2) to collar (1) and collar (3) to 150 ± 5 inch-pounds.							
1	145068(a) (Sheet 1.)	1	Collar				
	RD111-1009-0418	1	Bolt				
	RD153-5004-0004	1	Washer				
	145190	1	Block				
2	145065(a) (Sheet 1.)	1	Collar				
	145396	2	Bolt				
	RD153-1002-0008	2	Washer				
(a) On engines F-2003 through F-2010.							
					RD153-5004-0008	2	Washer
					RD114-8003-1008	2	Nut
					NAS1100C4-14	4	Bolt
					RD153-0115-0026	4	Washer
					RD111-1010-6413	6	Bolt
					RD153-9001-0002	6	Washer
3	145066(a) (Sheet 1.)	1	Collar				
	RD111-1009-0418	1	Bolt				
	RD153-5004-0004	1	Washer				
	145190	1	Block				
4	145067(a) (Sheet 1.)	1	Collar				
	145396	2	Bolt				
	RD153-1002-0008	2	Washer				
	RD153-5004-0008	2	Washer				
	RD114-8003-1008	2	Nut				
					NAS1100C4-14	4	Bolt
					RD153-0115-0026	4	Washer
					RD111-1010-6413	6	Bolt
					RD153-9001-0002	6	Washer
				NOTE			
				Steps i through ac install parts 4A through 4H for engines F-2011 through F-2016.			
				i. Install bracket (4A) by replacing 2 existing bolts of support bracket with bolts RD111-4009-0831 and RD111-4009-0839 (outboard hole), 10 washers RD153-1002-0008, and 2 nuts RD114-8005-1008.			
				NOTE			
				Existing bolts shall be replaced one at a time.			
				● Four washers shall be used with each bolt between bracket (4A) and interface panel flange.			
				j. Torque nuts to 1, 200 ± 50 inch-pounds and retorquing remaining existing bracket bolt to 1, 200 ± 50 inch-pounds.			

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 12 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
			<p>k. Install 2 brackets (4B) using 2 center bolts of 2 existing sets of 8 bolts.</p> <p>l. Remove existing washers at nuts, install brackets, and torque nuts to 900 ±10 inch-pounds.</p> <p>m. Install support bracket (4C) by replacing existing bolts, washers, and nuts at perimeter of oxidizer cutout with 5 bolts RD111-1010-6314, 5 washers RD153-5004-0003, 5 washers RD153-1002-0003, and 5 nuts RD114-8003-1003. Torque nuts to 20 ±3 inch-pounds.</p> <p>n. Install collar support (4D) by replacing existing bolts of strut support bracket with 2 bolts RD111-4009-0834, 2 washers RD153-5003-0008, 8 washers RD153-1003-0008, and 2 nuts RD114-8005-1008.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>Bolts shall be replaced one at a time.</p> <ul style="list-style-type: none"> <li>Four washers shall be used with each bolt between support (4D) and interface panel flange.</li> </ul> <p>o. Torque nuts to 1, 200 ±50 inch-pounds.</p> <p>p. Install collars (4E through 4H). Secure at overlaps using bolts NAS1100C4-14 and washers RD153-0115-0026, and bolts RD111-1010-6413 and washers RD153-9001-0001. Do not torque bolts.</p> <p>q. Secure collar (4G) to bracket (4C) with bolts RD111-1010-6310, 4 washers RD153-5004-0003, 4 washers RD153-1002-0003, and 4 nuts RD114-8003-1003. Do not torque nuts.</p> <p>r. Secure collar (4G) to brackets (4C) with 2 bolts RD111-1010-6410, 2 washers RD153-5004-0004, 2 washers RD153-1002-0004, and 2 nuts RD114-8003-1004. Do not torque nuts.</p> <p>s. Butt lugs of collar (4H) to lugs of collars (4E and 4G) and secure with bolts 145396,</p>				<p>washers RD153-1002-0008, washers RD153-5004-0008, and nuts RD114-8003-1008. Torque nuts to 100 ±5 inch-pounds.</p> <p>t. Secure collar (4H to bracket 4D) with bolt RD111-1010-6409 and washer RD153-5005-0005.</p> <p>u. Secure lugs of collar (4F) to lugs of collar (4E and 4G) using bolts 145396, washers RD153-1002-0008, washers RD153-5004-0008, and nuts RD114-8003-1008. Alternately torque nuts to 100 ±5 inch-pounds in 25 inch-pound increments.</p> <p>v. Install serrated blocks at serrated lugs of collar (4F) to collars (4E and 4G) using existing bolts RD111-1009-0418 and washers RD153-5004-0004. Torque bolts to 93 ±3 inch-pounds.</p> <p>w. Alternately torque nuts of bolts 145396 to 350 ±5 inch-pounds in 50 inch-pound increments.</p> <p>x. Secure collar (4F) to bracket (4A) with bolt RD111-1010-6409 and washer RD153-5005-0005. Torque bolt to 68 ±7 inch-pounds.</p> <p>y. Torque nuts installed in step p to 150 ±5 inch-pounds.</p> <p>z. Torque nuts installed in step q to 27 ±3 inch-pounds.</p> <p>aa. Torque nuts installed in step r to 68 ±7 inch-pounds.</p> <p>ab. Torque bolts installed in step t to 68 ±7 inch-pounds.</p> <p>ac. Safetywire all bolts not secured with nuts.</p>
				4A	145397 <sup>(b)</sup> (Sheet 1.)	1	Support
				4B	145359 <sup>(b)</sup> (Sheet 1.)	2	Bracket
				4C	145358 <sup>(b)</sup> (Sheet 1.)	1	Bracket

(b) On engines F-2011 through F-2016.

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 13 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
4D	145398(b) (Sheet 1.)	1	Support		NAS110C4-14	4	Bolt
					RD153-0115-0026	4	- Washer
4E	145351(b) (Sheet 1.)	1	Collar		RD111-1010-6413	6	Bolt
					RD153-9001-0002	6	Washer
	RD111-1009-0418	1	Bolt		RD111-1010-6409	1	Bolt
	RD153-5004-0004	1	Washer		RD153-5005-0005	1	Washer
	145190	1	Block	5	145315 (Sheet 1.)	1	Bracket
4F	145348(b) (Sheet 1.)	1	Collar	6	145106	1	Bracket
	145396	2	Bolt	6A	RD111-4010-6410	1	Bolt 85 ±5
	RD153-1002-0008	2	Washer	6B	RD111-4010-6411	1	Bolt 85 ±5
	RD153-5004-0008	2	Washer		RD153-5002-0004	2	Washer
	RD114-8003-1008	2	Nut				
	NAS1100C4-14	4	Bolt				
	RD153-0115-0026	4	Washer				
	RD111-1010-6413	6	Bolt				
	RD153-9001-0002	6	Washer				
	RD111-1010-6409	1	Bolt				
	RD153-5005-0005	1	Washer				
4G	145349(b) (Sheet 1.)	1	Collar	7	145105	1	Bracket
	RD111-1009-0418	1	Bolt	7A	RD111-4010-6411	2	Bolt 85 ±5
	RD153-5004-0004	1	Washer		RD153-5002-0004	2	Washer
	145190	1	Block				
	RD111-1010-6410	2	Bolt				
	RD153-5004-0004	2	Washer				
	RD153-1002-0004	2	Washer				
	RD114-8003-1004	2	Nut				
	RD111-1010-6310	4	Bolt				
	RD153-5004-0003	4	Washer				
	RD153-1002-0003	4	Washer				
	RD114-8003-1003	4	Nut				
4H	145350(b) (Sheet 1.)	1	Collar	8	145228	1	Bracket
	145396	2	Bolt		RD111-4010-6411	2	Bolt 85 ±5
	RD153-1002-0008	2	Washer		RD153-5002-0004	2	Washer
	RD153-5004-0008	2	Washer				
	RD154-8003-1008	2	Nut				

(b) On engines F-2011 through F-2016.

NOTE  
Bolts replace existing engine bolts  
RD111-4010-6408.

NOTE  
Bolt replaces existing engine bolt  
RD111-4010-6409.

NOTE  
Bolts replace existing engine bolts  
RD111-4010-0608.

- When installing bracket (6), two existing clamps securing flexible armored harness shall be relocated and a new clamp added. An additional spacer and screw must also be added when installing bracket (7). See figure 3-5, sheet 4 for location of clamps, spacer, and attaching hardware.

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 14 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145315 (Cont)			11	145227 (Sheet 1.)	1	Support Bow
	RD111-4010-6411	2	Bolt 85 ±5	12	145231	1	Bracket
	RD153-5002-0004	2	Washer	13	145233	1	Bracket
	NOTE				RD153-1002-0006	1	Washer
	Bolts replace existing engine bolts RD111-4010-0608.				RD114-1002-0006	1	Nut 15 ±5
	<ul style="list-style-type: none"> <li>When installing bracket (6), two existing clamps securing flexible armored harness shall be relocated and a new clamp added. An additional spacer and screw must also be added when installing bracket (7). See figure 3-5, sheet 4 for location of clamps, spacer, and attaching hardware.</li> </ul>				Attaches brackets (12, 13) to engine.		
9	145302	1	Bracket	14	145232	1	Bracket
	NAS1004-4A	4	Bolt	15	145233	1	Bracket
	RD153-5004-0004	4	Washer		RD153-1002-0006	1	Washer
	LD153-0010-0009	4	Washer		RD114-1002-0006	1	Nut 15 ±5
	NAS679C4W	4	Nut 150 ±5		Attaches brackets (14, 15) to engine.		
	RD153-9001-0002	4	Washer	16	145280 Attaches to engine.	1	Bracket
10	145104 Attaches to engine.	1	Stiffener		RD111-1009-0407	2	Bolt 65 ±5
	NAS1004-23A	2	Bolt		RD153-5004-0004	2	Washer
	RD153-5004-0004	2	Washer	17	145226 Attaches to brackets (6,9).	1	Bow Assembly
	LD153-0010-0009	2	Washer		NAS1004-4A	4	Bolt 150 ±5
	NAS679C4W	2	Nut 65 ±5		RD153-9001-0002	4	Washer
	Attaches to brackets (7,8).				RD153-1002-0004	4	Washer
	NAS1003-3A	2	Bolt		NAS679C4W	4	Nut
	RD153-5004-0003	2	Washer	18	145234	1	Bracket
	RD153-1002-0003	2	Washer		NAS1004-5A	4	Bolt
	NAS679C3W	2	Nut 40 ±5		RD153-1002-0004	4	Washer
	Attaches to bracket (4).				RD153-9001-0002	4	Washer
	NAS1004-24A	2	Bolt		NAS679C4W	4	Nut 150 ±5
	RD153-9003-0001	4	Washer	19	145235	1	Bracket
	NAS679C4W	2	Nut 65 ±5		NAS1004-3A	2	Bolt
	LD153-0010-0010	2	Washer		NAS1004-7A	2	Bolt
	NAS43HT4-53	2	Spacer		RD153-5004-0004	4	Washer
	Attaches brackets (7,8) to bows (17).				RD153-1002-0004	4	Washer
					NAS679C4W	4	Nut 65 ±5
				20	145278	1	Bracket

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 15 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145227 (Cont)			34	145279-17	1	Beam Support Tube
21	145300	1	Bracket		NAS1004-12A	15	Bolt 65 ±5
	NAS1005-8H	4	Bolt 100 ±5		RD153-5004-0004	15	Washers
	RD153-5004-0005	4	Washer		RD153-1002-0002	15	Washers
	Attaches brackets (20, 21).				NAS679C4W	15	Nut 65 ±5
22	145107	1	Bracket		AREM-4SP19	8	Rod End
23	145253	1	Bracket		AREML-4SP19	8	Rod End
24	145254	1	Bracket		RD114-1005-0002	8	Nut 50 ±5
25	145276	1	Bracket		RD114-1007-0002	8	Nut 50 ±5
	NAS1004-5A	16	Bolt		Attaches tubes (28 through 33).		
	RD153-1002-0004	16	Washer		RD111-4008-3404	1	Bolt
	RD153-9001-0002	16	Washer		RD153-5004-0004	1	Washer
	NAS679C4W	16	Nut 150 ±5		Attaches tube (34).		
	Attaches brackets (22 through 25).			35	145313 (Sheet 1.)	1	Bracket
26	145229	1	Bracket	NOTE			
27	145230	1	Bracket	Bracket (39) shall be loosely installed. Attach cocoon insulator (25, figure 3-7) to bracket (39) and locate bracket (35) using nominal hole location. Secure brackets in place, remove insulator, and torque attaching and assembly hardware as indicated.			
	RD111-1009-0414	2	Bolt 65 ±5	36	145247 Attaches to support (38).	1	Bracket
	RD153-5004-0004	2	Washer		RE127-7006-0756	2	Clamp 34 ±3
	Attaches brackets (26, 27).				NAS1004-21A	2	Bolt
28	145279-3	1	Beam Support Tube		RD153-9003-0001	4	Washer
29	145279-5	1	Beam Support Tube		NAS679C4W	2	Nut 150 ±5
30	145279-7	1	Beam Support Tube		LD153-0010-0009	2	Washer
31	145279-9	2	Beam Support Tube	37	145248 Attaches to engine (3 places).	1	Bracket
32	145279-13	1	Beam Support Tube		NAS1006-9A	2	Bolt
33	145279-15	1	Beam Support Tube		NAS1006-18A	1	Bolt
					LD153-0010-0014	3	Washer
					RD153-5004-0006	3	Washer
					NAS679C6	3	Nut 90 ±5
				38	145244 Attaches to bracket (37).	1	Support

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 16 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145313 (Cont)						
	NAS1004-21A	2	Bolt		LD153-0010-0010	2	Washer
	NAS1004-22A	2	Bolt		Attaches bracket (43) to bracket (42).		
	RD153-9003-0001	4	Washer				
	RD153-9001-0002	4	Washer				
	NAS679C4W	4	Nut 150 ±5	44	145295	1	Frame
	LD153-0010-0009	4	Washer		(Sheet 2.)		
					NOTE		
39	145314(a), 145320(b) (Sheet 1.)	1	Bracket		Brackets (44, 51, 55) shall be loosely installed. Attach cocoon insulators (8, 13, figure 3-7) to brackets and locate brackets using nominal hole locations. Secure brackets in place, remove insulators, and torque fasteners as indicated.		
40	145246 Attaches to engine.	1	Bracket				
	NAS1005-4H	3	Bolt 90 ±5				
	LD153-0010-0011	3	Washer				
	RD153-5004-0005	3	Washer				
41	145289 Attaches to bracket (40).	1	Bracket	45	145294	1	Bracket
	NAS1005-24A	2	Bolt		520C87-962M	2	Clamp 75±5
	NAS679C5	2	Nut 10 ±2	46	145261 Attaches to dome.	1	Bracket
	LD153-0010-0012	2	Washer		NAS1006-3H	2	Bolt 85 ±5
	RD153-5004-0005	2	Washer		RD153-5004-0006	2	Washer
42	145245 Attaches to engine.	1	Bracket	47	145262 Attaches to bracket (46).	1	Support
	NAS1006-7A	2	Bolt		NAS1004-19A	1	Bolt
	LD153-0010-0014	2	Washer		RD153-5004-0004	1	Washer
	RD153-5004-0006	2	Washer		NAS679C4W	1	Nut 5 ±1(c)
	NAS679C6	2	Nut 90 ±5		LD153-0010-0010	1	Washer
43	145243(a), 145319(b) Attaches to brackets (41,42).	1	Bracket	48	145264 Attaches to support (47)	1	Frame
	NAS1004-29A	2	Bolt		NAS1004-25A	1	Bolt
	RD153-9001-0002	4	Washer		RD153-5004-0004	1	Washer
	NAS679C4W	2	Nut 150 ±5		NAS679C4W	1	Nut 5 ±1(c)
	LD153-0010-0009	2	Washer		LD153-0010-0010	1	Washer
	Attaches bracket (43) to bracket (41).				520C87-962M	1	Clamp
	NAS1004-24A	2	Bolt	49	145297 Attaches to bracket (45) and frame (48).	1	Frame
	RD153-9001-0002	4	Washer				
	NAS679C4W	2	Nut 150 ±5				

(a) On engines F-2003 through F-2010.

(b) On engines F-2011 through F-2016.

(c) Above running torque.

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 17 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145295 (Cont)			55	145311	1	Bracket
	NAS1004-25A	1	Bolt		(Sheet 2.)		
	RD153-5004-0004	1	Washer		Located with		
	NAS679C4W	1	Nut 1-2(c)		brackets (44,51).		
	LD153-0010-0009	1	Washer	56	145242 Attaches	1	Bracket
	Attaches frame				around turbo-		
	(49) to bracket				pump strut.		
	(45).						
	NAS1004-7H	1	Bolt 20 ±3		NAS1004-24A	4	Bolt
	RD153-5004-0004	1	Washer		RD153-5004-0004	4	Washer
	Attaches frame				NAS679C4W	4	Nut 35 ±5
	(49) to frame (48).				LD153-0010-0010	4	Washer
50	145263	1	Saddle	57	145197	2	Bracket
	NAS1003-3A	8	Bolt 25 ±3		RE127-7006-0750	2	Clamp 34 ±3
	RD153-5004-0003	8	Washer	58	145238 Attaches to	1	Stiffener
	Attaches saddle				brackets (56, 57).		
	(50) to frame (48).						
51	145310	1	Bracket		NAS1004-27A	4	Bolt
	(Sheet 2.)				RD153-9003-0001	8	Washer
	Located with				NAS679C4W	4	Nut 150 ±5
	brackets (44, 55).				LD153-0010-0009	4	Washer
52	145240 Attaches to	1	Bracket	59	145316	1	Stiffener
	engine strut.				(Sheet 2.)		
	NAS1004-24A	4	Bolt				
	RD153-5004-0004	8	Washer				
	NAS679C4W	4	Nut 35 ±5				
	LD153-0010-0010	4	Washer				
53	145241 Attaches to	1	Bracket				
	stiffener (54).						
	RE127-7006-0731	1	Clamp 34 ±3				
54	145239 Attaches to	1	Stiffener				
	brackets (52, 53).						
	NAS1004-27A	4	Bolt	60	145251	1	Support
	RD153-9003-0001	8	Washer		NAS1006-3H	2	Bolt 80 ±5
	NAS679C4W	4	Nut 150 ±5		RD153-5004-0006	2	Washer
	LD153-0010-0009	4	Washer	61	145250	1	Support
					RE127-7006-0406	1	Clamp 50 ±5

## NOTE

Bracket (59) shall be loosely installed. Attach cocoon insulator 145082 to bracket (63) and locate bracket (59) using nominal hole locations. Secure brackets in place, remove insulator, and torque attaching and assembly hardware as indicated.

(c) Above running torque.

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 18 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145316 (Cont)				145265	1	Bushing
62	145249	1	Stiffener		145288-5	2	Washer
	NAS1004-23A	2	Bolt 150 ±5		NAS1005-38A	1	Bolt
	RD153-9003-0001	4	Washer		RD153-5004-0005	1	Washer
	NAS679C4W	2	Nut		NAS679C5	1	Nut 150 ±5
	LD153-0010-0009	2	Washer		RD153-1002-0005	4	Washer
	Attaches stiffener (62) to support (60).				Component hardware at offset of bracket (66).		
	NAS1003-26A	2	Bolt	67	145268	1	Attaches to bracket (66). Coupling
	RD153-9003-0002	4	Washer		NAS1004-32A	2	Bolt
	NAS679C3W	2	Nut 30 ±5		RD153-1002-0004	6	Washer
	LD153-0010-0008	2	Washer		NAS679C4W	2	Nut 5 ±1(c)
	Attaches stiffener (62) to support (61).				RD153-5004-0004	2	Washer
63	145269 (Sheet 2.)	1	Bracket	68	145060	1	Attaches to support (65) and coupling (67). Bracket
64	145266	1	Attaches to engine. Coupling		NAS1006-66A	1	Bolt
	NAS1006-11A	2	Bolt		RD153-5004-0006	1	Washer
	LD153-0010-0014	2	Washer		NAS679C6	1	Nut 5 ±1(c)
	RD153-5004-0006	2	Washer		RD153-1002-0006	2	Washer
	NAS679C6	2	Nut 120 ±10	69	145290 (Sheet 2.)	1	Bracket
65	145267	1	Attaches to coupling (64). Support	70	145275	1	Bracket
	NAS1297-5-32	2	Bolt		NOTE		
	RD153-5004-0006	2	Washer		Wrap-around lines support brackets have been alined. When installing bracket (69), replace two existing bolts in the wrap-around lines bracket with plate (70C or 70D) and one each of studs (70A, 70B). To avoid disturbing alinement, torque nuts for studs before replacing remaining existing bolts with remaining studs.		
	NAS679C5	2	Nut 48 ±3				
	RD153-1002-0005	2	Washer				
66	145103	1	Bracket				
	NAS1006-1H	2	Bolt 200 ±10	70A	145252-3	2	Stud
	RD153-5003-0006	2	Washer	70B	145252-5	2	Stud
	Attaches bracket (66) to dome bolts.						
	NOTE						
	Install bolts loosely. Used later to attach insulator.						

(c) Above running torque.

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 19 of 23)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	
	145290 (Cont)			74	145271 Attaches between brackets (73A).			
70C	145274-1	1	Plate		NAS1004-16A	6	Bolt 85 ±5	
70D	145274-2	1	Plate		RD153-5004-0004	2	Washer	
70E	145303	4	Washer		NAS1004-10A	2	Bolt	
	RD153-5002-0004	8	Washer		RD153-9001-0002	14	Washer	
	NAS679C4W	8	Nut 120 ±5		RD153-1003-0008	2	Washer	
71	145187 Attaches to bracket (70).		1	Bracket	75	145299 Attaches to dome.		
	NAS1004-12A	4	Bolt 65 ±5		RD111-1009-0409	1	Bolt 85 ±5	
	RD153-5004-0004	4	Washer		RD153-5004-0004	1	Washer	
	RD153-1002-0004	4	Washer		LD153-0010-0010	1	Washer	
	NAS679C4W	4	Nut		NAS1004-17A	1	Bolt	
71A	145273 Attaches to bracket (72).		1	Bracket	76	145298		
	NAS33CPA4	3	Bolt 37 ±5		RD153-1002-0004	1	Washer	
72	145270 Attaches to bracket (71).		1	Channel		RD153-5004-0004	1	Washer
72A	RD111-1006-0305	2	Bolt 40 ±5		NAS679C4W	1	Nut 65 ±5	
72B	RD111-1007-0305	4	Bolt 40 ±5		Attaches bracket (76) to bracket (75).			
	RD153-9003-0002	4	Washer		NAS1004-8A	3	Bolt 85 ±5	
					RD153-5004-0004	3	Washer	
					AREM-4SP19	1	Rod End	
					RD114-1005-0002	1	Nut 50 ±5	
	NOTE				NOTE			
	Bolt (72B) requires lubrication with Fel-Pro C5 (Felt Products).				Attaches bracket (76) to bracket (71).			
73	145237 Attaches to dome-to-LOX valve flange bolt-heads.		1	Bracket	77	145312 (Sheet 2.)		
	RD111-1007-0506	2	Bolt 100 ±5		78	145296		
	LD153-0013-0003	2	Washer			RE127-7006-0962	2	Clamp 50 ±5
73A	145318 Attaches to ends of bracket (74).		2	Bracket	79	145258		
	NAS1005-38A	2	Bolt			RE127-7006-0962	2	Clamp 50 ±5
	RD153-5004-0005	2	Washer	80	145260 Attaches to brackets (78,79).			
	RD153-1002-0005	2	Washer		NAS1004-24A	1	Bolt	
	NAS679C5W	2	Nut 48 ±3		NAS679C4W	1	Nut 150 ±5	

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 20 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145312 (Cont)						
	LD153-0010-0009	1	Washer		145288-7	2	Washer
	RD153-9001-0002	2	Washer		RD114-8005-1004	2	Nut 70 ±10
	NAS43HT4-54	1	Spacer		Attaches bracket (84) to brackets (83, 82).		
	Attaches stiffener (80) to bracket (78).				NAS1003-3A	4	Bolt 30 ±5
	NAS1004-21	1	Bolt		RD153-5004-0003	4	Washer
	AN320C4	1	Nut 1-2(c)		Attaches bracket (84) to bracket (83).		
	LD153-0010-0009	1	Washer	85	145255	2	Clamp
	RD153-5004-0004	1	Washer		(Sheet 2.)		
	MS9245-29	1	Pin		Attaches to bracket (84).		
	Attaches stiffener (80) to bracket (79).				NAS1004-20A	4	Bolt
81	145259 Attaches to bracket (79).	1	Stiffener		RD153-5004-0004	4	Washer
	NAS1004-21	1	Bolt		RD153-1002-0004	4	Washer
	AN320C4	1	Nut 1-2(c)		NAS679C4W	4	Nut
	LD153-0010-0009	1	Washer	86	145188	1	Bracket
	RD153-5004-0004	1	Washer		(Sheet 2.)		
	MS9245-29	1	Pin		Attaches to brackets (83,84).		
82	145256 Attaches to stiffener (82).	1	Bracket		NAS1004-4A	3	Bolt 35 ±5
	NAS1004-24A	1	Bolt		145288-7	3	Washer
	NAS679C4W	1	Nut 150 ±5		RD153-5004-0004	3	Washer
	LD153-0010-0009	1	Washer		Attaches bracket (86) to bracket (83).		
	RD153-9001-0002	2	Washer		NAS1004-3A	2	Bolt 40 ±5
	NAS43HT4-54	1	Spacer		NAS1004-4A	1	Bolt 40 ±5
83	145286 (Sheet 2.) Attaches to dome.	1	Bracket		RD153-5004-0004	3	Washer
	RD111-4010-0408	2	Bolt 70 ±10		Attaches bracket (86) to bracket (84) at junction to bracket (82).		
	RD153-5004-0004	2	Washer		NAS1004-2A	2	Bolt
84	145292(a), 145292-11(b) (Sheet 2.)	1	Bracket		RD153-1002-0004	2	Washer
	RD111-4009-0406	2	Bolt		RD153-5004-0004	2	Washer
	RD153-5004-0004	2	Washer		NAS679C4W	2	Nut 40 ±5
	RD153-1002-0004	2	Washer		Attaches bracket (86) to bracket (84) at junction to bracket (83).		

(a) On engines F-2003 through F-2010.

(b) On engines F-2011 through F-2016.

(c) Above running torque.

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 21 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
87	145304	1	Bracket		NAS1004-34A	2	Bolt
	(Sheet 2.)				RD153-9001-0002	2	Washer
	Attaches to oxidizer valve.				NAS1057W4-183	2	Spacer
	NAS1006-3A	1	Bolt		RD114-8003-0004	2	Nut 145 ±5
	RD153-5004-0006	1	Washer	94	145307 Attaches to stiffener (92).	1	Bracket
88	145305	1	Rod		NAS1004-4A	2	Bolt
	(Sheet 2.)				RD153-9001-0002	4	Washer
	Attaches to brackets (86, 87).				RD114-8003-0004	2	Nut 145 ±5
	RD114-1005-0003	1	Nut Check	95	145337(b) (Sheet 3.)	1	Stiffener
	RE131-7002-0002	1	Rod End		RD111-1010-6618	1	Bolt
	RD111-1010-6526	2	Bolt		RD153-5004-0006	1	Washer
	RD114-8003-1005	2	Nut		LD153-0010-0014	1	Washer
	RD153-1002-0005	2	Washer		RD114-8003-1006	1	Nut 150 ±15
RD153-5004-0005	2	Washer		Attaches stiffener at hole 72 of tool ring.			
89	145344(b) (Sheet 2.)	1	Bracket		NAS679C4W	1	Nut 68 ±7
	Attaches to dome.				LD153-0010-0010	1	Washer
	RD111-1009-0406	4	Bolt 68 ±7		Attaches stiffener at stud welded to thrust chamber.		
	RD153-5004-0004	4	Washer	96	145334	1	Channel
90	145339(b) (Sheet 3.)	1	Bracket	97	145336 Attaches to channel (96).	1	Stiffener
	Attaches to thrust chamber plate.				NAS1004-3A	2	Bolt 68 ±7
	RD111-1010-0507	2	Bolt 140 ±5		RD153-9001-0002	2	Washer
	RD153-5004-0005	2	Washer	98	145335 Attaches to stiffener (97).	1	Stiffener
91	145342(b) (Sheet 3.)	1	Stiffener		NAS1004-4A	4	Bolt 68 ±7
	Attaches to gimbal struts.				RD153-9001-0002	4	Washer
	NAS1004-18A	8	Bolt	99	145338(b) (Sheet 3.)	1	Stiffener
	RD153-5004-0004	8	Washer		NAS1004-20A	4	Bolt
	LD153-0010-0009	8	Washer		RD153-5004-0004	4	Washer
RD114-8003-0004	8	Nut 2-5(c)		LD153-0010-0009	4	Washer	
92	145341	1	Stiffener		RD114-8003-0004	4	Nut 2-5(c)
93	145306 Attaches to stiffener (92).	1	Bracket				

(b) On engines F-2011 through F-2016.

(c) Above running torque.

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 22 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145338 <sup>(b)</sup> (Cont)						
	NAS1004-17A	4	Bolt	103	145343 <sup>(b)</sup>	1	Bracket
	RD153-5004-0004	4	Washer		(Sheet 3.)		
	LD153-0010-0009	4	Washer		Attaches to turbo-		
	RD114-8003-0004	4	Nut 2-5 <sup>(c)</sup>		pump strut.		
	Attaching fasteners are part of stiffener (99).				NAS1004-21A	4	Bolt
					RD153-5004-0004	4	Washer
					RD153-1002-0004	4	Washer
					NAS679C4W	4	Nut 40 ±5
100	145340	1	Stiffener	104	145317 <sup>(b)</sup>	1	Bracket
101	145309 Attaches to stiffener (100).		1	(Sheet 3.)			
	NAS1004-34A	2	Bolt	NOTE			
	RD153-9001-0002	4	Washer	Telescopes into bracket (103).			
	NAS1057W4-167	2	Spacer	RD111-4001-6426	2	Bolt	
	RD114-8003-0004	2	Nut 145 ±5	RD153-9001-0002	2	Washer	
102	145308 Attaches to stiffener (100).		1	RD153-1002-0004	2	Washer	
	NAS1004-4A	2	Bolt	RD114-8005-1004	2	Nut 40 ±5	
	RD153-9001-0002	4	Washer				
	RD114-8003-0004	2	Nut 145 ±5				

<sup>(b)</sup> On engines F-2011 through F-2016.

<sup>(c)</sup> Above running torque.

Figure 3-5. Thermal Insulation Attach Brackets (Sheet 23 of 23)

3-15. INSTALLING THRUST CHAMBER AND NOZZLE EXTENSION INSULATORS.

3-16. Thrust chamber and nozzle extension insulators shall be installed in the order indicated by the index number sequence in figure 3-6.

a. Thrust chamber insulators (26, 27, 28) shall be installed during installation of cocoon insulation, as outlined in paragraph 3-17.

b. Safetywire insulator lacing studs, using applicable methods shown in figure 3-3.



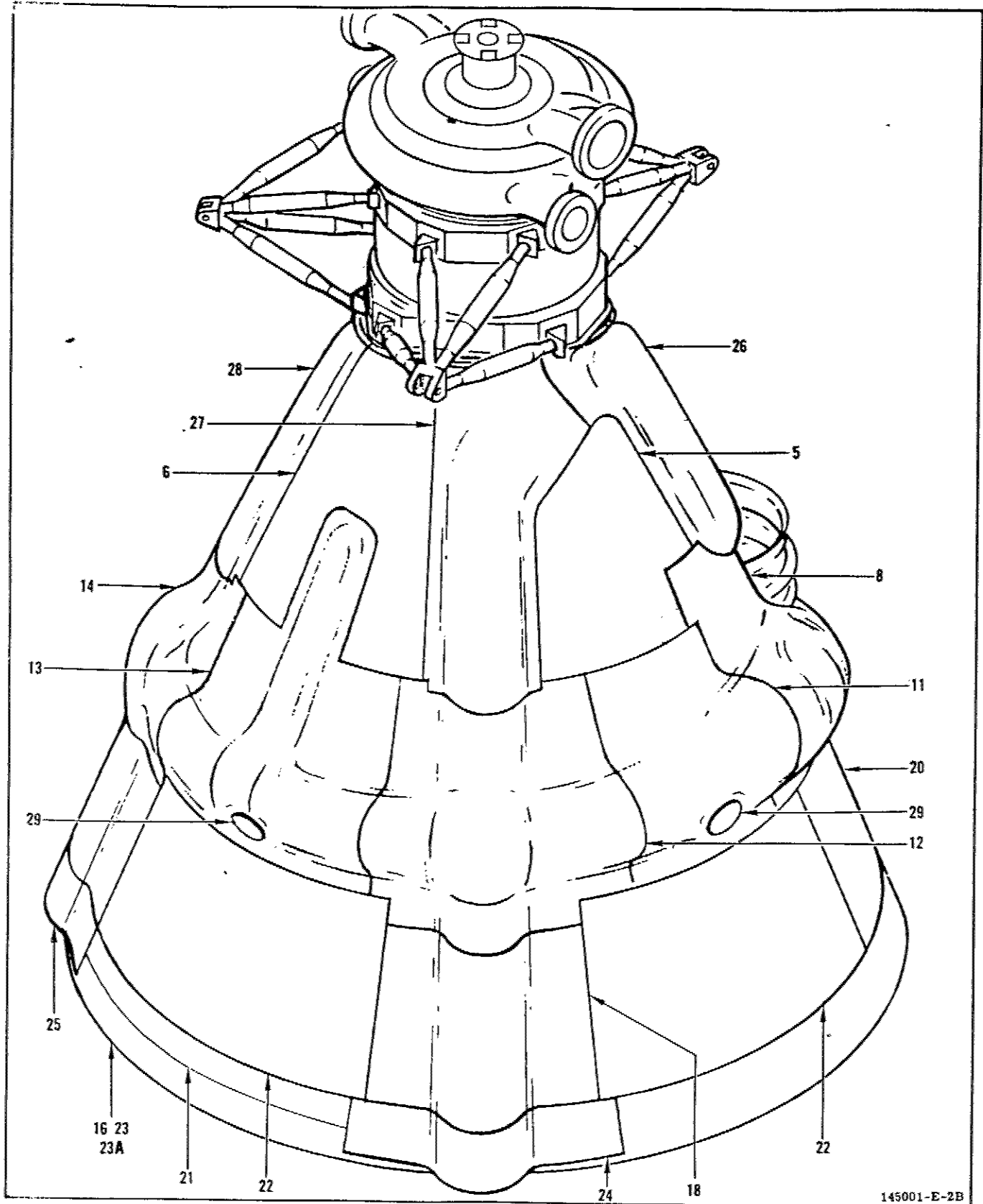


Figure 3-6. Thrust Chamber and Nozzle Extension Thermal Insulation (Sheet 2 of 5)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
1	145178	3	Strap	9	145225(g)	1	Insulator
	MS20500-1032	12	Nut 24-28		NAS1100-C3-12(h)	12	Screw
	NAS1003-5H	12	Bolt		RD153-0115-0020(h)	12	Washer
	RD153-0115-0020	12	Washer		RD114-8003-0003(h)	12	Nut 24-28
	RD153-5004-0003	12	Washer		145225-59(h)	1	Clamp 40 (+10, -0)
2	145179	3	Strap		145225-63(h)	1	Clamp 40 (+10, -0)
	MS20500-1032	12	Nut 24-28				
	NAS1003-5H	12	Bolt				
	RD153-0115-0020	12	Washer				
	RD153-5004-0003	12	Washer				
3	145177(a),145902(b)	1	Insulator				
	MS20500-1032	3	Nut 24-28		NAS1100-C3-8	16	Screw 24-28
	RD153-0115-0023	3	Washer		RD114-5002-0002	16	Nut Clip
4	145153(a),145901(b)	1	Insulator	10	145165	1	Insulator
	MS20500-1032	3	Nut 24-28		MS20500-1032	31	Nut
	NAS1100-C3-12	5	Screw		RD153-0115-0021	31	Washer
	RD153-0115-0023	8	Washer	11	145160(a),145908(b)	1	Insulator
5	145154(a),145903(b)	1	Insulator		MS20500-1032	7	Nut 24-28
	MS20500-1032	4	Nut 24-28		NAS1100-C3-12	8	Screw
	RD153-0115-0023	4	Washer		RD153-0115-0023	15	Washer
6	145155(a),145904(b)	1	Insulator	12	145161(a),145909(b)	1	Insulator
	MS20500-1032	1	Nut 24-28		MS20500-1032	4	Nut 24-28
	RD153-0115-0023	1	Washer		NAS1100-C3-12	8	Screw
					RD153-0115-0023	12	Washer
7	145175(a),145174(b)	1	Insulator		NAS1100-C3-8	10	Screw
	MS20500-1032	7	Nut 24-28		RD114-5002-0002	10	Nut Clip
	RD153-0115-0023	7	Washer	13	145162(a),145910(b)	1	Insulator
8	145156(a),145173(b)	1	Insulator		MS20500-1032	13	Nut 24-28
	MS20500-1032	5	Nut 24-28		NAS1100-C3-12	8	Screw
	NAS1100-C3-12	9	Screw		RD153-0115-0023	21	Washer
	RD153-0115-0023	14	Washer	14	145163(a),145911(b)	1	Insulator
					MS20500-1032	4	Nut 24-28
					NAS1100-C3-12	8	Screw

## NOTE

Clamp joints shall be located parallel with mating line of insulator (9) segments.

- (a) On engines F-2003 through F-2010.  
 (b) On engines F-2011 through F-2016.  
 (g) Requires disassembly prior to installation.  
 (h) A component of assembly.

Figure 3-6. Thrust Chamber and Nozzle Extension Thermal Insulation (Sheet 3 of 5)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145163(a), 145911(b) (Cont)			22	145168(a), 145915(b)	3	Insulator
	RD153-0115-0023	12	Washer		NAS1100-C3-16	39 <sup>(d)</sup> 28 <sup>(c)</sup>	Screw 24-28
	NAS1100-C3-8	9	Screw		RD153-0115-0023	47 <sup>(d)</sup> 36 <sup>(c)</sup>	Washer
	RD114-5002-0002	9	Nut Clip		NAS1100C3-22	2	Screw
15	145164(a), 145912(b)	1	Insulator		NAS1100C3-12	6	Screw
	MS20500-1032	7	Nut 24-28	23	145152(a)(d), 145932(b)(d)	1	Insulator
	NAS1100-C3-12	16	Screw		NAS1100-C3-22(a)	105	Screw 24-28
	RD153-0115-0023	23	Washer		RD153-0115-0021(a)	105	Washer
16	145151(a) (c)	1	Insulator		NAS1100-C3-22(b)	5	Screw 24-28
	NAS1100-C3-22	120	Screw 24-28		RD153-0115-0021(b)	178	Washer
	RD153-0115-0021	120	Washer		145929(b)	72	Stud
17	145169(a), 145916(b)	1	Insulator		145930(b)	72	Ablative Cap
	NAS1100-C3-12	10	Screw 24-28		NAS1100C3-16(b)	54	Screw
	RD153-0115-0023	10	Washer		NAS1100C3-12(b)	47	Screw
	NAS1100-C3-8	15	Screw 24-28				
	RD114-5002-0002	15	Nut Clip				
18	145170(a), 145917(b)	1	Insulator				
	NAS1100-C3-12	14	Screw 24-28				
	RD153-0115-0023	14	Washer				
	NAS1100-C3-8	15	Screw 24-28				
	RD114-5002-0002	15	Nut Clip				
19	145167(a), 145914(b)	1	Insulator				
	NAS1100-C3-22	4	Screw 24-28				
	RD153-0115-0023	4	Washer				
20	145166(a), 145913(b)	1	Insulator				
	NAS1100-C3-22	8	Screw 24-28				
	RD153-0115-0023	8	Washer				
21	145180(a)(d) 145180-11(b)(d)	1	Plate				

## NOTE

Silicone sealant RTV102 (General Electric) is required in threaded recess of ablative caps. Torque caps hand tight.

23A	145931(b)(c)	1	Insulator
	NAS1100-C3-22(b)	116	Screw 24-28
	RD153-0115-0021(b)	188	Washer
	NAS1100C3-22(b)	2	Screw
	NAS1100C3-16(b)	56	Screw
	NAS1100C3-12(b)	57	Screw
	145929(b)	72	Stud
	145930(b)	72	Ablative Cap

## NOTE

Silicone sealant RTV102 (General Electric) is required in threaded recess of ablative caps. Torque caps hand tight.

- (a) On engines F-2003 through F-2010.  
 (b) On engines F-2011 through F-2016.  
 (c) On inboard (center) engine only.  
 (d) On outboard engines only.

Figure 3-6. Thrust Chamber and Nozzle Extension Thermal Insulation (Sheet 4 of 5)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
24	145171(a)(e), 145171-11(b)(e)	1	Insulator
	NAS1100-C3-16	8	Screw 24-28
	NAS1100-C3-22	1	Screw 24-28
	RD153-0115-0021	11	Washer
	NAS1100C3-24	1	Screw 24-28
	NAS1100C3-28	1	Screw 24-28
25	145172(a)(e), 145172-11(b)(e)	1	Insulator
	NAS1100-C3-16	5	Screw 24-28
	NAS1100-C3-22	4	Screw 24-28
	RD153-0115-0021	9	Washer
26	145157(a)(f), 145905(b)(f)	1	Insulator
27	145158(a)(f), 145906(b)(f)	1	Insulator
28	145159(a)(f), 145907(b)(f)	1	Insulator
29	145101 Used on insulators(11, 13, 15).	3	Door
	NAS1100-C3-8	3	Screw 24-28
30	145176(a),145918(b)	1	Insulator
	NAS1100-C3-8	1	Screw
	MS20500-1032	16(a) 14(b)	Nut 24-28
	RD153-0115-0020	16(a) 14(b)	Washer

## NOTE

Insulators (26, 27, 28) are listed with cocoon insulation (figure 3-7) for proper installation sequence.

- (a) On engines F-2003 through F-2010.  
 (b) On engines F-2011 through F-2016.  
 (e) Make cross-slit (+) openings in asbestos for drain lines.  
 (f) Installed following installation of cocoon insulators.

Figure 3-6. Thrust Chamber and Nozzle Extension Thermal Insulation (Sheet 5 of 5)

## 3-17. INSTALLING COCOON INSULATORS.

3-18. Cocoon insulators are installed in the order shown in figure 3-7 except as noted. Threaded fasteners provided with drilled heads shall be safetywired with inconel lockwire MS20995N. Insulator lacing shall be performed following installation of all insulators (figure 3-3).

## NOTE

To prevent damage to cocoon insulators during installation of wrap-around lines insulators (figure 3-9), a deviation in installation is recommended as outlined in steps a through d.

a. Install cocoon insulators (10, 19).

b. Partially install cocoon insulator (20) by attaching it at interface panel and dome.

c. Install wrap-around lines insulators as outlined in paragraph 3-21.

d. Complete installation of cocoon insulators.

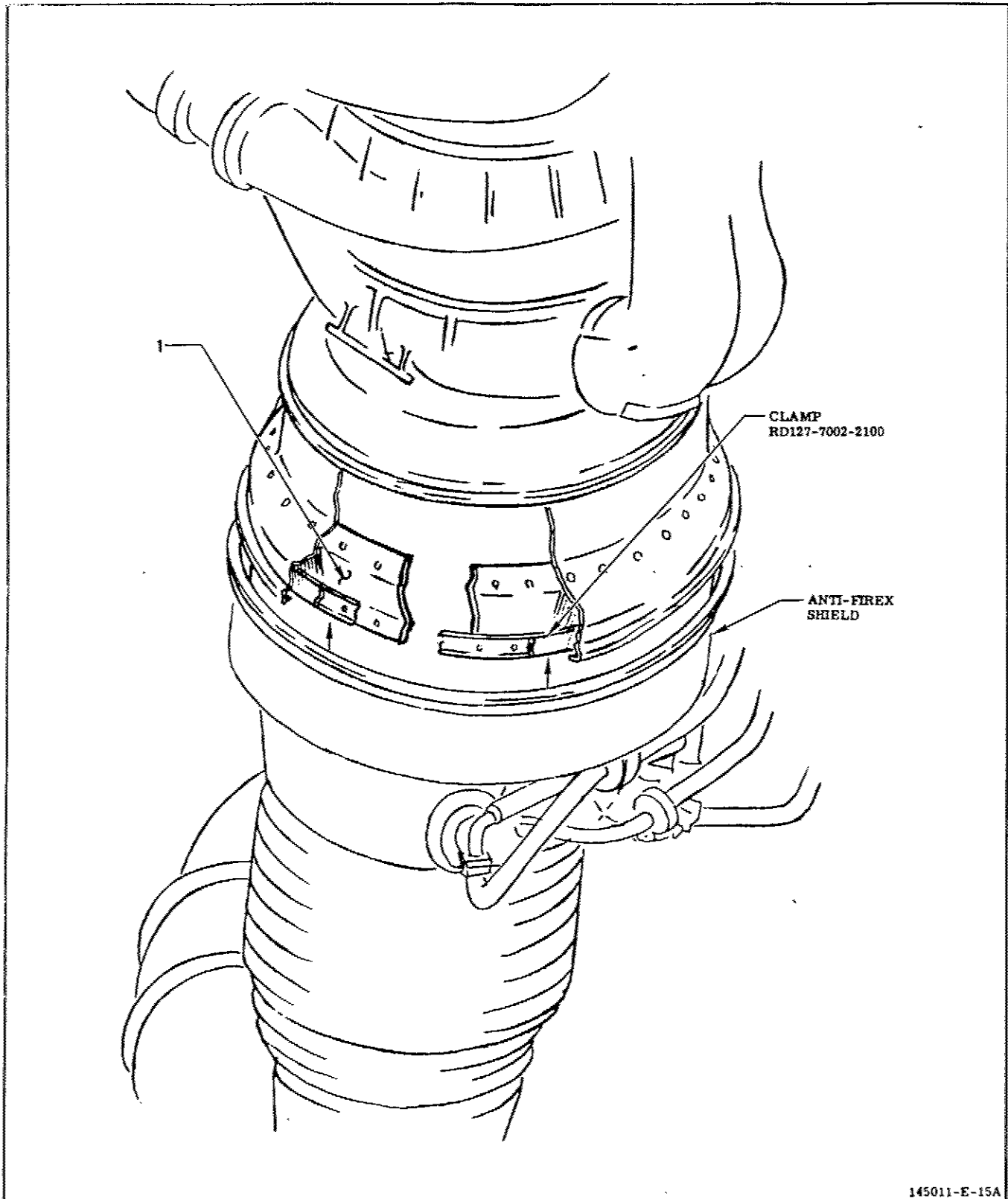
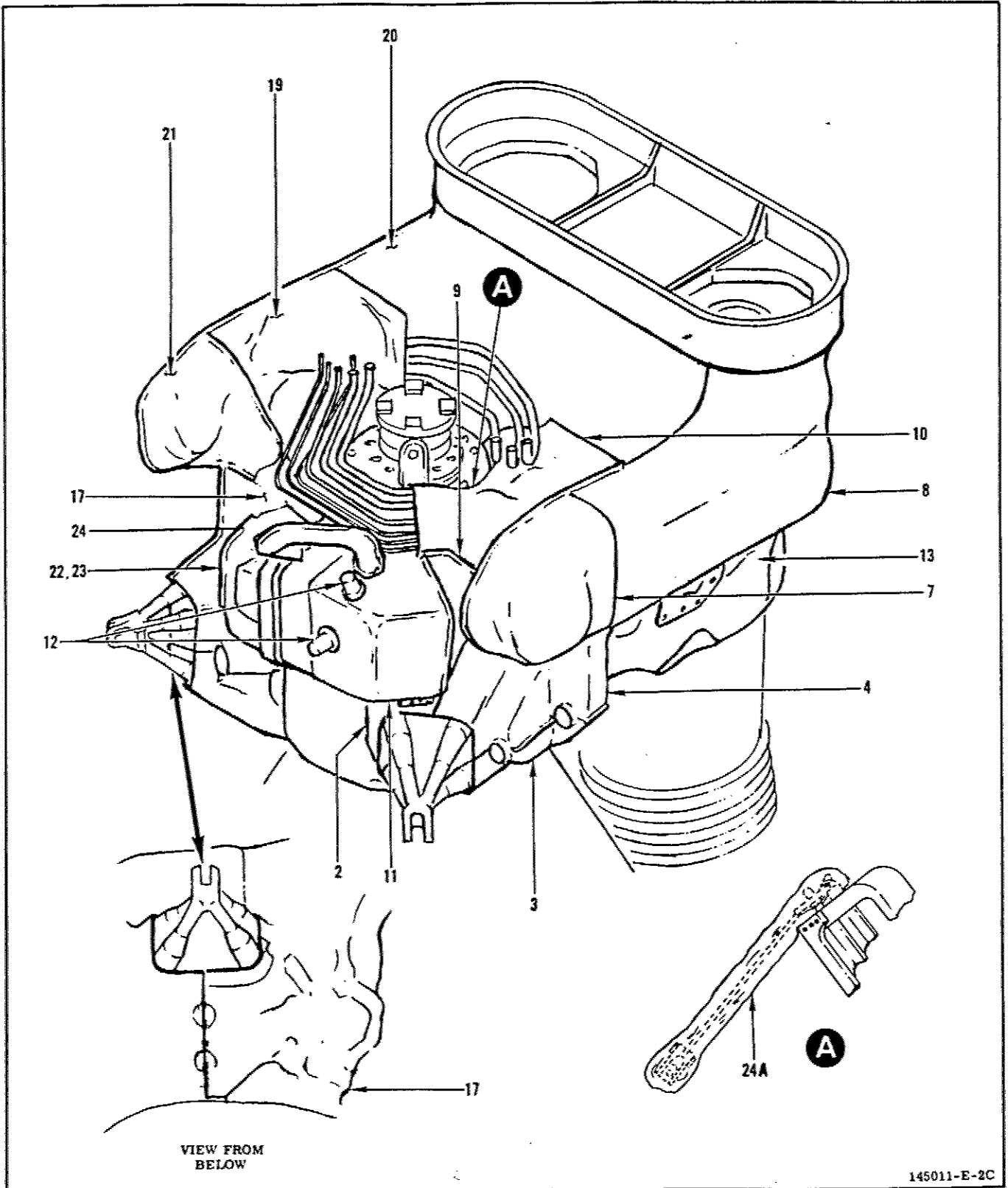
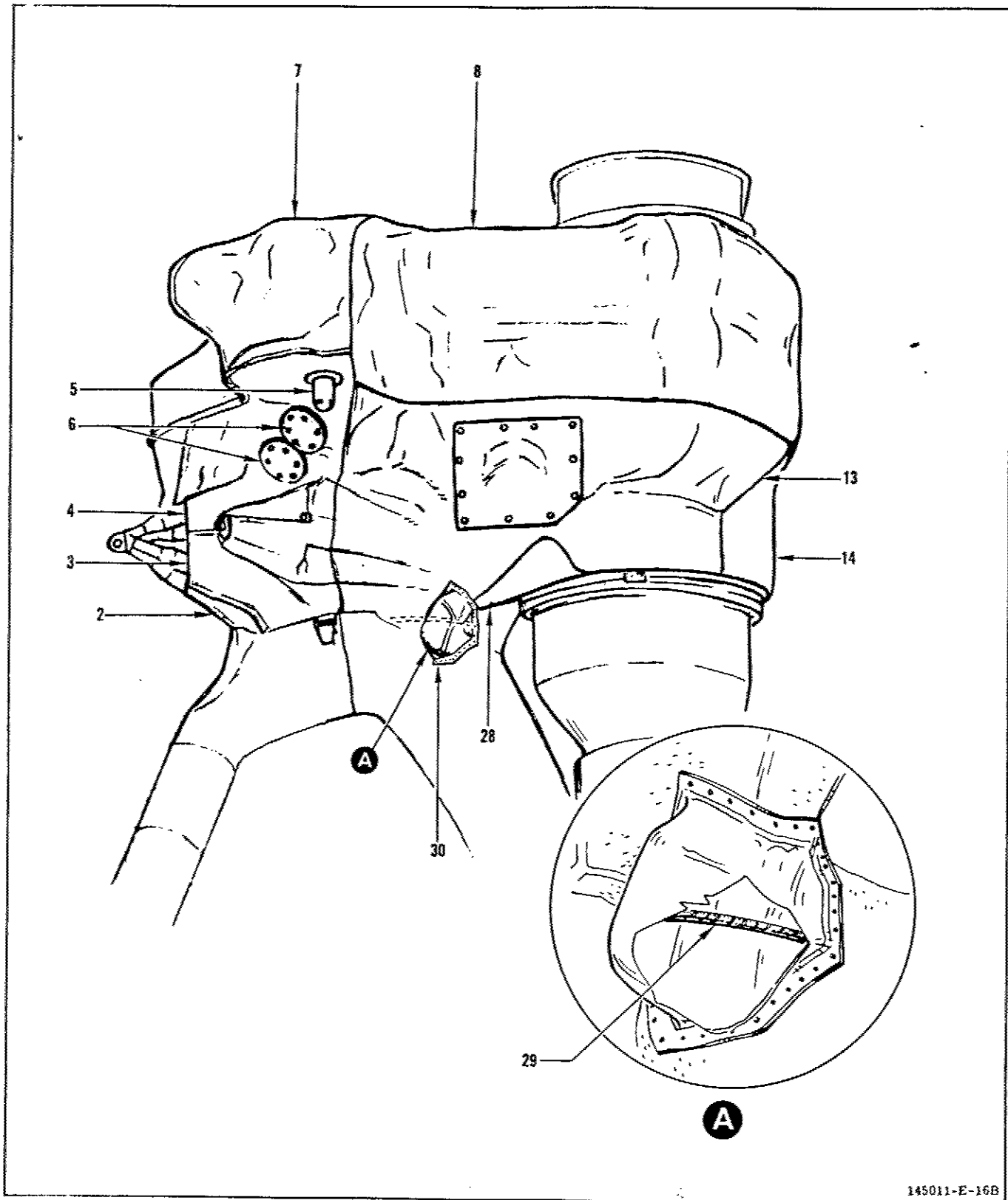


Figure 3-7. Cocoon Thermal Insulation (Sheet 1 of 22)



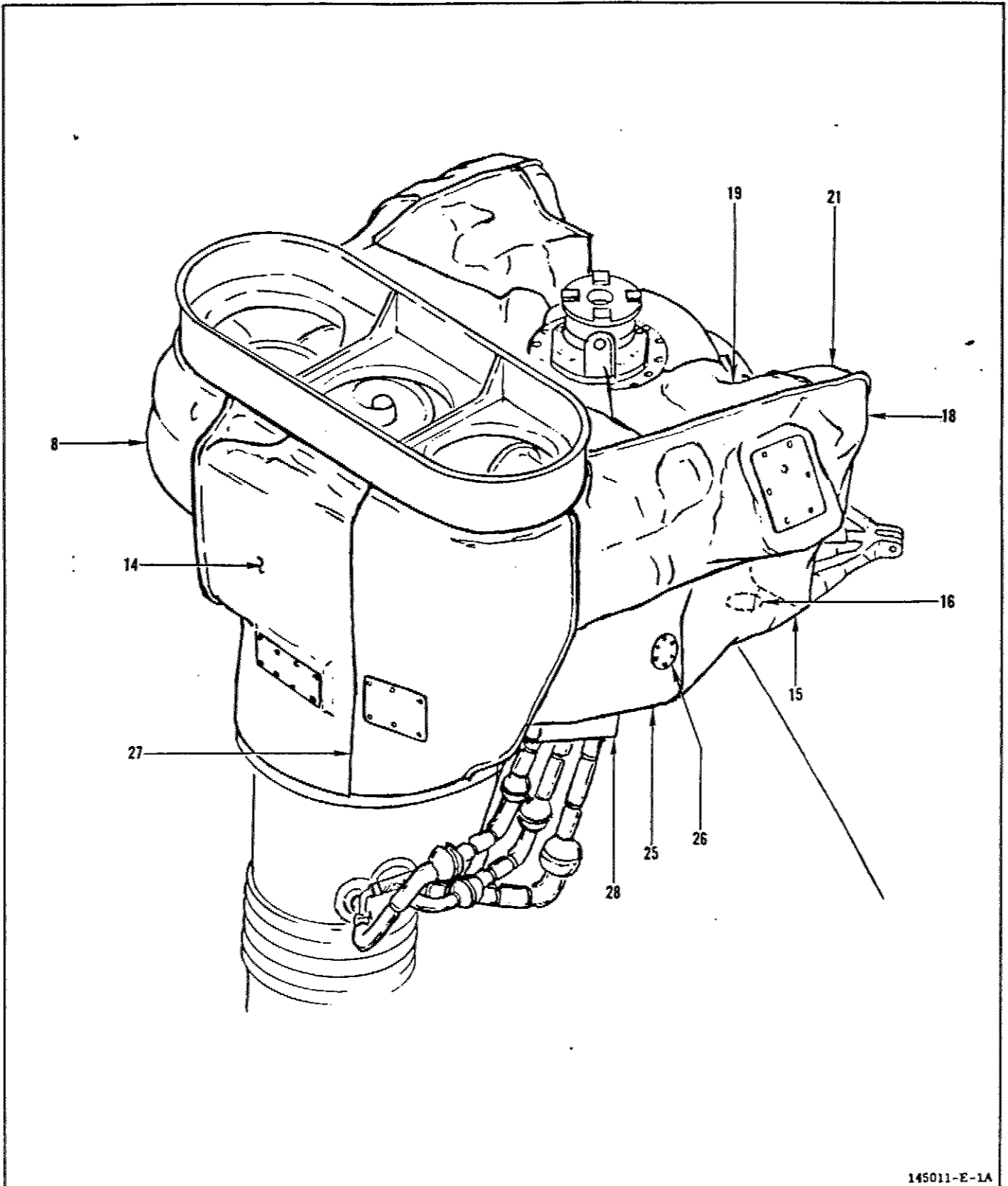
145011-E-2C

Figure 3-7. Cocoon Thermal Insulation (Sheet 2 of 22)



145011-E-16B

Figure 3-7. Cocoon Thermal Insulation (Sheet 3 of 22)



145011-E-1A

Figure 3-7. Cocoon Thermal Insulation (Sheet 4 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
1	145144 (Sheet 1.)	2	Insulator	2	145081 <sup>(a)</sup> , 145329 <sup>(b)</sup>	1	Insulator
<p>NOTE</p> <p>The following instructions install insulator (1).</p> <p>a. Disconnect anti-firex shield assembly from turbopump water shield.</p> <p>b. Thread 12 bolts RD111-1010-6311 with washers RD153-5005-0003 through each half of water shield into 12 nutplates attached to each insulator 145144. Torque bolts to 20 ±3 inch-pounds.</p> <p>NOTE</p> <p>Joint lines of insulators (1) shall align with joint lines of water shield. Bolt installation shall start at first hole nearest joint line and shall be progressively installed either clockwise or counterclockwise.</p> <p>c. Lace studs at each end of insulator as shown in figure 3-3.</p> <p>d. Secure lower edge of insulator to turbine manifold, using 2 clamps RD127-7002-2100 hooked together. Torque clamp nuts to 25 ±3 inch-pounds.</p> <p>e. Reinstall anti-firex shield assembly on turbopump water shield. Torque nuts of coupling 4451C4490M to 90 ±5 inch-pounds.</p> <p>NOTE</p> <p>Coupling joints shall be positioned within 3 degrees of a line extending from the center of the fuel inlet elbows through the turbopump aft supports.</p>				<p>RE127-7004-0419<sup>(c)</sup> 3      Clamp 20 ±3 Attaches to gimbal outrigger.</p> <p>RD111-1010-6413    1      Bolt 1-2<sup>(m)</sup> RD153-5005-0005    1      Washer Attaches to bracket (59)<sup>(d)</sup>.</p> <p>RD111-1010-6413    9      Bolt 150 ±5 RD153-9001-0001    9      Washer Attaches to bracket (63)<sup>(d)</sup>.</p> <p>NOTE</p> <p>During installation of insulators (3 through 14), insulators (15 through 27) may be simultaneously installed.</p> <p>3    145098<sup>(a)</sup>, 145544<sup>(b)</sup>      1      Insulator Attaches to gimbal outrigger and in- sulator (2).</p> <p>NOTE</p> <p>Split asbestos flap of insulator 145544 to accommodate drain line.</p> <p>RE127-7004-0419<sup>(c)</sup> 2      Clamp 20 ±3 Attaches to gimbal outrigger.</p> <p>NAS1100C3-10      6      Screw 25 ±3 RD114-5001-0001    6      Clip Attaches to insulator (2) 145081<sup>(a)</sup>, 145329<sup>(b)</sup>.</p> <p>RD111-1010-6410    2      Bolt 150 ±5 RD153-9001-0001    2      Washer Attaches to insulator (2) 145081<sup>(a)</sup>, 145329<sup>(b)</sup>.</p>			
<p>(a) On engines F-2003 through F-2010. (b) On engines F-2011 through F-2016. (c) A component of insulator. (d) See figure 3-5 for indexed brackets. (m) Above running torque.</p>							

Figure 3-7. Cocoon Thermal Insulation (Sheet 5 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
4	145099(a), 145542(b) Attaches to insulator (2) 145081(a), 145329(b) and insulator (3) 145098(a), 145544(b).	1	Insulator		NAS1100C3-10	7	Screw 25 ±3
	RE127-7004-0419(c)	2	Clamp 20 ±3		RD114-5001-0001	6	Clip
	Attaches to gimbal outrigger.				RD114-5002-0002(e)	1	Clip
	RD111-1010-6410	2	Bolt 150 ±5		Attaches to insulator (3) 145098(a), 145544(b).		
	RD153-9001-0001	2	Washer		NOTE		
	Attaches to insulator (2) 145081(a), 145329(b).				When attaching to insulator (3) clip RD114-5002-0002 is to be installed at first hole starting from insulator 145100(a), 145545(b) (k), or 145545-11(b) (l).		
	NAS1100C3-10	5	Screw 25 ±3		NAS1100C3-7	2	Screw 25 ±3
	RD114-5001-0001	5	Clip		Attaches lanyard for door (6) 145101.		
	Attaches to insulator (2) 145081(a), 145329(b).				NAS1100C3-7	1	Screw 25 ±3
	NAS1004-5A	2	Bolt 5 ±1(m)		Attaches lanyard for door (5) 145072.		
	Attaches to insulator (3) 145098(a), 145544(b).			5	145072	1	Door
	RD153-5004-0004	4	Washer		Attaches to insulator (4) 145099(a), 145542(b).		
	NAS679C4W	2	Nut 5 ±1(m)		RD112-5002-0001(f)	4	Screw 5 ±1(m)
	Attaches at boots 145283.				RD153-0115-0020(f)	4	Washer
					Attaches to insulator (4) 145099(a), 145542(b).		
				6	145101	2	Door
					Attaches to insulator (4) 145099(a), 145542(b).		

(a) On engines F-2003 through F-2010.

(b) On engines F-2011 through F-2016.

(c) A component of insulator.

(e) Clip RD114-5002-0001 may be substituted.

(f) A component of door.

(k) On inboard engines.

(l) On outboard engines.

(m) Above running torque.

Figure 3-7. Cocoon Thermal Insulation (Sheet 6 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145101 (Cont)				RD111-1010-6413 <sup>(a)</sup>	16	Bolt 150 ±5
	RD112-5002-0001 <sup>(f)</sup>	6	Screw 5 ±1 <sup>(m)</sup>		RD153-5005-0005 <sup>(c)</sup>	16	Washer
	RD153-0115-0020 <sup>(f)</sup>	6	Washer		Attaches to bracket (2) <sup>(d)</sup> .		
	Attaches to insulator (4) 145099 <sup>(a)</sup> , 145542 <sup>(b)</sup> .				RD111-1010-6410 <sup>(b)</sup>	16	Bolt 150 ±3
7	145077	1	Insulator		RD153-9001-0001 <sup>(b)</sup>	16	Washer
	Attaches to oxidizer valve and insulator (4).				Attaches to bracket (1) <sup>(d)</sup> .		
	RE127-7005-1150 <sup>(c)</sup>	1	Clamp 20 ±3		RD111-1010-6413 <sup>(b)</sup>	2	Bolt 1-2 <sup>(m)</sup>
	Attaches to oxidizer valve.				RD153-5005-0005 <sup>(b)</sup>	2	Washer
	NAS1100C3-10	15	Screw 25 ±3		Attaches to bracket (11) <sup>(d)</sup> .		
	RD114-5001-0001	9	Clip		NAS1004-3A	6	Bolt 150 ±5
	RD114-5002-0002 <sup>(e)</sup>	6	Clip		RD153-9001-0001	6	Washer
	Attaches to insulator (4) 145099 <sup>(a)</sup> , 145542 <sup>(b)</sup> .				Attaches to bracket (44) <sup>(d)</sup> .		
	NOTE				NAS1100C3-10	3	Screw 25 ±3
	When attaching to insulator (4) clips RD114-5002-0002 are to be installed at holes 1, 8 through 11, and 15, starting from end of insulator 145099 <sup>(a)</sup> or 145542 <sup>(b)</sup> adjacent to insulator 145079 <sup>(a)</sup> or 145546 <sup>(b)</sup> .				RD114-5002-0002 <sup>(e)</sup>	3	Clip
					Attaches to insulator (4) 145099 <sup>(a)</sup> , 145542 <sup>(b)</sup> .		
8	145079 <sup>(a)</sup> , 145546 <sup>(b)</sup>	1	Insulator		NAS1100C3-10	12	Screw 25 ±5
	Attaches to propellant ducts and brackets.				RD114-5001-0001	10	Clip
	RE127-7005-0975	4	Clamp 20 ±3		RD114-5002-0002	2	Clip
	RE127-7005-0744	5	Clamp 20 ±3		Attaches to insulator (7) 145077.		
	Attaches to propellant ducts.				NOTE		
					When attaching to insulator (7) clips RD114-5002-0002 are to be installed at holes 1 and 12, starting from adjacent insulator 145099 <sup>(a)</sup> or 145542 <sup>(b)</sup> .		
9	145073	1	Insulator				
	Attaches to bracket (69) and insulators (2, 4).						

- (a) On engines F-2003 through F-2010.  
 (b) On engines F-2011 through F-2016.  
 (c) A component of insulator.  
 (d) See figure 3-5 for indexed brackets.  
 (e) Clip RD114-5002-0001 may be substituted.  
 (f) A component of door.  
 (m) Above running torque.

Figure 3-7. Cocoon Thermal Insulation (Sheet 7 of 22)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
145073 (Cont)				10	145080(a), 145345(b)	1	Insulator
NAS1003-1A		9	Bolt 25 ±3		Attaches to dome bolts, brackets (44, 69) and insulators (7, 8, 9).		
RD153-5004-0003		9	Washer				
Attaches to bracket (69)(d).							
NAS1100C3-10		4	Screw 25 ±3				
RD114-5001-0001		3	Clip		RD111-1009-0407	3	Bolt 150 ±5
RD114-5002-0002(e)		1	Clip		RD153-9001-0001	3	Washer
Attaches to insulator (2) 145081(a), 145345(b).					Attaches to dome bolt.		
<b>NOTE</b>							
When attaching to insulator (2) clip RD114-5002-0002 is to be installed at the first hole, starting from insulator 145082.					NAS1004-4A	11	Bolt 150 ±5
					RD153-9001-0001	11	Washer
					Attaches to bracket (44)(d).		
					RD111-1010-6311	12	Bolt 40 ±5
					RD111-1009-0316	2	Bolt 40 ±5
					RD111-5005-0003	14	Washer
					Attaches to bracket (69)(d)		
					<b>NOTE</b>		
					Install group of 2 bolts in holes nearest insulator (9).		
					NAS1100C3-10	12	Screw 25 ±3
					RD114-5001-0001	7	Clip
					RD114-5002-0002(e)	5	Clip
					Attaches to insulator (7) 145077.		
					<b>NOTE</b>		
					When attaching to insulator (7) clips RD114-5002-0002 are to be installed at holes 1, 2, 8, 9, and 12, starting from insulator 145079(a) or 145546(b).		

- (a) On engines F-2003 through F-2010.
- (b) On engines F-2011 through F-2016.
- (d) See figure 3-5 for indexed brackets.
- (e) Clip RD114-5002-0001 may be substituted.

Figure 3-7. Cocoon Thermal Insulation (Sheet 8 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145080(a), 145345(b) (Cont)				NOTE Existing bracket bolt shall be loosely installed for subsequent insulator attachment.		
	NAS1100C3-10	5	Screw 25 ±3		RD111-1010-6413	9	Bolt 150 ±5
	RD114-5001-0001	4	Clip		RD153-9001-0001	9	Washer
	RD114-5002-0002(e)	1	Clip		Attaches to bracket (59)(d).		
	Attaches to insulator (8) 145079(a), 145546(b).				RD111-1010-6314	5	Bolt 1-2(m)
	NOTE				RD153-5005-0005	5	Washer
	When attaching to insulator (8) clip RD114-5002-0002 is to be in the first hole, starting from insulator 145077.				Attaches to bracket (59)(d).		
	RD111-1009-0408	1	Bolt 150 ±5		NAS1100C3-10	10	Screw 25 ±5
	RD153-9001-0001	1	Washer		RD114-5001-0001	7	Clip
	Attaches to dome bolt and insulator (9) 145073.				RD114-5002-0002(e)	3	Clip
	RD111-1010-6308	3	Bolt 40 ±5		Attaches to insulator (2) 145081(a), 145329(b).		
	RD153-5005-0003	3	Washer		NOTE		
	Attaches to insulator (9) 145073.				When attaching to insulator (2) clips RD114-5002-0002 are to be installed at holes 1, 5, and 6, starting from door assembly.		
	NAS1100C3-10	11	Screw 25 ±3		NAS1100C3-7	2	Screw 25 ±3
	RD114-5002-0002(e)	11	Clip		Attaches door lanyard for door (12) 145072.		
	Attaches to insulator (9) 145073.				NAS1100C3-10	10	Screw 25 ±3
11	145082	1	Insulator		RD114-5001-0001	7	Clip
	Attaches to dome bolts, bracket (59) and insulators (2, 9).				RD114-5002-0002(e)	3	Clip
	RD111-1009-6610	2	Bolt 245 ±35		Attaches to insulator (9) 145073.		
	RD153-5004-0006	2	Washer		NOTE		
	RD153-1002-0006	4	Washer		When attaching to insulator (9) clips RD114-5002-0002 are to be installed at holes 5, 6, and 10, starting from insulator 145080(a) or 145345(b).		
	Attaches to dome bolt.						

(a) On engines F-2003 through F-2010.  
 (b) On engines F-2011 through F-2016.  
 (d) See figure 3-5 for indexed brackets.  
 (e) Clip RD114-5002-0001 may be substituted.  
 (m) Above running torque.

Figure 3-7. Cocoon Thermal Insulation (Sheet 9 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
12	145072	2	Door		NAS1100C3-10	6	Screw 25 ±3
	RD112-5002-0001(f)	4	Screw 5 ±1(m)		RD114-5001-0001	5	Clip
	RD153-0115-0020(f)	4	Washer		RD114-5002-0002(e)	1	Clip
	Attaches door to insulator (11) 145082.				Attaches to insulator (3) 145098(a), 145544(b).		
13	145100(a), 145545(b)(k), 145545-11(b)(l)	1	Insulator		NOTE		
	Attaches to strut, brackets (95, 51, 55) and insulators (3, 4, 8).				When attaching to insulator (3) clip RD114-5002-0002 is to be installed at the first hole, starting from insulator 145099(a) or 145542(b).		
	RE127-7003-0368(c)	2	Clamp 20 ±3		NAS1100C3-10	12	Screw 25 ±3
	Attaches to turbo-pump support strut.				RD114-5001-0001	10	Clip
	RD111-1010-6417(b)	1	Bolt 68 ±7		RD114-5002-0002(e)	2	Clip
	RD153-5004-0004(b)	1	Washer		Attaches to insulator (4) 145099(a), 145542(b).		
	Attaches to bracket (95)(d).				NOTE		
	RD111-1010-6413	5	Bolt 1-2(m)		When attaching to insulator (4) clips RD114-5002-0002 are to be installed at holes 1 and 12, starting from insulator 145098(a) or insulator 145544(b).		
	RD153-5005-0005	5	Washer		NAS1100C3-10	33	Screw 25 ±3
	Attaches to bracket (51) 145239(d).				RD114-5001-0001	31	Clip
	RD111-1010-6413(a)	6	Bolt 1-2(m)		RD114-5002-0002(e)	2	Clip
	RD153-5005-0005(a)	6	Washer		Attaches to insulator (8) 145079(a), 145392(b).		
	Attaches to bracket (55)(d).				NOTE		
	RD111-1010-6413(b)	1	Bolt 1-2(m)		When attaching to insulator (8) clips RD114-5002-0002 are to be installed at holes 1 and 33, starting from insulator 145099(a) or 145542(b).		
	RD153-9001-0001(b)	1	Washer				
	Attaches at hole at aft end of bracket (55)(d).						
	RD111-1010-6413(b)	5	Bolt 1-2(m)				
	RD153-5005-0005(b)	5	Washer				
	Attaches to bracket (55)(d).						

(a) On engines F-2003 through F-2010.

(b) On engines F-2011 through F-2016.

(c) A component of insulator.

(d) See figure 3-5 for indexed brackets.

(e) Clip RD114-5002-0001 may be substituted.

(f) A component of door.

(k) On inboard engines.

(l) On outboard engines.

(m) Above running torque.

Figure 3-7. Cocoon Thermal Insulation (Sheet 10 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
14	145092	1	Insulator	NOTE			
	Attaches to brackets as indicated and insulators (8, 13).			When attaching to insulator (8) clips RD114-5002-0002 are to be installed at holes 1 through 5 and 14, starting from end of insulator (14) adjacent to bracket 145068(a) or bracket 145351(b).			
	RD111-1010-6413	8	Bolt 1-2(m)		NAS1100C3-10	13	Screw 25±3
	RD153-5005-0005	8	Washer		RD114-5001-0001	12	Clip
	Attaches to bracket (11)(d).				RD114-5002-0002(e)	1	Clip
	RD111-1010-6413(a)	10	Bolt 150 ±5	Attaches to insulator(13) 145100(a), 145545(b) (k), 145545-11(b) (l).			
	RD153-5005-0005(a)	10	Washer	NOTE			
	Attaches to bracket (1)(d).			When attaching to insulator (13) clip RD114-5002-0002 is to be installed at first hole, starting from middle of insulator 145092.			
	RD111-1010-6413(b)	10	Bolt 150 ±5	15	145084(a),	1	Insulator
	RD153-9001-0001	10	Washer		145543(b)		
	Attaches to bracket (4E)(d).			Attaches to gimbal outrigger, bracket (63) and insulators (2, 15).			
	RD111-1010-6413(a)	2	Bolt 150 ±5	NOTE			
	RD153-5005-0005(a)	2	Washer	Split asbestos flap to accommodate drain line.			
	Attaches to bracket (2)(d) and bracket (1)(d).				RE127-7004-0419	6	Clamp 20 ±3
	RD111-1010-6413(b)	2	Bolt 150 ±5	Attaches to gimbal outrigger.			
	RD153-9001-0001(b)	2	Washer				
	Attaches to bracket (4F)(d) and bracket (4E)(d).						
	NAS1100C3-10	14	Screw 25 ±3				
	RD114-5001-0001	8	Clip				
	RD114-5002-0002(e)	6	Clip				
	Attaches to insulator (8) 145079(a), 145546(b).						

- (a) On engines F-2003 through F-2010.  
 (b) On engines F-2011 through F-2016.  
 (d) See figure 3-5 for indexed brackets.  
 (e) Clip RD114-5002-0001 may be substituted.  
 (k) On inboard engines.  
 (l) On outboard engines.  
 (m) Above running torque.

Figure 3-7. Cocoon Thermal Insulation (Sheet 11 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145084(a), 145543(b) (Cont)				RD111-1010-6413	6	Bolt 150 ±5
					RD153-9001-0001	6	Washer
	RD111-1010-6413	5	Bolt 150 ±5		Attaches to bracket (63)(d).		
	RD153-9001-0001	5	Washer		RD111-1010-6410	4	Bolt 150 ±5
	Attaches to bracket (63)(d) insulator (2) 145081(a), 145329(b) and overlaps insulator (15).				RD153-9001-0001	4	Washer
					Attaches to insulator (15) 145084(a) 145543(b).		
	NAS1100C3-7	1	Screw 25 ±3		NAS1004-5A	4	Bolt
	Attaches door lanyard for door (16) 145101.				RD153-5004-0004	8	Washer
16	145101	1	Door		NAS679C4W	4	Nut 5 ±1(m)
					Attaches to insulator (15) 145084(a), 145543(b).		
	RD112-5002-0001(f)	6	Screw 5 ±1(m)		NAS1100C3-10	3	Screw 25 ±3
	RD153-0115-0020(f)	6	Washer		RD114-5001-0001	3	Clip
	Attaches to insulator (15) 145084(a), 145543(b).				Attaches to insulator (15) 145084(a), 145543(b).		
17	145085(a), 145541(b)	1	Insulator		NAS1004-3A(b)	3	Bolt
	Attaches to gimbal outrigger, dome bolts, bracket (63), and insulator (15).				LD153-0013-0002(b)	3	Washer
					RD153-1002-0004(b)	3	Washer
	RE127-7004-0419(c)	2	Clamp 20 ±3		NAS679C4(b)	3	Nut 61-75
	Attaches to gimbal outrigger.				Attaches at boot flanges to insulator (15) 145543(b).		
	RD111-1009-6610	2	Bolt 245 ±35		NAS1100C3-10	9	Screw 25 ±3
	RD153-5004-0006	2	Washer		RD114-5001-0001	6	Clip
	RD153-1002-0006	4	Washer		RD114-5002-0002(e)	3	Clip
	Attaches to dome bolt.				Attaches to insulator (15) 145084(a), 145543(b).		

(a) On engines F-2003 through F-2010.

(b) On engines F-2011 through F-2016.

(c) A component of insulator.

(d) See figure 3-5 for indexed brackets.

(e) Clip RD114-5002-0001 may be substituted.

(f) A component of door.

(m) Above running torque.

Figure 3-7. Cocoon Thermal Insulation (Sheet 12 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145085(a), 145541(b) (Cont)				NAS1100C3-10	9	Screw 20 ±3
					RD114-5001-0001	6	Clip
					RD114-5002-0002(e)	3	Clip
					Attaches to insulator (15) 145084(a), 145543(b).		
					NOTE		
			When attaching to insulator (15) clips RD114-5002-0002 are to be installed at holes 1, 3, and 4, starting from insulator 145086.				
18	145078(a), 145540(b)	1	Insulator Attaches to propellant ducts, brackets indicated, and insulator (15).				
	RE127-7005-0975(c)	1	Clamp 20 ±3				
	RE127-7005-1150(c)	1	Clamp 20 ±3				
	RE127-7005-0744(c)	1	Clamp 20 ±3				
			Attaches to propellant ducts.				
	NAS1004-3A	6	Bolt 150 ±5				
	RD153-9001-0001	6	Washer				
			Attaches to bracket (77)(d).				
	RD111-1010-6313	5	Bolt 1-2(m)				
	RD153-5005-0003	5	Washer				
			Attaches to bracket (5)(d).				
	RD111-1010-6413(a)	6	Bolt 150 ±5				
	RD153-5005-0005(a)	6	Washer				
			Attaches to bracket (4)(d).				
	RD111-1010-6410(b)	6	Bolt 150 ±5				
	RD153-9001-0001(b)	6	Washer				
			Attaches to bracket (4H)(d).				
				19	145076	1	Insulator
							Attaches to dome bolts, brackets (83, 86, 77) and insulators (17, 18).
					RD111-1009-0407	3	Bolt 150 ±5
					RD153-9001-0001	3	Washer
							Attaches to dome bolt.
					NAS1003-3A	2	Bolt 25 ±3
					RD153-5005-0003	2	Washer
							Attaches to bracket (83)(d).
					NAS1003-2A	8	Bolt 25 ±3
					RD153-5005-0003	8	Washer
							Attaches to bracket (86)(d).
					RD111-1010-6412	5	Bolt 150 ±5
					RD153-9001-0001	5	Washer
							Attaches to bracket (77)(d).
					NAS1100C3-10	5	Screw 25 ±3
					RD114-5001-0001	4	Clip
					RD114-5002-0002(e)	1	Clip
					Attaches to insulator (17) 145085(a) 145541(b).		

- (a) On engines F-2003 through F-2010.  
 (b) On engines F-2011 through F-2016.  
 (c) A component of insulator.  
 (d) See figure 3-5 for indexed brackets.  
 (e) Clip RD114-5002-0001 may be substituted.  
 (m) Above running torque.

Figure 3-7. Cocoon Thermal Insulation (Sheet 13 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
19	145076 (Cont)						
			NOTE				
			When attaching to insulator (17) clip RD114-5002-0002 is to be installed at the first hole, starting from insulator 145086.				
	NAS1100C3-10	11	Screw 25 ±3		RD111-1010-6307 <sup>(b)</sup>	6	Bolt 40 ±3
	RD114-5001-0001	10	Clip		RD153-8002-0001 <sup>(b)</sup>	6	Washer
	RD114-5002-0002 <sup>(e)</sup>	1	Clip		Attaches to insulator (10) 145345 <sup>(b)</sup> .		
	Attaches to insulator (18) 145078 <sup>(a)</sup> , 145540 <sup>(b)</sup> .				RD111-1010-6412	1	Bolt 50 ±5
			NOTE		RD153-5004-0004	1	Washer
			When attaching to insulator (18) clip RD114-5002-0002 is to be installed at the first hole, starting from insulator 145086.		Attaches to insulator (10) 145080 <sup>(a)</sup> , 145345 <sup>(b)</sup> and bracket (44) <sup>(d)</sup> .		
	NAS1100C3-12	31	Screw 40 ±3		RD153-5004-0003	31	Washer
	Attaches to insulator (18) 145078 <sup>(a)</sup> , 145540 <sup>(b)</sup> .				Attaches to brackets (44) <sup>(d)</sup> .		
			NOTE		NAS1100C3-12	5	Screw 40 ±3
			When attaching to insulator (18) clip RD114-5002-0002 is to be installed at the first hole, starting from insulator 145086.		RD153-8002-0001	5	Washer
					Attaches to insulator (8) 145079 <sup>(a)</sup> , 145546 <sup>(b)</sup> .		
20	145087 <sup>(a)</sup> , 145346 <sup>(b)</sup>	1	Insulator		RD111-1010-6412	1	Bolt 100 ±5
	Attaches to dome, brackets as indicated, interface panel, and insulators (10, 8).				RD153-5005-0005	1	Washer
					Attaches to insulator (8) 145079 <sup>(a)</sup> , 145546 <sup>(b)</sup> and bracket (2) <sup>(d)</sup> .		
	RD111-1009-0407 <sup>(a)</sup>	4	Bolt 70 ±5		RD111-1010-6412	3	Bolt 100 ±5
	RD153-5004-0003 <sup>(a)</sup>	4	Washer		RD153-5005-0005	3	Washer
	Attaches to dome.				Attaches to bracket (2) <sup>(d)</sup> .		
	NAS679C4W <sup>(b)</sup>	14	Nut 42 ±5		RD111-1010-6412	13	Bolt 100 ±5
	RD153-1002-0004 <sup>(b)</sup>	14	Washer		RD153-5004-0004	13	Washer
	Attaches to bracket (89) <sup>(d)</sup> .				Attaches to interface panel bracket (3) <sup>(d)</sup> .		
	RD111-1010-0307 <sup>(a)</sup>	5	Bolt 20 ±2				
	RD153-5004-0003 <sup>(a)</sup>	5	Washer				
	Attaches to insulator (10) 145080 <sup>(a)</sup> , 145345 <sup>(b)</sup> .						
							NOTE
							Install in holes at No. 2 side.

- (a) On engines F-2003 through F-2010.  
 (b) On engines F-2011 through F-2016.  
 (d) See figure 3-5 for indexed brackets.  
 (e) Clip RD114-5002-0001 may be substituted.

Figure 3-7. Cocoon Thermal Insulation (Sheet 14 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145087(a), 145346(b) (Cont)	-			RD111-1010-6312	10	Bolt 40 ±3
	RD111-1010-6413	1	Bolt 100 ±5		RD153-5004-0003	10	Washer
	RD153-5003-0004	1	Washer		Attaches to bracket (84)(d).		
	Attaches to inter-face panel bracket (3)(d).				NAS1100C3-12	1	Screw 40 ±3
	NOTE				RD153-5004-0003	1	Washer
	Install in center hole.				Attaches to bracket (83)(d).		
	RD111-1010-6412	11	Bolt 100 ±5	21	145086	1	Insulator
	RD153-5003-0004	11	Washer		Attaches to brackets as indicated and insulators (15, 18, 19, 17).		
	Attaches to inter-face panel bracket (3)(d).				NAS1100C3-10	6	Screw 25 ±3
	NOTE				RD114-5002-0002(e)	6	Clip
	Install in holes at No. 1 side.				Attaches to insulator (15) 145084(a), 145543(b).		
	RD111-1010-6412	4	Bolt 100 ±5		NAS1100C3-10	18	Screw 25 ±3
	RD153-5003-0004	4	Washer		RD114-5001-0001	14	Clip
	Attaches to inter-face panel bracket (2)(d) and (4)(d).				RD114-5002-0002(e)	4	Clip
	NOTE				Attaches to insulator (18) 145078(a), 145540(b).		
	Install 2 each in holes of raised channel doubler of brackets noted.				NOTE		
	RD111-1010-6412	6	Bolt 100 ±5		When attaching to insulator (18) clips RD114-5002-0002 are to be installed at holes 1, 3, 4, and 18, starting from insulator 145084(a) or 145543(b).		
	RD153-5005-0005	6	Washer		NAS1100C3-10	9	Screw 25 ±3
	Attaches to inter-face panel bracket (4)(d).				RD114-5001-0001	7	Clip
	NAS1100C3-12	19	Screw 40 ±3		RD114-5002-0002(e)	2	Clip
	RD153-5004-0003	19	Washer		Attaches to insulator (19) 145076.		
	Attaches to bracket (77)(d).						

- (a) On engines F-2003 through F-2010.  
 (b) On engines F-2011 through F-2016.  
 (d) See figure 3-5 for indexed brackets.  
 (e) Clip RD114-5002-0001 may be substituted.

Figure 3-7. Cocoon Thermal Insulation (Sheet 15 of 22)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
145086 (Cont)  <p style="text-align: center;"><b>NOTE</b></p> When attaching to insulator (19) clips RD114-5002-0002 are to be installed at holes 1 and 9, starting from insulator 145078(a) or 145540(b).				RD111-1010-6413      10      Bolt 150 ±5 RD153-9001-0001    10      Washer Attaches to bracket (63) <sup>(d)</sup> .			
NAS1100C3-10          7      Screw 25 ±3 RD114-5001-0001      5      Clip RD114-5002-0002(e)   2      Clip Attaches to insulator (17) 145085(a), 145541(b).				NAS1100C3-10          18      Screw 25 ±3 RD114-5001-0001      16      Clip RD114-5002-0002(e)   2      Clip Attaches to insulator (17) 145085(a), 145541(b).			
<p style="text-align: center;"><b>NOTE</b></p> When attaching to insulator (17) clips RD114-5002-0002 are to be installed at holes 1 and 7, starting from insulator 145084(a) or 145543(b).				<p style="text-align: center;"><b>NOTE</b></p> When attaching to insulator (17) clips RD114-5002-0002 are to be installed at the 2 corner holes of insulator 145074.			
22	145074	1	Insulator Attaches to dome bolt, bracket (63) and insulator (17).				
	RD111-1009-6610	1	Bolt 245 ±35				
	RD153-5004-0006	1	Washer				
	RD153-1002-0006	2	Washer Attaches to dome bolt.				
<p style="text-align: center;"><b>NOTE</b></p> Torque existing 2 bolts attaching bracket 145269 to dome bolts to 245 ±35 inch-pounds.				23	145075	1	Insulator Attaches to insulator (22) 145074.
	MS20995N40	AR	Lockwire				
	RD111-1009-6610	1	Bolt 245 ±35	24	145083(a), 145535-31(b)	1	Insulator Attaches to dome bolt and bracket (63).
	RD153-5004-0006	1	Washer				
	RD153-1002-0006	2	Washer Attaches to dome bolt.				
	RD127-7001-0249(c)	3	Clamp 5 ±2 <sup>(m)</sup> Attaches insulator (24) 145083.				
	RD111-1009-6610	1	Bolt 85 ±5				
	RD153-5004-0006	1	Washer				
	RD153-1002-0006	2	Washer Attaches to dome bolt.				

(a) Engines F-2003 through F-2010.  
 (b) Engines F-2011 through F-2016.  
 (c) A component of insulator.  
 (d) See figure 3-5 for indexed brackets.  
 (e) Clip RD114-5002-0001 may be substituted.  
 (m) Above running torque.

Figure 3-7. Cocoon Thermal Insulation (Sheet 16 of 22)

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Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145083 (Cont)				NOTE		
	RD111-1010-6413	2	Bolt 150 ±5		Adjust brackets (103, 104) as required and torque nuts NAS679C4W to 40 ±5 inch-pounds.		
	RD153-9001-0001	2	Washer				
	Attaches to bracket (63)(d).						
24A	145393(b)	1	Insulator		RD111-1010-6413	5	Bolt 1-2(m)
					RD153-5005-0005	5	Washer
					Attaches to bracket (39)(d).		
	NOTE				RD111-1010-6411(b)	2	Bolt 150 ±5
	Install around strut (76). (See figure 3-5.)				RD153-9001-0001(b)	2	Washer
					Attaches to bracket (39)(d).		
25	145102(a), 145333(b)	1	Insulator		RD111-1010-6313	3	Bolt 1-2(m)
	Attaches to brackets indicated and insulators (18, 15).				RD153-5005-0003	3	Washer
					Attaches to bracket (5)(d).		
	NOTE				NAS1100C3-10	19	Screw 25 ±3
	Split asbestos to accommodate drain line.				RD114-5001-0001	17	Clip
					RD114-5002-0002(e)	2	Clip
					Attaches to insulator (18) 145078(a), 145540(b).		
	o Split asbestos radially for quick-disconnect and secure flaps to quick-disconnect using inconel lockwire MS20995N.				NOTE		
	RD111-1010-6413	6	Bolt 1-2(m)		When attaching to insulator (18) clips RD114-5002-0002 are to be installed at holes 1 and 19, starting from insulator 145084(a) or 145543(b).		
	RD153-5005-0005	6	Washer		NAS1100C3-10	17	Screw 25 ±3
	Attaches to bracket (35)(d).				RD114-5001-0001	14	Clip
	RD111-1010-6410(b)	2	Bolt 68 ±7		RD114-5002-0002(e)	1	Clip
	RD153-5004-0004(b)	2	Washer		Attaches to insulator (15) 145084(a), 145543(b).		
	Attaches to bracket (104)(d) and bolts into nut plates of insulator (25) 145333(b).						

(a) On engines F-2003 through F-2010.

(b) On engines F-2011 through F-2016.

(d) See figure 3-5 for indexed brackets.

(e) Clip RD114-5002-0001 may be substituted.

(m) Above running torque.

Figure 3-7. Cocoon Thermal Insulation (Sheet 17 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145102(a), 145333(b) (Cont)				RD111-1010-6413(a) 10 RD153-5005-0005(a) 10		Bolt 150 ±5 Washer
	NOTE				Attaches to bracket (4)(d).		
	When attaching to insulator (15) clip RD114-5002-0002 is installed at the first hole, starting from insulator 145078(a) or 145540(b).				RD111-1010-6410(b) 10 RD153-9001-0001(b) 10		Bolt 150 ±5 Washer
					Attaches to bracket (4H)(d).		
	NAS1100C3-7 Attaches door lanyard for door (26) 145200.	1	Screw 13 ±2		RD111-1010-6413(a) 2 RD153-5005-0005(a) 2		Bolt 150 ±5 Washer
26	145200 Attaches to insulator (25) 145102(a), 145333(b).	1	Door		Attaches to bracket (4)(d) and bracket overlap (1)(d).		
	RD112-5002-0001(f) 6 RD153-0115-0020(f) 6 Attaches to insulator (25) 145102(a) 145333(b).	6	Screw 5 ±1(m) Washer		RD111-1010-6410(b) 2 RD153-9001-0001(b) 2		Bolt 150 ±5 Washer
					Attaches to bracket (4H)(d) and bracket overlap (4E)(d).		
27	145091 Attaches to brackets indicated and insulators (14, 25, 18).	1	Insulator		RD111-1010-6413(a) 4 RD153-5005-0005(a) 4		Bolt 150 ±5 Washer
	RD111-1010-6413 18 RD153-5005-0005 18 Attaches to bracket (11)(d).	18	Bolt 1-2(m) Washer		Attaches to bracket (1)(d).		
	RD111-1010-6313 8 RD153-5005-0003 8 Attaches to bracket (5)(d).	8	Bolt 1-2(m) Washer		RD111-1010-6410(b) 4 RD153-9001-0001(b) 4		Bolt 150 ±5 Washer
					Attaches to bracket (4E)(d).		
					RD111-1010-6413(a) 1 RD153-5005-0005(a) 1		Bolt 150 ±5 Washer
					Attaches to insulator (14) 145092 and bracket (1)(d).		
					RD111-1010-6410(b) 1 RD153-9001-0001(b) 1		Bolt 150 ±5 Washer
					Attaches to insulator (14) 145092 and bracket (4E)		

- (a) On engines F-2003 through F-2010.  
 (b) On engines F-2011 through F-2016.  
 (d) See figure 3-5 for indexed brackets.  
 (f) A component of door.  
 (m) Above running torque.

Figure 3-7. Cocoon Thermal Insulation (Sheet 18 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145091 (Cont)				145399(b)	2	Insulator
	RD111-1010-6409	24	Bolt 150 ±5				
	RD153-9001-0001	24	Washer				
	Attaches to insulator (14) 145092.				NOTE		
					Install under clamp clevis locks.		
	NAS1100C3-10	13	Screw 25 ±5		NAS1100C3-8(a)	17	Screw 25 ±3
	RD114-5002-0002(e)	13	Clip		RD153-8002-0001(a)	17	Washer
	Attaches to insulator (25) 145102(a), 145333(b).				NAS1100C3-8(b)	6	Bolt 25 ±3
	NAS1100C3-10	13	Screw 25 ±5		RD153-8003-0001(b)	6	Washer
	RD114-5001-0001	11	Clip		Attaches to insulator (13) 145100(a), 145545(b)(k), 145545-11(b)(l).		
	RD114-5002-0002(b)	2	Clip		RD111-1010-6408(b)	9	Bolt 68 ±7
	Attaches to insulator (18) 145078(a), 145540(b).				RD153-8002-1002(b)	9	Washer
					Attaches to bracket (95)(d).		
	NOTE				NAS1100C3-8	40	Screw 25 ±3
	When attaching to insulator (18) clips RD114-5002-0002 are to be installed at holes 1 and 2, starting from insulator 145102(a) or 145333(b).				RD153-8002-0001	40	Washer
					Attaches to insulator (25) 145102(a), 145333(b).		
28	145059(a), 145357(b)	1	Insulator		NAS1100C4-14	6	Screw 5 ±1(m)
	Installed at thrust chamber throat to turbine.				LD153-0010-0010	12	Washer
					NAS679C4W(h)	6	Nut
	RE127-7005-2238(a)	1	Clamp		Install at clamp 145063-3 of insulator (28).		
	145394(b)				NAS1100C4-14	4	Screw 5 ±1(m)
	NOTE				LD153-0010-0010	8	Washer
	Install over insulators 145091 (27), 145092 (14), 145100 (13)(a), 145545 (13)(b)(k), 145545-11 (13)(b)(l), 145102(25)(a), 145333(25)(b), and secure to clamp attached to insulator (28) 145059(a), 145357(b).				NAS679C4W(h)	4	Nut
					Install at clamps 145063-5 and 145063-7 of insulator (28).		
(a)	On engines F-2003 through F-2010.						
(b)	On engines F-2011 through F-2016.						
(d)	See figure 3-5 for indexed brackets.						
(e)	Clip RD114-5002-0001 may be substituted.						
(h)	Torque after installation of heat exchanger lines.						
(k)	On inboard engines.						
(l)	On outboard engines.						
(m)	Above running torque.						

Figure 3-7. Cocoon Thermal Insulation (Sheet 19 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145059(a), 145357(b) (Cont)			h. Unfasten latch and safetywire turnbuckles. On cable 145395, slip the hose sections over the safetywired turnbuckles.			
	NAS1100C4-12	1	Screw 25 ±3	i. Install cable and close and safetywire latches.			
	LD153-0010-0010	2	Washer				
	NAS679C4W(h)			NOTE  Before final closing of latches of cable 145395, insulator 145399 shall be positioned under each latch with the lacing studs positioned toward the engine.			
	Install at shell 145059-29 of insulator (28).						
	NAS1100C3-10	4	Screw				
	RD153-8002-0001	8	Washer	j. Fold insulators 145399 around latches and safetywire lacing studs.			
	NAS679C3W(h)	4	Nut 25 ±3				
	Install at shell 145059-59 of insulator (28).						
	NAS1100C3-10	22	Screw	145157(a)(j)	1		Insulator(j)
	RD153-8002-0001	44	Washer	145905(b)(j)			
	NAS679C3W(h)	22	Nut 25 ±3	MS20500-1032	8		Nut 27 ±3
	Attaches flanges to adjacent insulator in heat exchanger lines exit area.			RD153-0115-0023	8		Washer
29	145328(a), 145395(b)	1	Cable	Attaches to thrust chamber studs.			
				NAS679C4W(a)	9		Nut 35 ±5
				RD153-5005-0006(a)	9		Washer
				Attaches to insulator (28) 145059(a).			
				RD111-1010-6415(b)	7		Bolt 36 ±2
				RD153-5005-0006	7		Washer
				Attaches to insulator (28) 145357(b) bracket (95)(d).			
				RD111-1010-6413(a)	10		Bolt 35 ±5
				RD153-5005-0006(a)	10		Washer
				Attaches to insulator (13) 145100(a).			

NOTE

Steps f through j install cables (29).

f. Install cable through belt loop of insulator (28). Position cable around thrust chamber throat through hooked end of bracket (63) and over bracket (95). See figure 3-5.

g. Adjust turnbuckles until load required to close last latch is 60 ±10 inch-pounds at latch tip.

- (a) On engines F-2003 through F-2010.
- (b) On engines F-2011 through F-2016.
- (d) See figure 3-5 for indexed brackets.
- (h) Torque after installation of heat exchanger lines.
- (j) See figure 3-6 for location.

Figure 3-7. Cocoon Thermal Insulation (Sheet 20 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
145157(a)(j), 145905(b)(j) (Cont)				NAS1100C3-8		9	Screw 25 ±3
RD111-1010-6415		2	Bolt 36 ±2	RD114-5002-0002		9	Clip
RD153-5005-0006		2	Washer	Attaches to insulator (26) 145157(a)(j), 145905(b)(j).			
Attaches to insulator (13) 145545(b)(k), 145545-11(b)(l) bracket (90)(d), insulator (3) 145544(b) bracket (90)(d).				145159(a)(j), 145907(b)(j)		1	Insulator(j)
RD111-1010-6413(a)		1	Bolt 35 ±5	MS20500-1032		10	Nut 27 ±3
RD153-5005-0006(a)		1	Washer	RD153-0115-0023		10	Washer
Attaches to insulator (3) 145098(a).				Attaches to thrust chamber studs.			
145158(a)(j), 145906(b)(j)		1	Insulator(j)	RD111-1010-6413(a)		11	Bolt 35 ±5
MS20500-1032		11	Nut 27 ±3	RD153-5005-0006(a)		11	Washer
RD153-0115-0023		11	Washer	Attaches to insulator (15) 145084(a).			
Attaches to thrust chamber studs.				RD111-1010-6413(a)		13	Bolt 35 ±5
RD111-1010-6413(a)		11	Bolt 35 ±5	RD153-5005-0006(a)		13	Washer
RD153-5005-0006(a)		11	Washer	Attaches to insulator (25) 145102(a).			
Attaches to insulator (3) 145098(a).				RD111-1010-6415(b)		24	Bolt 36 ±2
RD111-1010-6413(a)		1	Bolt 35 ±5	RD153-5005-0006(b)		24	Washer
RD153-5005-0006(a)		1	Washer	Attaches to insulator (15) 145543(b) and 145333(b).			
Attaches to insulator (2) 145081(a).				NAS1100C3-8		1	Screw 25 ±3
RD111-1010-6415(b)		12	Bolt 36 ±2	Attaches door lanyard for door 145101.			
RD153-5005-0006(b)		12	Washer	145101		1	Door
Attaches to insulators (3) 145543(b) and 145329 (2)(b).				Attaches to insulator (28) 145059(a)(j), 145907(b)(j).			
				RD112-5002-0002(f)		6	Screw 5 ±1 (m)
				RD153-0115-0020(f)		6	Washer
				Attaches door 145101 to insulator (28).			

- (a) On engines F-2003 through F-2010.  
 (b) On engines F-2011 through F-2016.  
 (d) See figure 3-5 for indexed brackets.  
 (f) A component of door.  
 (j) See figure 3-6 for location.  
 (k) On inboard engines.  
 (l) On outboard engines.  
 (m) Above running torque.

Figure 3-7. Cocoon Thermal Insulation (Sheet 21 of 22)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
30	145356(b)	1	Cover
	RD111-1010-6411	11	Bolt 150 ±5
	RD153-9001-0001	11	Washer
	Attaches to insulator (13) 145545(b)(k) 145545-11(b)(l).		
	RD111-1010-6411	4	Bolt 68 ±7
	RD153-5005-0005	4	Washer
	Attaches to insulator (28) 145357(b).		
	RD111-1010-6411		Bolt 68 ±7
	RD153-5005-0006		Washer
	Attaches to insulators 145905 (26)(b)(j), 145357 (28)(b) bracket (95)(d).		
	RD111-1010-6409	13	Bolt 150 ±5
	RD153-5005-0006	13	Washer
	Attaches to insulator (26) 145905(b)(j).		
	RD111-1010-6415	1	Bolt 150 ±5
	RD153-9001-0001	1	Washer
	Attaches to insulator (26) 145905(b)(j) bracket (90)(d).		

- (b) On engines F-2011 through F-2016.  
(d) See figure 3-5 for indexed brackets.  
(j) See figure 3-6 for location.  
(k) On inboard engines.  
(l) On outboard engines.

Figure 3-7. Cocoon Thermal Insulation  
(Sheet 22 of 22)

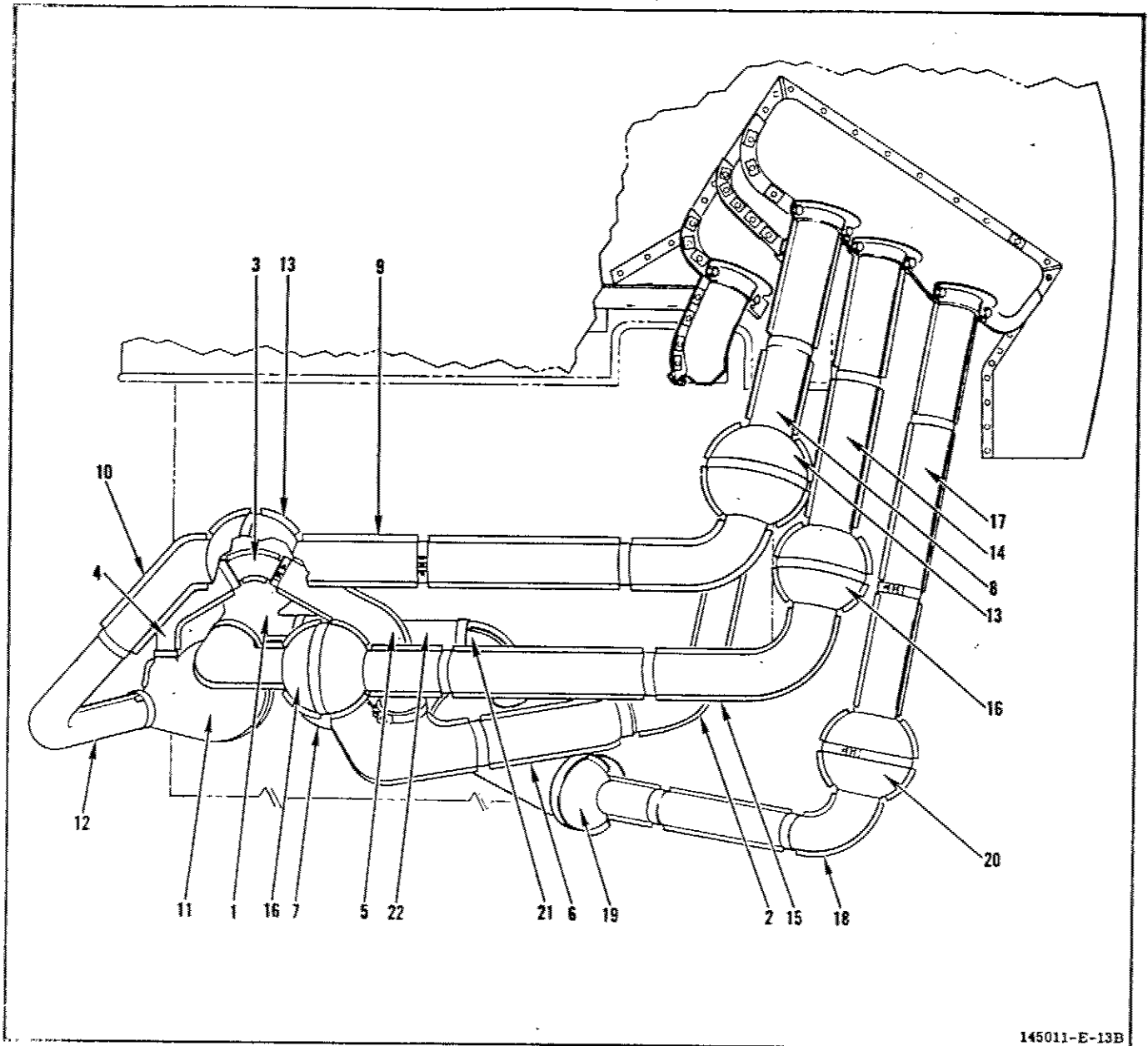
### 3-19. INSTALLING HEAT EXCHANGER LINES INSULATORS.

3-20. Heat exchanger lines insulators are installed in the order shown in figure 3-8. Special instructions applicable to this procedure are as follows:

a. Following completion of installation of insulators, the clamps attached to cocoon insulator (28, figure 3-7) shall be closed around the heat exchanger lines insulators (8, 14, and 17), and the screws torqued to  $5 \pm 1$  inch-pounds above running torque.

b. Safetywire screws of all insulator clamps.

c. Fold flanges of insulators.



145011-E-13B

Figure 3-8. Heat Exchanger Lines Thermal Insulation (Sheet 1 of 2)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
1	145207	1	Insulator	15	145206	1	Insulator
	RE127-7001-0566(a)	1	Clamp(b)		RE127-7001-0206(a)	2	Clamp(b)
	RE127-7001-0206(a)	1	Clamp(b)	16	145202	2	Insulator
2	145211	1	Insulator		RE127-7001-0438(a)	2	Clamp(b)
	RE127-7001-0156(a)	2	Clamp(b)	17	145201	1	Insulator
3	145217 (-11, -21)	1	Insulator		RE127-7001-0181(a)	2	Clamp(b)
4	145218	1	Insulator	18	145203	1	Insulator
	RE127-7001-0192(a)	1	Clamp(b)		RE127-7001-0182(a)	2	Clamp(b)
	RE127-7001-0131(a)	1	Clamp(b)	19	145204	1	Insulator
5	145220	1	Insulator		RE127-7001-0566(a)	1	Clamp(b)
	RE127-7001-0194(a)	1	Clamp(b)		RE127-7001-0438(a)	1	Clamp(b)
6	145213	1	Insulator	20	145202-11	1	Insulator
	RE127-7001-0250(a)	1	Clamp(b)		RE127-7001-0438(a)	1	Clamp(b)
	RE127-7001-0263(a)	2	Clamp(b)	21	145215	1	Insulator
7	145214	1	Insulator		RE127-7001-0206(a)	1	Clamp(b)
	RE127-7001-0650(a)	1	Clamp(b)	22	145216	1	Insulator
	RE127-7001-0278(a)	1	Clamp(b)		RE127-7001-0206(a)	2	Clamp(b)
8	145208	1	Insulator				
	RE127-7001-0206(a)	1	Clamp(b)				
9	145209	1	Insulator				
	RE127-7001-0206(a)	2	Clamp(b)				
10	145219 (-11, -21)	1	Insulator				
11	145210	1	Insulator				
	RE127-7001-0646(a)	1	Clamp(b)				
12	145212	1	Insulator				
	RE127-7001-0206(a)	2	Clamp(b)				
13	145202-21	2	Insulator				
	RE127-7001-0500(a)	2	Clamp(b)				
14	145205	1	Insulator				
	RE127-7001-0206(a)	1	Clamp(b)				

(a) A component of insulator.

(b) Clamp screws: 3-7 inch-pounds above running torque.

Figure 3-8. Heat Exchanger Lines Thermal Insulation (Sheet 2 of 2)

### 3-21. INSTALLING WRAP-AROUND LINES INSULATORS.

3-22. Wrap-around lines insulators are installed in the order shown in figure 3-9. Safety-wiring is required for clamps RE127-7001 used in this procedure. These clamps shall be ordered for replacement where clamps RD127-7001 are specified.

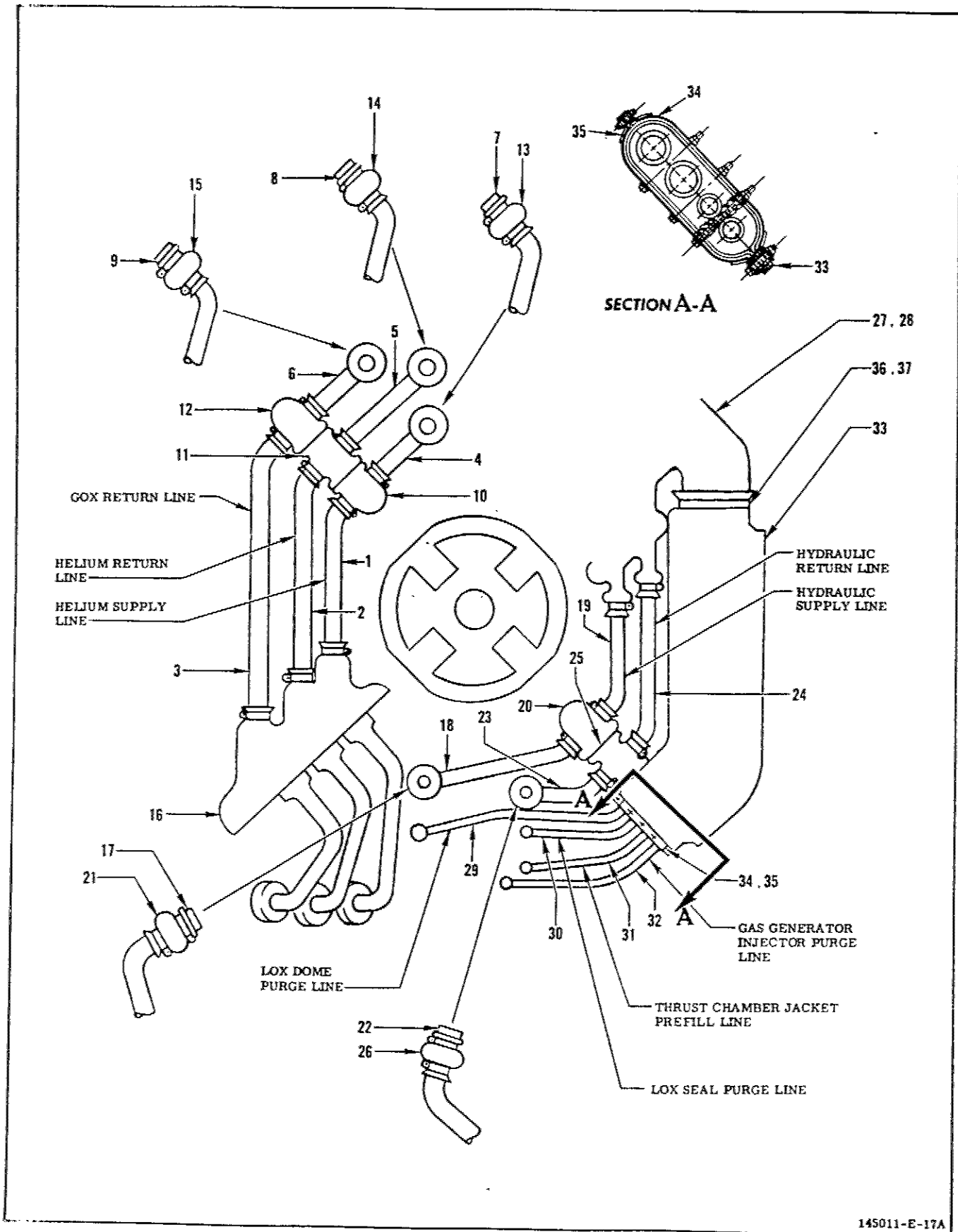


Figure 3-9. Wrap-Around Lines Thermal Insulation (Sheet 1 of 5)

145011-E-17A

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
1	145089	1	Insulator	13	145148	1	Insulator
	RD127-7001-1096(a)	1	Clamp(b)		RD127-7001-0366(c)	1	Clamp(b)
					RD127-7001-0173(c)	1	Clamp(b)
2	145090	1	Insulator		RE127-7001-0397(d)	1	Clamp(b)
	RD127-7001-0222(a)	2	Clamp(b)		RE127-7001-0206(d)	1	Clamp(b)
3	145088	1	Insulator	14	145145	1	Insulator
	RD127-7001-0222(a)	2	Clamp(b)		RD127-7001-0199(c)	1	Clamp(b)
					RD127-7001-0378(c)	1	Clamp(b)
4	145118	1	Insulator		RE127-7001-0234(d)	1	Clamp(b)
	RD127-7001-0196(a)	1	Clamp(b)		RE127-7001-0409(d)	1	Clamp(b)
5	145119	1	Insulator	15	145147	1	Insulator
	RD127-7001-0222(a)	1	Clamp(b)		RD127-7001-0199(c)	1	Clamp(b)
					RD127-7001-0378(c)	1	Clamp(b)
6	145117	1	Insulator		RE127-7001-0234(d)	1	Clamp(b)
	RD127-7001-0222(a)	1	Clamp(b)		RE127-7001-0409(d)	1	Clamp(b)
7	145120-21	2	Insulator	16	145150-11	1	Insulator
8	145120-31	2	Insulator		RD127-7001-0155(c)	1	Clamp(b)
9	145120-41	2	Insulator		RD127-7001-0179(c)	2	Clamp(b)
10	145193	1	Insulator		NAS1100C3-7	3	Screw
	RD127-7001-0173(c)	2	Clamp(b)		RD153-1003-0010	4	Washer
	RE127-7001-0206(d)	2	Clamp(b)		RD114-8003-1003	3	Nut 17-23
11	145194	1	Insulator		Install in flange		
	RD127-7001-0199(c)	2	Clamp(b)		holes between GOX		
	RE127-7001-0234(d)	2	Clamp(b)		RETURN and HELIUM		
12	145192	1	Insulator		RETURN outlets. Do		
	RD127-7001-0199(c)	2	Clamp(b)		not install washers in		
	RE127-7001-0234(d)	2	Clamp(b)		innermost hole.		
					NAS1100C3	2	Screw
					RD153-1003-0008	4	Washer
					RD114-8003-1003	2	Nut 17-23
					Install in holes at		
					lower flange of		
					HELIUM SUPPLY		
					outlet.		

(a) A component of insulator.

(b) Clamp screws: 3-7 inch-pounds above running torque.

(c) Engines F-2003 through F-2010.

(d) Engines F-2011 through F-2016.

Figure 3-9. Wrap-Around Lines Thermal Insulation (Sheet 2 of 5)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145150-11 (Cont)			22	145120-11	2	Insulator
	NAS1100C3-12	23	Screw	23	145134	1	Insulator
	RD153-1003-0010	46	Washer		RD127-7001-0234(a)	1	Clamp(b)
	RD114-8003-1003	23	Nut 5 ±1(e)	24	145096	1	Insulator
	Install in remaining flange holes.				RD127-7001-0234(a)	1	Clamp(b)
	RD111-1010-6310	11	Bolt 17-23	25	145196	1	Insulator
	RD153-1003-0010	11	Washer		RD127-7001-0185(c)	2	Clamp(b)
	NOTE				RE127-7001-0222(d)	2	Clamp(b)
	Install in attach holes of brackets.				NAS1100C3-10(a)	10	Screw
	RE127-7001-0185(d)	1	Clamp(b)		RD153-0115-0010(a)	20	Washer
	RE127-7001-0210(d)	2	Clamp(b)		RD114-8003-1003(a)	10	Nut 5 ±1(e)
17	145120-11	2	Insulator	26	145136	1	Insulator
18	145135	1	Insulator		RD127-7001-0185(c)	1	Clamp(b)
	RD127-7001-0234(a)	1	Clamp(b)		RD127-7001-0334(c)	1	Clamp(b)
19	145095	1	Insulator		RE127-7001-0222(d)	1	Clamp(b)
	RD127-7001-0234(a)	1	Clamp(b)		RE127-7001-0366(d)	1	Clamp(b)
20	145195	1	Insulator		NAS1100C3-10(a)	10	Screw
	RD127-7001-0185	2	Clamp(b)		RD153-0115-0019(a)	20	Washer
	RE127-7001-0222(d)	2	Clamp(b)		RD114-8003-1003(a)	10	Nut 5 ±1(e)
	NAS1100C3-10(a)	12	Screw	27	145149-21	1	Insulator
	RD153-0115-0119(a)	24	Washer		RD111-1010-6312	11	Bolt
	RD114-8003-1003(a)	12	Nut 5 ±1(e)		RD153-1003-0010	11	Washer
21	145137	1	Insulator	28	145149-11	1	Insulator
	RD127-7001-0185(c)	1	Clamp(b)		RD111-1010-6310	13	Bolt 15-20
	RD127-7001-0334(c)	1	Clamp(b)		RD153-0115-0019	13	Washer
	RE127-7001-0222(d)	1	Clamp(b)		Attaches insulator to bracket except at 2 outboard holes.		
	RE127-7001-0366(d)	1	Clamp(b)		NOTE		
	NAS1100C3-10(a)	10	Screw		Strut (76) figure 3-4 shall be temporarily disconnected to facilitate installation of insulator.		
	RD153-0115-0019(a)	20	Washer				
	RD114-8003-1003(a)	10	Nut 5 ±1(e)				

(a) A component of insulator.

(b) Clamp screws: 3-7 inch-pounds above running torque.

(c) Engines F-2003 through F-2010.

(d) Engines F-2011 through F-2016.

(e) Above running torque.

Figure 3-9. Wrap-Around Lines Thermal Insulation (Sheet 3 of 5)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
145149-11 (Cont)				29	145124	1	Insulator
	RD111-1009-0310	2	Bolt 15-20		RD127-7001-0172(a)	2	Clamp <sup>(b)</sup>
	RD153-0115-0019	2	Washer		RD127-7001-0228(a)	1	Clamp <sup>(b)</sup>
	Install in 2 remaining holes at outboard end of bracket. Safety-wire boltheads.			30	145123	1	Insulator
	RD127-7001-0167(c)	2	Clamp <sup>(b)</sup>		RD127-7001-0172(a)	2	Clamp <sup>(b)</sup>
	RE127-7001-0199(d)	2	Clamp <sup>(b)</sup>		RD127-7001-0228(a)	2	Clamp <sup>(b)</sup>
	Install around insulators at line outlets.			31	145122	1	Insulator
	NAS1100C3-12	30	Screws		RD127-7001-0172(a)	2	Clamp <sup>(b)</sup>
	RD153-1003-0010	60	Washer		RD127-7001-0210(a)	1	Clamp <sup>(b)</sup>
	RD114-8003-1003	30	Nut 15-20	32	145125	1	Insulator
	Install in flange holes except the 4 grommeted holes between line outlets.				RD127-7001-0148(a)	2	Clamp <sup>(b)</sup>
	NAS1100C3-12	2	Screw		RD127-7001-0186(a)	1	Clamp <sup>(b)</sup>
	RD153-1003-0008	4	Washer	NOTE			
	RD114-8003-1003	2	Nut 15-20	The following special instructions apply to installation of parts (33 through 37):			
	Install in 2 outermost grommeted holes between line outlets.			a.	Position blanket (33) in place.		
	NAS1100C3-12	2	Screw	b.	See section A-A of figure 3-9 and insert aft rubber cushion of blanket over and between lines.		
	RD153-1003-0010	4	Washer	c.	Install clamp (34) at aft side of blanket. Using 3 screws 10-32 approximately 5 inches in length, aline the clamp and blanket cushion holes. Loosely install screws.		
	RD114-8003-1003	2	Nut 15-20	d.	Fold the forward side of the blanket in place and install clamp (35). Aline by pushing screws through forward cushion of blanket and holes of clamp.		
	Install in 2 innermost grommeted holes between line outlets.			e.	Compress assembly with applicable washers and nuts on screws.		
NOTE							
Following installation of insulators (29 through 32), lockwire may be used at the ends nearest clamp (34) to prevent gapping of the insulators.							
(a) A component of insulator.							
(b) Clamp screws: 3-7 inch-pounds above running torque.							
(c) Engines F-2003 through F-2010.							
(d) Engines F-2011 through F-2016.							

Figure 3-9. Wrap-Around Lines Thermal Insulation (Sheet 4 of 5)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
f. Secure ends of clamps using hardware listed with clamp (35). See detail A-A for direction of installation.			
g. Push screws 10-32 out, using applicable screw listed with clamp (35).			
h. Tighten nuts to compress assembly with approximately equal torque for each nut.			
i. Secure the remaining end of blanket (33) by overlapping flaps of previously installed adjacent insulators under the inner clamping area of the blanket. Install clamps (36, 37) and secure them using hardware listed with clamp (37). Ensure that layers of adjacent insulators are sandwiched between layers of blanket at outer clamping area.			
j. Secure edges of blanket (33) using hardware listed with it.			
33	145097	1	Blanket
	NAS1100C3-16	29	Screw
	RD153-1003-0006	58	Washer
	RD114-8003-1003	29	Nut 5 ±1(e)
34	145130	1	Clamp
35	145131	1	Clamp
	NAS1100C3-12	1	Screw
	NAS1101C3-48	3	Screw
	NAS1100C3-21	1	Screw
	RD153-0115-0020	10	Washer
	RD114-8003-1003	5	Nut 20 ±5(e)
36	145139	1	Clamp
37	145138	1	Clamp
	NAS1100C3-12	1	Screw
	NAS1100C3-26	1	Screw
	RD153-0115-0020	4	Washer
	RD114-8003-1003	2	Nut 20 ±5(e)

(e) Above running torque.

3-23. REMOVAL.

3-24. Removal of thermal insulation is accomplished in the reverse order of the installation sequence. Tools and equipment required are listed in section II.

Figure 3-9. Wrap-Around Lines Thermal Insulation (Sheet 5 of 5)

## SECTION IV

## INSTALLATION AND REMOVAL (ENGINES F-2017 AND SUBSEQUENT)

## WARNING

TRUNNION NUT TORQUE WRENCH G4086 MUST BE OPERATED BY  
AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

4-1. **SCOPE.** This section contains installation and removal procedures for thermal insulation sets 12-1 and subsequent, the sequence in which the thermal insulation must be installed, and safety precautions to be taken during handling of the insulation.

4-2. SAFETY PRECAUTIONS.

4-3. Precautionary measures are required to protect personnel against injury and to prevent damage to the equipment. The following precautions must be observed when handling, installing, and removing thermal insulation:

- a. Wear leather gloves and arm protection to prevent injury from sharp edges and corners of insulators.
- b. Do not force-fit brackets.
- c. Use enough personnel when handling insulators to prevent buckling or distortion of panels.
- d. Use extreme care when handling insulators in windy areas.

## NOTE

Because of the extreme lightness of insulators, in comparison with their surface area, they must not be placed where winds or drafts could blow them about.

- e. Leave protective packaging on insulators until ready for installation.
- f. Do not stack or pile insulators on work platform.
- g. Use tiedowns to secure insulators; do not use weights.
- h. Protect insulators from punctures or tears when handling near sharp projections or tools.

i. Do not place equipment against insulators or use them for hand or foot holds.

j. Do not bend flange tabs of insulators to a sharp radius.

k. Do not expose insulators to liquids or moisture. The insulation between foil sheets cannot be conveniently dried. Insulation damaged by fuel absorption must be replaced prior to engine firing. Insulators that have absorbed water do not require replacement if vent holes have been incorporated by ECP F1-573.

l. Make sure that vent covers on inner foils of cocoon and thrust chamber and nozzle extension insulators are not distorted and are free of obstructions.

m. Insulators must not be alined with drift pins engaging nut plates of brackets.

n. Do not wear clothing containing sharp objects that may damage engine finishes.

o. Exercise extreme care to prevent damage to engine equipment.

p. Insulators are not rigid components until installed. If misalignment of attaching features occurs due to deformation of insulators from handling, it may be necessary to use hand-force to effect installation. To prevent damage to insulators, apply hand-force to large areas either by pushing or striking with the heel of the hand. Wear gloves to prevent injury to hands.

4-3A. WEIGHT AND BALANCE.

4-3B. The weight and balance of thermal insulation affects vehicle performance, and any affects to weight and balance resulting from modifications to the thermal insulation must be considered. A breakdown of thermal insulation weight and balance is outlined in steps a through d. Totals are outlined in steps e and f. The

data in steps c and d must be entered in the Stage Weight and Balance History Log. (Arm is referenced from gimbal bearing centerline, plus (+) being in the aft direction.)

a. Brackets and insulators installed by Rocketdyne:

(1) Weight (pounds) +212.0:

NOTE

Weight is included in total delivered-engine weight in engine log books starting with engine F-2062.

(2) Arm (inches) +31.2.

(3) Moment (inch-pounds) 6,614.

b. Remaining brackets and blanket insulator:

(1) Weight (pounds) +96.0.

(2) Arm (inches) +20.0.

(3) Moment (inch-pounds) 1,920.

c. Thermal insulation insulators (inboard engines):

(1) Weight (pounds) +880.0.

(2) Arm (inches) +95.0.

(3) Moment (inch-pounds) 83,574.

d. Thermal insulation insulators (outboard engines):

(1) Weight (pounds) +890.0.

(2) Arm (inches) +94.8.

(3) Moment (inch-pounds) 84,353.

e. Totals (inboard engines):

(1) Weight (pounds) +1,188.0.

(2) Arm (inches) +77.5.

(3) Moment (inch-pounds) 92,108.

f. Totals (outboard engines):

(1) Weight (pounds) +1,198.0.

(2) Arm (inches) +77.5.

(3) Moment (inch-pounds) 92,887.

4-4. INSTALLATION.

4-5. Component installation order, identification, and associated hardware are listed in each installation figure. Index numbers in the figures indicate the sequence of installation for the listed parts. Detail and attaching parts are indented in the listing following the indexed assembly. Special instructions occur in a listing in the order of performance. Applicable installation tools are indicated in section II. A numerical list of parts and their shipping box and figure locations is outlined in section VII. The following is a suggested sequence of installation:

a. Transducer insulators (paragraph 4-7, figure 4-1).

b. Cocoon purge manifold (paragraph 4-9, figure 4-2).

c. Attach brackets (paragraph 4-11, figure 4-4).

d. Oxidizer lines (paragraph 4-13, figure 4-5).



e. Thrust chamber and nozzle extension (paragraph 4-15, figure 4-7).

f. Cocoon (paragraph 4-17, figure 4-8).

g. Heat exchanger lines (paragraph 4-19, figure 4-9).

h. Wrap-around lines (paragraph 4-21, figure 4-10).

4-6. The following must be observed where applicable:

a. Engine areas must be inspected prior to closing out the areas with insulators.

b. Cautions and notes must be observed. These are located following the condition to which they apply, unless they specifically indicate their application to a subsequent condition.

#### 4-7. INSTALLING PRESSURE TRANSDUCER INSULATORS.

4-8. Insulators must be installed on the engine instrumentation transducers as indicated in figure 4-1. The following special instructions apply:

a. Install insulator 19-145114, using 4 screws NAS1100C08-37, 8 washers LD153-0010-0005, and 4 nuts NAS679C08W. Torque nuts to  $16 \pm 2$  inch-pounds.

b. Install remaining insulators, using inconel lockwire MS20995N20. Install lockwire as shown in figure 4-6.

#### NOTE

Any separation of bonding between metal tab and insulator body is acceptable when insulators are safetywired as shown in figure 4-6.

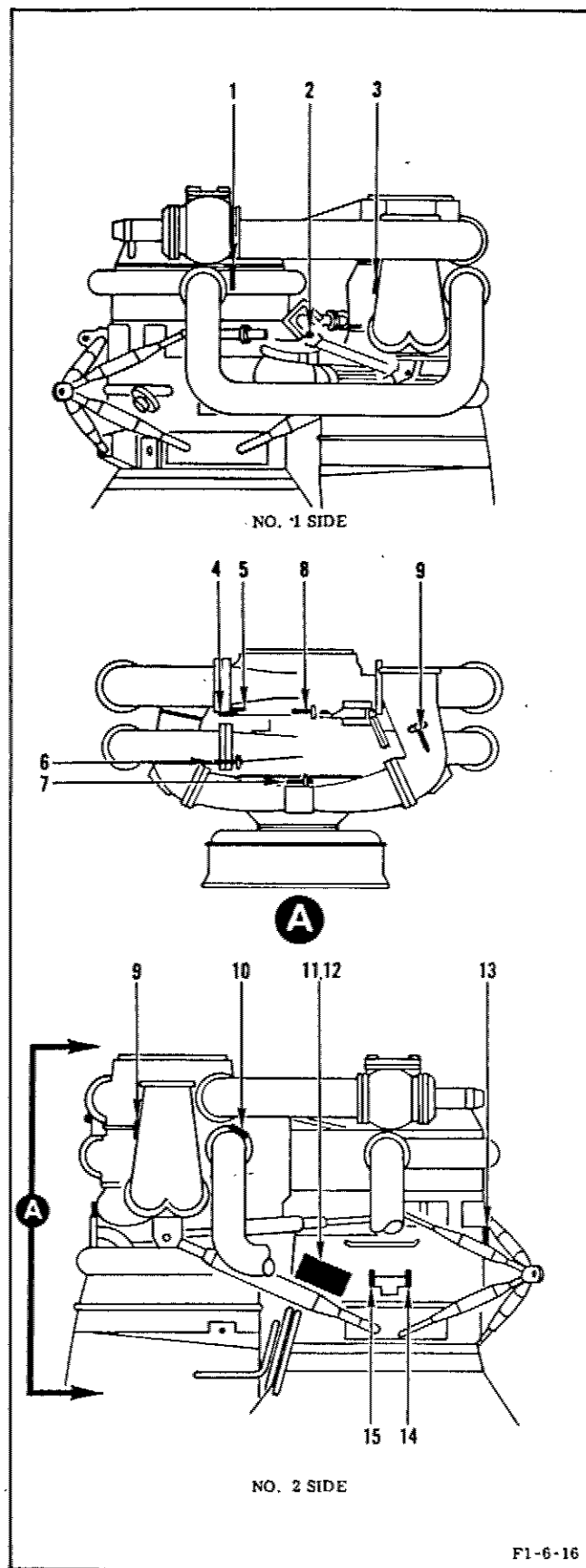


Figure 4-1. Pressure Transducer Insulators  
(Sheet 1 of 2)

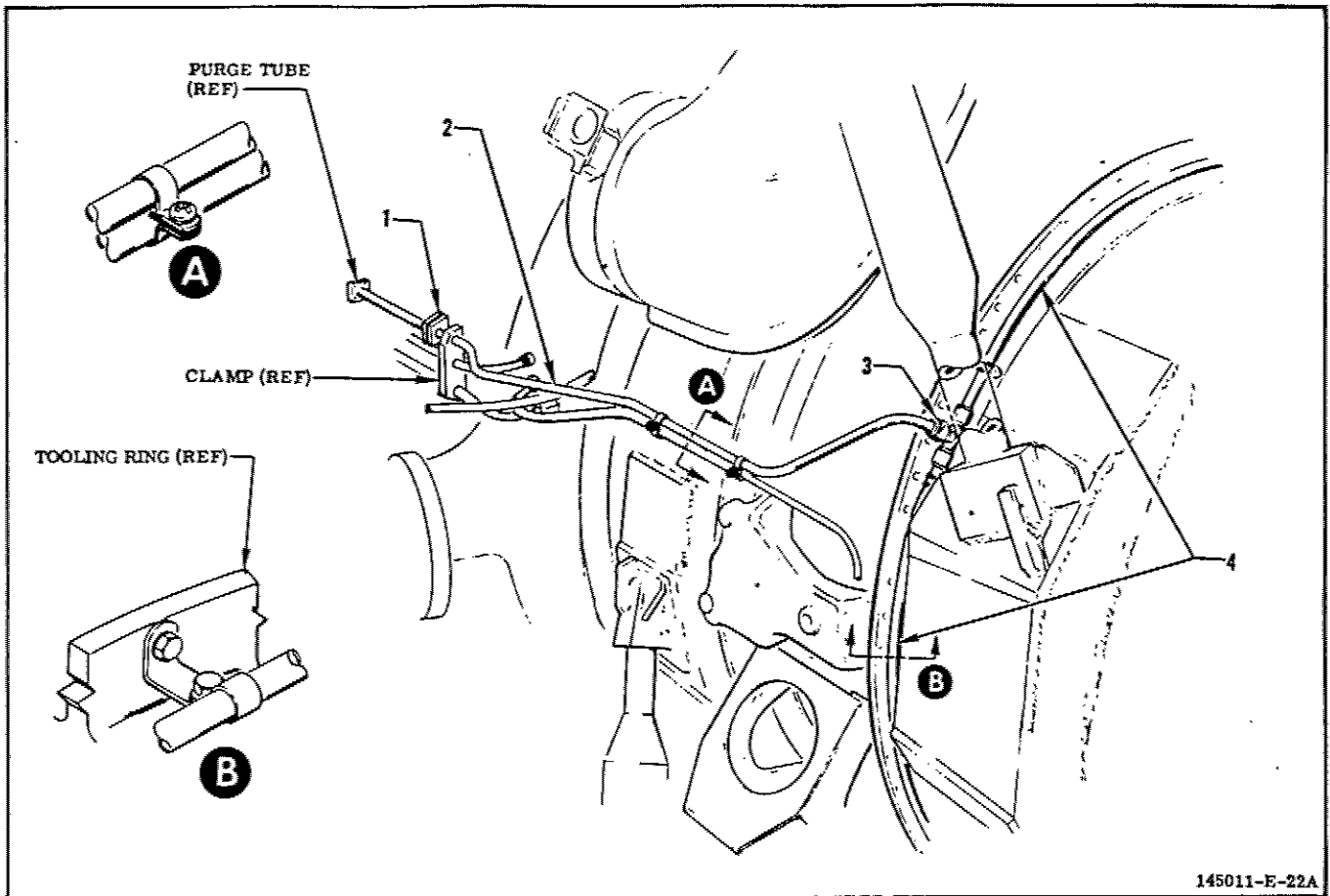
Index Number	Insulator Part Number	Transducer Plug (Ref)
1	19-145113-4	P123
2	19-145112-2	P119
3	19-145113-1	P116
4	19-145113-1(a) 19-145112-3(b)	P117
5	19-145112-1(a)	P159
6	19-145113-1(a)	P155
7	19-145113-1	P118
8	19-145113-3(a)	P162
9	19-145113-1(a)	P121
10	19-145113-1	P120
11	19-145113-1(b)	P121
12	19-145114(a)	P161, P163, P164, P165, P166
13	19-145112-2	P122
14	19-145113-1(a)	P160
15	19-145113-1(a)	P158

(a) Used on thermal insulation sets 12-1 through 15-7.  
(b) Used on thermal insulation sets 16-1 and subsequent.

Figure 4-1. Pressure Transducer Insulators  
(Sheet 2 of 2)

4-9. INSTALLING COCOON PURGE MANIFOLD.

4-10. The cocoon purge manifold is installed in the index number order outlined in figure 4-2 which is applicable to engines not having the equipment already installed by the manufacturer prior to engine delivery. Observe applicable safety precautions outlined in paragraph 4-2.



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
1	RD251-4084-0272	1	Orifice	3	AN824-10C	1	Tee
2	145523 Attaches to tee (3).	1	Tube	<p>NOTE</p> <p>Coupling nuts of tubes (2, 4) must be torqued as follows: Record maximum running torque. Continue to torque to 700-800 inch-pounds above recorded torque.</p>			
	RD111-1010-6425	4	Bolt				
	RD153-5004-0004	4	Washer				
	LD153-0010-0010	4	Washer				
	RD114-8003-2004	4	Nut 38 ±3	4	145388 Attaches to tee (3).	2	Tube

Figure 4-2. Cocoon Purge Manifold (Sheet 1 of 2)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
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NOTE

The following parts attach tube (2) to existing parallel tube. (See sheet 1, detail A.)

RE127-2001-0006	4	Clamp
NAS1003-3A	2	Bolt
LD153-0010-0007	2	Washer
RD153-5004-0003	2	Washer
RD114-8003-2003	2	Nut 27 ±3

NOTE

The following parts attach at tooling ring holes 4, 10, 14, 20, 31, 40, 42, 58, 66, and 69. (See sheet 1, detail B.)

MS9104-14	10	Bracket
NAS1005-8A	10	Bolt
LD153-0010-0011	10	Washer
RD153-5004-0005	10	Washer
RD114-8003-2005	10	Nut 90 ±10

NOTE

The following parts attach tubes (4) to brackets at tooling ring holes.

RE127-2001-0006	10	Clamp
NAS1003-3A	10	Bolt
LD153-0010-0007	10	Washer
RD153-5004-0003	10	Washer
RD114-8003-2003	10	Nut 27 ±3

Figure 4-2. Cocoon Purge Manifold  
(Sheet 2 of 2)

4-11. INSTALLING THERMAL INSULATION ATTACH BRACKETS.

4-12. The thermal insulation attach brackets are installed in the index number order outlined in figure 4-4. Special instructions and variations are included, in sequence, with the applicable indexed part. Engine alinement must be completed prior to the installation of brackets in the dome area. On specific engines, some of the brackets have been installed and alined by the manufacturer prior to engine delivery, and only the applicable portion of the procedure pertinent to the remaining uninstalled brackets indexed 5 through 9, 11, 12, 25, and 41 need be performed. Those fasteners provided with drilled holes for lockwire must be safetywired with inconel lockwire following final torquing. See figure 4-3 for special wrench and alinement equipment. Observe applicable safety precautions outlined in paragraph 4-2. If a bolt replacement is necessary but not locally available, a substitute bolt of identical callout, one or two dash numbers longer, may be used. A maximum of three washers LD153-0013 may be installed under the attaching nut to prevent the nut from engaging the imperfect bolt threads. A maximum of two washers is used when a serrated washer is specified as part of the installation. Where lubrication for fasteners is specified in this procedure, the lubricant must be applied as follows:

- a. Apply lubricant in a streak 1/8 inch to 1/4 inch wide across all threads and flush with top of threads.
- b. Distribute lubricant streak uniformly around fastener threads with a clean nylon brush. Remove excess lubricant.

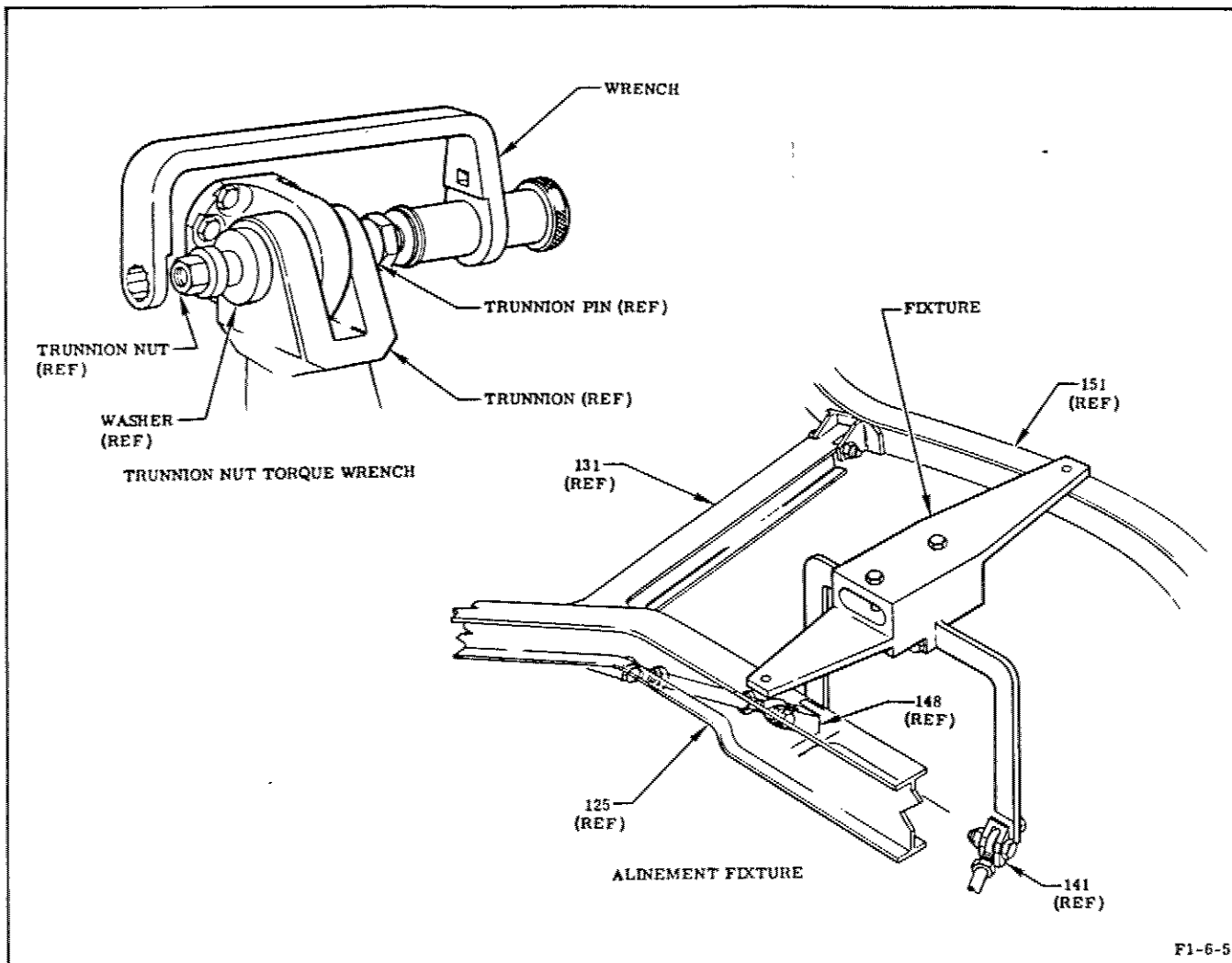


Figure 4-3. Trunnion Nut Torque Wrench G4086 and Alinement Fixture G4084

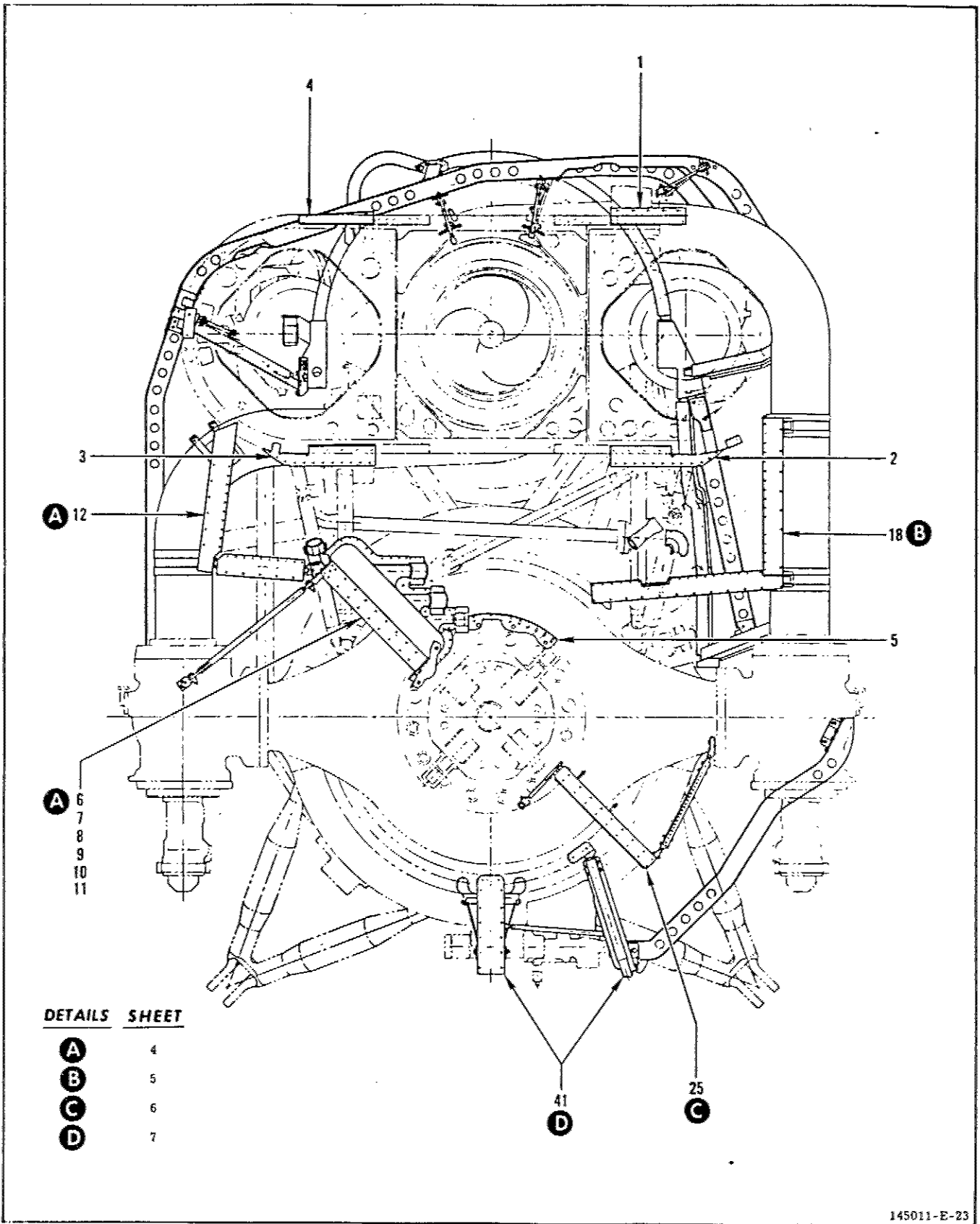


Figure 4-4. Thermal Insulation Attach Brackets (Sheet 1 of 44)

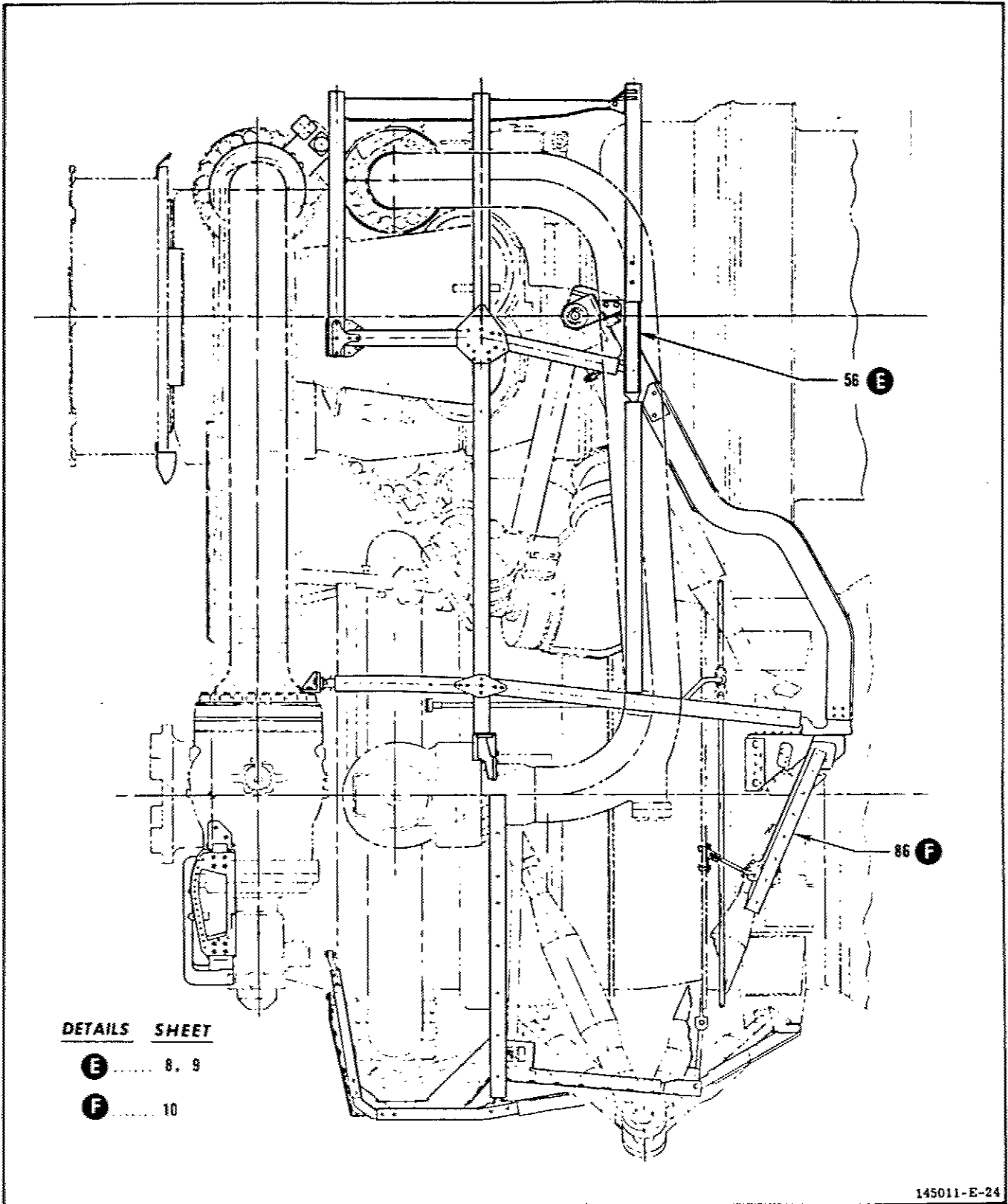


Figure 4-4. Thermal Insulation Attach Brackets (Sheet 2 of 44)

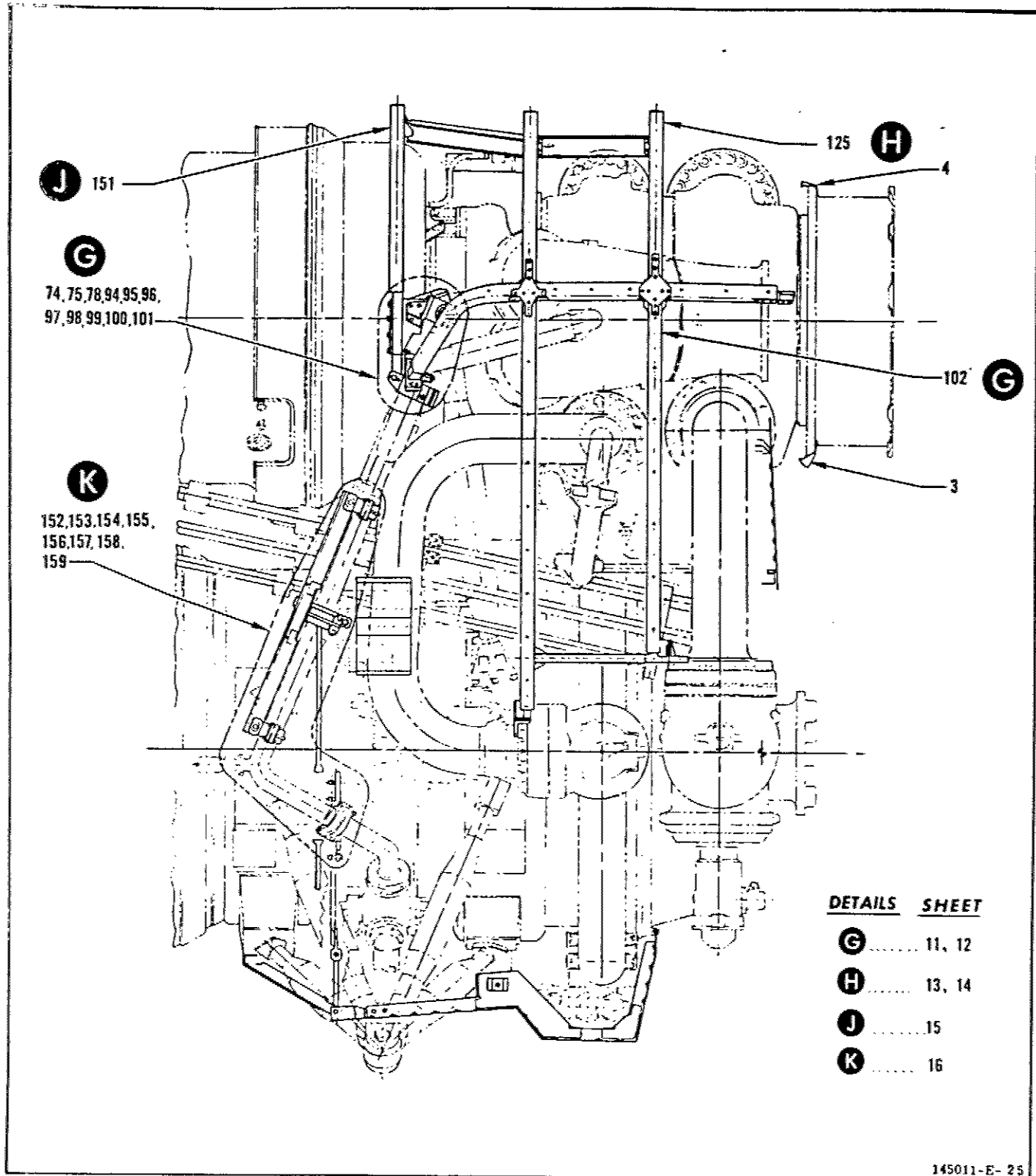


Figure 4-4. Thermal Insulation Attach Brackets (Sheet 3 of 44)



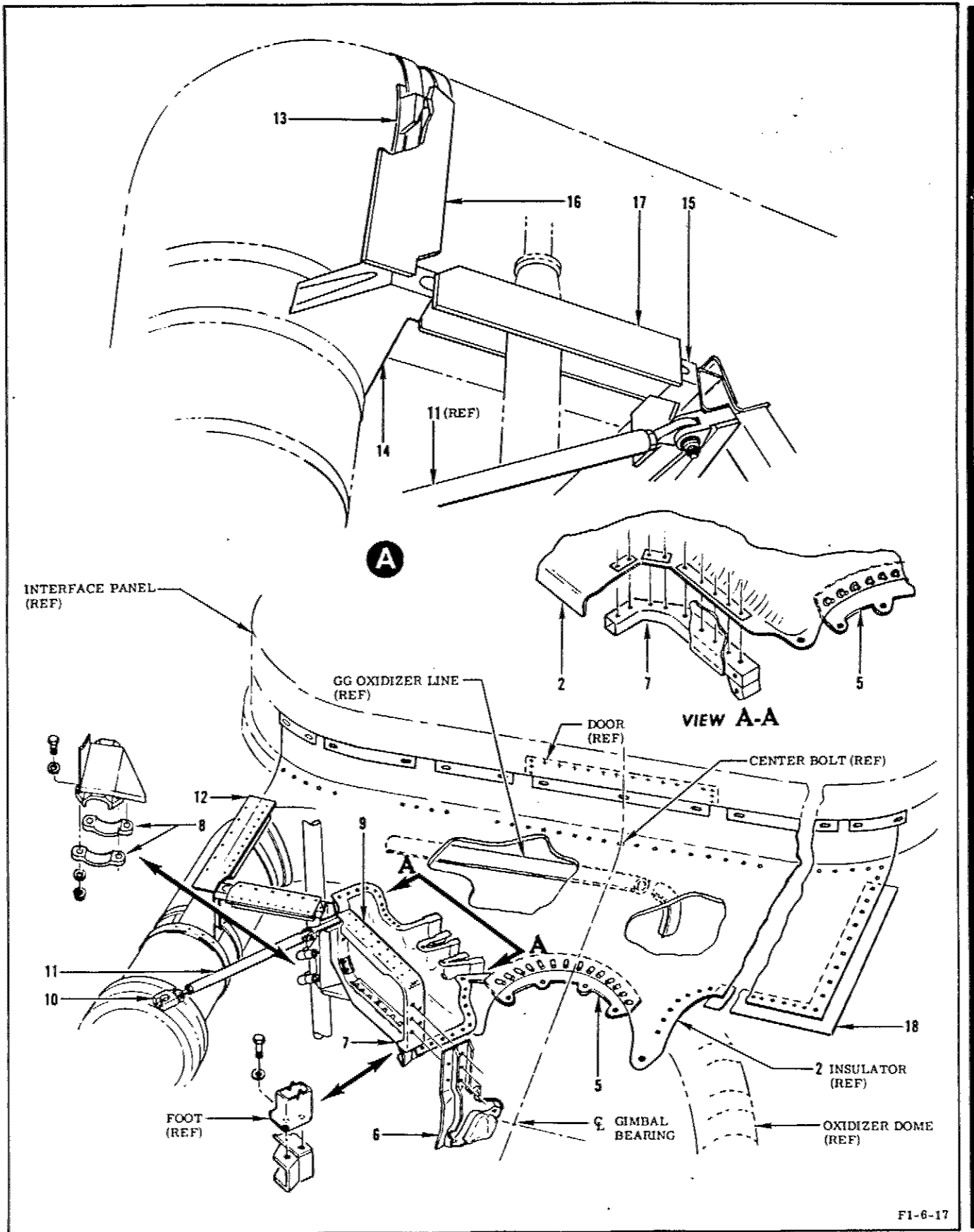
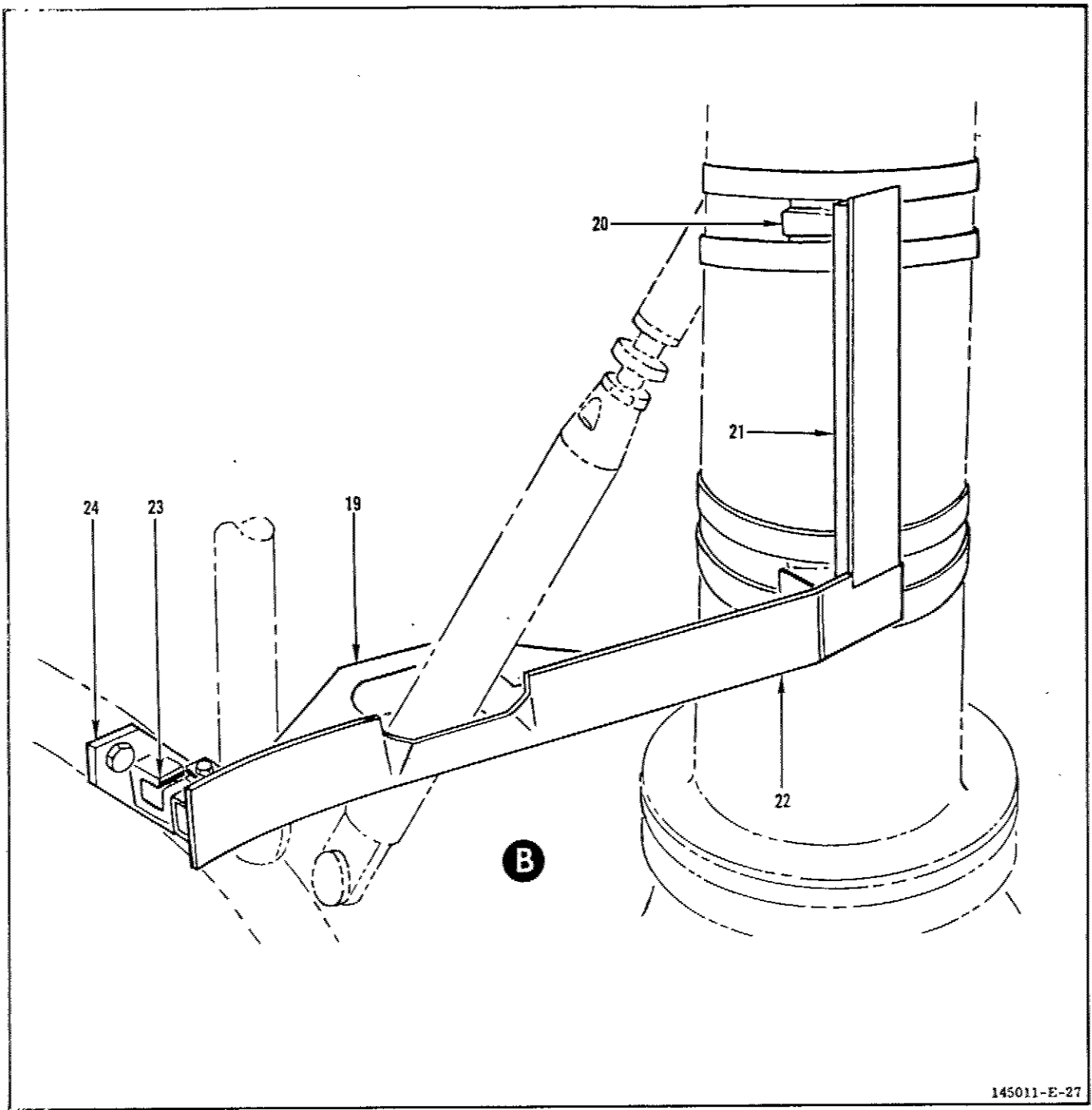


Figure 4-4. Thermal Insulation Attach Brackets (Sheet 4 of 44)

Change No. 7 - 30 June 1970

4-9



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Figure 4-4. Thermal Insulation Attach Brackets (Sheet 5 of 44)

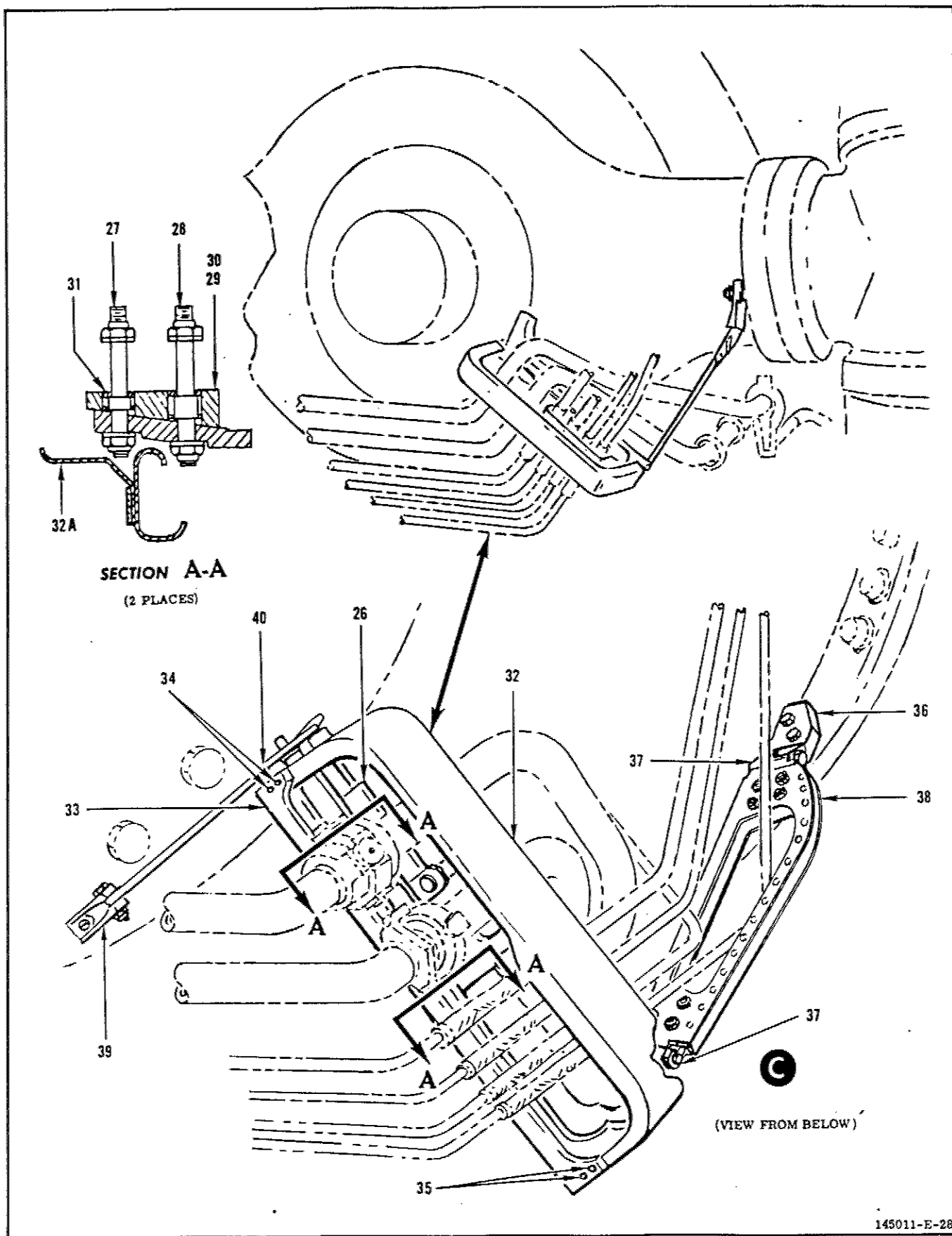
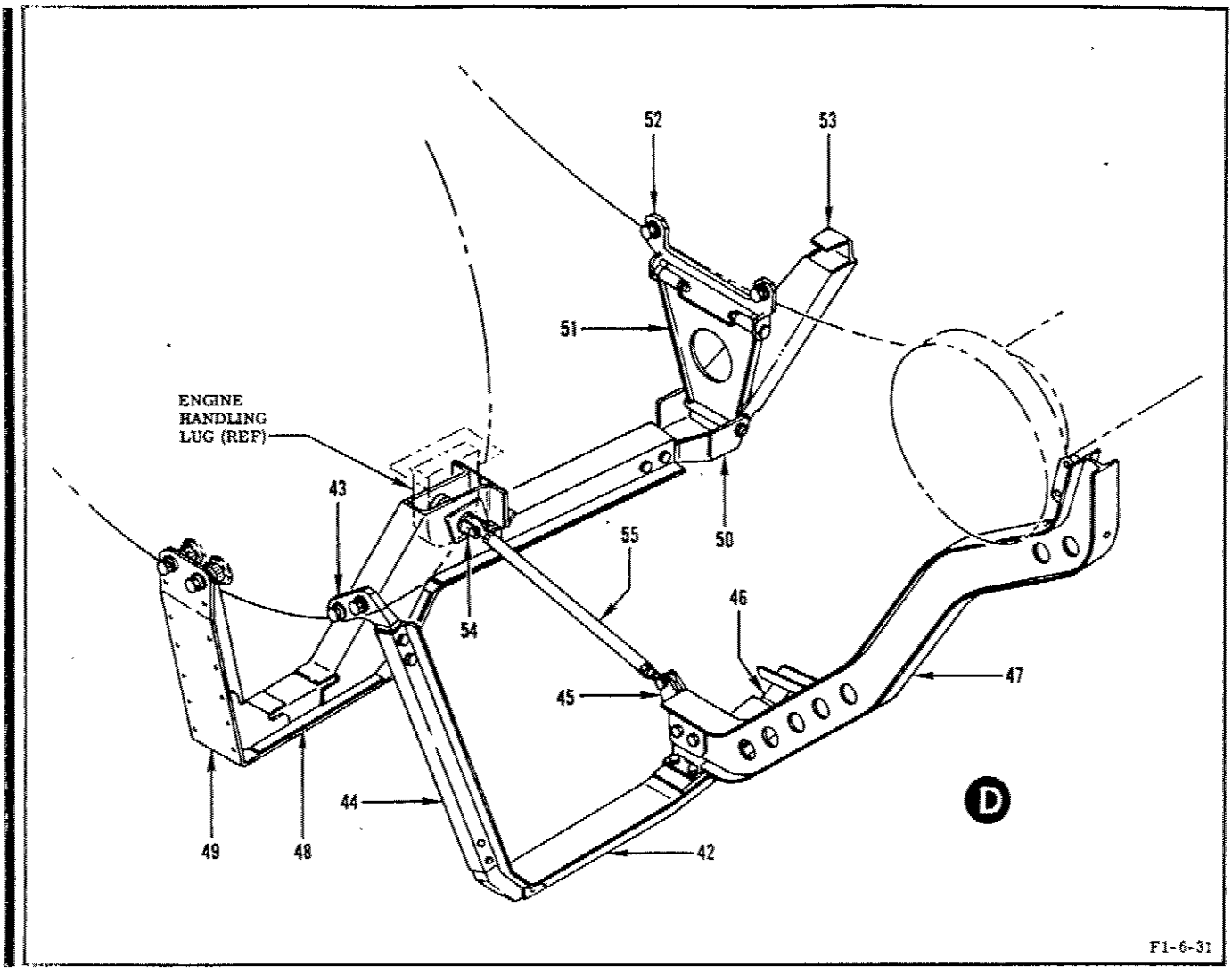


Figure 4-4. Thermal Insulation Attach Brackets (Sheet 6 of 44)



F1-6-31

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 7 of 44)

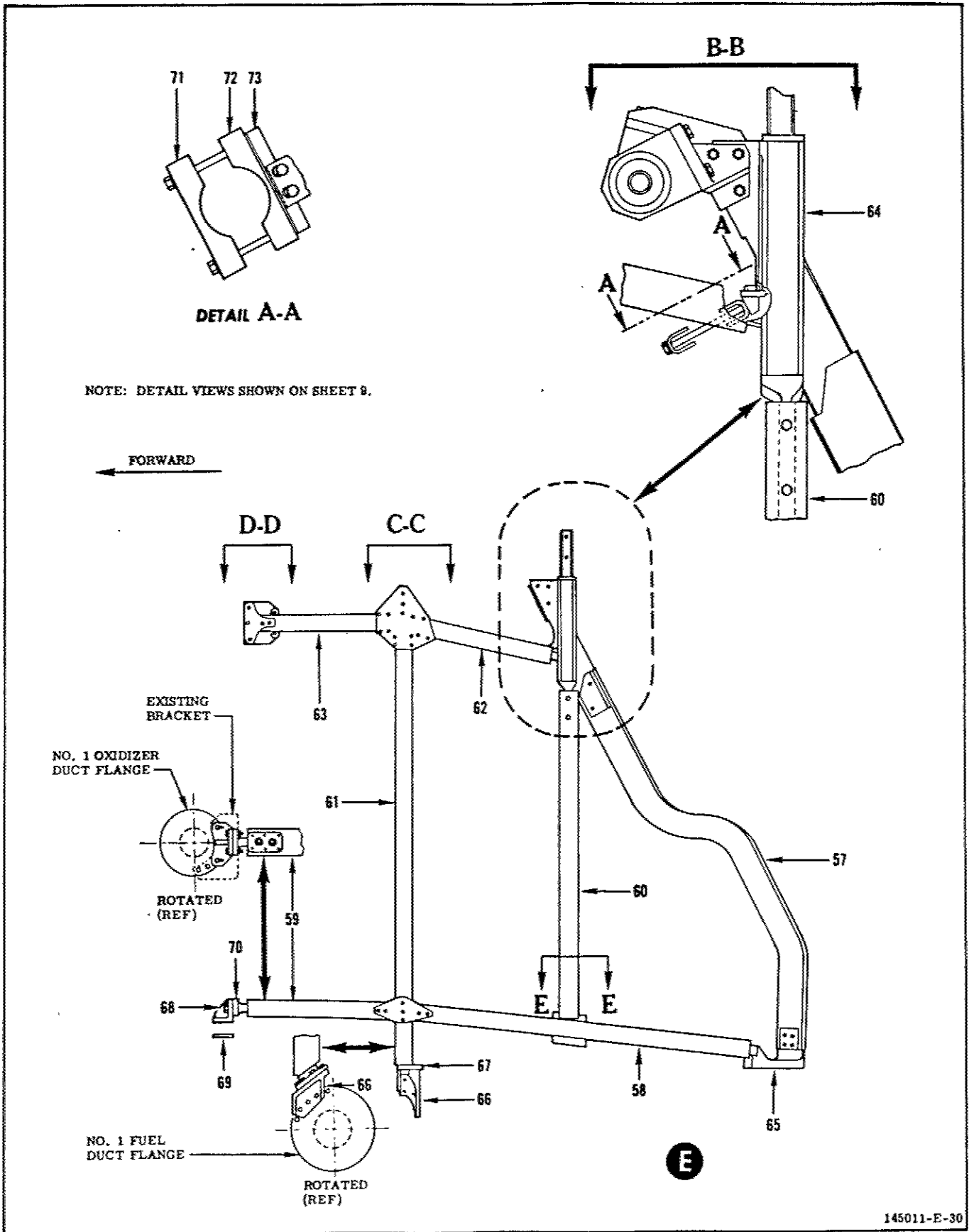
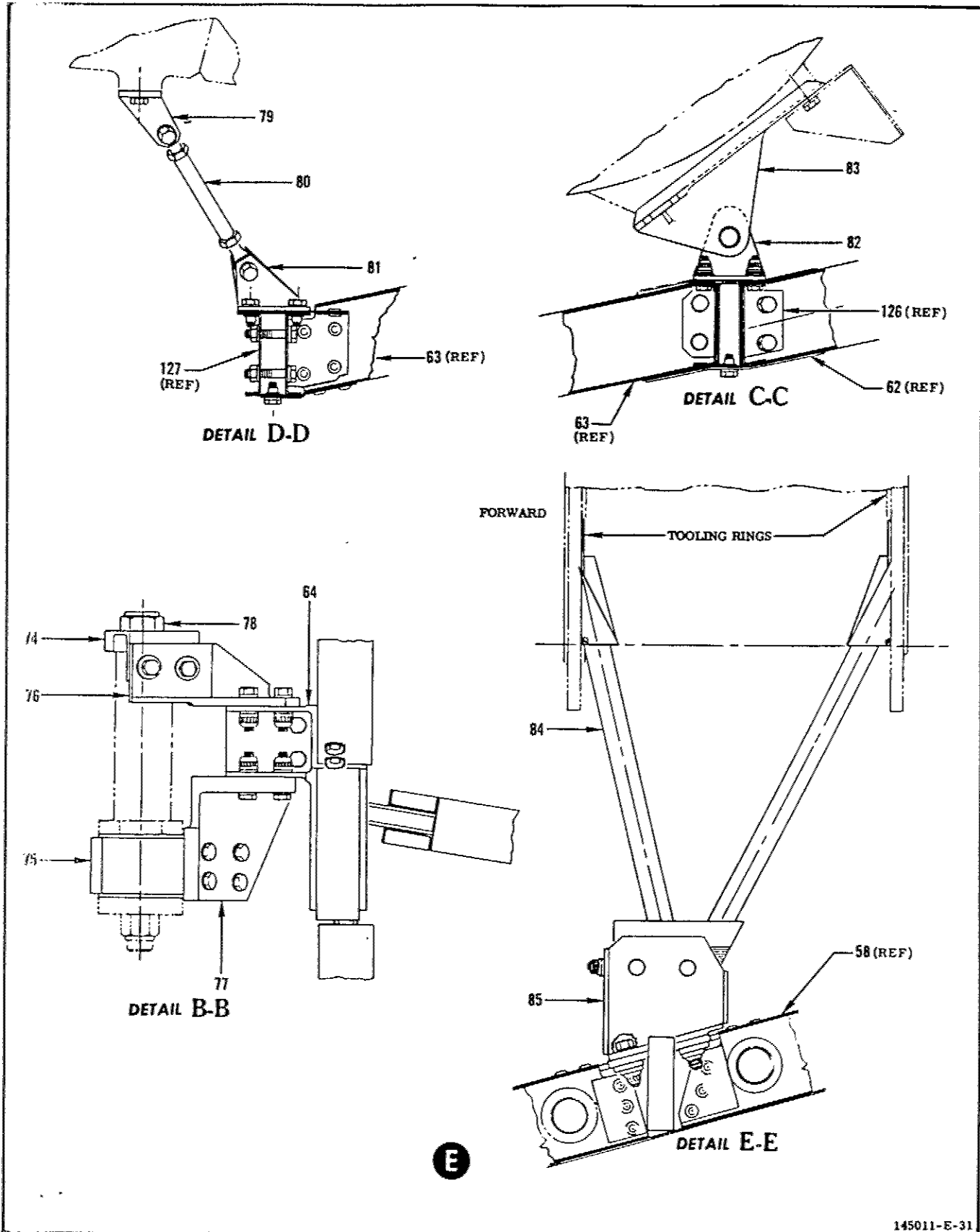
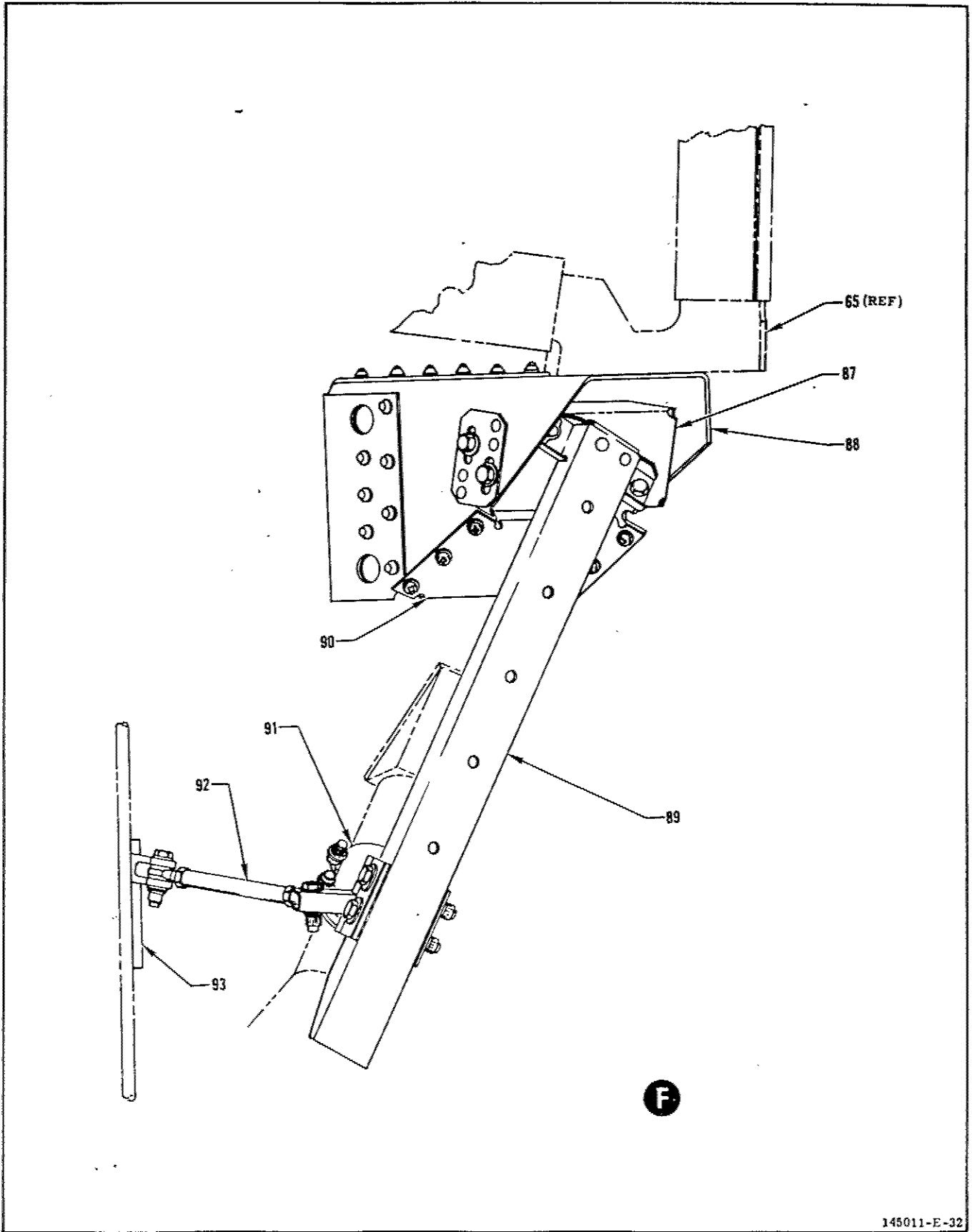


Figure 4-4. Thermal Insulation Attach Brackets (Sheet 8 of 44)



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Figure 4-4. Thermal Insulation Attach Brackets (Sheet 9 of 44)



145011-E-32

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 10 of 44)

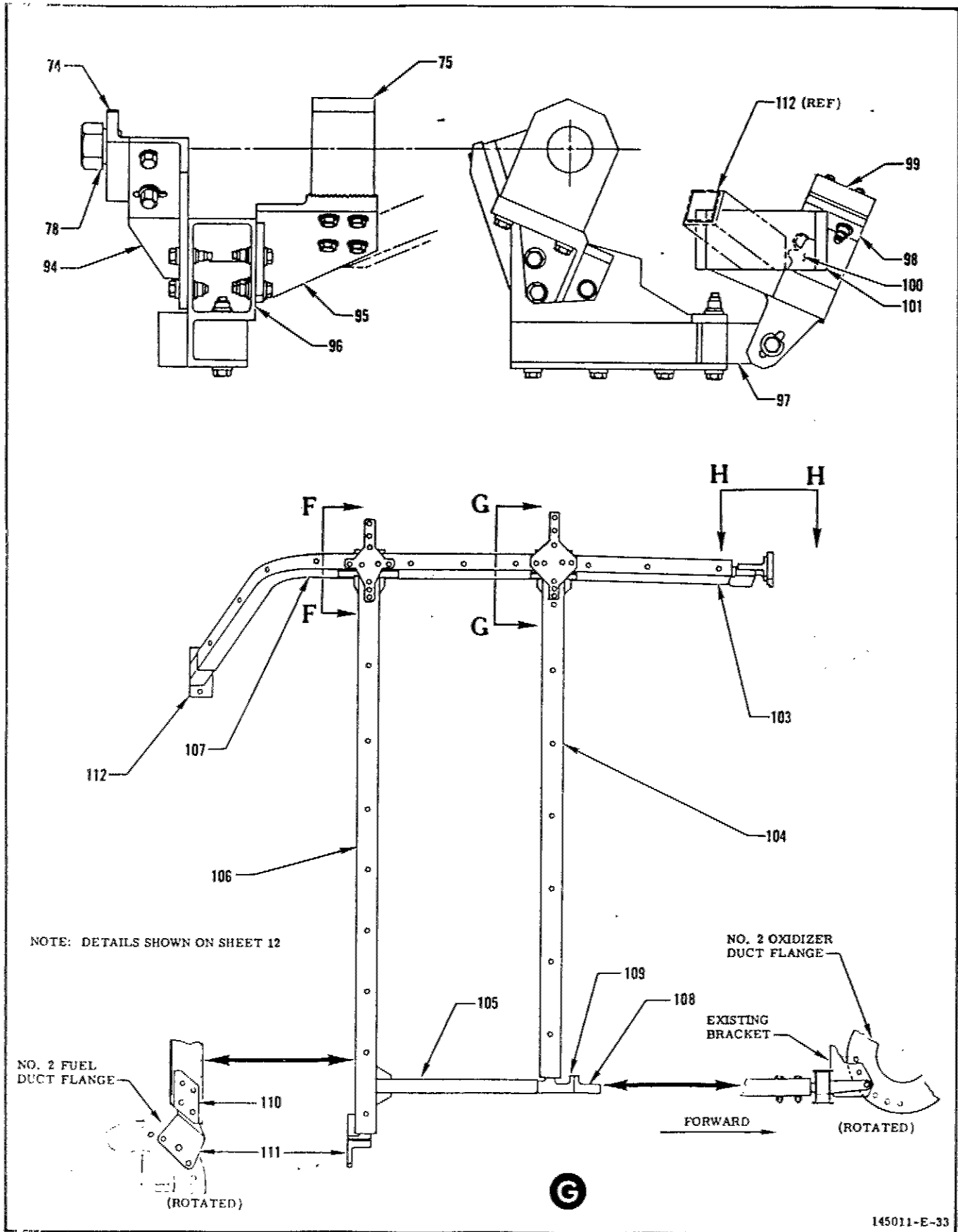
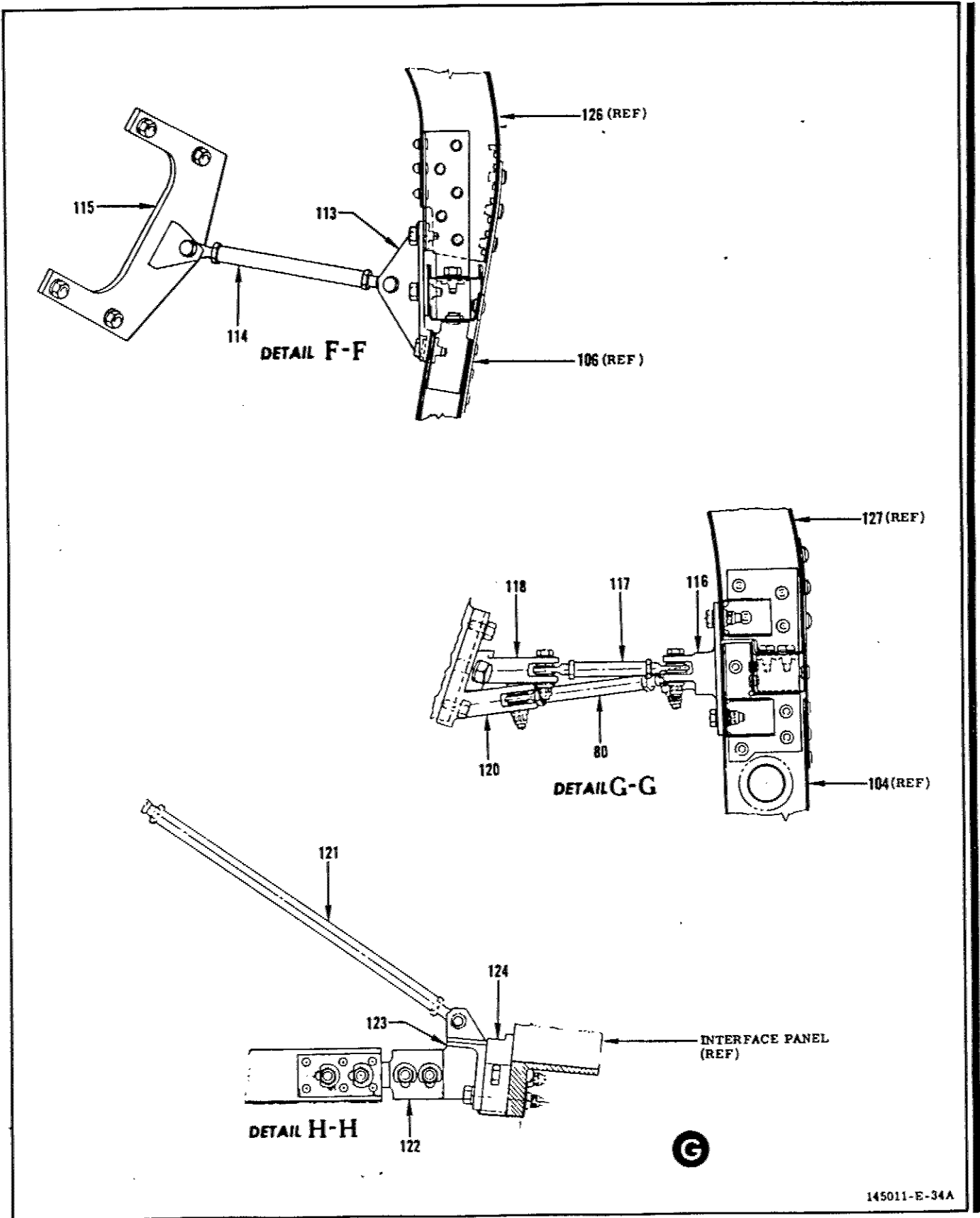


Figure 4-4. Thermal Insulation Attach Brackets (Sheet 11 of 44)

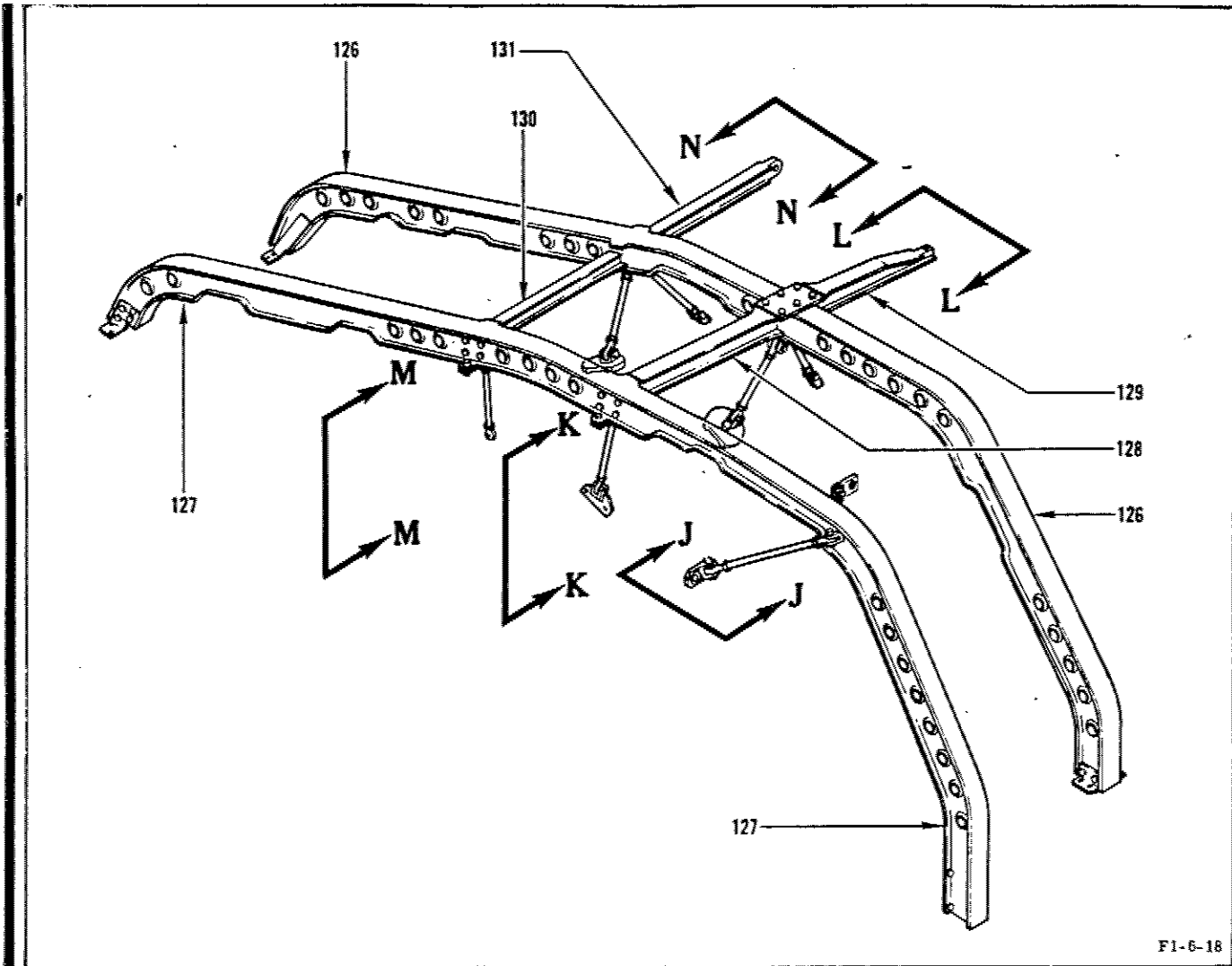




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Figure 4-4. Thermal Insulation Attach Brackets (Sheet 12 of 44)

Change No. 2 - 24 May 1967 4-17



F1-6-18

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 13 of 44)

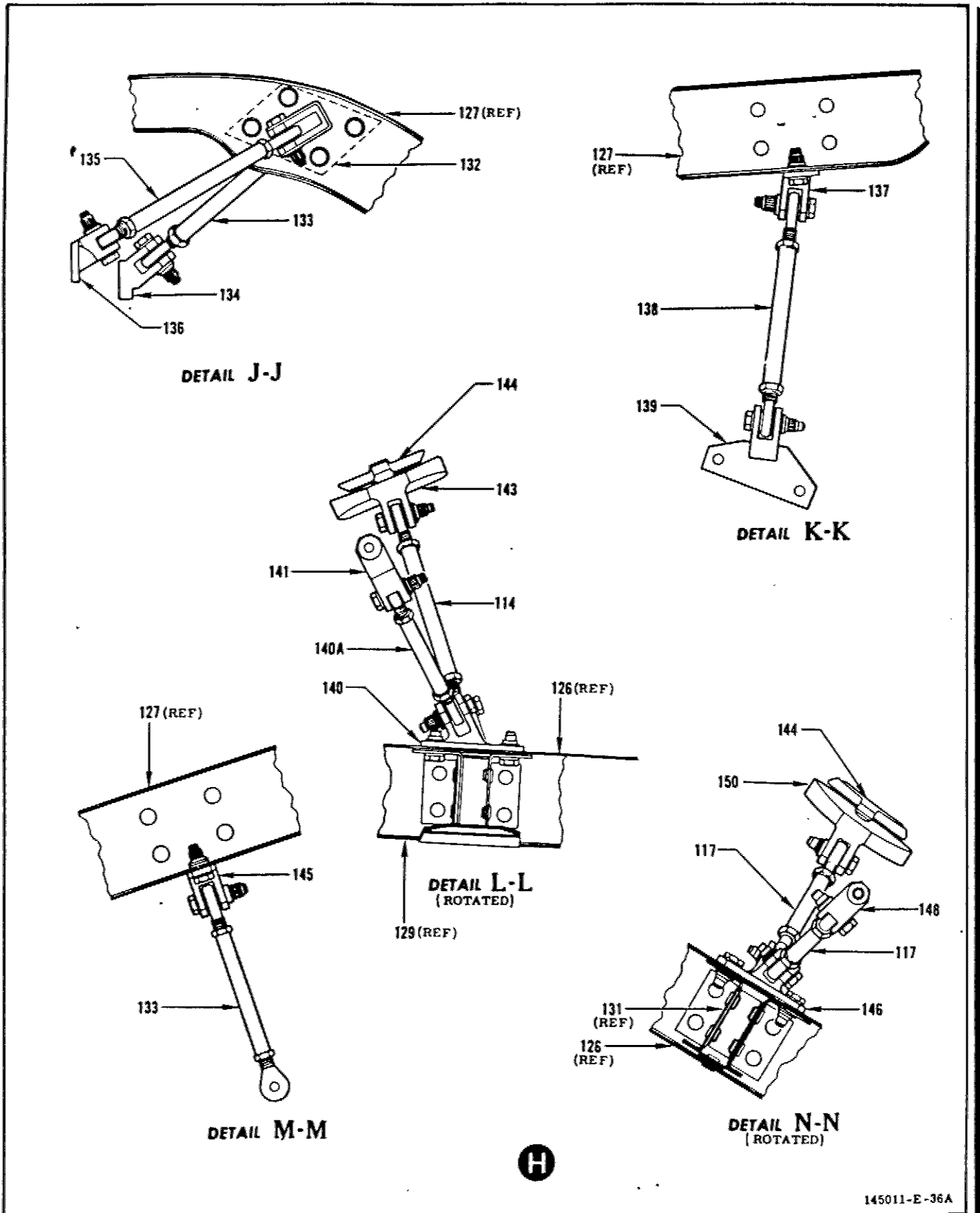


Figure 4-4. Thermal Insulation Attach Brackets (Sheet 14 of 44)

Change No. 2 - 24 May 1967 4-19

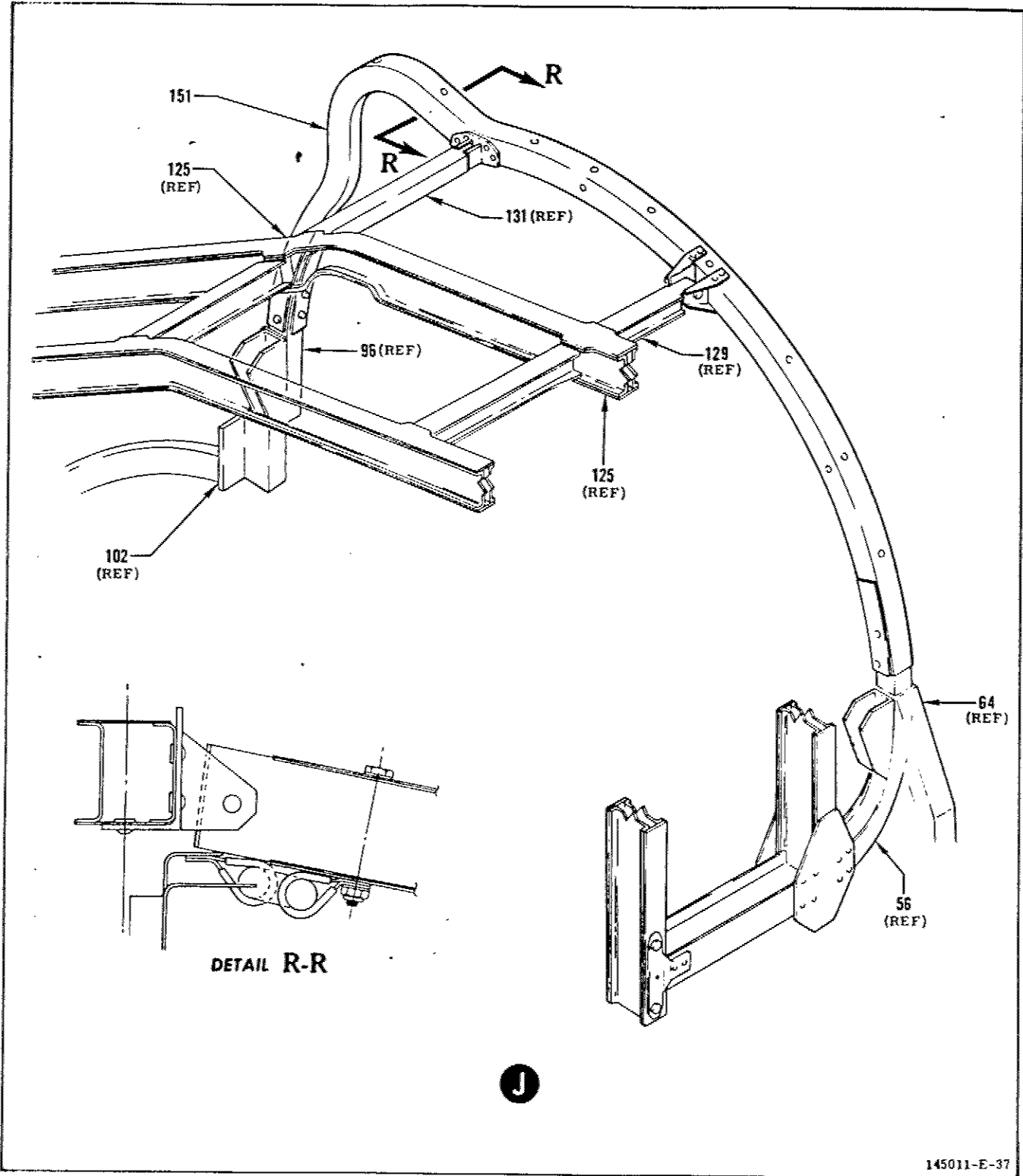


Figure 4-4. Thermal Insulation Attach Brackets (Sheet 15 of 44)

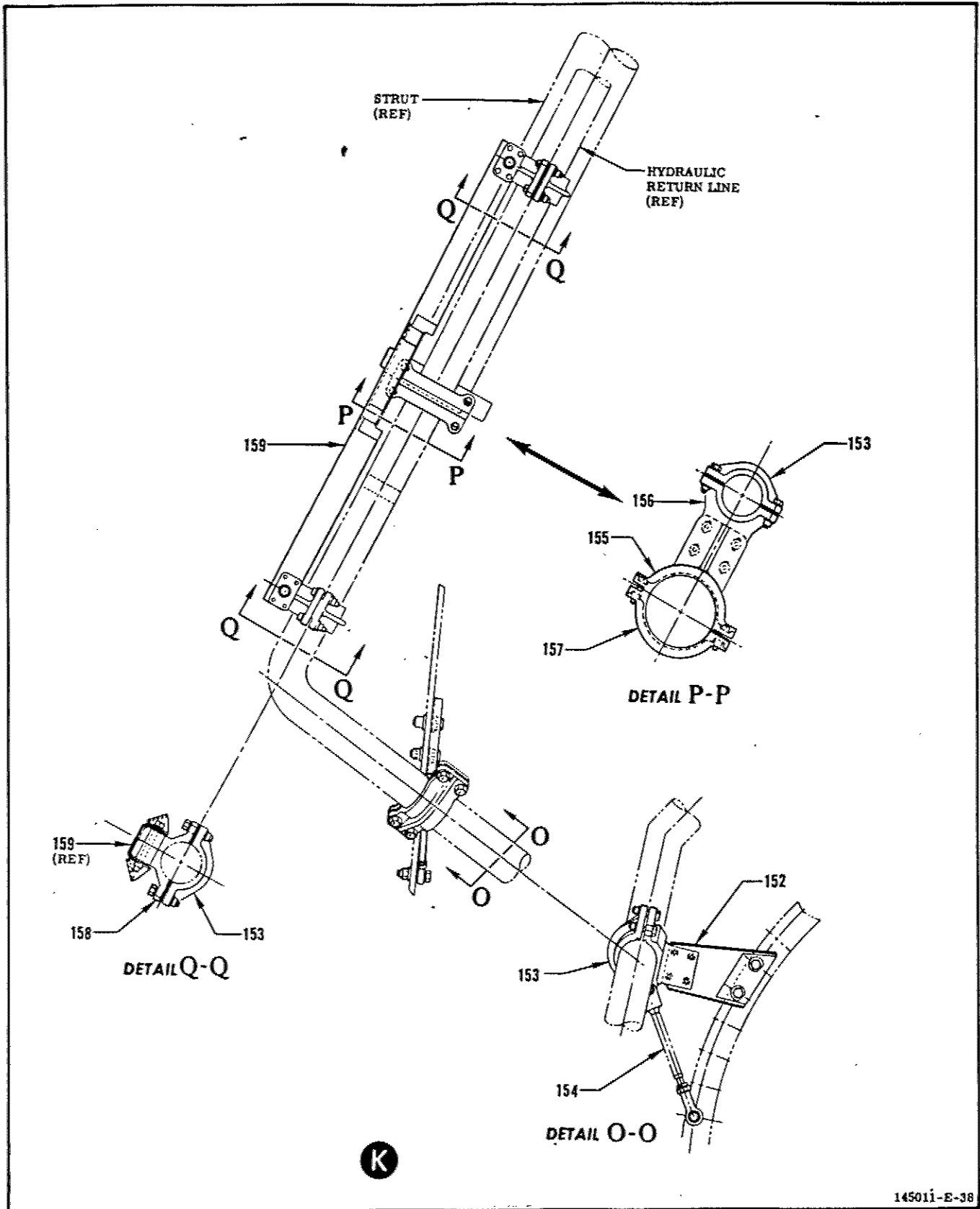


Figure 4-4. Thermal Insulation Attach Brackets (Sheet 16 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
1	145352 (Sheet 1.) Attaches to interface panel.	1	Bracket				
	HL30-8-18	5	HI-LOK Pin				
	HL194W-8		HI-LOK Collar				
2	145354 (Sheet 1.) Attaches to interface panel.		Bracket				
	HL30-8-18	4	HI-LOK Pin				
	HL30-8-19	2	HI-LOK Pin				
	HL194W-8	6	HI-LOK Collar				
NOTE							
Two each of pins HL30-8-19 and collars HL194W-8 replace two existing interface panel pins and collars.							
3	145355 (Sheet 1.) Attaches to interface panel.	1	Bracket				
	HL30-8-18	6	HI-LOK Pin				
	HL194W-8	6	HI-LOK Collar				
4	145353 (Sheet 1.) Attaches to interface panel.	1	Bracket				
	HL30-8-18	5	HI-LOK Pin				
	HL194W-8	5	HI-LOK Collar				
NOTE							
The following procedure installs brackets (5 through 9) with cocoon insulator (2) shown in figure 4-8.							
a. See figure 4-5 and install gas generator oxidizer feed line insulators.							
b. See figure 4-8 and obtain insulator (2). Lay out insulator on a clean surface, bright side up, relative to its position when installed on the engine.							
c. See sheet 4 for locations and obtain brackets (5, 7).							
d. Install bracket (7) to insulator as shown, using 9 bolts RD111-1010-6311. Torque bolts to 45 ±5 inch-pounds.							
NOTE							
Holes in channel of insulator may be elongated up to 1/4 inch additional length to match holes in bracket 145614 (7).							
e. Position bracket (5) under insulator and secure with 14 nuts NAS679C4W and 14 washers RD153-1002-0004. Torque nuts to 68 ±7 inch-pounds.							
				f.			Install bracket (6) to oxidizer dome with 2 bolts RD111-4010-0408 and 2 washers RD153-5004-0004. Do not tighten bolts.
				g.			Carefully position insulator (2) with brackets attached on engine.
				h.			Attach bracket (7) to bracket (6), using 2 bolts RD111-4009-0406, 2 washers RD153-5002-0004, and two serrated washers 145288-7. Do not tighten bolts.
				NOTE			
				If interference exists between bracket 145614 (7) and the oxidizer dome torus, remove bracket 145286 (6) and lengthen slotted holes as necessary, except that the edge distance of the slotted hole nearest the end of the bracket must not be less than 0.12 inch. Washer edges may be trimmed if interference exists between washer and bracket surface.			
				i. If wrap-around pressurization lines are installed, remove protective covers from gimbal joints. Install bracket (9) and attach as follows, using hardware indicated: (Do not torque bolts at this time.)			
				(1) Foot of bracket (9) to bracket (7); 2 bolts NAS1004-2A and 2 washers LD153-0013-0002.			
				(2) Through bracket (6) into bracket (9); 3 bolts NAS1004-4A, 3 washers 145288-7, and 3 washers RD153-5004-0004.			
				(3) Through bracket (9) into bracket (7) at clevis end; one bolt NAS1004-4A, 2 bolts NAS1004-3A, and 3 washers RD153-5004-0004.			
				j. Install 2 clamps (8) with 4 bolts NAS1004-20A, 4 washers RD153-5004-0004, 4 washers RD153-1002-0004, and 4 nuts NAS679C4W. Torque nuts to 68 ±7 inch-pounds.			
				k. Torque fasteners installed in steps f, h, and i to 68 ±7 inch-pounds.			
				NOTE			
				Rotating the engine, if required, must be performed prior to performing steps l through o, since the attach point at the turbopump will not be accessible.			

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 17 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	<p>l. Attach bracket (5) to dome with 4 bolts RD111-1009-0406 and 4 washers RD153-5004-0004. Torque bolts to 68 ±7 inch-pounds and safetywire.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>If interference exists between bracket 145344 (5) and the gimbal bearing adjustment block, the bracket may be reworked as outlined in section VI.</p> <p>m. Install bolt RD111-1010-6308 and washer RD153-1003-0006 through insulator (2) into leg of bracket (6). Torque bolts to 45 ±5 inch-pounds.</p> <p>n. Center insulator (2) with center of interface panel door. Attach to interface panel flange brackets, using 41 bolts RD111-1010-6410 and 41 washers LD153-0013-0002. Install bolt in center hole and 20 bolts on each side of center hole. Torque bolts to 95-100 inch-pounds.</p> <p>o. Attach forward edge of insulator to interface panel, using 11 screws NAS1100C3-15 (or bolts RD111-1010-6313) and 11 washers RD153-0115 0021. Lubricate screws with thread compound Fel-Pro C-5A (Felt Products). Do not install in 2 end holes at either side. Torque screws to 27 ±3 inch-pounds.</p> <p>p. Continue with installation of bracket (10).</p>						
5	145344 (Sheet 1.)	1	Bracket Attaches to oxidizer dome.	9	145188 (Sheets 1 and 4.)	1	Bracket Attaches to brackets (6, 7)
6	145286 (Sheets 1 and 4.)	1	Bracket Attaches to oxidizer dome.		NAS1004-4A	3	Bolt 68 ±7
	RD111-4010-0408	2	Bolt 68 ±7		145288-7	3	Washer
	RD153-5002-0004	2	Washer		RD153-5004-0004	3	Washer Attaches to bracket (6).
7	145614 (Sheets 1 and 4.)	1	Bracket Attaches to bracket (6).		NAS1004-3A	2	Bolt 68 ±7
	RD111-4009-0406	2	Bolt 68 ±7		NAS1004-4A	1	Bolt 68 ±7
	RD153-5002-0004	2	Washer		RD153-5004-0004	3	Washer Attaches to bracket (7).
	145288-7	2	Washer		NAS1004-2A	2	Bolt 68 ±7
8	145255 (Sheets 1 and 4.)	2	Clamp Attaches to bracket (7).		LD153-0013-0002	2	Washer Attaches to bracket (7) at bracket (6).
	NAS1004-20A	4	Bolt	10	145304 (Sheets 1 and 4.)	1	Bracket Attaches to oxidizer valve.
	RD153-5004-0004	4	Washer		RD111-1010-0612	1	Bolt 68 ±7
	RD153-1002-0004	4	Washer		RD153-5004-0006	1	Washer
	NAS679C4W	4	Nut 68 ±7		<b>NOTE</b>		
					Replaces existing bolt RD111-9001-0016 on valve.		
				11	145305 (Sheets 1 and 4.)	1	Tie Rod Attaches to brackets (9, 10).
					MS9201-03	1	Check Nut 68 ±7
					RE131-7002-0002	1	Rod End
					RD111-1010-6526	2	Bolt
					RD114-8003-1005	2	Nut 15 ±2
					RD153-1002-0005	2	Washer
					RD153-5004-0005	2	Washer

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 18 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
12	145324(f), 145324-11(g) (Sheets 1 and 4.) Attaches to oxidizer duct and bracket (7).	1	Support		RD111-1010-6428 RD153-5004-0004 LD153-0010-0009 RD114-8003-1004 Attaches to bracket (14).	1 1 1 1	Bolt Washer Washer Nut 1-7(a)
NOTE				17	145259	1	Stiffener
Final location is determined by applicable insulator.					RD111-1010-6428 RD153-5004-0004 LD153-0010-0009 RD114-8003-1004 Attaches to bracket (14).	1 1 1 1	Bolt Washer Washer Nut 1-7(a)
● Parts (13 through 17) are detailed parts of this assembly.					NAS43HT4-54 RD111-1010-6430 LD153-0010-0009 RD153-9001-0002 RD114-8003-1004 Attaches to bracket (15).	1 1 1 2 1	Spacer Bolt Washer Washer Nut 1-7(a)
13	145462 Attaches to oxidizer duct. 551-88-790(b)	1 2	Bracket Clamp 50 ±5	18	145325 (Sheets 1 and 5.) Attaches to oxidizer duct and dome.	1	Frame
14	145461(f), 145461-11(g) Attaches to oxidizer duct. 551-88-790(b)	1 2	Bracket Clamp 50 ±5	NOTE			
NOTE				Final location is determined by applicable insulator.			
Maximum spacing between clamps must be at outer curvature of duct.				● Parts (19 through 24) are detailed parts of this assembly.			
15	145256 Attaches to bracket (7). NAS1003-3A RD153-5004-0003	1 4 4	Bracket Bolt 27 ±3 Washer	19	145631 Attaches to frame (22).	1	Saddle
NOTE				NOTE			
The following parts groups are part of support (12). Fasteners must be torqued following installation.				Saddle must be removed and reinstalled to encompass strut.			
16	145260-11 NAS43HT4-75 RD111-1010-6430 LD153-0010-0009 RD153-9001-0002 RD153-5004-0004 RD114-8003-1004 Attaches to bracket (13).	1 1 1 1 2 1 1	Stiffener Spacer Bolt Washer Washer Washer Nut 1-7(a)		NAS333CPA4(b)	8	Bolt 27 ±3
(a) Above running torque.							
(b) A component of an assembly.							
(f) Used on thermal insulation sets 12-1 through 12-5, 13-8, and 14-6.							
(g) Used on thermal insulation sets 12-6 through 13-7, 14-1 through 14-5, 14-7, and subsequent.							

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 19 of 44)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	
	145325 (Cont)				RD111-1010-6426	1	Bolt	
20	145463	1	Bracket		RD153-5004-0004	1	Washer	
	Attaches to oxidizer duct.				LD153-0010-0010	1	Washer <sup>(a)</sup>	
	551-88-790 <sup>(b)</sup>	2	Clamp 50 ±5		RD114-8003-1004	1	Nut 1-7 <sup>(a)</sup>	
21	145424	1	Frame		Attaches bracket (24) to arm (23).			
22	145464	1	Frame	25	145290 (Sheets 1 and 6.)	1	Bracket	
23	145262	1	Arm		Attaches to wrap-around line support bracket and oxidizer dome.			
24	145261	1	Bracket		NOTE			
	Attaches to dome boltheads.				Parts (26 through 40) are detailed parts of this assembly.			
	NOTE				<ul style="list-style-type: none"> <li>Disassembly of brackets (32) and (32A) from channel (33) is required for installation. Hardware must be retained for assembly.</li> <li>Wrap-around lines support bracket has been alined. When installing bracket (25), the two existing bolts in the wrap-around lines bracket must be replaced with plate (29 or 30), one each of studs (27 and 28), and washer (31). To avoid disturbing alinement, nuts for studs must be torqued before replacing remaining existing bolts with remaining studs.</li> <li>If interference exists between attachment lugs of bracket 145187 (32) of bracket 145290 (25) and the customer connect support bracket 601912, bracket 145187 may be reworked as outlined in section VI.</li> </ul>			
	Bolts must be lubricated with thread compound Fel-Pro C-5A (Felt Products).				26	145275	1	Bracket
	NAS1006-3H	2	Bolt 68 ±7		Attaches to wrap-around lines support bracket.			
	RD153-5004-0006	2	Washer	27	145252-3 (Sheet 6.)	2	Stud	
	NOTE							
	The following parts groups are part of frame (18). Fasteners must be torqued following installation.							
	RD111-1010-6430	1	Bolt					
	RD153-9001-0002	1	Washer					
	LD153-0010-0009	1	Washer					
	RD114-8003-1004	1	Nut 1-7 <sup>(a)</sup>					
	Attaches bracket (20) to frame (21).							
	RD111-1010-6429	1	Bolt					
	RD153-5004-0004	1	Washer					
	LD153-0010-0010	1	Washer					
	RD114-8003-1004	1	Nut 1-7 <sup>(a)</sup>					
	Attaches arm (23) to frame (22).							

(a) Above running torque.

(b) A component of an assembly.

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 20 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145290 (Cont)			37	145318	2	Bracket
28	145252-5	2	Stud	38	145271	1	Bracket
29	145274-1 (left)	1	Plate	NOTE			
30	145274-2 (right)	1	Plate	Bolts at each end are used for length adjustment.			
31	145303	4	Washer	39	145299	1	Bracket
	RD153-5002-0004 <sup>(b)</sup>	8	Washer	Attaches to oxidizer dome.			
	NAS679C4W <sup>(b)</sup>	8	Nut 68 ±7		RD111-4010-0408	1	Bolt 68 ±7
NOTE					RD153-5004-0004	1	Washer
Washers (31) must be recessed in plates (29, 31) before nuts are torqued.				40	145298	1	Bracket
32	145187	1	Bracket	NOTE			
	Attaches to channel (33).			The following part groups are part of bracket (25). Fasteners must be torqued following installation.			
32A	145273	1	Bracket		NAS1005-38A	1	Bolt
	Attaches to bracket (33).				RD153-5004-0005	1	Washer
	NAS333CPA4 <sup>(b)</sup>	3	Bolt		RD153-1002-0005	1	Washer
33	145270	1	Channel		NAS679C5W	1	Nut 68 ±7
	Attaches to bracket (32).			Attaches bracket (36) to bracket (37).			
34	RD111-1006-0305 <sup>(b)</sup>	2	Bolt 68 ±7		NAS333CPA10	2	Bolt
35	RD111-1007-0305 <sup>(b)</sup>	2	Bolt 68 ±7		RD153-1002-0003	2	Washer
	RD153-9003-0002 <sup>(b)</sup>	4	Washer		NAS679C3W	2	Nut 40 ±5
NOTE				Attaches channel (33) to bracket.			
Bolts must be lubricated with thread compound Fel-Pro C-5A (Felt Products).					NAS1003-12A	2	Bolt
36	145237	1	Bracket		RD153-5004-0003	2	Washer
	Attaches to oxidizer dome-to-valve flange boltheads.				LD153-0010-0008	2	Washer
	RD111-1007-0506	2	Bolt 68 ±7		NAS679C3W	2	Nut 27 ±3
	LD153-0013-0003	2	Washer	Attaches channel (33) to bracket (32).			
NOTE					NAS1004-12A	4	Bolt
Bolts must be lubricated with thread compound Fel-Pro C-5A (Felt Products).					RD153-5004-0004	4	Washer
					RD153-1002-0004	4	Washer
					NAS679C4W	4	Nut 68 ±7
				Attaches bracket (32) to bracket (26).			

(b) A component of an assembly.

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 21 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
145290 (Cont)				NOTE			
	NAS1004-16A	4	Bolt	The frame may be disassembled, as necessary, for convenience of installation.			
	RD153-9001-0002	8	Washer	● If interference exists between bracket 145103 (49) and the spherical bearing on the thrust chamber, or between coupling 145268 (50) and customer bracketry, the bracket or coupling may be reworked as outlined in section VI.			
	NAS679C4W	2	Nut 68 ±7	● Parts (42 through 55) are detailed parts of this assembly.			
	Attaches bracket (37) to bracket (38).			42	145476	1	Stiffener
	NAS1004-16A	2	Bolt	43	145251	1	Support
	RD153-9001-0002	4	Washer	Attaches to oxidizer dome bolt-heads numbered 8 and 40 on dome.			
	NAS679C4W	2	Nut 68 ±7		RD111-1009-6610	2	Bolt
	Attaches bracket (37) to bracket (38).				LD153-0013-0004	2	Washer
	NAS1004-10A	2	Bolt	NOTE			
	RD153-5004-0004	2	Washer	Bolts must be lubricated with thread compound Fel-Pro C-5A (Felt Products) and torqued to 5-10 <sup>(a)</sup> inch-pounds; also used to install cocoon insulator. Final torque is 150 ±15 inch-pounds.			
	RD153-9001-0002	2	Washer	44	145441	1	Stiffener
	RD153-1003-0008	2	Washer	45	145459	1	Bracket
	NAS679C4W	2	Nut 68 ±7	46	145608	1	Bracket
	Attaches bracket (37) to bracket (38).			Attaches to gimbal actuator strut.			
	NAS1005-38A	1	Bolt		RD127-7008-0406 <sup>(b)</sup>	2	Clamp 50 ±5
	RD153-5004-0005	1	Washer	47	145412	1	Stiffener
	RD153-1002-0005	1	Washer	Attaches to No. 1 fuel valve flange bolt-heads.			
	NAS679C5W	1	Nut 68 ±7		NAS1005-13H	2	Bolt 68 ±7
	Attaches bracket (37) to channel (33).				RD153-9004-0002	2	Washer
	NAS1004-17A	1	Bolt	NOTE			
	RD153-1002-0004	1	Washer	Bolts must be lubricated with thread compound Fel-Pro C-5A (Felt Products).			
	RD153-5004-0004	1	Washer				
	NAS679C4W	1	Nut 68 ±7				
	Attaches bracket (39) to bracket (40).						
	AREM-4SP19	1	Rod				
	RD114-1009-1003	1	Nut 27 ±3				
	NAS1004-8A	3	Bolt 85 ±5				
	RD153-5004-0004	3	Washer				
	Attaches bracket (40) to bracket (39) and bracket (32).						
41	145477 (Sheets 1 and 7.)	1	Frame				
	Attaches to oxidizer dome bolt-heads, tooling ring and fuel line flange.						
(a) Above running torque.							
(b) A component of an assembly.							

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 22 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145477 (Cont)				NAS679C4W	2	Nut 27 ±3
48	145609	1	Bracket		Attaches bracket (43) to stiffener (44).		
49	145103	1	Bracket		NAS1004-7A	4	Bolt
	Attaches to oxidizer dome bolt-heads.				RD153-9003-0001	4	Washer
	RD111-1009-6610	2	Bolt		LD153-0010-0009	4	Washer
	LD153-0013-0004	2	Washer		NAS679C4W	4	Nut 68 ±7
					Attaches bracket (45) to stiffener (44).		
					NAS1003-25A	2	Bolt
					RD153-9003-0002	4	Washer
					LD153-0010-0002	2	Washer
					NAS679C3W	2	Nut 27 ±3
					Attaches bracket (46) to stiffener (44).		
50	145268	1	Coupling		NAS1004-18A	2	Bolt
51	145267	1	Support		RD153-1002-0004	2	Washer
52	145266	1	Coupling		RD153-9004-0001	2	Washer
	Attaches at thrust chamber tooling ring holes (35, and 39).				RD114-8003-1004	2	Nut 45 ±5
					Attaches stiffener (47) to stiffener (42).		
	NAS1006-11A	2	Bolt		NAS1004-32A	2	Bolt 1-7 <sup>(a)</sup>
	LD153-0010-0014	2	Washer		RD153-1002-0004	6	Washer
	RD153-5004-0006	2	Washer		RD153-5004-0004	2	Washer
	NAS679C6	2	Nut 68 ±7		NAS679C4W	2	Nut
					Attaches bracket (49) to coupling (50).		
53	145060	1	Bracket		NAS1006-66A	1	Bolt 1-7 <sup>(a)</sup>
54	145465	1	Bracket		RD153-5004-0006	1	Washer
55	145469	1	Rod		RD153-1002-0006	2	Washer
					NAS679C6	1	Nut
					Attaches coupling (50) to support (51) and bracket (53).		
					NAS1297-5-33	2	Bolt
					RD153-5004-0006	2	Washer
					RD153-1002-0005	2	Washer
					NAS679C5	2	Nut 27 ±3 <sup>(a)</sup>
					Attaches support (51) to coupling (52).		

## NOTE

Bolts must be lubricated with thread compound Fel-Pro C-5A (Felt Products) and torqued to 5-10 inch-pounds<sup>(a)</sup>; also used to install cocoon insulator. Final torque is 150 ±15 inch-pounds.

## NOTE

The following part groups are part of bracket (41). Fasteners must be torqued following installation.

NAS1004-23A	2	Bolt
RD153-9003-0001	4	Washer
LD153-0010-0009	2	Washer

(a) Above running torque.

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 23 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145477 (Cont)						
	145265	1	Bushing				b. Remove and discard inboard trunnion nut. Leave trunnion nut washer installed.
	RD153-9004-0002	2	Washer				c. Remove outboard trunnion nut and washer and retain for installation.
	RD114-8003-1005	1	Nut 27 ±3				d. Disassemble frame (56) by removing plate (76) and bracket (77) from bracket (64). Retain hardware for installation. See sheets 8 and 9 for part locations.
	Attaches bracket (54) to bracket (49).						e. Install bracket (74) at inboard side of trunnion and retain with nut (78). Using wrench G4086 (figure 4-3), torque nut to 825 ±10 inch-pounds.
	NAS1004-13A	2	Bolt				<b>CAUTION</b>  The cylindrical portion of nut must be engaged in hole of bracket before tightening.  f. Make sure a minimum gap or 0.040 inch exists on both sides of bracket (74), between bracket and shoulder of nut (78), and between bracket and existing washer.  g. Install collar (75) at outboard side of trunnion and reinstall trunnion washer and nut. Torque nut to 825 ±10 inch-pounds.  h. Remove clamp (71) and retain clamp and hardware for installation.  i. Remove bracket (85) with brace (84) attached. Retain assembly and hardware for installation.  j. Install remaining portion of frame (56) by securing bracket (64) between plate (76) and bracket (77). Secure with hardware retained in step d.
	LD153-0013-0002	2	Washer				
	RD153-1002-0004	2	Washer				
	RD114-8003-1004	2	Nut 30 ±3				
	Attaches rod ends at bracket (54) and bracket (45).						
	KE4-22	1	Rod End				
	KEL4-22	1	Rod End				
	RD114-1009-0003	1	Nut 27 ±3				
	RD114-1009-1003	1	Nut 27 ±3				
	Attaches to rod (55).						
56	145498 (Sheets 2, 8, and 9.)	1	Frame				
	<b>NOTE</b>						
	Parts (57 through 67, 69 through 77, and 79 through 85) are detailed parts of this assembly. Plate (68) and nut (78) are included for sequence purposes.						
	<ul style="list-style-type: none"> <li>• This assembly requires alignment with assemblies (86, 102, 125, and 151). The following procedure installs and aligns these assemblies: (Each assembly must be attached as specified, using only the indicated hardware. Installation is completed after alignment.)</li> <li>• Steps a through m install frame (56). See sheet 2 for location and sheets 8 and 9 for details.</li> </ul>						
	a. Disconnect fuel drain line inboard of No. 1 side turbopump trunnion.						
	<b>NOTE</b>						
	Fasteners securing plate (76) and bracket (77) must be loosened before tightening fasteners securing bracket (64) between them.						

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 24 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)																																																												
<p>k. Using 3 bolts NAS1005-4H and 3 washers RD153-9004-0002, attach bracket (66) (sheet 8) to fuel line flange. Torque bolts to 68 ±7 inch-pounds.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>Frame may be temporarily supported at oxidizer valve flange until attached at fuel line flange.</p> <p>l. Install fuel drain line and torque coupling nut to 420-600 inch-pounds.</p> <p>m. Loosely install clamp (71). Reinstall bracket (85).</p> <p style="text-align: center;"><b>NOTE</b></p> <p>Step n installs bracket 145496 (86). See sheet 2 for location and sheet 10 for details.</p> <p>n. Disassemble bracket (88) from assembly (86). Using 4 bolts NAS1004-6A, 4 washers RD153-9004-0001, 4 washers RD153-1002-0004, and 4 nuts NAS679C4W, loosely install bracket (88) to the plate of the thrust chamber. Retain disassembled hardware for reassembly. Do not attach other portions of the bracket.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>Steps o through s install a part group at the No. 2 side turbo-pump trunnion consisting of parts (74, 75, 78, and 94 through 101). See sheet 3 for locations and sheets 11 and 12 for details.</p> <p>o. Remove trunnion nuts at No. 2 side. Leave inboard washer installed, discard inboard nut, and retain outboard nut and washer.</p> <p>p. Install bracket (74) at inboard side of trunnion and retain with nut (78). Using wrench G4086 (figure 4-3), torque nut to 825 ±10 inch-pounds.</p>				<p style="text-align: center;"><b>CAUTION</b></p> <p>Ensure that cylindrical portion of nut is engaged in hole of bracket before tightening.</p> <p>q. Ensure that a minimum gap of 0.040 inch exists on both sides of bracket (74), between bracket and shoulder of nut (78), and between bracket and existing washer.</p> <p>r. Install collar (75) at outboard side of trunnion. Reinstall trunnion washer and nut. Torque nut to 825 ±10 inch-pounds.</p> <p>s. Install parts (94 through 101) using the following hardware groups: (Clamp (99) shall be loosely installed.)</p> <table border="0"> <tr> <td>94</td> <td>145432-2</td> <td>1</td> <td>Bracket</td> </tr> <tr> <td></td> <td>RD111-1009-0412</td> <td>2</td> <td>Bolt 68 ±7</td> </tr> <tr> <td></td> <td>LD153-0013-0002</td> <td>2</td> <td>Washer</td> </tr> <tr> <td></td> <td>RD153-9004-0001</td> <td>2</td> <td>Washer</td> </tr> <tr> <td></td> <td colspan="3">Attaches to bracket (74).</td> </tr> <tr> <td>95</td> <td>145471-2</td> <td>1</td> <td>Bracket</td> </tr> <tr> <td></td> <td>RD111-1009-0416</td> <td>4</td> <td>Bolt 68 ±7</td> </tr> <tr> <td></td> <td>LD153-0013-0002</td> <td>4</td> <td>Washer</td> </tr> <tr> <td></td> <td colspan="3">Attaches to collar (75).</td> </tr> <tr> <td>96</td> <td>145601</td> <td>1</td> <td>Bracket</td> </tr> <tr> <td></td> <td>NAS1004-7A</td> <td>6</td> <td>Bolt</td> </tr> <tr> <td></td> <td>LD153-0013-0002</td> <td>6</td> <td>Washer</td> </tr> <tr> <td></td> <td>RD153-1002-0004</td> <td>6</td> <td>Washer</td> </tr> <tr> <td></td> <td>RD114-8003-1004</td> <td>6</td> <td>Nut 68 ±7</td> </tr> <tr> <td></td> <td colspan="3">Attaches to plate (94) and bracket (95).</td> </tr> </table> <p style="text-align: center;"><b>NOTE</b></p> <p>Fasteners attaching bracket (94) and bracket (95) must be loosened before torquing fasteners attaching bracket (96) between them.</p>				94	145432-2	1	Bracket		RD111-1009-0412	2	Bolt 68 ±7		LD153-0013-0002	2	Washer		RD153-9004-0001	2	Washer		Attaches to bracket (74).			95	145471-2	1	Bracket		RD111-1009-0416	4	Bolt 68 ±7		LD153-0013-0002	4	Washer		Attaches to collar (75).			96	145601	1	Bracket		NAS1004-7A	6	Bolt		LD153-0013-0002	6	Washer		RD153-1002-0004	6	Washer		RD114-8003-1004	6	Nut 68 ±7		Attaches to plate (94) and bracket (95).		
94	145432-2	1	Bracket																																																																
	RD111-1009-0412	2	Bolt 68 ±7																																																																
	LD153-0013-0002	2	Washer																																																																
	RD153-9004-0001	2	Washer																																																																
	Attaches to bracket (74).																																																																		
95	145471-2	1	Bracket																																																																
	RD111-1009-0416	4	Bolt 68 ±7																																																																
	LD153-0013-0002	4	Washer																																																																
	Attaches to collar (75).																																																																		
96	145601	1	Bracket																																																																
	NAS1004-7A	6	Bolt																																																																
	LD153-0013-0002	6	Washer																																																																
	RD153-1002-0004	6	Washer																																																																
	RD114-8003-1004	6	Nut 68 ±7																																																																
	Attaches to plate (94) and bracket (95).																																																																		

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 25 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
97	145615	1	Attaches to bracket (96). Tongue	<p style="text-align: center;">NOTE</p> <p>Frame may be temporarily supported at No. 1 oxidizer valve flange until attached at fuel line flange.</p>			
	NAS1004-30A	2	Bolt				
	RD153-9004-0001	4	Washer				
	RD114-8003-1004	2	Nut 27 ±3				
98	145493	1	Attaches to turbopump support strut tongue (97). Clamp	<p>u. Remove HI-LOK pins HL30-8-9 and collars HL194-W-8 from interface panel and attach bracket (124) to the interface panel, using one bolt NAS1004-26A, one bolt NAS1004-14A, 2 washers LD153-0013-0002, 2 washers RD153-1002-0004, and 2 nuts RD114-8003-1004. Torque nuts to 68 ±7 inch-pounds. (See sheet 12, detail H-H.)</p> <p style="text-align: center;">NOTE</p> <p>Step v installs stiffener (151). See sheets 3 and 15 for location.</p> <p>v. Install stiffener (151) and secure to brackets (64) and (96), using following hardware:</p>			
	NAS1004-10A	1	Bolt				
	RD153-9004-0001	1	Washer				
	RD153-1002-0004	1	Washer				
	RD114-8003-1004	1	Nut 68 ±7				
99	145626	1	Attaches to turbopump support strut, clamp (98), and bracket (101). Clamp	<p>NAS1005-27A            2       Bolt</p> <p>NAS1005-20A           2       Bolt</p> <p>LD153-0013-0003       4       Washer</p> <p>RD153-1002-0005       4       Washer</p> <p>RD114-8003-1005       4       Nut 1-7(a)</p> <p>Attaches to bracket (64).</p>			
	RD111-4008-3413	4	Bolt 68 ±7				
	LD153-0013-0002	4	Washer	<p>NAS1004-29A           3       Bolt</p> <p>LD153-0013-0002       3       Washer</p> <p>RD153-1002-0004       3       Washer</p> <p>RD114-8003-1004       3       Nut 1-7(a)</p> <p>Attaches to bracket (96).</p>			
100	145616	1	Attaches to bracket (101). Plate				
	NAS1004-9A	2	Bolt	<p>Attaches to bracket (64).</p>			
	LD153-0013-0002	2	Bolt				
	RD153-1002-0004	2	Washer				
	RD114-8003-1004	2	Nut 68 ±7				
101	145454	1	Attaches to clamp (98). Bracket				
	NAS1004-32A	2	Bolt	<p>Attaches to bracket (96).</p>			
	RD153-9004-0001	4	Washer				
	NAS1057T4-117	2	Spacer				
	RD114-8003-1004	2	Nut 27 ±3				
NOTE							
Steps t and u install frame (102). See sheet 3 for location and sheets 11 and 12 for details.							
t. Install frame and, using 3 bolts NAS1005-4H and 3 washers RD153-9004-0002, attach bracket (111) of frame at the No. 2 fuel line flange. Torque bolts to 68 ±7 inch-pounds.							
(a) Above running torque.							

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 26 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
w.	(Deleted)						
wA.	Prepare support bow (125) for installation by adjusting the following indexed items to the lengths indicated. Dimensions given are between centerlines of rod end bolts. Make sure rod ends are properly oriented as shown in the noted details prior to torquing and safetywiring jamnuts.						
	(1) Tube (140A), detail L-L:	5.24 ±0.03					
	inch.						
	(2) Tube (133), detail M-M:	5.25 ±0.03					
	inch.						
	(3) Tube (138), detail K-K:	5.75 ±0.03					
	inch.						
	(4) Tube (117) and bracket (148), detail N-N:	4.28 ±0.03					
	inch.						
x.	See sheet 15 and install bow (125) and secure intercostals (129, 131) to frame (151), using the following hardware groups:						
	NAS1004-17A	1	Bolt				
	RD153-5004-0004	1	Washer				
	RD153-1002-0004	1	Washer				
	RD114-8003-1004	1	Nut 1-7 <sup>(a)</sup>				
	Attaches frame (151) to intercostal (131) of bracket (125).						
	<sup>(a)</sup> Above running torque.						
	NAS1004-19A	1	Bolt				
	RD153-1002-0004	1	Washer				
	LD153-0010-0009	1	Washer				
	RD114-8003-1004	1	Nut 1-7 <sup>(a)</sup>				
	Attaches frame (151) to intercostal (129) of bracket (125).						
	xA. Connect attach feature for tubes, adjusted in step wA, to the engine, using the following attaching hardware:						
	RD111-1010-0415	1	Bolt 68 ±7				
	LD153-0013-0002	1	Washer				
	Attaches bracket (141) for tube (140A) to turbopump.						
	NAS1004-4H	1	Bolt 68 ±7				
	LD153-0013-0002	1	Washer				
	Attaches rod end for tube (133) to turbopump.						
	NOTE						
	Bolts must be lubricated with thread compound Fel-Pro C-5A (Felt Products).						
	NAS1004-2H	2	Bolt 68 ±7				
	LD153-0013-0002	2	Washer				
	Attaches bracket (139) for tube (138) to turbopump.						
	NOTE						
	Bolts must be lubricated with thread compound Fel-Pro C-5A (Felt Products).						

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 27 of 44)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	NAS1004-5A	1	Bolt 68 ±7		RD111-1016-0406	2	Bolt 68 ±7
	LD153-0013-0002	1	Washer		LD153-0013-0002	2	Washer
	Attaches bracket (148) for tube (117) to turbopump.				Attaches bracket (113) to stiffener (126).		
	NOTE				NOTE		
	Bolts must be lubricated with Fel-Pro C5 (Felt Products).				If stiffener (126) is not equipped with nut plates, use two washers RD153-1002-0004 and two nuts RD114-8003-1004 with listed bolts and washers.		
	xB. Secure brackets (144) for tubes (114, 117) to turbopump. (See details L-L and N-N.) Adjust tube lengths, as necessary, to maintain alinement of support bow. Torque nuts for brackets (144) to 68 ±7 inch-pounds.			127	RD111-1016-0405	2	Bolt 68 ±7
	y. Secure stiffeners (126 and 127) of bow (125) to frames (56 and 102), using the following hardware groups: (See sheets 9 and 11 for details. Details C-C and F-F apply to stiffener (126). Details D-D and G-G apply to stiffener (127).			(Ref)	Attaches at plate of intercostal (63).		
126	RD111-1016-0405	2	Bolt 68 ±7		NAS1004-15A	4	Bolt
(Ref)	Attaches plates of frame (56).				LD153-0013-0002	4	Washer
	NAS1004-16A	4	Bolt		LD153-0010-0010	4	Washer
	LD153-0013-0002	4	Washer		NAS679C4W	4	Nut 1-7(a)
	RD153-1002-0004	4	Washer		Attaches stiffener (127) at intercostal (63).		
	RD114-8003-1004	4	Nut 68 ±7		RD111-1016-0407	4	Bolt
	Attaches stiffener (126) to stiffener (62) and intercostal (63).				LD153-0013-0002	4	Washer
	RD111-1016-0405	2	Bolt 68 ±7		LD153-0010-0010	4	Washer
	RD153-5005-0005	2	Washer		NAS679C4W	4	Nut 68 ±7
	NAS679C4W	2	Nut		Attaches bracket (81) to stiffener (127).		
	Attaches bracket (82) to plate of frame.				NOTE		
	NAS1004-21A	4	Bolt		Replaces existing attaching hardware for bracket (81).		
	LD153-0013-0002	4	Washer		RD111-1016-0405	2	Bolt 68 ±7
	LD153-0010-0010	4	Washer		Attaches at plate of stiffener (103).		
	NAS679C4W	4	Nut 1-7(a)		NAS1004-21A	4	Bolt
	Attaches stiffener (126) at stiffener (103) and stiffener (107).				LD153-0013-0002	4	Washer
					LD153-0010-0010	4	Washer
					NAS679C4W	4	Nut 1-7(a)
					Attaches stiffener (127) to stiffener (103).		

(a) Above running torque.

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 28 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	RD111-1016-0407	2	Bolt				
	LD153-0013-0002	2	Washer				
	RD153-1002-0004	2	Washer				
	RD114-8003-1004	2	Nut 68 ±7				
	Attaches bracket (116) to stiffener (127).						
	z. (Deleted)						
	aa. Install Thermal Insulation Reference Tool G4084 (figure 4-3) by removing bolts attaching brackets (141, 148) to fuel inlet bracket aft of lube control valve. Check that the higher portion of tool indicator leg faces aft, then position tool over inlet bosses and, using bolts that were removed, secure tool and brackets (141, 148) to fuel inlet. Tighten bolts to prevent movement of tool, but do not torque bolts to full torque.						ae. Check that a minimum gap of 0.040 inch exists on both sides of brackets (74) between bracket and washer at each trunnion area. Check that serrations are aligned, and retorquer bolts loosened in steps ab and ac.
	ab. See detail B-B, sheet 9, and loosen bolts attaching collar (75) to bracket (77) and bracket (74) to plate (76) at No. 1 side trunnion area.						af. See sheet 11 and adjust frame (102) for fore and aft location by adjusting angle (110) and brackets (111, 108) until aft edge of stiffener (104) is within 3.500 ±0.125 inches from centerline of forward side of gas generator fuel supply line flange. Torque fasteners to maintain frame alignment.
	ac. See sheet 11 and loosen bolts attaching collar (75) to bracket (95) and bracket (74) to bracket (94) at No. 2 trunnion area.						ag. See sheet 8 and secure frame (56) by torquing fasteners through angle (67) at stiffener (61) and fasteners at bracket (68) and plate (69).
	ad. Slide complete frame assembly across the engine in the direction required to align rivet heads in stiffener (126) and frame (151) with holes in reference tool. Rivet heads must align with holes within ±0.125 inch.						ah through am. (Deleted)
							an. Starting with frame (56) of listed parts on sheet 30, progressively connect remaining bracket attach points to engine and torque all attaching and assembly fasteners as indicated.
							CAUTION
							Aligned positions must not be disturbed during torquing.
							ao. Remove reference system and reinstall bolts at brackets (141, 148). Torque bolts to 68 ±7 inch-pounds.

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 29 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145498 (Cont)			70	145624	1	Bracket
57	145415	1	Stiffener	71	145606	1	Clamp
58	145410	1	Stiffener		(Sheet 8, detail A-A.)		
59	145416	1	Intercostal	72	145607	1	Channel
60	145413	1	Stiffener	73	145605	1	Block
61	145404	1	Stiffener	74	145446	1	Bracket
62	145409	1	Stiffener		(Sheet 9, detail B-B.)		
63	145417	1	Intercostal	75	145445	1	Collar
64	145474	1	Bracket	76	145432-1	1	Plate
65	145603	1	Bracket	77	145632	1	Bracket
66	145620 Attaches to fuel line flange boltheads.	1	Bracket	78	145630	1	Nut 825 ±10
	NAS1005-4H	3	Bolt 68 ±7	79	145450	1	Bracket
	RD153-9004-0002	3	Washer		(Sheet 9, detail D-D.) Attaches to fuel inlet elbow.		
	NOTE				NAS1004-4H	2	Bolt 68 ±7
	Lubricate bolts with Fel-Pro C5 (Felt Products).				LD153-0013-0002	2	Washer
67	145621	1	Angle	80	145279-5	1	Tube
68	145617 Attaches to oxidizer line flange boltheads.	1	Bracket	81	145457	1	Bracket
	NAS1005-4H	2	Bolt 68 ±7	82	145456	1	Bracket
	LD153-0013-0003	2	Washer		(Sheet 9, detail C-C.)		
	NOTE						
	Lubricate bolts with Fel-Pro C5 (Felt Products).						
69	145618 (Sheet 8.)	1	Plate				

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 30 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145498 (Cont)				KE4-22	1	Rod End
83	145466 Attaches to fuel inlet elbow.	1	Bracket		KEL4-22	1	Rod End
	NAS1004-3H	3	Bolt 68 ±7		Attaches to tube (80).		
	LD153-0013-0002	3	Washer		RD114-1009-1003	1	Nut 27 ±3
					RD114-1009-0003	1	Nut 27 ±3
	NOTE				NAS1004-6A	4	Bolt
	Replaces existing bolt RD111-4010-6408.				LD153-0013-0002	4	Washer
84	145458	1	Brace		RD153-1002-0004	4	Washer
	(Sheet 9, detail E-E.) Attaches to tooling rings.				RD114-8003-1004	4	Nut 68 ±7
	RD111-1010-6624	2	Bolt		Attaches bracket (81) to intercostal (63).		
	LD153-0013-0004	2	Washer		NAS1006-9A	1	Bolt
	RD153-1002-0006	4	Washer		LD153-0013-0004	1	Washer
	RD114-8003-1006	2	Nut 150 ±15		RD153-9004-0003	1	Washer
	Attaches to aft tooling ring holes (11) and (12).				RD114-8003-1006	1	Nut 150 ±15
	RD111-1010-6624	2	Bolt		Attaches bracket (82) to bracket (83).		
	LD153-0013-0004	2	Washer		RD111-1016-0405	2	Bolt
	RD153-1002-0006	4	Washer		RD153-5005-0005	2	Washer
	RD114-8003-1006	2	Nut 150 ±15		NAS679C4W	2	Nut 68 ±7
	Attaches to forward tooling ring holes (11) and (12).				Attaches bracket (82) to stiffener (62) and intercostal (63).		
85	145494	1	Bracket		RD111-1009-0411		Bolt 68 ±7
					NAS1004-4A	2	Bolt 68 ±7
	NOTE				LD153-0013-0002	2	Washer
	The following part groups are part of frame (56). Fasteners must be torqued following installation and alinement.				Attaches block (73) to bracket (64).		
	NAS1004-13A	2	Bolt		NOTE		
	LD153-0013-0002	2	Washer		Bolts RD111-1009-0411 subsequently replace bolts NAS1004-4A. Bolts NAS1004-4A must be lubricated with Fel-Pro C5 (Felt Products).		
	RD153-1002-0004	2	Washer				
	RD114-8003-1004	2	Nut 15 ±2				
	Attaches tube (80) to bracket (79) and bracket (81).						

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 31 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
145498 (Cont)				NOTE			
	RD111-1009-0442		Bolt 27 ±3	Bolts RD111-1009-0416 may be substituted. Bolts NAS1004-8H must be lubricated with Fel-Pro C5 (Felt Products).			
	NAS1004-51H	2	Bolt 27 ±3				
	LD153-0013-0002	2	Washer				
	Attaches clamp (71) to channel (72).						
NOTE							
Bolts RD111-1009-0442 subsequently replace bolts NAS1004-51H. Bolts NAS1004-51H must be lubricated with Fel-Pro C5 (Felt Products).							
	NAS1004-8A	3	Bolt	NAS1004-14A	2	Bolt	
	LD153-0013-0002	3	Washer	LD153-0013-0002	2	Washer	
	RD153-1002-0004	3	Washer	RD153-1002-0004	2	Washer	
	RD114-8003-1004	3	Nut 68 ±7	RD114-8003-1004	2	Nut 1-7(a)	
	Attaches plate (76) to bracket (64).			NAS1004-42A	1	Bolt	
	NAS1004-12A(c)	3	Bolt	LD153-0013-0002	1	Washer	
	RD111-1010-6420(d)			RD153-1002-0004	1	Washer	
	LD153-0013-0002	3	Washer	RD114-8003-1004	1	Nut 1-7(a)	
	RD153-1002-0004	3	Washer	Attaches stiffener (60) to bracket (64).			
	RD114-8003-1004	3	Nut 68 ±7	NAS1004-24A	1	Bolt	
	Attaches bracket (77) to bracket (64).			LD153-0013-0002	1	Washer	
	NAS1004-5H	2	Bolt 68 ±7	RD153-1002-0004	1	Washer	
	RD153-9004-0001	2	Washer	RD114-8003-1004	1	Nut 1-7(a)	
	Attaches plate (76) to bracket (74).			Attaches stiffener (60) to bracket (64).			
NOTE				NAS1004-42A	2	Bolt	
Bolts RD111-1009-0412 may be substituted. Bolts NAS1004-5H must be lubricated with Fel-Pro C5 (Felt Products).				LD153-0013-0002	2	Washer	
	NAS1004-8H	4	Bolt 68 ±7	RD153-1002-0004	2	Washer	
	LD153-0013-0002	4	Washer	RD114-8003-1004	2	Nut 1-7(a)	
	Attaches bracket (77) to collar (75).			NAS1004-14A	2	Bolt	
				LD153-0013-0002	2	Washer	
				RD153-1002-0004	2	Washer	
				RD114-8003-1004	2	Nut 1-7(a)	
				Attaches bracket (64) to stiffener (62).			
				NAS1004-17A	2	Bolt	
				RD153-9004-0001	4	Washer	
				RD114-8003-1004	2	Nut 27 ±3	
				Attaches bracket (70) to intercostal (59).			
				NAS1004-10A	2	Bolt	
				LD153-0013-0002	2	Washer	
				RD153-1002-0004	2	Washer	
				MS20500-428	2	Nut 68 ±7	
				Attaches bracket (68) to bracket (70).			

(a) Above running torque.  
 (c) Used on thermal insulation sets 12-1 through 15-6.  
 (d) Used on thermal insulation sets 15-7 and subsequent.

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 32 of 44)

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Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145498 (Cont)				NOTE		
	NAS1004-18A	4	Bolt		Bolts RD111-1009-0412 subsequently replace bolts NAS1004-5H. Bolts NAS1004-5H require lubricating with Fel-Pro C5 (Felt Products).		
	RD153-9004-0001	8	Washer		NAS1004-6A	4	Bolt
	RD114-8003-0004	4	Nut 27 ±3		RD153-9004-0001	4	Washer
	Attaches bracket (67) to stiffener (61).				RD153-1002-0004	4	Washer
	NAS1004-6A	3	Bolt		NAS679C4W	4	Nut 68 ±7
	LD153-0013-0002	3	Washer		Attaches to thrust chamber plate.		
	RD153-9004-0001	3	Washer	89	145414	1	Beam
	RD114-8003-1004	3	Nut 68 ±7	90	145483	1	Panel
	Attaches brace (84) to bracket (85).			91	145629	1	Bracket
	NAS1004-12A	4	Bolt		Attaches to gimbal actuator strut.		
	LD153-0013-0002	4	Washer		NOTE		
	RD153-9004-0001	4	Washer		Disassembly required to install.		
	NAS679C4W	4	Nut 68 ±7	92	145279-47	1	Tube
	Attaches bracket (85) to stiffener (58).			93	145602	1	Clevis
	RD111-1009-0411		Bolt 68 ±7		Attaches to thrust chamber tooling ring hole (23).		
	NAS1004-4H	4	Bolt 68 ±7		NOTE		
	LD153-0013-0002	4	Washer		The following part groups are part of support (86). Torque shall be applied following installation and alinement.		
	Attaches bracket (66) to angle (67).				NAS1006-10A	2	Bolt
	NOTE				LD153-0013-0004	2	Washer
	Bolts RD111-1009-0411 subsequently replace bolts NAS1004-4H. Bolts NAS1004-4H require lubricating with Fel-Pro C5 compound (Felt Products).				RD153-1002-0006	2	Washer
86	145496 (Sheets 2 and 10.)	1	Support		RD114-8003-1006	2	Nut 150 ±15
	Attaches to thrust chamber plate, gimbal strut, and frame (56).				NOTE		
	NOTE				The following part groups are part of support (86). Torque shall be applied following installation and alinement.		
	Parts (87 through 93) are detailed parts of this assembly.				NAS1003-2A	2	Bolt 27 ±3
87	145604	1	Beam		NAS1003-3A	2	Bolt 27 ±3
88	145443	1	Bracket		LD153-0013-0001	4	Washer
	RD111-1009-0412		Bolt 68 ±7		Attaches beam (89) to beam (87).		
	NAS1004-5H	4	Bolt 68 ±7				
	RD153-9004-0001	4	Washer				
	Attaches bracket (88) to frame (56).						

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 33 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
145496 (Cont)				NOTE			
	NAS1101C3-10	6	Screw 27 ±3	The following part groups (74, 75, 78, and 94 through 101) are installed at the No. 2 side turbo-pump trunnion during installation, in preparation for alinement. (See sheets 3 and 11.)			
	RD153-5004-0003	6	Washer				
	Attaches panel (90) to beam (87).			74	145446 (Sheets 3 and 11.)	1	Bracket
	NAS1004-5A	4	Bolt 27 ±3	Attaches at inboard side of trunnion.			
	RD153-9004-0001	4	Washer				
	Attaches beam (87) to bracket (88).			75	145445	1	Collar
	NAS1004-18A	4	Bolt	Attaches at outboard side of trunnion.			
	LD153-0013-0002	8	Washer				
	RD114-8003-1004	4	Nut 68 ±7				
	Joins parts of bracket (91).			78	145630	1	Nut 825 ±10
	NAS1004-32A	2	Bolt	Attaches at inboard end of trunnion pin.			
	RD153-9004-0001	2	Washer				
	RD114-8003-1004	2	Nut 27 ±3				
	Attaches bracket (91) to beam (89).			94	145432-2	1	Bracket
	RD114-1009-1003	1	Nut 27 ±3	Attaches to bracket (74).			
	RD114-1009-0003	1	Nut 27 ±3				
	KE4-22	1	Rod End	RD111-1009-0412	2	Bolt 68 ±7	
	KEL4-22	1	Rod End	RD153-9004-0001	2	Washer	
	Attaches tube (92) to bracket (91) and clevis (93).			95	145471-2	1	Bracket
	NAS1004-10A	1	Bolt	Attaches to collar (75).			
	LD153-0013-0002	1	Washer				
	RD153-9004-0001	1	Washer	RD111-1009-0416	4	Bolt 68 ±7	
	RD114-8003-1004	1	Nut 18	LD153-0013-0002	4	Washer	
	Attaches bracket (91) to tube (92) rod end.			96	145601	1	Bracket
	NAS1004-13A	1	Bolt	Attaches to plate (94) and bracket (95).			
	LD153-0013-0002	1	Washer				
	RD153-1002-0004	1	Washer				
	RD114-8003-1004	1	Nut 27 ±3				
	Attaches clevis (93) to tube (92) rod end.			NAS1004-7A	6	Bolt	
	LD153-0013-0002	1	Washer	LD153-0013-0002	6	Washer	
	RD153-1002-0004	1	Washer	RD153-1002-0004	6	Washer	
	RD114-8003-1004	1	Nut 27 ±3	RD114-8003-1004	6	Nut 68 ±7	

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 34 of 44)

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Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
97	145615	1	Attaches to bracket (96). Tongue	102	145497 (Sheets 3, 11, and 12.)	1	Frame
	NAS1004-30A	2	Bolt	NOTE			
	RD153-9004-0001	4	Washer	Parts (103 through 124) are detailed parts of this assembly.			
	RD114-8003-1004	2	Nut 1-2(a)				
98	145493	1	Attaches to turbopump support strut tongue (97). Clamp	<ul style="list-style-type: none"> <li>When installing frame (102), bracket (112) attaches to plate (100) at the turbopump trunnion, with hardware used to attach the plate to bracket (101).</li> </ul>			
	NAS1004-10A	1	Bolt				
	RD153-9004-0001	1	Washer				
	RD153-1002-0004	1	Washer				
	RD114-8003-1004	1	Nut 68 ±7	103	145411	1	Stiffener
99	145626	1	Attaches to turbopump support strut, clamp (98), and bracket (101). Clamp	104	145403	1	Stiffener
	RD111-4008-3413	4	Bolt 68 ±7	105	145422	1	Stiffener
	LD153-0013-0002	4	Washer	106	145406	1	Stiffener
100	145616	1	Plate	107	145407	1	Stiffener
NOTE				108	145619	1	Attaches to oxidizer line flange bolthead. Bracket
Plate must be assembled with bracket (101).					NAS1005-5H	1	Bolt 68 ±7
	NAS1004-9A	2	Bolt		LD153-0013-0003	1	Washer
	LD153-0013-0002	2	Washer		RD153-9004-0002	1	Washer
	RD153-1002-0004	2	Washer	NOTE			
	RD114-8003-1004	2	Nut 68 ±7	Bolt must be lubricated with Fel-Pro C5 (Felt Products).			
101	145454	1	Attaches to clamp (98). Bracket	<ul style="list-style-type: none"> <li>Serrated washer installs between existing engine bracket and bracket (108).</li> </ul>			
	NAS1004-32A	2	Bolt				
	RD153-9004-0001	4	Washer	109	145623	1	Bracket
	NAS1057T4-117	2	Spacer				
	RD114-8003-1004	2	Nut 27 ±3				

(a) Above running torque.

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 35 of 44)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145497 (Cont)			118	145451 Attaches to fuel inlet elbow.	1	Bracket
110	145621-3	1	Angle		NAS1006-2H	1	Bolt 68 ±7
111	145622 Attaches to fuel line flange boltheads.	1	Bracket		LD153-0013-0004	1	Washer
	NAS1005-4H	3	Bolt 68 ±7		NOTE		
	RD153-9004-0002	3	Washer		Maximum acceptable tilt under bolt-head must not exceed 0.050 inch.		
	NOTE				● Existing bolt RD111-9001-0018 must be removed.		
	Bolts must be lubricated with thread compound Fel-Pro C-5A (Felt Products).			119	145279-5 (Sheet 12, detail G-G.)	1	Tube
112	145425	1	Bracket	120	145452 Attaches to fuel inlet elbow.	1	Bracket
	NOTE				NAS1004-1H	2	Bolt 68 ±7
	Attaches at plate (100) at turbopump trunnion, using existing hardware for plate (100) to bracket (101).				LD153-0013-0002	2	Washer
113	145455 (Sheet 12, detail F-F.)	1	Bracket		NOTE		
114	145279-43	1	Tube		Replaces existing instrumentation bracket bolt.		
115	145482 Attaches to fuel inlet elbow.	1	Bracket	121	145279-23	1	Tube
	NOTE			122	145486	1	Bracket
	Bracket must be installed between instrumentation receptacle support bracket and fuel inlet elbow. The following bolts replace existing engine bolts RD111-4010-6409:			123	145488	1	Bracket
	RD111-4010-6411	4	Bolt 68 ±7	124	145487 Attaches to interface panel.	1	Bracket
	LD153-0013-0002	4	Washer		NAS1004-26A	1	Bolt
116	145453 (Sheet 12, detail G-G.)	1	Bracket		NAS1004-14A	1	Bolt
117	145633	1	Tube		LD153-0013-0002	2	Washer
					RD153-1002-0004	2	Washer
					RD114-8003-1004	2	Nut 68 ±7
					NOTE		
					HI-LOK pins HL30-8-9 and collars HL194-W-8 must be removed from interface panel to obtain holes for bolts.		

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 36 of 44)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
145497 (Cont)					NAS1004-26A	2	Bolt
	KE4-22	1	Rod End		RD153-9004-0001	4	Washer
	KEL4-22	1	Rod End		RD153-1002-0004	2	Washer
	RD114-1009-1003	1	Nut 27 ±3		RD114-8003-1004	2	Nut 27 ±3
	RD114-1009-0003	1	Nut 27 ±3		Attaches bracket (122) to stiffener (103).		
	Attaches to tube (117).				NAS1004-14A	2	Bolt
	NAS1004-13A	2	Bolt		RD153-9004-0001	2	Washer
	LD153-0013-0002	2	Washer		RD153-1002-0004	2	Washer
	RD153-1002-0004	2	Washer		RD114-8003-1004	2	Nut 68 ±7
	RD114-8003-1004	2	Nut 27 ±3 <sup>(a)</sup>		Attaches bracket (122) to bracket (123).		
	Attaches tube (117) rod ends to bracket (116) and bracket (118).				NAS1004-4H	1	Bolt 68 ±7
	KE4-22	1	Rod End		LD153-0013-0002	1	Washer
	KEL4-22	1	Rod End		Attaches bracket (123) to bracket (124).		
	RD114-1009-1003	1	Nut 27 ±3	125	145499 (Sheets 3, 13, and 14.)		1 Support Bow
	RD114-1009-0003	1	Nut 27 ±3		NOTE		
	Attaches to tube (80).				Parts (126 through 150) are detailed parts of this assembly.		
	NAS1004-13A	2	Bolt	126	145405 Attaches to frames (56, 102).	1	Stiffener
	LD153-0013-0002	2	Washer		RD111-1016-0405	2	Bolt 68 ±7
	RD153-1002-0004	2	Washer		Attaches plate of frame (56) to stiffener (126) at bracket (82).		
	RD114-8003-1004	2	Nut 27 ±3 <sup>(a)</sup>		NOTE		
	Attaches tube (80) rod ends to bracket (116) and bracket (120).				A gap exceeding 0.032 inch but less than 0.064 inch requires washer LD153-0010-0009 in the gap and on the bolt.		
	KE4-22	1	Rod End		NAS1004-16A	4	Bolt
	KEL4-22	1	Rod End		LD153-0013-0002	4	Washer
	RD114-1009-1003	1	Nut 27 ±3		RD153-1002-0004	4	Washer
	RD114-1009-0003	1	Nut 27 ±3		RD114-8003-1004	4	Nut 68 ±7
	Attaches to tube (121).				Attaches to stiffener (62) and intercostal (63).		
	NAS1004-13A	2	Bolt				
	LD143-0013-0002	2	Washer				
	RD153-1002-0004	2	Washer				
	RD114-8003-1004	2	Nut 27 ±3 <sup>(a)</sup>				
	Attaches tube (121) rod ends to bracket (120) and bracket (123).						

(a) Above running torque.

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 38 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145499 (Cont)				NAS1004-15A	4	Bolt
	RD111-1016-0405	2	Bolt 68 ±7		LD153-0013-0002	4	Washer
	Attaches plate of frame (102) to stiffener (126).				LD153-0010-0010	4	Washer
	NOTE				NAS679C4W	4	Nut 1-7(a)
	A gap exceeding 0.032 inch but less than 0.064 inch requires washer LD153-0010-0009 in the gap and on the bolt.				Attaches stiffener at intercostal (63).		
	RD111-1016-0405	2	Bolt 68 ±7		RD111-1016-0407	4	Bolt
	RD153-5005-0005	2	Washer		LD153-0013-0002	4	Washer
	Attaches bracket (82) to plate of frame.				LD153-0010-0010	4	Washer
	NAS1004-21A	4	Bolt		NAS679C4W	4	Nut 68 ±7
	LD153-0013-0002	4	Washer		Attaches bracket (81) to stiffener.		
	LD153-0010-0010	4	Washer		NOTE		
	NAS679C4W	4	Nut 1-7(a)		Replaces existing attaching hardware for bracket (81).		
	Attaches to stiffener (103) and stiffener (107).				RD111-1016-0405	2	Bolt 68 ±7
	RD111-1016-0406	2	Bolt 68 ±7		Attaches plate of frame (56) to stiffener (127).		
	LD153-0013-0002	2	Washer		NOTE		
	Attaches bracket (113) to stiffener (126).				A gap exceeding 0.032 inch but less than 0.064 inch requires washer LD153-0010-0009 in the gap and on the bolt.		
	NOTE				NAS1004-21A	4	Bolt
	If stiffener (126) is not equipped with nut plates, two washers RD153-1002-0004 and two nuts RD114-8003-1004 must be used with listed bolts and washers.				LD153-0013-0002	4	Washer
					LD153-0010-0010	4	Washer
					NAS679C4W	4	Nut 1-7(a)
					Attaches to stiffener (103).		
127	145401	1	Stiffener		RD111-1016-0407	2	Bolt
	RD111-1016-0405	2	Bolt 68 ±7		LD153-0013-0002	2	Washer
	Attaches plate at bracket (81).				RD153-1002-0004	2	Washer
	NOTE				RD114-8003-1004	2	Nut 68 ±7
	A gap exceeding 0.032 inch but less than 0.064 inch requires washer LD153-0010-0009 in the gap and on the bolt.				Attaches bracket (116) to stiffener.		
				128	145420	1	Intercostal
				129	145418	1	Intercostal
				130	145421	1	Intercostal

(a) Above running torque.

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 39 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145499 (Cont)			141	145427 Attaches to turbopump.	1	Bracket
131	145419	1	Intercostal		RD111-1010-0415	1	Bolt 68 ±7
132	145426 (Sheet 14, detail J-J.)	1	Bracket		LD153-0013-0002	1	Washer
NOTE				114	145279-43	1	Tube
Part of stiffener (127).				143	145436	1	Bracket
133	145279-35	1	Tube	144	145233 Attaches to turbopump.	1	Bracket
134	145437 Attaches to No. 1 fuel line flange bolthead.			NOTE			
	NAS1005-1H	1	Bolt 68 ±7	Disassembly from bracket (143) is not required for installation.			
	LD153-0013-0003	1	Washer	145	145434 (Sheet 14, detail M-M.)	1	Bracket
	RD153-1002-0005	1	Washer	133	145279-35 Attaches to turbopump.	1	Tube
NOTE				NOTE			
Bolt must be lubricated with Fel-Pro C5 (Felt Products).				Rod end attaches to turbopump.			
135	145279-39	1	Tube		NAS1004-4H	1	Bolt 68 ±7
136	145468 Attaches to No. 1 oxidizer line flange bolthead.	1	Bracket		LD153-0013-0002	1	Washer
	NAS1005-1H	1	Bolt 68 ±7	146	145430 (Sheet 14, detail N-N.)	1	Bracket
	LD153-0013-0003	1	Washer	117	145633	1	Tube
NOTE				NOTE			
Replaces existing electrical cable support attaching bolt.				If tube length does not allow rod ends to meet inspection requirements for visibility at tube holes, tube 145279-3, -37, or -45 may be substituted.			
● Bolt must be lubricated with Fel-Pro C5 (Felt Products).				148	145428 Attaches to turbopump.	1	Bracket
137	145433 (Sheet 14, detail K-K.)	1	Bracket		RD111-1010-0415	1	Bolt 68 ±7
138	145279-17	1	Tube		LD153-0013-0002	1	Washer
139	145280 Attaches to turbopump.	1	Bracket	117	145633	1	Tube
	NAS1004-2H	2	Bolt 68 ±7	150	145435	1	Bracket
	LD153-0013-0002	2	Washer	144	145233 Attaches to turbopump.	1	Bracket
NOTE				NOTE			
Bolts must be lubricated with Fel-Pro C5 (Felt Products).				Disassembly from bracket (150) is not required for installation.			
140	145429 (Sheet 14, detail L-L.)	1	Bracket				
140A	145279-9	1	Tube				

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 40 of 44)

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Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
	145499 (Cont)						
	and tube (140A)						tube (117) rod ends to bracket (146) and bracket (150).
	rod ends to bracket (140)						
	and bracket (141).						
	NOTE						NOTE
	Torque nuts RD114-8003-1004 at rod ends to bracket (140) to 27 ±3 inch-pounds. Torque nuts RD114-8003-1004 at rod ends to brackets (141, 143) to 15 ±2 inch-pounds.						Torque nuts RD114-8003-1004 at rod ends to bracket (146) to 27 ±3 inch-pounds. Torque nuts RD114-8003-1004 at rod ends to brackets (148, 150) to 15 ±2 inch-pounds.
	<ul style="list-style-type: none"> <li>Maximum tilt gap of 0.050 inch between nut and washer is acceptable after torquing is completed.</li> </ul>						<ul style="list-style-type: none"> <li>Maximum tilt gap of 0.050 inch between nut and washer is acceptable after torquing is completed.</li> </ul>
	RD153-1002-0006	1	Washer		RD153-1002-0006	1	Washer
	RD114-8003-1006	1	Nut 68 ±7(a)		RD114-8003-1006	1	Nut 68 ±7(a)
	Attaches bracket (143) to bracket (144).				Attaches bracket (144) to bracket (150).		
	NOTE						NOTE
	Bracket (144) must be initially positioned in casting hole with one leg toward front of engine. Final position (prior to torquing nut) must seat chamfered end of forward bracket leg in deepest recess of forward one-third of inner edge of casting hole. Approximately one-half of chamfer at end of leg must extend under edge of casting.				Bracket (144) must be initially positioned in casting hole with one leg toward front of engine. Final position (prior to torquing nut) must seat chamfered end of forward bracket leg in deepest recess of forward one-third of inner edge of casting hole. Approximately one-half of chamfer at end of leg must extend under edge of casting.		
	NAS1004-5A	4	Bolt				
	LD153-0013-0002	4	Washer				
	RD153-1002-0004	4	Washer				
	RD114-8003-1004	4	Nut 68 ±7				
	Attaches bracket (146) to intercostal (126).						
	NAS1004-14A	4	Bolt				
	LD153-0013-0002	4	Washer				
	RD153-1002-0004	8	Washer				
	RD114-8003-1004	4	Nut				
	KEL-4-22	2	Rod End				
	KE4-22	2	Rod End				
	RD114-1009-0003	4	Nut 27 ±3				
	Attaches tube (117) rod ends to bracket (146) and (148), and						
	(a) Above running torque.						
				151	145408	1	Attaches to brackets (64, 96) and bow (125). (Sheets 3 and 15.)
					NAS1005-27A	2	Bolt
					NAS1005-20A	2	Bolt
					LD153-0013-0003	4	Washer
					RD153-1002-0005	4	Washer
					RD114-8003-1005	4	Nut 1-7(a)
					Attaches to bracket (64).		
					NAS1004-29A	3	Bolt
					LD153-0013-0002	3	Washer
					RD153-1002-0004	3	Washer
					RD114-8003-1004	3	Nut 1-7(a)
					Attaches to bracket (96).		

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 42 of 44)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
145408 (Cont)				154	145491	1	Strut
	NAS1004-17A	1	Bolt				NOTE
	RD153-5004-0004	1	Washer				Threads must be lubricated with
	RD153-1002-0004	1	Washer				Fel-Pro C5 (Felt Products)
	RD114-8003-1004	1	Nut 1-7(a)				
	Attaches to intercostal (131) of bracket (125).				NAS1006-9A	1	Bolt
	NAS1004-19A	1	Bolt		LD153-0013-0004	1	Washer
	RD153-1002-0004	4	Washer		RD153-1002-0006	1	Washer
	LD153-0010-0009	2	Washer		RD114-8003-1006	1	Nut 68 ±7
	RD114-8003-1004	1	Nut 1-7(a)		Attaches to bracket (152).		
	Attaches to intercostal (129) of bracket (125).				H-6CR Attaches	1	Rod End strut (154).
			NOTE				NOTE
	Use one each of washers LD153-0010-0009 and RD153-1002-0004 as spacers on each side of intercostal (129).				Rod end must be installed at threaded end of strut (154).		
	Final position of items indexed (152 through 159) is determined by insulator attaching to stiffener (159).				NAS1006-17A	1	Bolt
					LD153-0013-0004	1	Washer
152	145627 (Sheet 16, detail O-O.)	1	Bracket		RD153-1002-0006	3	Washer
	Attaches at thrust chamber tooling ring hole (52) and hole (53).				RD114-8003-1006	1	Nut 68 ±7
	NAS1006-12A(c)	2	Bolt		Attaches rod end to tooling ring hole (48).		
	RD111-1010-6624(d)	2	Bolt	155	145490 (Sheet 16, detail P-P.)	1	Bracket
	RD153-9004-0003	2	Washer				
	RD153-1002-0006	2	Washer	156	145489 Attaches to bracket (155).	1	Bracket
	RD114-8003-1006	2	Nut 68 ±7		NAS1004-9A	4	Bolt
153	601932 Attaches to bracket (152).	1	Support Cap		LD153-0013-0002	4	Washer
	K2207-24	2	Pad		RD153-1002-0004	4	Washer
	NAS1004-14A	4	Bolt		RD114-8003-1004	4	Nut 68 ±7
	LD153-0013-0002	4	Washer	153	601932 Attaches to bracket (156).	1	Support Cap
	RD153-1002-0004	4	Washer		NAS1004-14A	4	Bolt
	MS20500-428	4	Nut 27 ±3		LD153-0013-0002	4	Washer
			NOTE		RD153-1002-0004	4	Washer
	Pads must be installed between bracket (152) and line and cap (153) and line.				RD114-8003-1004	4	Nut 27 ±3
					K2207-24	2	Pad
							NOTE
					Pad must be installed between bracket (156) and line and between cap (153) and line.		

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 43 of 44)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
157	308228 Attaches to bracket (155).	1	Bracket Cap
	NAS1005-11A	2	Bolt
	LD153-0013-0003	2	Washer
	RD153-1002-0005	2	Washer
	RD114-8003-1005	2	Nut 150 ±15
158	145447 (Sheet 16, detail Q-Q.)	2	Bracket
153	601932 Attaches to brackets (158).	2	Support Cap
	K2207-24	4	Pad
	NAS1004-14A	8	Bolt
	LD153-0013-0002	8	Washer
	RD153-1002-0004	8	Washer
	RD114-8003-1004	8	Nut 27 ±3

## NOTE

Pads must be installed between bracket (158) and line and cap (153) and line.

159	145423 Attaches to brackets (158).	1	Stiffener
-----	------------------------------------	---	-----------

## NOTE

Chamfered end (45 degrees) must be installed toward fuel inlet elbow end of return line.

	NAS1004-38A	2	Bolt
	RD153-9004-0001	4	Washer
	RD114-8003-1004	2	Nut 27 ±3

## NOTE

The following hardware reroutes turbine inlet temperature transducer cable to attach to intercostal (131) as shown on sheet 15, detail R-R. Rotate remaining clamp and discard extra clip.

	NAS1003-30A	1	Bolt
	LD153-0013-0001	1	Washer
	LD153-0010-0007	1	Washer
	NAS679C3	1	Nut 1-7(a)

(a) Above running torque.

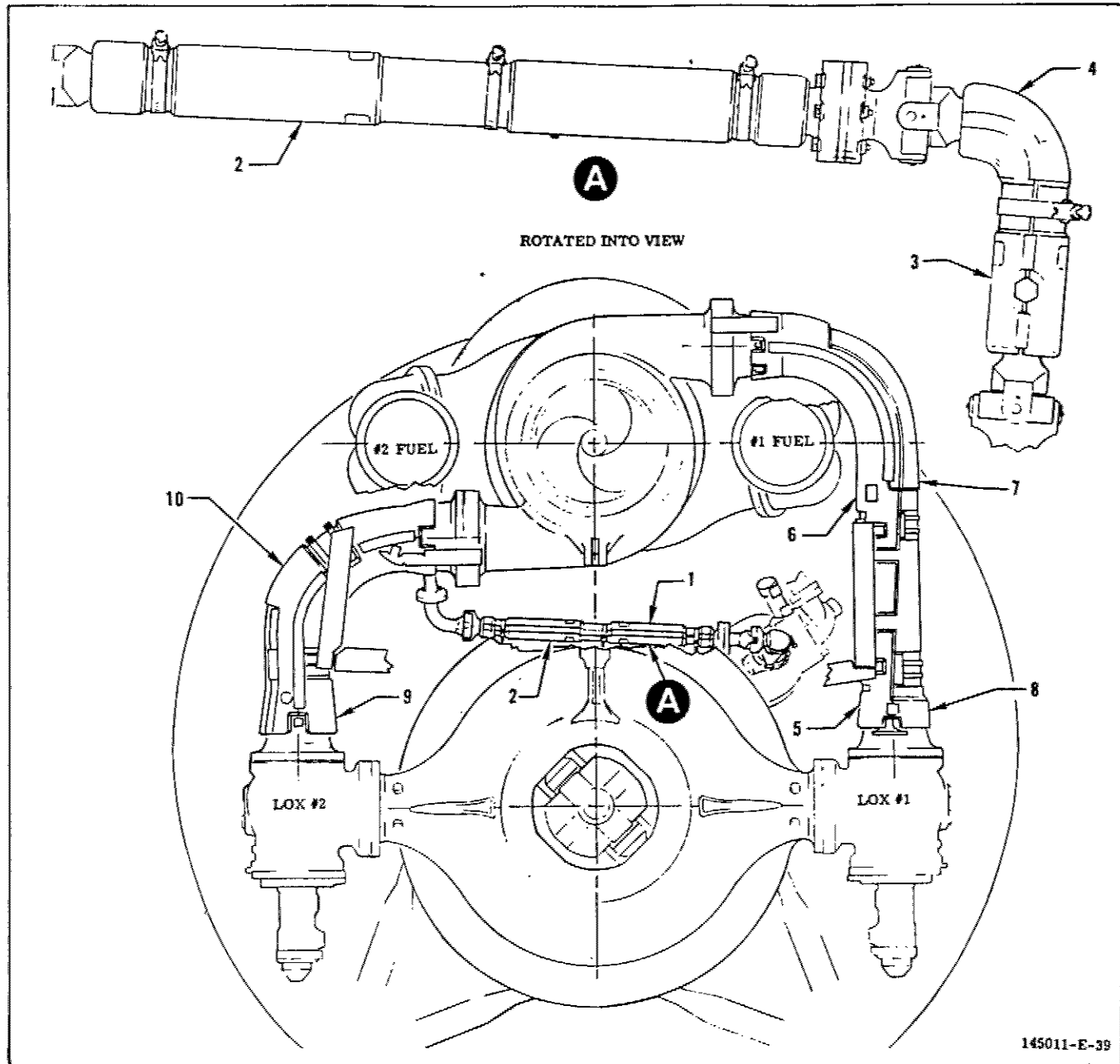
## 4-13. INSTALLING OXIDIZER LINES THERMAL INSULATION.

4-14. Insulators are installed on the No. 1 and No. 2 oxidizer lines and the gas generator oxidizer feed line, following bracket installations. Insulators are installed in the index order indicated in figure 4-5, except for gas generator oxidizer duct insulators that were installed during installation of brackets in figure 4-4. Safetywiring methods for insulator lacing studs are shown in figure 4-6. Use inconel lockwire MS20995N40.

## NOTE

Longitudinal gaps occurring between adjacent insulators on the oxidizer ducts must be equally distributed.

Figure 4-4. Thermal Insulation Attach Brackets (Sheet 44 of 44)



Index No.	Part No.	Quantity	Name	Index No.	Part No.	Quantity	Name
1	145369-11 <sup>(a)</sup>	1	Insulator	6	145383	1	Insulator
2	145370-11	1	Insulator	7	145382	1	Insulator
3	145371	1	Insulator	8	145385	1	Insulator
4	145372 <sup>(a)</sup>	1	Insulator	9	145380	1	Insulator
5	145384	1	Insulator	10	145381	1	Insulator

(a) Torque insulator clamp screws to 9 ±1 inch-pounds.

Figure 4-5. Oxidizer Lines Thermal Insulation

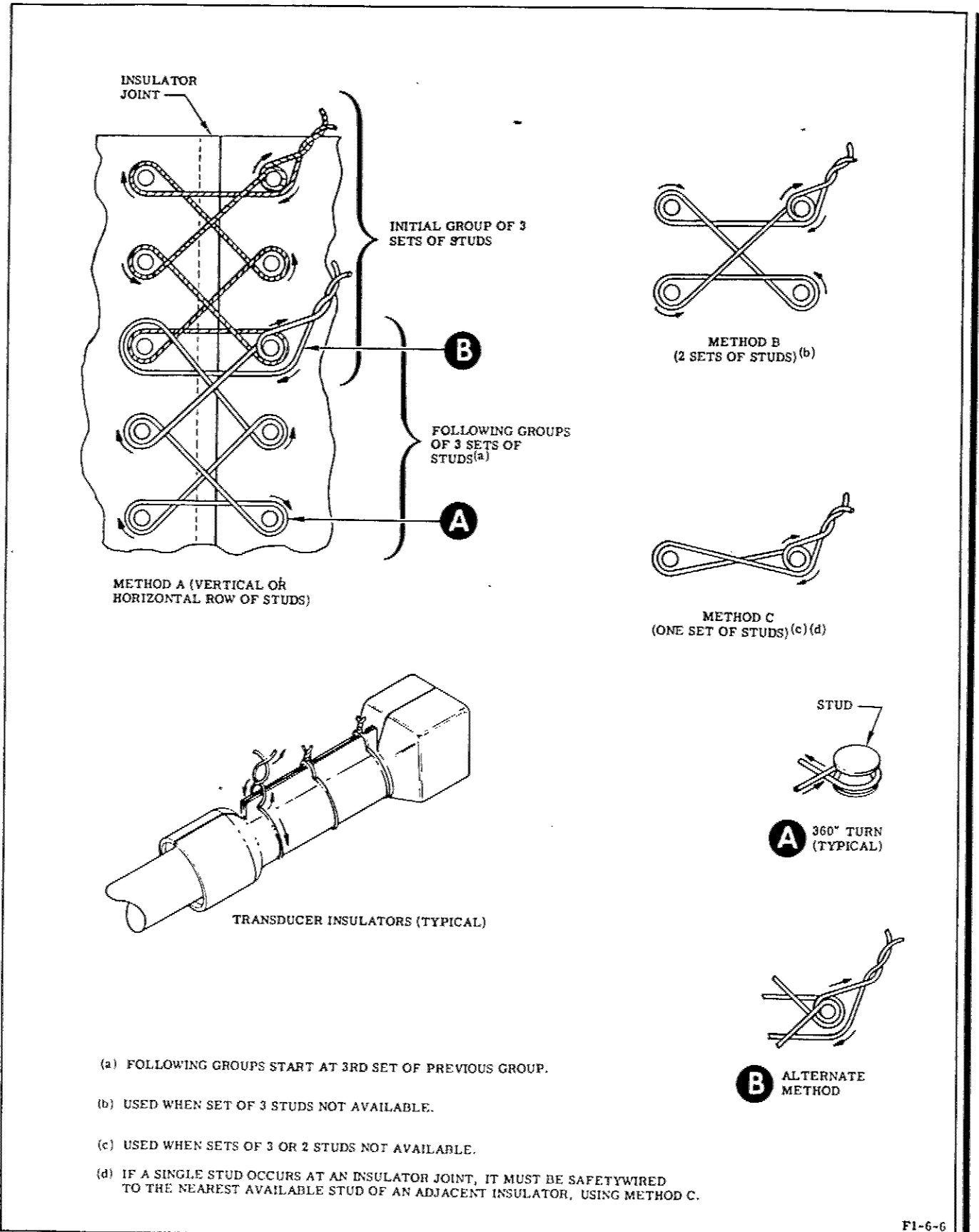
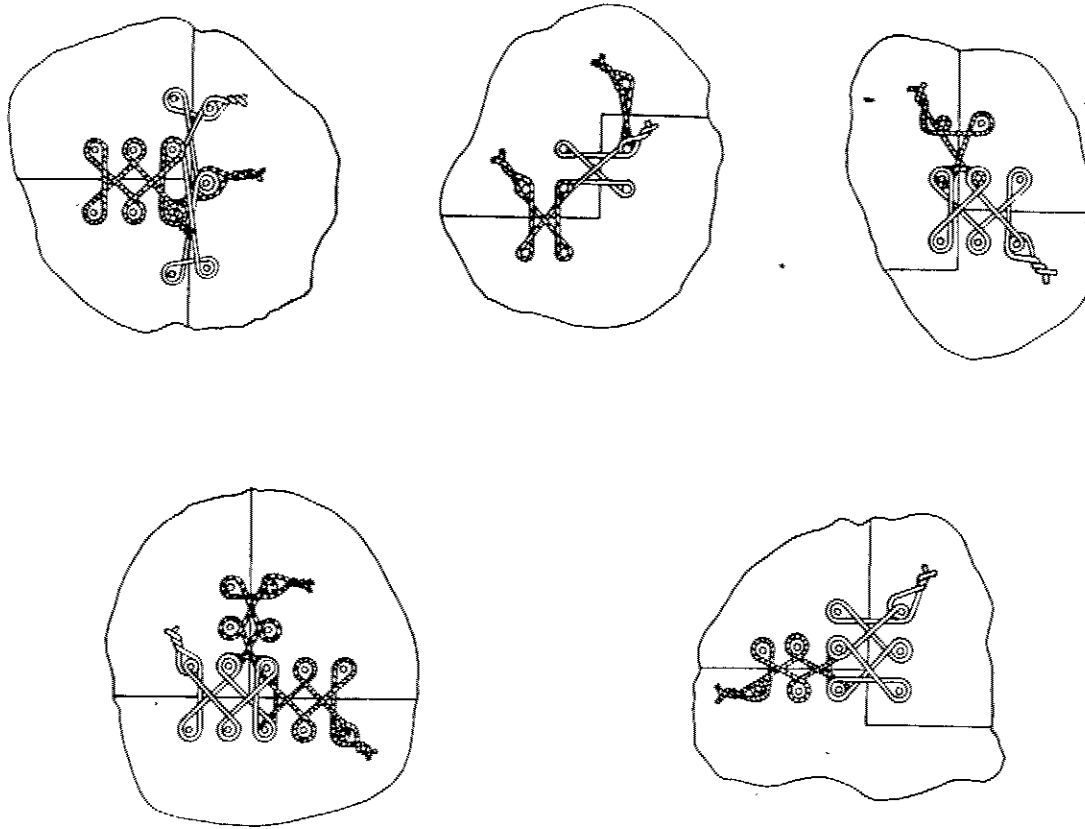


Figure 4-6. Safetywiring Methods for Thermal Insulation (Sheet 1 of 2)

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TYPICAL INSULATOR JUNCTIONS

F1-6-7

Figure 4-6. Safetywiring Methods for Thermal Insulation (Sheet 2 of 2)

#### 4-15. INSTALLING THRUST CHAMBER AND NOZZLE EXTENSION INSULATORS.

4-16. Insulators are installed in the index order indicated in figure 4-7. The following special instructions are required:

a. Torque fasteners attaching thrust chamber nozzle extension to thrust chamber to  $120 \pm 5$  inch-pounds.

aA. Prior to installing nozzle extension insulators, clean threads of all nut plates on nozzle extension using brush BR6100 (Anderson Corp), or equivalent.

b. Safetywire insulator lacing studs with inconel lockwire MS20995N40 using methods shown in figure 4-6.

c. Do not secure common attaching points until subsequent insulator is installed.

d. Observe applicable safety precautions outlined in paragraph 4-2.

e. Where different bolt lengths are specified in a parts group in figure 4-7, the longer bolts must be installed where insulation overlaps are thickest.

f. If washers used on thrust chamber studs interfere with lacing studs, relocate lacing studs using applicable procedure outlined in section VI.

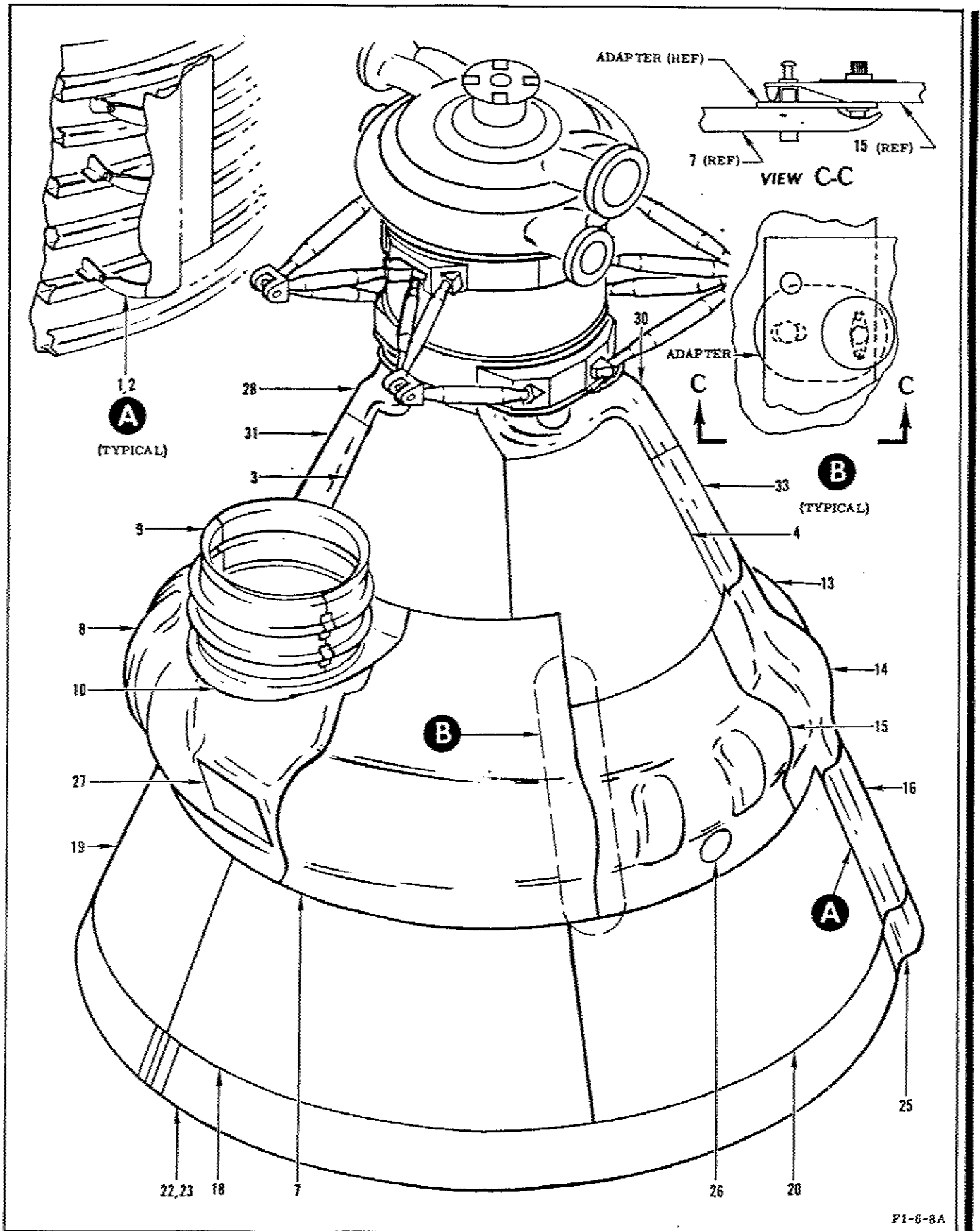
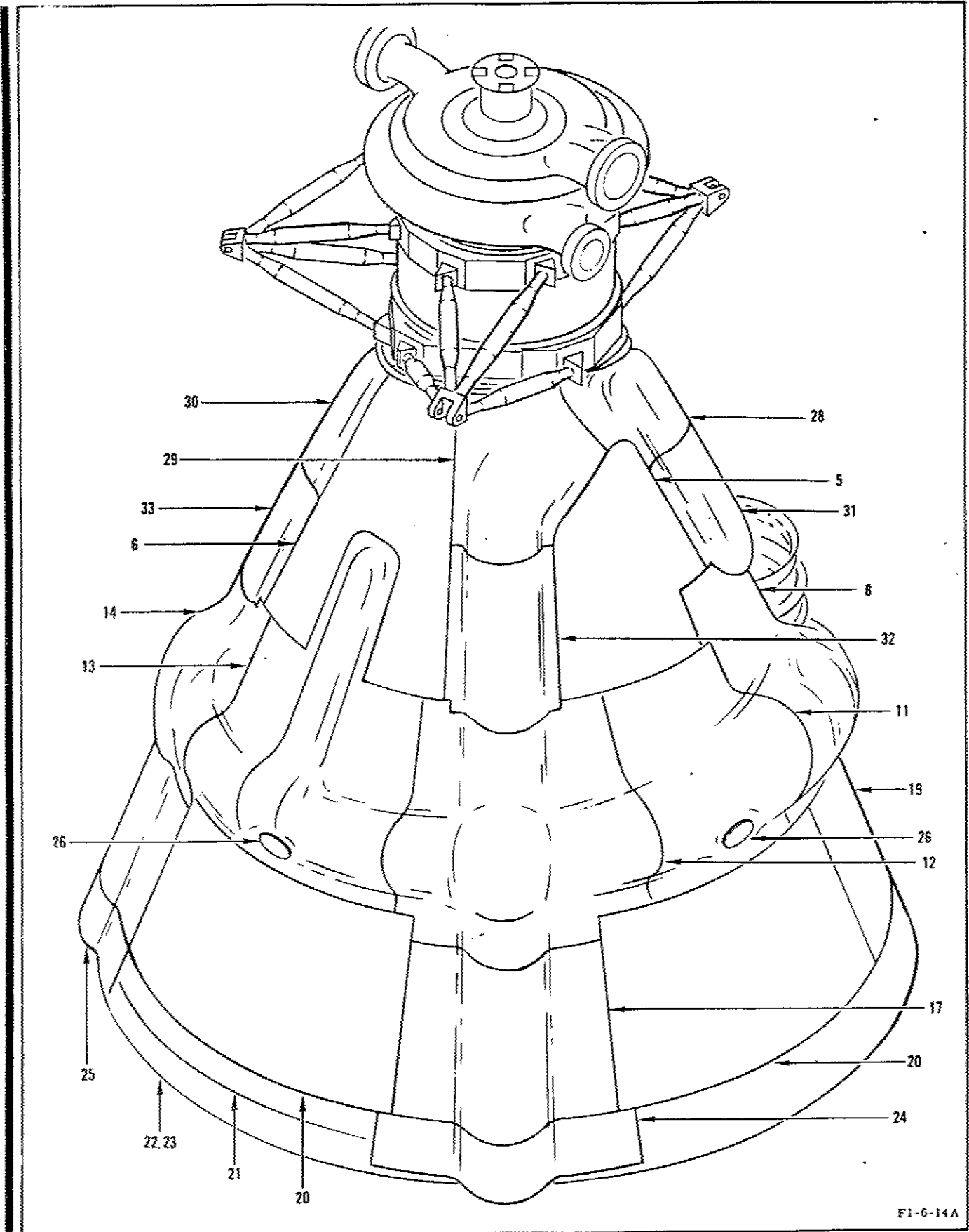


Figure 4-7. Thrust Chamber and Nozzle Extension Thermal Insulation (Sheet 1 of 5)

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Figure 4-7. Thrust Chamber and Nozzle Extension Thermal Insulation (Sheet 2 of 5)

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Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
NOTE							
Make sure nut plates of straps (1, 2) are alined so that attaching hardware for subsequent insulators can be installed. Clearance holes in straps for nut plates may be elongated, if required.							
1	145178	3	Strap (No. 1 side)				
	MS20500-1032	12	Nut 26 ±2		MS20500-1032	5	Nut 26 ±2
	NAS1003-5H	12	Bolt		MS21279-10	9	Bolt 26 ±2
	RD153-0115-0020	12	Washer		RD153-0115-0023	14	Washer
	RD153-5004-0003	12	Washer	9	145225-61(a)	1	Insulator
NOTE				NOTE			
2	145179	3	Strap (No. 2 side)	Disassembly is required for installation.			
	MS20500-1032	12	Nut 26 ±2	• Thrust chamber studs interfering with insulator may be shortened to 11/16-inch minimum length.			
	NAS1003-5H	12	Bolt		NAS1100-C3-12(a)	12	Screw
	RD153-0115-0020	12	Washer		RD153-0115-0020(a)	12	Washer
	RD153-5004-0003	12	Washer		RD114-8003-0003(a)	12	Nut 26 ±2
3	145920-11	1	Insulator		145225-59(a)	1	Clamp 45 ±5
	MS20500-1032	3	Nut 26 ±2		145225-63(a)	1	Clamp 45 ±5
	RD153-0115-0023	3	Washer	NOTE			
4	145919-11	1	Insulator	Clamp joints must be parallel with mating line of insulator (9) segments.			
	MS20500-1032	3	Nut 26 ±2	• To allow closing of shell halves, forward end of insulation may be bent away from heat exchanger.			
	RD153-0115-0023	9	Washer	• If clamp bolts butt against insulation, the insulation may be tapered for clearance or the clamps bent outward at the junctions prior to torquing.			
	MS21279-10	6	Bolt		MS21279-06	16	Bolt 26 ±2
5	145921-11	1	Insulator		RD114-5002-0002	16	Nut Clip
	MS20500-1032	4	Nut 26 ±2	10	145165	1	Insulator
	RD153-0115-0023	4	Washer		MS20500-1032	30	Nut 26 ±2
6	145922-11	1	Insulator		RD153-0115-0021	30	Washer
	MS20500-1032	1	Nut 26 ±2	11	145908-21	1	Insulator
	RD153-0115-0023	1	Washer		MS20500-1032	7	Nut 26 ±2
7	145174-21	1	Insulator		MS21279-10	8	Bolt 26 ±2
NOTE					RD153-0115-0023	15	Washer
Do not secure corner overlap to insulator (3).				12	145909-21	1	Insulator
	MS20500-1032	7	Nut 26 ±2		MS20500-1032	4	Nut 26 ±2
	RD153-0115-0023	7	Washer		MS21279-10	8	Bolt 26 ±2
8	145173-21	1	Insulator		RD153-0115-0023	12	Washer
NOTE				13	145910-21	1	Insulator
Igniter harness clamps must clear insulator. Reverse clamps, if necessary.					MS20500-1032	13	Nut 26 ±2
					MS21279-10	8	Bolt 26 ±2
					RD153-0115-0023	21	Washer
(a) A component of assembly.							

Figure 4-7. Thrust Chamber and Nozzle Extension Thermal Insulation (Sheet 3 of 5)

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Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
14	145911-21	1	Insulator		MS21279-10	14	Bolt 26 ±2
	MS20500-1032	4	Nut 26 ±2		RD153-0115-0023	14	Washer
	MS21279-10	8	Bolt 26 ±2		MS21279-06	15	Bolt 26 ±2
	RD153-0115-0023	12	Washer		RD114-5002-0002	15	Nut Clip
15	145912-21	1	Insulator	18	145914-21	1	Insulator
	MS20500-1032	7	Nut 26 ±2		MS21279-14	2	Bolt 26 ±2
	MS21279-10	16	Bolt 26 ±2		RD153-0115-0023	4	Washer
	RD153-0115-0023	23	Washer		MS21279-10	2	Bolt 26 ±2
NOTE				19	145913-21	1	Insulator
If grommets adjacent to insulator (7) cannot be aligned to install attaching hardware into nut plates of insulator (7), install adapters 145933 on insulator (7) using bolts NAS1003-1A as shown in detail B. Use adapters only at holes where misalignment cannot be corrected. Pull insulator (15) in place and align adapters so that adapter nut plates are positioned in line with grommets of insulator (15). Torque adapter bolts to 26 ±2 inch-pounds.					MS21279-20	1	Bolt 26 ±2
					RD153-0115-0023	7	Washer
					MS21279-14	4	Bolt 26 ±2
					MS21279-10	2	Bolt 26 ±2
16	145916-21	1	Insulator	20	145915-21	3	Insulator
NOTE				NOTE			
Before installing insulator, make sure attaching hardware can be installed in nut plates of straps (2).				Uninsulated gaps at corners adjacent to insulators (12, 17) and (14, 16) are permissible if the gaps do not exceed one square inch.			
	MS21279-10	10	Bolt 26 ±2		MS21279-20	2	Bolt 26 ±2
	RD153-0115-0023	10	Washer		MS21279-14	28	Bolt 26 ±2
	MS21279-06	15	Bolt 26 ±2		RD153-0115-0023	36	Washer
	RD114-5002-0002	15	Nut Clip		MS21279-10	6	Bolt 26 ±2
17	145917-21	1	Insulator	21	145180-11 <sup>(c)</sup>	1	Plate
NOTE					MS21279-14	11	Bolt 26 ±2
Before installing insulator, make sure attaching hardware can be installed in nut plates of straps (1).					RD153-0115-0023	11	Washer
				22	145932 <sup>(c)</sup>	1	Insulator
				NOTE			
				Disconnect lower drain line bracket cover from fuel and oxidizer overboard drain lines to install cutouts in insulator between respective drain lines and brackets. Reinstall covers and torque bolts to 18-22 inch-pounds.			
					MS21279-10	47	Bolt 26 ±2
					MS21279-20	5	Bolt 26 ±2
					MS21279-14	54	Bolt 26 ±2
					RD153-0115-0021	178	Washer
					145929	72	Stud
					145930 <sup>(b)</sup>	72	Ablative Cap Hand-tight.

(b) Silicone sealant RTV102 (General Electric) is required in threaded recess. Torque cap hand-tight.  
(c) On outboard engines.

Figure 4-7. Thrust Chamber and Nozzle Extension Thermal Insulation (Sheet 4 of 5)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
23	145931 <sup>(d)</sup>	1	Insulator		MS21279-22	1	Bolt 26 ±2
					MS21279-26	1	Bolt 26 ±2
			NOTE				
			Disconnect lower drain line bracket cover from fuel and oxidizer overboard drain lines to install cutouts in insulator between respective drain lines and brackets. Reinstall covers and torque bolts to 18-22 inch-pounds.	26	145101-21 Used on insulators (11, 13, and 15).	3	Door
					MS21279-06	3	Bolt 26 ±2
				27	145918-11	1	Insulator
					MS21279-06	1	Bolt 26 ±2
					RD153-0115-0020	14	Washer
					MS20500-1032	14	Nut 26 ±2
							NOTE
							The following insulators are installed after cocoon insulation is installed and are listed in sequence in figure 4-8 as part of the cocoon insulation installation.
				28	145926-11	1	Insulator
				29	145927-11	1	Insulator
				30	145928-11	1	Insulator
				31	145923-11	1	Insulator
				32	145924-11	1	Insulator
				33	145925-11	1	Insulator
24	145171-11 <sup>(e)</sup>	1	Insulator				
					MS21279-14	8	Bolt 26 ±2
					MS21279-20	1	Bolt 26 ±2
					RD153-0115-0021	11	Washer
					MS21279-22	1	Bolt 26 ±2
					MS21279-26	1	Bolt 26 ±2
25	145172-11 <sup>(e)</sup>	1	Insulator				
					MS21279-14	6	Bolt 26 ±2
					MS21279-20	1	Bolt 26 ±2
					RD153-0115-0021	9	Washer

(b) Silicone sealant RTV102 (General Electric) is required in threaded recess. Torque cap hand-tight.

(d) On inboard engines.

(e) Make cross-slit (+) openings in asbestos for drain lines.

Figure 4-7. Thrust Chamber and Nozzle Extension Thermal Insulation (Sheet 5 of 5)

#### 4-17. INSTALLING COCOON INSULATORS.

4-18. Insulators are installed in the index number order outlined in figure 4-8. Two teams may be used for installation. One team may install insulators (1 through 12) while the other team installs insulators (13 through 28). As a visual aid for locating groups of attaching hardware, apply a piece of tape bearing the part

index number to each insulator as it is installed. Remove tape at completion of cocoon installation. Special instructions and deviations are included in the procedures. The following general instructions are applicable throughout the procedure:

- a. Using inconel lockwire MS20995N32, safetywire all fasteners not secured with nuts.

b. Using inconel lockwire MS20995N40, safetywire lacing stubs after all insulators are installed.

c. Where nut clips RD114-5002-0002 are used at corners of insulator flanges and difficulty of installation may result in damage to the insulation, a bolt (as specified for use with the nut clip), two washers RD153-1003-0006, and a nut NAS679C3W, or equivalent, may be substituted.

d. Trim nonfoldover standing flanges if flange height prevents installation of nut clip when foldover standing flange is folded in place. A 0.15-inch edge distance must be maintained from edge of holes in nonfoldover standing flanges.

e. Refold foldover standing flanges, when necessary, to accomplish installation of nut clips.

f. Notch foldover standing flanges at "T" intersection with adjacent insulators, as necessary. Do not notch past fold line.

g. When misalignment of flat flanges prevents installation of fasteners, add a doubler to area using methods outlined in section VI. New holes must be at least 0.38 inch from edge of added doubler.

h. If washers used on thrust chamber threaded studs interfere with lacing studs, relocate lacing studs using applicable procedure outlined in section VI.

i. If a gap exists between asbestos insulation overlapping an adjacent insulator, install sufficient lacing studs in insulators to allow additional safetywiring to hold asbestos insulation against underlapping insulator.

j. On insulators with integral clamps, use longer tee bolts, if necessary, to form clamps and facilitate installation of insulator.

k. Enlarge pierced holes in asbestos insulation, if necessary, for installation of attaching hardware. Use a suitable sharp-pointed tool to prevent breaking filler wire in insulation, and do not enlarge hole beyond size required to install fastener.

l. If new holes are required in asbestos insulation, they must be at least 0.75 inch from edge of insulation or the same distance as any existing holes in the area.

m. Longer or shorter bolts of the same basic part number may be used in place of those specified. Bolts may also be shortened by installing a maximum of 2 washers LD153-0013-XXXX under the bolthead. If a serrated washer is part of the installation, the flat washers must be installed between the serrated washer and the bolthead. Changing bolt lengths for use in tapped holes requires a depth measurement to make sure that the bolt will not bottom out and that sufficient thread engagement is obtained. Any change in bolt lengths must meet the following installation requirements:

(1) A portion of the full thread at the end of the bolt must extend through a nut or nutplate.

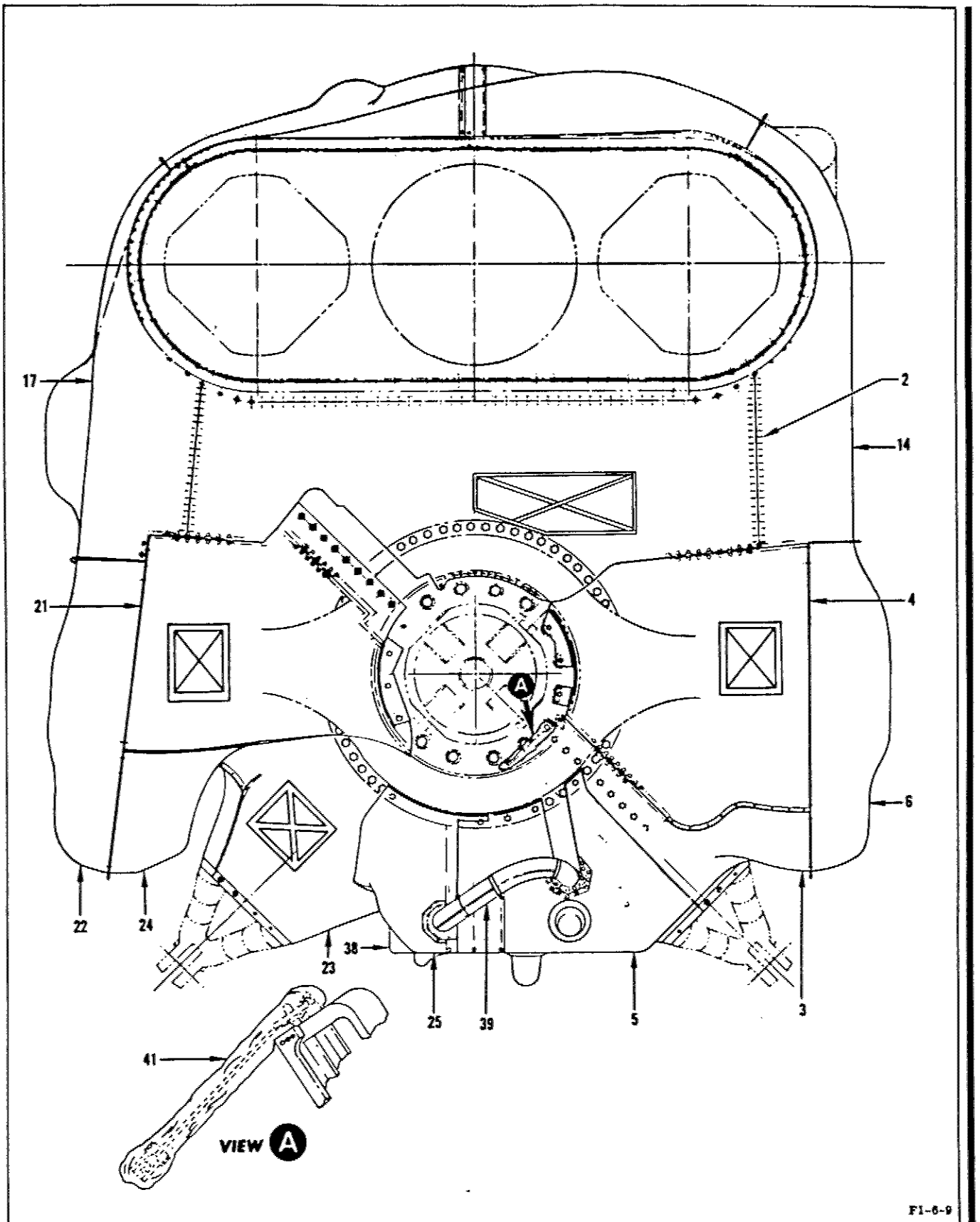
(2) Imperfect bolt threads must not engage threads of nuts, nutplates, or tapped holes.

(3) End clearance must be sufficient to prevent interference with adjacent surfaces or bottoming out in tapped holes.

n. Where lubrication for fasteners is specified in this procedure, the lubricant must be applied as follows:

(1) Apply lubricant in a streak 1/8 inch to 1/4 inch wide across all threads and flush with top of threads.

(2) Distribute lubricant streak uniformly around fastener threads with a clean nylon brush. Remove excess lubricant.



F1-6-9

Figure 4-8. Cocoon Thermal Insulation (Sheet 1 of 23)

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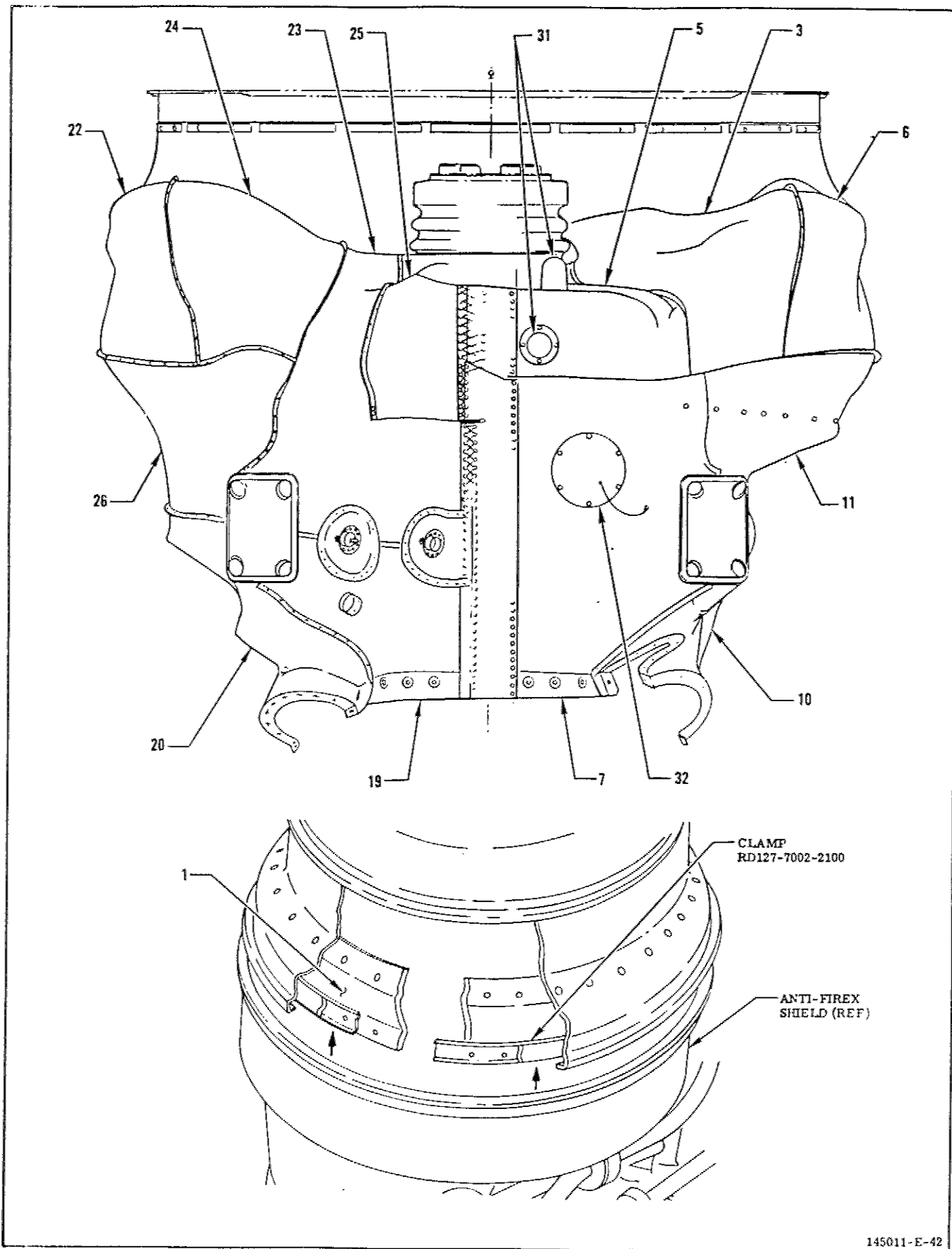


Figure 4-8. Cocoon Thermal Insulation (Sheet 2 of 23)

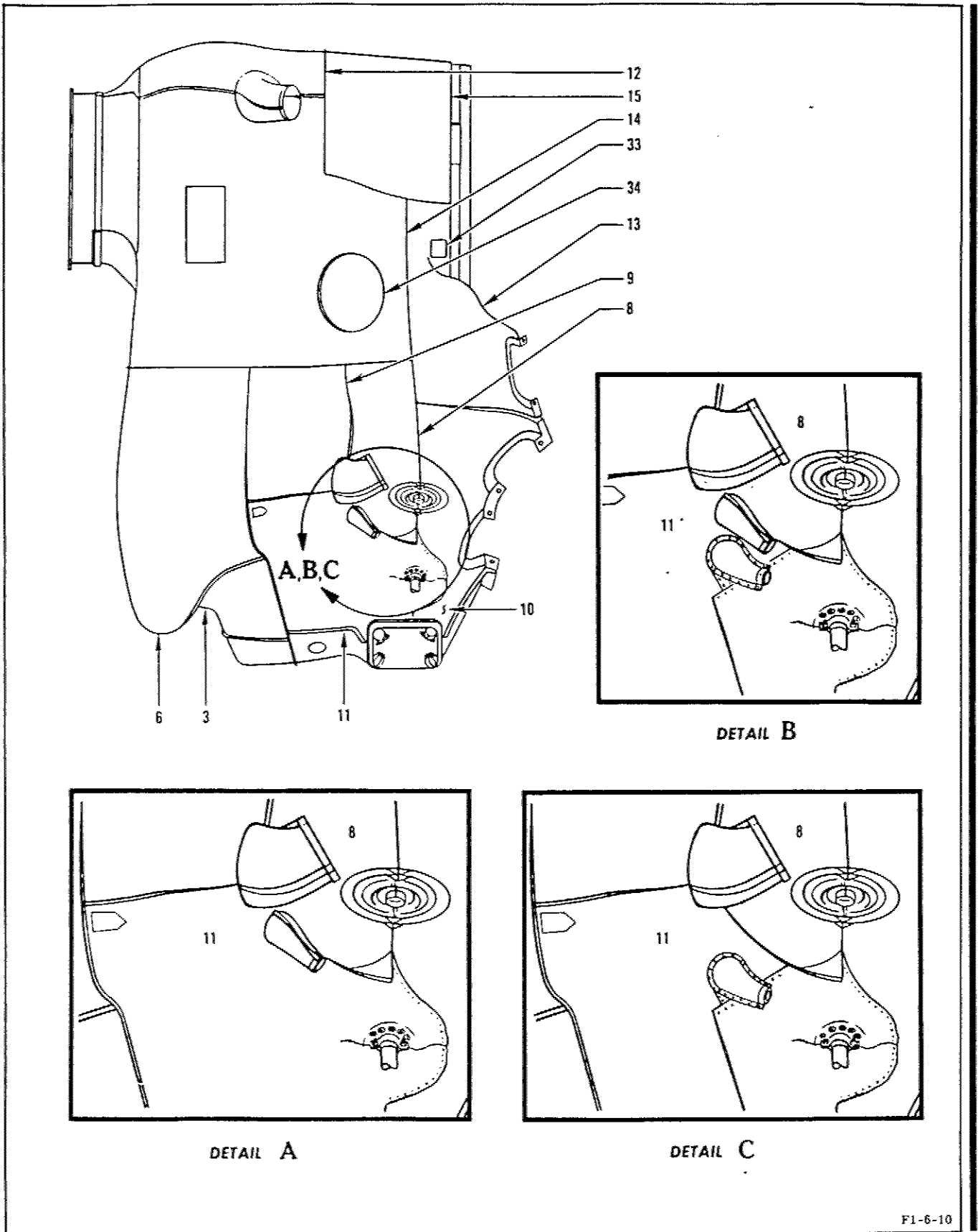
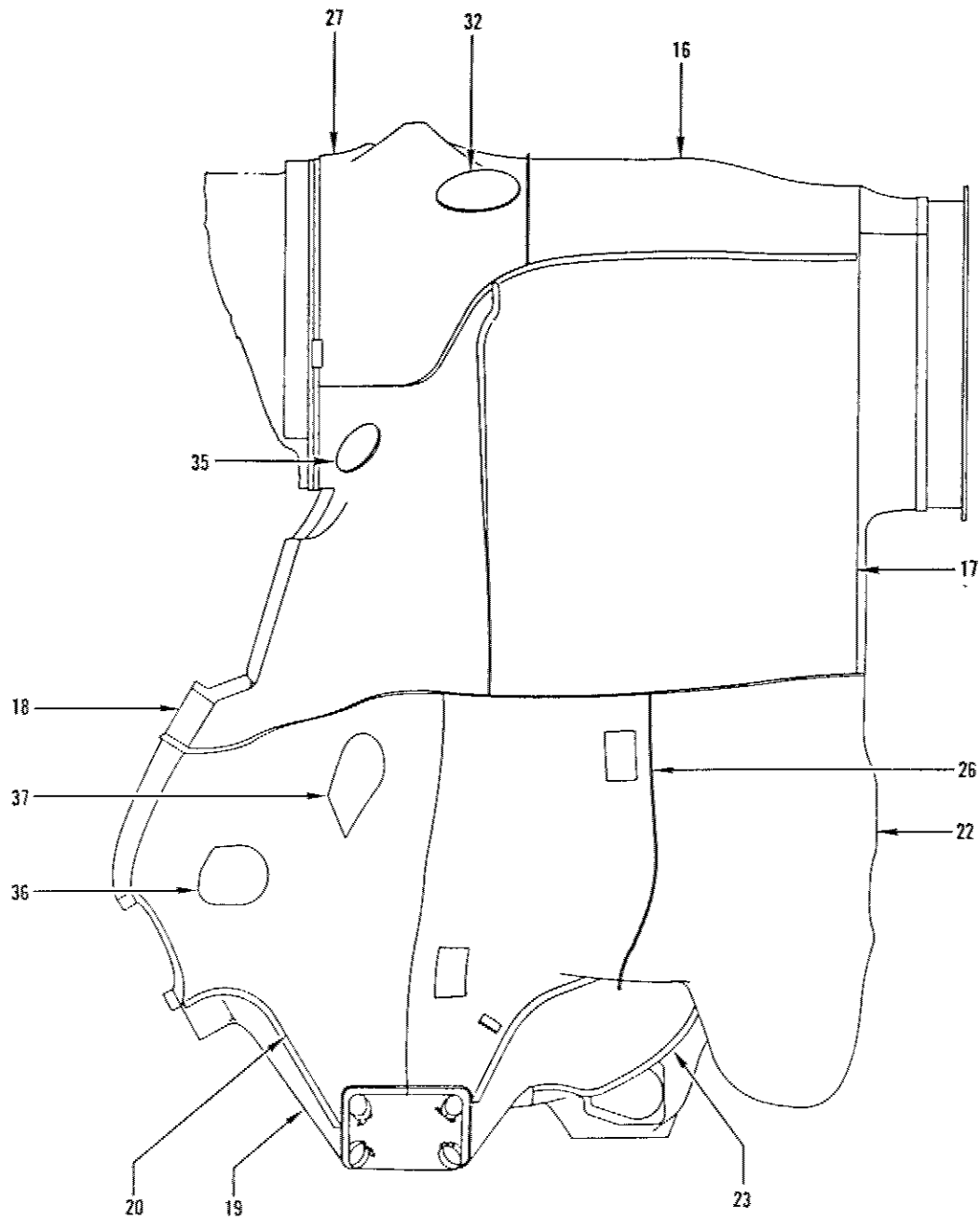


Figure 4-8. Cocoon Thermal Insulation (Sheet 3 of 23)

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F1-6-11

Figure 4-8. Cocoon Thermal Insulation (Sheet 4 of 23)

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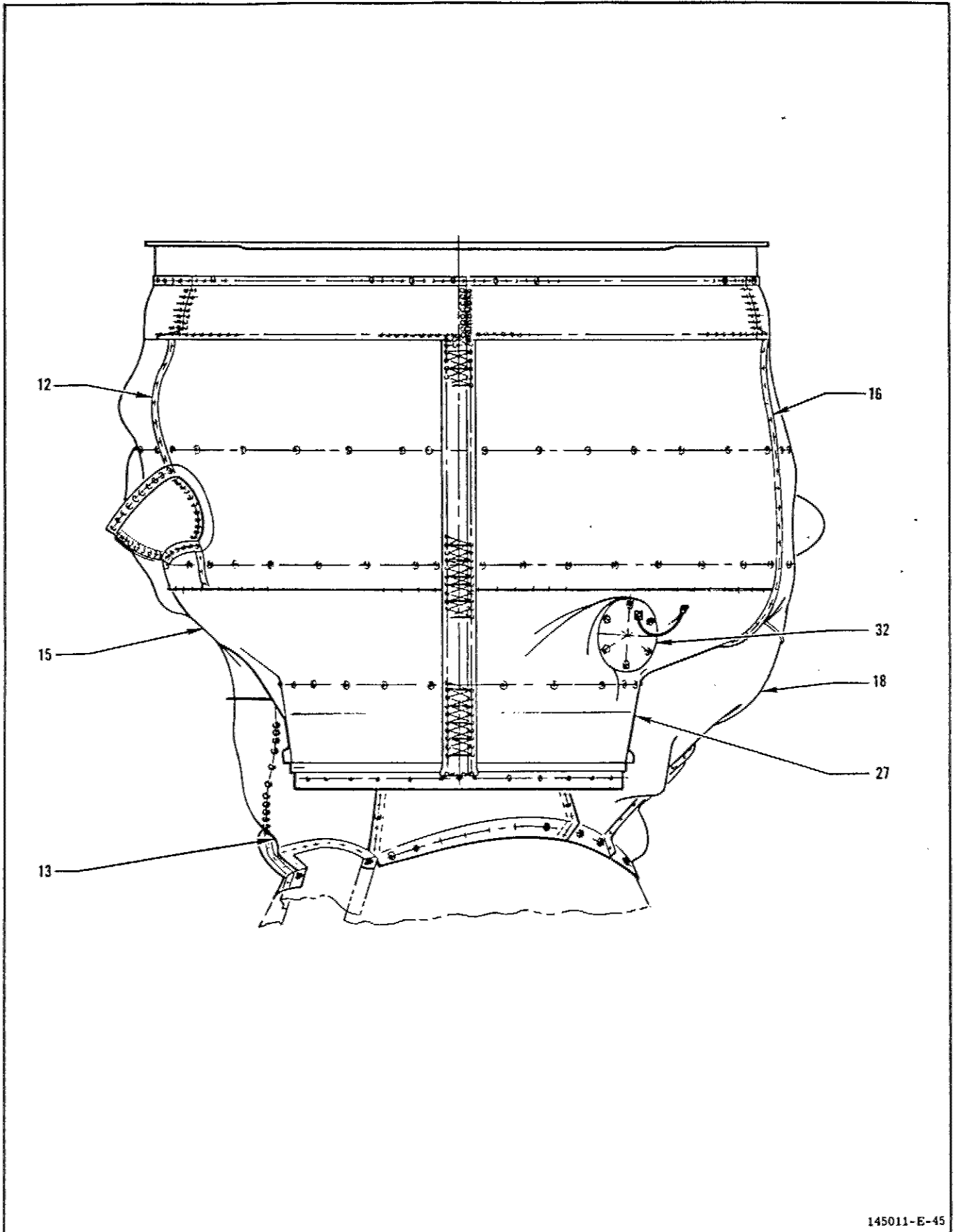


Figure 4-8. Cocoon Thermal Insulation (Sheet 5 of 23)

145011-E-45

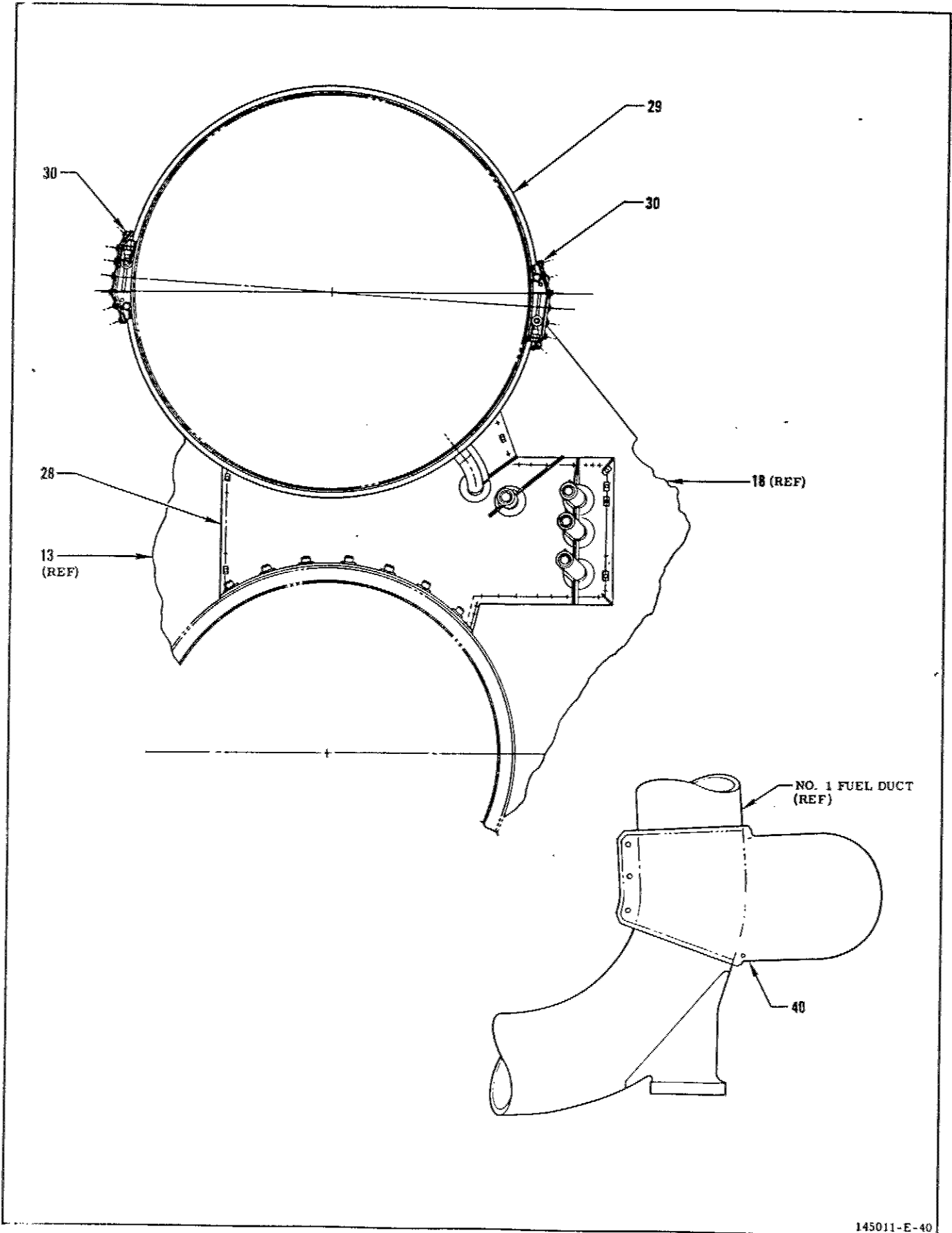


Figure 4-8. Cocoon Thermal Insulation (Sheet 6 of 23)

145011-E-40



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
1	145144 (Sheet 2.)	2	Insulator	2	145532(a), 145532-11(b) (Sheet 1.)	1	Insulator
<p style="text-align: center;">NOTE</p> <p>The following instructions apply to installation of insulator (1):</p> <p>a. Disconnect anti-firex shield assembly from turbopump water shield.</p> <p>b. Thread 12 bolts RD111-1010-6311 with washers RD153-5005-0003 through each half of water shield into 12 nut plates attached to each insulator 145144. Torque bolts to 27 ±3 inch-pounds.</p> <p style="text-align: center;">NOTE</p> <p>Joint lines of insulator (1) must align with joint lines of water shield. Bolt installation must start at first hole nearest joint line and be installed progressively in either clockwise or counterclockwise direction.</p> <ul style="list-style-type: none"> <li>• Washers LD153-0013-0001 may be used where interference exists between washers RD153-5005-0003 and the anti-firex shield.</li> </ul> <p>c. Lace studs at each end of insulator, using methods shown in figure 4-6.</p> <p>d. Secure lower edge of insulator to turbine manifold, using 2 clamps RD127-7002-2100 hooked together. Torque clamp nuts to 45 ±5 inch-pounds above running torque.</p> <p>e. Reinstall anti-firex shield assembly on turbopump water shield. Torque nuts of coupling 4451C4490M to 90 ±5 inch-pounds.</p> <p style="text-align: center;">NOTE</p> <p>Coupling joints must be positioned within three degrees of a line extending from the center of the fuel inlet elbows through the turbopump aft supports.</p>				<p style="text-align: center;">NOTE</p> <p>Insulator (2) was partially installed with brackets in figure 4-4. Completion of installation is accomplished following installation of insulators (28 through 30).</p> <ul style="list-style-type: none"> <li>• Gimbal boot flexible halves must be removed and strut (40) disconnected from channel (32). Then loosen bracket (39) and rotate strut for clearance to install applicable insulator attaching hardware. See figure 4-4 for strut location.</li> <li>• See figure 4-10 and install wrap-around line insulators (1 through 3) before installing insulator 145509-11 (3).</li> </ul>			
3	145509-11 (Sheets 1, 2, and 3.)		Insulator				
	NAS1003-1A	9	Bolt 45 ±5				
	LD153-0013-0001	9	Washer				
	RD153-0115-0019	9	Washer				
	Attaches to bracket 145290(25).						
	RD111-1009-6610	Ref	Bolt 150 ±15				
	LD153-0013-0004	Ref	Washer				
	Attaches insulator using existing bracket 145477 (41) attach bolts.						
				NOTE			
				Bolts must be lubricated with Fel-Pro C5 (Felt Products).			
(a) Used on thermal insulation sets 12-1 through 13-4, 13-6, 13-7, and 14-1 through 18-4.				(b) Used on thermal insulation sets 18-5 and subsequent.			

Figure 4-8. Cocoon Thermal Insulation (Sheet 7 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
4	145524-11 <sup>(c)</sup> 145524-21 <sup>(d)</sup> (Sheet 3.)	1	Insulator				
			NOTE				NOTE
			Adjust upper portion of bracket 145290 (25) to aline hole in insulator with holes in oxidizer dome. Use extreme care not to disturb alinement of wrap-around lines.				If washers RD153-9001-0001 damage insulator as fasteners are tightened, washers RD153-9003-0003 may be used instead. Position flat edge of washers RD153-9003-0003 toward insulator.
			RD111-1009-0407 3 Bolt 68 ±7				RD114-5002-0002 1 Clip
			RD153-9001-0001 3 Washer				MS21279-08 1 Bolt 27 ±3
			Attaches to dome face.				Attaches to insulator (3) at end hole adjacent to insulator (6).
			NOTE				RD114-5001-0002 8 Clip
			If washers RD153-9001-0001 damage insulator as fasteners are tightened, washers RD153-9003-0003 may be used instead. Position flat edge of washers RD153-9003-0003 toward insulator.				MS21279-08 8 Bolt 27 ±3
			RD111-1010-6410 11 Bolt 150 ±15				Attaches to insulator (3).
			RD153-9001-0001 11 Washer				NOTE
			Attaches to bracket 145325 (18).				Insulator (2) must be secured to insulator (4) at dome torus, using six bolts RD111-1010-6308 and six washers RD153-1003-0006. Torque bolts to 45 ±5 inch-pounds.
			RD111-1010-6311 12 Bolt 45 ±5	5	145082-21 (Sheets 1 and 2.)	1	Insulator
			RD153-5005-0003 12 Washer				NOTE
			Attaches to bracket 145290 (25) front side.				Adjust applicable parts of bracket 145477 (41) to insulator before securing insulator with attaching hardware groups.
			NOTE				RD111-1009-6610 Ref Bolt 150 ±15
			If bolts bottom against bracket structure, use washers LD153-0013-0001, or equivalent, in addition to washers specified.				LD153-0013-0004 Ref Washers
			RD111-1010-6308 3 Bolt 45 ±5				Attaches to bracket 145477 (41), using existing dome attach bolts for bracket.
			RD153-9003-0002 3 Washer				RD111-1010-6410 10 Bolt 150 ±15
			Attaches at overlap to insulator (3).				RD153-9001-0001 10 Washer
			RD111-1009-0407 1 Bolt 68 ±7				Attaches to bracket 145477 (41).
			RD153-9001-0001 1 Washer				
			Attaches at overlap to insulator (3).				

(c) Used on thermal insulation sets 13-5 and 13-8.

(d) Used on thermal insulation sets 12-1 through 13-4, 13-6, 13-7, and 14-1 and subsequent.

Figure 4-8. Cocoon Thermal Insulation (Sheet 8 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)				
5	145082 (Cont)				RD127-7007-1138 <sup>(f)</sup>		Clamp 45 ±5 Attaches to oxidizer valve.				
	RD111-1010-6410	4	Bolt 8 ±3 <sup>(e)</sup>	7	145511-11	1	Insulator (Sheet 2.)				
	RD153-5005-0005	4	Washer		RD114-5002-0002	4	Clip				
	Attaches to bracket 145477 (41).				MS21279-08	4	Bolt 27 ±3				
	RD111-1009-6608	1	Bolt 150 ±15		Attaches to insulators (3, 5).						
	LD153-0013-0004	1	Washer		RD114-5001-0002	9	Clip				
	Attaches insulator to dome.				MS21279-08	9	Bolt 27 ±3				
	NOTE										
	Bolt must be lubricated with Fel-Pro C5 (Felt Products).										
	RD114-5001-0002	10	Clip		Attaches to insulator (5).						
	MS21279-08	10	Bolt 27 ±3		NOTE						
	Attaches to insulator (3).				Torque clamp fasteners at gimbal outriggers to 27 ±3 inch-pounds.						
	RD114-5002-0002	1	Clip		RD111-1010-6410	10	Bolt 150 ±15				
	MS21279-08	1	Bolt 27 ±3		RD153-9001-0001	10	Washer				
	Attaches to insulator (3) at end hole nearest to insulator (7).				Attaches to bracket 145477 (41).						
	NOTE										
	Prior to installing insulator (6), install wrap-around line insulators (4 through 16, figure 4-10) and cocoon insulator (21, figure 4-8).										
6	145505-11 (Sheets 1, 2, and 3.)	1	Insulator		NAS1004-6A	1	Bolt 8 ±3 <sup>(e)</sup>				
	RD114-5002-0002	4	Clip		RD153-5005-0006	1	Washer				
	MS21279-08	4	Bolt 27 ±3		Attaches to bracket 145477 (41) through grommets hole of insulator.						
	Attaches to insulators (3, 4) at first and last holes of each flange.				RD153-5005-0006	6	Washer				
	RD114-5001-0002	25	Clip		MS20500-428	3	Nut 27 ±3				
	MS21279-08	25	Bolt 27 ±3		Attaches to thrust chamber insulator 145922-11.						
	Attaches to insulators (3, 4).				NOTE						
	Washers and nuts must not be installed on the thrust chamber stud common to overlap of cocoon insulators (7) and (19).										
(e) Above running torque.				(f) A component of insulator.							

Figure 4-8. Cocoon Thermal Insulation (Sheet 9 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	
8	145507-21 <sup>(g)</sup> , 145507-31 <sup>(h)</sup> (Sheet 3.)	1	Insulator		NAS1004-4A	1	Bolt -	
	NAS1004-6A	2	Bolt 27 ±3		LD153-0013-0002	1	Washer	
	RD153-5005-0006	2	Washer		RD153-1002-0004	1	Washer	
	Installs through grommeted holes of insulator.				NAS679C4W	1	Nut 27 ±3	
9	145506-11 (Sheet 3.)	1	Insulator	10	145508-11 (Sheets 2 and 3.)	1	Insulator	
	NAS1004-6A	3	Bolt 27 ±3		NAS1004-6A	9	Bolt 8 ±3 <sup>(e)</sup>	
	RD153-5005-0006	3	Washer		RD153-5005-0006	9	Washer	
	Installs through grommeted holes of insulator.				Installs through grommeted holes of insulator.			
	RD114-5002-0002	2	Clip		RD127-7006-0419 <sup>(f)</sup>	2	Clamp 27 ±3	
	MS21279-08	2	Bolt 27 ±3		Attaches to gimbal actuator strut.			
	Attaches to insulator (6) at end holes of flange.				RD114-5002-0002	2	Clip	
	RD114-5001-0002	10	Clip		MS21279-08	2	Bolt 27 ±3	
	MS21279-08	10	Bolt 27 ±3		Attaches to insulator (8) at end hole of flange and hole between boots.			
	Attaches to insulator (6).				RD114-5001-0002	5	Clip	
	RD114-5002-0002	2	Clip		MS21279-08	5	Bolt 27 ±3	
	MS21279-08	2	Bolt 27 ±3		Attaches to insulator (8) at flange holes between end hole and boot.			
	Attaches to insulator or (8) at end hole and hole adjacent to boot flange.				MS21279-08	2	Bolt 27 ±3	
	RD114-5001-0002	4	Clip		LD153-0013-0001	2	Washer	
MS21279-08	4	Bolt 27 ±3	RD153-0115-0019	2	Washer			
Attaches to insulator (8).			Attaches to insulator (8) at 2 holes between boots.					
NAS1004-2A	2	Bolt	NAS1004-3A	2	Bolt 27 ±3			
LD153-0013-0002	2	Washer	NAS1004-4A	2	Bolt 8 ±3 <sup>(e)</sup>			
RD153-1002-0004	2	Washer	LD153-0013-0002	4	Washer			
NAS679C4W	2	Nut 27 ±3	RD153-1002-0004	4	Washer			
Installs in 2 inboard holes of boot flange of insulator (8).			NAS679C4W	4	Nut			
			Attaches boot flanges to insulator (8). Install bolts NAS1004-3A in end holes of flange.					

(e) Above running torque.

(f) A component of insulator.

(g) Used on thermal insulation sets 12-1 through 19-3.

(h) Used on thermal insulation sets 19-4 and subsequent.

Figure 4-8. Cocoon Thermal Insulation (Sheet 10 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
10	145508 (Cont)				RD111-1010-6410	4	Bolt 150 ±15
	RD127-7006-0419 <sup>(f)</sup>	2	Clamp 27 ±3		RD153-9001-0001	4	Washer
	Attaches to gimbal actuator struts.				Attaches to insulator (10) at holes at either side of insulator clamp to strut.		
	RD114-5002-0002	1	Clip		RD127-7006-0419 <sup>(f)</sup>	1	Clamp 27 ±3
	MS21279-08	1	Bolt 27 ±3		Attaches to gimbal actuator strut.		
	Attaches to insulator (7) in flange hole nearest tunnel opening.				NAS1004-4A	2	Bolt
	RD114-5001-0002	8	Clip		NAS1004-2A	15	Bolt
	MS21279-08	8	Bolt 27 ±3		LD153-0013-0002	17	Washer
	Attaches to insulator (7).				RD153-1002-0004	17	Washer
	RD111-1010-6410	2	Bolt 150 ±15		NAS679C4W	17	Nut 27 ±3
	RD153-9001-0001	2	Washer		Attaches flanges of large boot at junctions with insulators (8, 9). Bolts NAS1004-4A are used in end holes.		
	Installs in slotted holes adjacent to insulator (7).				NAS1004-4A	2	Bolt
11	145510-41 <sup>(c)</sup>	1	Insulator		NAS1004-2A	6	Bolt
	145510-71 <sup>(i)</sup>				LD153-0013-0002	8	Washer
	145510-81 <sup>(j)</sup>				RD153-1002-0004	8	Washer
	145510-111 <sup>(k)</sup>				NAS679C4W	8	Nut 27 ±3
	(Sheets 2 and 3, details A, B and C.)				Attaches boot flanges of insulator to insulator 145507-21 (8). Plug 145536 must be installed to close opening of small boot at joint of insulators. Bolts NAS1004-4A are used in end holes. (Sheet 3, details A and B.)		
	NOTE						
	When installing insulator, boot must be disassembled as required. Reinstall bolts MS21279-08 and washers LD153-0013-0001. Torque bolts to 27 ±3 inch-pounds. (See sheet 3, details B or C.)						
	NAS1004-6A	6	Bolt 8 ±3 <sup>(e)</sup>				
	RD153-5005-0006	6	Washers				
	Installs through grommets holes in insulator.						
	(c) Used on thermal insulation sets 13-5 and 13-8.						
	(e) Above running torque.						
	(f) A component of insulator.						
	(i) Used on thermal insulation sets 12-5, 12-8, 13-1, 13-7, 14-1, 14-6, 15-1, 15-6, 16-1, 17-2, 17-6, 18-1, and 19-1.						
	(j) Used on thermal insulation sets 12-1 through 12-4, 12-6, 12-7, 13-2 through 13-4, 13-6, 14-2 through 14-5, 14-7, 15-2 through 15-5, 15-7, 16-2 through 17-1, 17-3 through 17-5, 17-7, 18-2 through 18-7, 19-2, and 19-3.						
	(k) Used on thermal insulation sets 19-4 and subsequent.						

Figure 4-8. Cocoon Thermal Insulation (Sheet 11 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
11	145510 (Cont)				RD114-5001-0002	6	Clip
	NAS1004-4A	2	Bolt		MS21279-08	6	Bolt 27 ±3
	NAS1004-2A	11	Bolt		Attaches to insulator (3).		
	LD153-0013-0002	13	Washer		RD114-5002-0002	5	Clip
	RD153-1002-0004	13	Washer		MS21279-08	5	Bolt 27 ±3
	NAS679C4W	13	Nut 27 ±3		Installs at flange holes between boots to insulator (8).		
	Closes boot flanges of insulator (11). Bolts NAS1004-4A are used in end holes.				RD114-5002-0002	2	Clip
	NAS1004-3A	2	Bolt		MS21279-08	2	Bolt 27 ±3
	NAS1004-4A	2	Bolt		Attaches to insulators (3, 7) in corner hole nearest strut clamp and in corner hole adjacent to insulator (3).		
	LD153-0013-0002	4	Washer		RD114-5001-0002	3	Clip
	RD153-1002-0004	4	Washer		MS21279-08	3	Bolt 27 ±3
	NAS679C4W	4	Nut 27 ±3		Attaches to insulator (7) in remaining flange holes.		
	Attaches to boot flanges at insulator (10). Use NAS1004-3A bolts at outer clamps.				MS21279-08	2	Bolt 27 ±3
	RD114-5002-0002	2	Clip		LD153-0013-0001	2	Washer
	MS21279-08	2	Bolt 27 ±3		RD153-0115-0019	2	Washer
	Attaches to insulator (9) in flange hole nearest to boot and in flange hole adjacent to insulator (6).				Attaches to insulator (8). Installs in 2 holes.		
	RD114-5001-0002	4	Clip		MS21279-08	13	Bolt 27 ±3
	MS21279-08	4	Bolt 27 ±3		RD153-0115-0021	13	Washer
	Attaches to insulator (9).				Attaches to insulators (8, 10) in holes at perimeter of asbestos flap.		
	RD114-5002-0002	2	Clip		MS21279-08	2	Bolt
	MS21279-08	2	Bolt 27 ±3		LD153-0013-0001	4	Washer
	Attaches to insulator (6) corner hole adjacent to insulator (9).				RD114-8003-0003	2	Nut 27 ±3
	RD114-5001-0002	6	Clip		Install to close slit in asbestos flap.		
	MS21279-08	6	Bolt 27 ±3	12	145501-11 (Sheets 3 and 5.)	1	Insulator
	Attaches to insulator (6).				NAS1004-6A	14	Bolt 8 ±3 <sup>(e)</sup>
	RD114-5002-0002	2	Clip		RD153-5005-0006	14	Washer
	MS21279-08	2	Bolt 27 ±3		Installs through grommeted holes of insulator.		
	Attaches to insulator (3) in corner holes 1, 6, and 7 from junction with insulator (7).						

(e) Above running torque.

Figure 4-8. Cocoon Thermal Insulation (Sheet 12 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
12	145501 (Cont)				RD114-5001-0002	11	Clip
	RD111-1010-6410	16	Bolt 150 ±15		MS21279-08	11	Bolt 27 ±3
	RD153-9001-0001	16	Washer		Attaches to insulator (10).		
	Attaches to interface panel brackets except at end holes of insulator at engine centerline.			14	145503-11(c) 145503-21(d) (Sheets 1 and 3.)		Insulator
	NOTE				NOTE		
	Elongated holes in the insulator that do not align with the holes in the brackets on the interface panel may be elongated to a maximum of 1.25 inches. A 0.3-inch edge distance must be maintained for end holes, and the distance between holes must not be less than 0.5 inch.				Insulator must align with holes in bracket (18). If necessary, bracket clamps around oxidizer duct and bolts attaching insulator (4) to bracket may be loosened to align bracket. Torque for clamp nuts is 45-55 inch-pounds.		
13	145504-11 (Sheet 3.)	1	Insulator		NAS1004-8A	1	Bolt 8 ±3(e)
	NOTE				NAS1004-6A	16	Bolt 8 ±3(e)
	Prior to installation, insulator (13) must be attached to insulator (28), at joint shown on sheet 6, with 13 bolts RD111-1010-6408 and 13 washers RD153-0115-0024. Bolts must be torqued to 68 ±7 inch-pounds. Insulator (28) must be supported and installation completed in normal sequence.				RD153-5005-0006	17	Washer
	NAS1004-6A	11	Bolt 8 ±3(e)		Installs through grommeted holes of insulator. Use bolt NAS1004-8A in third grommeted hole from insulator flange in front of flange boot.		
	RD153-5005-0006	11	Washer		RD127-7007-0825(f)	3	Clamp 27 ±3
	Installs through grommeted holes of insulator.				RD114-5002-0002	3	Clip
	RD114-5001-0002	2	Clip		MS21279-08	3	Bolt 27 ±3
	MS21279-08	2	Bolt 27 ±3		Attaches to insulator (12) in first flange hole at either side of boot and in corner hole adjacent to insulator (15).		
	Attaches to insulator (8) at 2 center holes of 4 holes.				RD114-5001-0002	6	Clip
	RD114-5002-0002	2	Clip		MS21279-08	6	Bolt 27 ±3
	MS21279-08	2	Bolt 27 ±3		Attaches to insulator (12).		
	Attaches to insulator (8) in 2 end holes of 4 holes.						
	RD114-5002-0002	1	Clip				
	MS21279-08	1	Bolt 27 ±3				
	Attaches to insulator (10). Installs in end hole adjacent to insulator (8).						

(c) Used on thermal insulation sets 13-5 and 13-8.

(d) Used on thermal insulation sets 12-1 through 13-4, 13-6, 13-7, and 14-1 and subsequent.

(e) Above running torque.

(f) A component of insulator.

Figure 4-8. Cocoon Thermal Insulation (Sheet 13 of 23)





Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
16	145518 (Cont)	-		NOTE			
	RD111-1010-6410	19	Bolt 150 ±15	Elongated holes in the insulator that do not align with the holes in the brackets on the interface panel may be elongated to a maximum of 1.25 inches. A 0.3-inch edge distance must be maintained for end holes, and the distance between holes must not be less than 0.5 inch.			
	RD153-9001-0001	19	Washer				
	Attaches to interface panel brackets.				RD111-1010-6410	6	Bolt 150 ±15
	NOTE				RD153-9001-0001	6	Washer
	Elongated holes in the insulator that do not align with the holes in the brackets on the interface panel may be elongated to a maximum of 1.25 inches. A 0.3-inch edge distance must be maintained for end holes, and the distance between holes must not be less than 0.5 inch.				Attaches to bracket 145324 (12).		
17	145516-11 (Sheets 1 and 4.)	1	Insulator	18	145517-11 (Sheets 4 and 5.)	1	Insulator
	NOTE			NOTE			
	Insulator must align with holes in bracket (12). Insulator (17) must be positioned in place and hole alignment with insulators (17, 21) checked. If necessary, clamps of bracket (12) at oxidizer duct may be loosened and bracket and insulator holes aligned. Torque for nuts of bracket clamps is 50 ±5 inch-pounds.			Insulator determines final location of brackets (152 through 159) at hydraulic return line.			
	NAS1004-6A	19	Bolt 8 ±3 <sup>(e)</sup>		NAS1004-6A	3	Bolt 8 ±3 <sup>(e)</sup>
	RD153-5005-0006	19	Washer		RD153-5005-0006	3	Washer
	Installs through grommeted holes of insulator.				Attaches to bracket 145497 (102) through grommeted holes.		
	RD114-5002-0002	1	Clip		RD111-1010-6312	7	Bolt 8 ±3 <sup>(e)</sup>
	MS21279-08	1	Bolt 27 ±3		RD153-0115-0023	7	Washer
	Attaches to insulator (16) in end hole adjacent to junction of insulator (18).				Attaches to bracket 145423 (159) through grommeted holes.		
	RD114-5002-0002	1	Clip		RD114-5002-0002	2	Clip
	MS21279-08	1	Bolt 27 ±3		MS21279-08	2	Bolt 27 ±3
	Attaches to insulator (21).				Attaches to insulator (17) in end holes.		
	RD114-5001-0002	13	Clip		RD114-5001-0002	16	Clip
	MS21279-08	13	Bolt 27 ±3		MS21279-08	16	Bolt 27 ±3
	Attaches to insulator (16).				Attaches to insulator (17).		
	RD111-1010-6410	9	Bolt 135-165		RD153-5005-0006	4	Washer
	RD153-9001-0001	9	Washers		MS20500-428	1	Nut 27 ±3
	Attaches to interface panel brackets.				Attaches on thrust chamber stud at thrust chamber insulators 145919-11 and 145920-11.		

(e) Above running torque.

Figure 4-8. Cocoon Thermal Insulation (Sheet 15 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
19	145512-11 (Sheets 2 and 4.)	1	Insulator		RD114-5001-0002	14	Clip
	RD127-7006-0419 <sup>(f)</sup>	2	Clamp 27 ±3		MS21279-08	14	Bolt 27 ±3
	Attaches to gimbal actuator strut.				Attaches to insulator (18).		
	RD111-1010-6410	7	Bolt 150 ±15		RD153-5005-0006	6	Washer
	RD153-9001-0001	7	Washer		MS20500-428	3	Nut 27 ±3
	Attaches to insulator (7).				Installs on thrust chamber studs at insulators (18) and thrust chamber insulator 145919-11.		
	RD153-5005-0006	3	Washer		RD111-1010-6410	2	Bolt 150 ±15
	MS20500-428	1	Nut 27 ±3		RD153-9001-0001	2	Washer
	Attaches on thrust chamber stud at overlap of insulator (7) and thrust chamber insulator 145922-11.				Attaches to insulator (19) at slotted holes.		
	RD153-5005-0006	8	Washer	21	145522-11 <sup>(c)</sup>	1	Insulator
	MS20500-428	4	Nut 27 ±3		145522-21 <sup>(d)</sup>		
	Attaches on thrust chamber studs at thrust chamber insulator 145922-11.				(Sheet 1.)		
20	145515-11 (Sheet 2.)	1	Insulator		NOTE		
	RD111-1010-6312	3	Bolt 8 ±3 <sup>(e)</sup>		Bracket 145324 or 145324-11 may be adjusted, as necessary, to install insulator. Torque bracket hardware as indicated in figure 4-4. Following installation of this insulator, continue with installation of insulator (6).		
	RD153-0115-0023	3	Washer		NAS1003-2A	8	Bolt 45 ±5
	Installs through grommets holes of insulator.				RD153-5005-0003	8	Washer
	RD127-7006-0419 <sup>(f)</sup>	1	Clamp 27 ±3		Attaches to bracket 145188 (9).		
	Attaches to gimbal actuator strut.				RD111-1010-6410	5	Bolt 150 ±15
	RD114-5001-0002	8	Clip		RD153-9001-0001	5	Washer
	MS21279-08	8	Bolt 27 ±3		Attaches to bracket 145324 or 145324-11 (12).		
	Attaches to insulator (19).				NAS1003-3A	2	Bolt 45 ±5
	RD114-5002-0002	1	Clip		RD153-5005-0003	2	Washer
	MS21279-08	1	Bolt 27 ±3		Attaches to bracket 145286 (6).		
	Attaches to insulator (18) in each hole adjacent to insulator (26).						

(c) Used on thermal insulation sets 13-5 and 13-8.

(d) Used on thermal insulation sets 12-1 through 13-4, 13-6, 13-7, and 14-1 and subsequent.

(e) Above running torque.

(f) A component of insulator.

Figure 4-8. Cocoon Thermal Insulation (Sheet 16 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
21	145522 (Cont)				RD114-5001-0002	5	Clip
	RD111-1009-0407	3	Bolt 68 ±7		MS21279-08	5	Bolt 27 ±3
	RD153-9001-0001	3	Washer				Attaches to insulator (21).
			Attaches to dome face.		RD114-5001-0002	1	Clip
					RD114-5002-0002	2	Clip
22	145513-11 (Sheets 1, 2, and 4.)	1	Insulator		MS21279-08	3	Bolt 27 ±3
							Attaches to insulator (19) at flange holes between boots.
	NOTE						
	Do not install insulator (22) until procedures for insulators (1 through 21) have been accomplished.						
	RD127-7007-1138 <sup>(f)</sup>	1	Clamp 45 ±5		NAS1004-3A	3	Bolt 27 ±3
			Attaches to oxidizer valve.		NAS1004-4A	4	Bolt 8 ±3 <sup>(e)</sup>
	RD114-5002-0002	4	Clip		LD153-0013-0002	7	Washer
	MS21279-08	4	Bolt 27 ±3		RD153-1002-0004	7	Washer
			Attaches to insulators (17, 21) at corner and end holes.		NAS679C4W	7	Nut
	RD114-5001-0002	17	Clip				Attaches to insulator (19) at boot flanges. Install bolts NAS1004-2A in clamps of boot flange.
	MS21279-08	17	Bolt 27 ±3		RD111-1010-6410	7	Bolt 150 ±15
			Attaches to insulators (17, 21).		RD153-9001-0001	7	Washer
23	145520-11 <sup>(c)</sup> 145520-21 <sup>(d)</sup> (Sheets 1, 2, and 4.)	1	Insulator				Attaches to bracket 145477 (41).
	RD127-7006-0419 <sup>(f)</sup>	2	Clamp 27 ±3		RD111-1009-6608	2	Bolt 150 ±15
			Attaches to gimbal actuator strut.		LD153-0013-0004	2	Washer
	RD114-5002-0002	1	Clip				Attaches to dome bolts.
	MS21279-08	1	Bolt 27 ±3				NOTE
			Attaches to insulator (21) in end hole adjacent to insulator (24).		Bolts must be lubricated with Fel-Pro C5 (Felt Products).		
					RD111-1010-6410	3	Bolt 150 ±15
					RD153-9001-0001	3	Washer
							Attaches to insulator (19) at slotted holes at outrigger struts.

(c) Used on thermal insulation sets 13-5 and 13-8.

(d) Used on thermal insulation sets 12-1 through 13-4, 13-6, 13-7, and 14-1 and subsequent.

(e) Above running torque.

(f) A component of insulator.

Figure 4-8. Cocoon Thermal Insulation (Sheet 17 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	
24	145521-11 (Sheets 1 and 2.)	1	Insulator		RD111-1010-6410	11	Bolt 150 ±15	
	RD114-5002-0002	2	Clip		RD153-9001-0001	11	Washer	
	MS21279-08	2	Bolt 27 ±3		Attaches to bracket 145477 (41).			
	Attaches to insulator (21) at end holes.				RD114-5002-0002	2	Clip	
	RD114-5001-0002	7	Clip		MS21279-08	2	Bolt 27 ±3	
	MS21279-08	7	Bolt 27 ±3		Attaches to insulator (23) at adjacent corner holes at corner of insulator.			
	Attaches to insulator (21).				RD114-5001-0002	14	Clip	
	RD114-5002-0002	2	Clip		MS21279-08	14	Bolt 27 ±3	
	MS21279-08	2	Bolt 27 ±3		Attaches to insulator (23).			
	Attaches to insulator (23) at end holes.				RD111-1009-6610	Ref	Bolt 150 ±15	
25	RD114-5001-0002	6	Clip		LD153-0013-0004	Ref	Washer	
	MS21279-08		Bolt 27 ±3		Attaches to insulator (5) and dome bolts using existing bracket attach bolts.			
	Attaches to insulator (23).				NOTE			
	RD114-5002-0002	4	Clip		Bolts must be lubricated with Fel-Pro C5 (Felt Products).			
	MS21279-08	4	Bolt 27 ±3		RD111-1009-6608	1	Bolt 150 ±15	
	Attaches to insulator (22) at end holes and in holes 3 and 4 from junction of insulator (26).				LD153-0013-0004	1	Washer	
	RD114-5001-0002	14	Clip		Attaches to dome boltheads. Bolt must be lubricated with Fel-Pro C5 (Felt Products).			
	MS21279-08	14	Bolt 27 ±3					
	Attaches to insulator (22).							
	145534-11(c), 145534-21(d) (Sheets 1 and 2.)			1	Insulator			
NOTE								
Removal of hypergol unit cap is required to install insulator. Cap must be reinstalled.								

(c) Used on thermal insulation sets 13-5 and 13-8.

(d) Used on thermal insulation sets 12-1 through 13-4, 13-6, 13-7, and 14-1 and subsequent.

Figure 4-8. Cocoon Thermal Insulation (Sheet 18 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	
26	145514-11 <sup>(c)</sup>	1	Insulator	27	RD114-5001-0002	17	Clip	
	145514-21 <sup>(d)</sup>				MS21279-08	17	Bolt 27 ±3	
	(Sheets 2 and 4.)				Attaches to insulator (20).			
	NAS1004-6A	1	Bolt 8 ±3 <sup>(e)</sup>		RD114-5002-0002	1	Clip	
	RD153-5005-0006	1	Washer		MS21279-08	1	Bolt 27 ±3	
	Installs through grommets hole of insulator.				Attaches to insulator (23) at hole nearest insulator (24).			
	RD127-7006-0419 <sup>(f)</sup>	2	Clamp 27 ±3		RD114-5001-0002	8	Clip	
	Attaches to gimbal actuator strut.				MS21279-08	8	Bolt 27 ±3	
	RD111-1010-6410	4	Bolt 150 ±15		Attaches to insulator (23).			
	RD153-9001-0001	4	Washer		27 145519-11 (Sheets 4 and 5.)			
	Attaches to insulators (20, 23) through slotted holes.				Installs under adjoining edge of insulator (15).			
	RD114-5002-0002	6	Clip		NAS1004-6A	6	Bolt 8 ±3 <sup>(e)</sup>	
	MS21279-08	6	Bolt 27 ±3		RD153-5005-0006	6	Washer	
	Attaches to insulators (17, 18) at corner holes at junctions to insulators.				Installs through grommets holes of insulator.			
	RD114-5001-0002	6	Clip		RD111-1010-6410	9	Bolt 150 ±15	
MS21279-08	6	Bolt 27 ±3	RD153-9001-0001	9	Washer			
Attaches to insulators (17, 18).			Installs through insulator (15).					
RD114-5002-0002	4	Clip	RD114-5002-0002	2	Clip			
MS21279-08	4	Bolt 27 ±3	MS21279-08	2	Bolt 27 ±3			
Attaches to insulators (22, 24) and at end holes and in holes at either side of junctions of noted insulators.			Attaches to insulator (16) at end hole nearest insulator (17).					
RD114-5001-0002	18	Clip	RD114-5001-0002	18	Clip			
MS21279-08	18	Bolt 27 ±3	MS21279-08	18	Bolt 27 ±3			
Attaches to insulators (22, 24).			Attaches to insulator (16).					
RD114-5002-0002	1	Clip	27 145519-11 (Sheets 4 and 5.)					
MS21279-08	1	Bolt 27 ±3	Installs under adjoining edge of insulator (15).					
Installs in hole adjacent to insulator (18).			Installs through grommets holes of insulator.					

(c) Used on thermal insulation sets 13-5 and 13-8.

(d) Used on thermal insulation sets 12-1 through 13-4, 13-6, 13-7, and 14-1 and subsequent.

(e) Above running torque.

(f) A component of insulator.

Figure 4-8. Cocoon Thermal Insulation (Sheet 19 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
27	145519 (Cont)			NOTE			
	RD114-5002-0002	3	Clip	The following part groups are used to close out the boots of cocoon insulator (28) after installation of heat exchanger line insulators (2, 11, 19, 23).			
	MS21279-08	3	Bolt 27 ±3				
	Attaches to insulator (18) at hole nearest insulator (16) and in holes at either side of junctions of insulators (17, 18).			Installs in holes at either side of each boot.			
	RD114-5001-0002	13	Clip				
	MS21279-08	13	Bolt 27 ±3	Installs in flanges adjacent to boots and flange of turbine manifold instrumentation line boot, except for end hole.			
	Attaches to insulators (17, 18).						
28	145531 (Sheet 6.)	1	Insulator	Installs in end hole of turbine manifold instrumentation line boot.			
	NOTE						
	Partially installed during installation of insulator (13).			Installation of insulator 145532 (2) must be completed by installing the following part groups.			
29,	145394 (29) (Sheet 6.)	1	Clamp 30 ±5(e)				
30	145399 (30) (Sheet 6.)	2	Insulator	Attaches to brackets 145324 or 145324-11 (12) and 145325 (18).			
(Ref)	NOTE						
	Clamp (29) must be installed over insulators and secure to ends of clamp of insulator (28). Insulator (30) must be installed under each clamp connection before tightening.			RD111-1010-6308 51 Bolt 45 ±5 RD153-1003-0006 51 Washer			
	RD153-5005-0006	7	Washer				
	MS20500-428	7	Nut 27 ±3	Attaches to brackets 145324 or 145324-11 (12) and 145325 (18).			
	Attaches to thrust chamber insulator 145920-11 at thrust chamber studs (except for stud adjacent to tunnel).						
	NOTE			See figure 4-9 and install heat exchanger line insulators (2, 11, 19, 23).			
	RD111-1010-6408	30	Bolt 68 ±7				
	RD153-0115-0024	30	Washer	Attaches to insulators (13, 18).			
	Attaches to insulators (13, 18).						
(e) Above running torque.							

Figure 4-8. Cocoon Thermal Insulation (Sheet 20 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
28	145531 (Cont)			33	145526-11 (Sheet 3.)	1	Door
	RD111-1010-6410	20	Bolt 150 ±15		Attaches to insulator (13).		
	LD153-0013-0002	18	Washer		Attach lanyard to existing insulator screw.		
	RD153-0115-0024	2	Washer		Torque insulator screw and door screws to 27 ±3 inch-pounds.		
	Attaches to insulator (2) and overlap of insulators (14, 17).						
	NOTE						
	Washers RD153-0115-0024 are used at last hole at each end of insulator.			34	145527-11 (Sheet 3.)	1	Door
	NAS1100C3-15	38	Screw		Attaches to insulator (14). Attach lanyard to existing insulator screw.		
	RD153-0115-0021	38	Washer		Torque insulator screw and door screws to 27 ±3 inch-pounds.		
	Attaches to interface panel.						
	NOTE						
	Bolts RD111-1010-6313 may be used in place of screws. Fasteners must be lubricated with Fel-Pro C5 (Felt Products).			35	145530-11 (Sheet 4.)		Door
31	145072-21 (Sheet 2.)	2	Door		Attaches to insulator (18). Attach lanyard to existing insulator screw.		
	Attaches to insulator 145082 (5).				Torque insulator screw and door screws to 27 ±3 inch-pounds.		
	NAS1100C3-7	2	Screw 27 ±3				
	Attaches lanyards to insulator. Torque door screws to 27 ±3 inch-pounds.			36	145529-11 (Sheet 4.)	1	Door
32	145101-21 (Sheets 2 and 4.)	2	Door		RD153-0115-0020	12	Washer
	Attaches to insulators (7, 27). Attach lanyards to existing insulator screw. Torque lanyard screw and door screws to 27 ±3 inch-pounds.				MS21279-08	12	Bolt 27 ±3
					Attaches to insulator 145515 (20). Attach lanyard to existing insulator screw. Torque screw to 27 ±3 inch-pounds.		

Figure 4-8. Cocoon Thermal Insulation (Sheet 21 of 23)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
37	145528-11 (Sheet 4.)	1	Door	NOTE			
	Attaches to insulator (20). Attach lanyard to existing insulator screw. Torque insulator screw and door screws to 27 ±3 inch-pounds.				Strut (40) must be reconnected to bracket (32) (figure 4-4) using three bolts NAS1004-8A and three washers RD153-5004-0004. Bolts must be torqued to 85 ±5 inch-pounds. Bolt attaching bracket (39) to dome must be torqued to 68 ±7 inch-pounds. Safetywire bolts.		
38	145533-11 (Sheet 1.)	1	Insulator		● Install halves of flexible gimbal boot; then install wrap-around line insulators (17 through 37, figure 4-10).		
	NAS1100C3-7	1	Screw 27 ±3		● The following insulators are part of thrust chamber insulation. See figure 4-7 for locations. The asbestos baffle must be cut at the lower end of thrust chamber insulators (28 through 30) as required to encompass equipment in the tunnel areas. The baffle must be safetywired in place prior to installation of subsequent insulators.		
39	145535-121 <sup>(l)</sup> (Sheet 1.) 145535-71(m)	1	Insulator		145926-11(28) 1 Insulator (Figure 4-7.) Attaches to cocoon insulator (13) and thrust chamber insulators 145920-11 and 145921-11.		
	RD111-1010-6410	2	Bolt 150 ±15		RD153-0115-0023 2 Washer		
	RD153-9001-0001	2	Washer		MS20500-1032 2 Nut 26 ±2		
	Attaches to bracket 145477 (41).				Installs on studs for adjoining insulator 145920-11.		
	RD127-7001-0249 <sup>(f)</sup>		Clamp 8 ±3 <sup>(e)</sup>		RD153-5005-0006 2 Washer		
40	145525-21 (Sheet 6.)	1	Cover		MS20500-428 2 Nut 36 ±2		
	Attaches to No. 1 fuel duct.				Installs on studs adjacent to cocoon insulator (13).		
	RD111-1010-6410	3	Bolt				
	RD153-0115-0024	6	Washer				
	NAS679C4W	3	Nut 8 ±3 <sup>(e)</sup>				
41	145393 (Sheet 1.)	1					
	Attaches to strut 145298 of bracket 145290 (25).						

(e) Above running torque.

(f) A component of insulator.

(l) Used on thermal insulation sets 13-8 and 14-6.

(m) Used on thermal insulation sets 12-1 through 13-7, 14-1 through 14-5, and 14-7 and subsequent.

Figure 4-8. Cocoon Thermal Insulation (Sheet 22 of 23)



Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
41	145393 (Cont)				RD153-5005-0006	2	Washer
	RD153-5005-0006	8	Washer		MS20500-428	2	Nut 36 ±2
	NAS1004-5A	8	Bolt 36 ±2		Installs on studs for adjacent cocoon insulator (20).		
	Attaches to insulator (13).				RD153-5005-0006	8	Washer
	145927-11 (29)	1	Insulator		NAS1004-5A	8	Bolt 26 ±2
	(Figure 4-7.) Attaches to cocoon insulators (7, 10) and thrust chamber insulator 145921-11.				Attaches to cocoon insulator (20).		
	RD153-0115-0023	3	Washer		145923-11(31)	1	Insulator
	MS20500-1032	3	Nut 26 ±2		(Figure 4-7.)		
	Installs on studs for cocoon insulator (7) and thrust chamber insulator 145921-11.				RD153-0115-0023	6	Washer
	RD153-5005-0006	4	Washer		MS20500-1032	6	Nut 26 ±2
	MS20500-428	4	Nut 36 ±2		Attaches to thrust chamber studs.		
	Installs on studs for cocoon insulators (7, 10) and thrust chamber insulator 145921-11.				NOTE		
	RD153-5005-0006	15	Washer		If the washer and nut specified cannot be installed on the stud at the junction of insulators 145923-11, 145921-11, and 145173-21 due to tolerance buildup, stud adapter 145934 may be installed on the stud. The adapter must be torqued to 26 ±2 inch-pounds and safetywired to the nearest available lacing stud.		
	NAS1004-5A	15	Bolt 36 ±2		RD153-0115-0023	4	Washer
	Attaches to cocoon insulator (10).				MS21279-10	4	Bolt 26 ±2
	145928-11 (30)	1	Insulator		Attaches to thrust chamber insulator 145926-11.		
	(Figure 4-7.) Attaches to cocoon insulator (20) and thrust chamber insulator 145922-11.				145924-11 (32)	1	Insulator
	RD153-0115-0023	2	Washer		(Figure 4-7.) Attaches to thrust chamber insulators 145927-11 and 145909-21.		
	MS20500-1032	2	Nut 36 ±2		RD153-0115-0023	8	Washer
	Installs on studs for cocoon insulator (27) and thrust chamber insulator 145922-11.				MS20500-1032	8	Nut 26 ±2
					Attaches to thrust chamber studs.		
					RD153-0115-0023	3	Washer
					MS21279-10	3	Bolt 26 ±2
					Attaches to thrust chamber insulator 145927-11.		

Figure 4-8. Cocoon Thermal Insulation (Sheet 22A of 23)

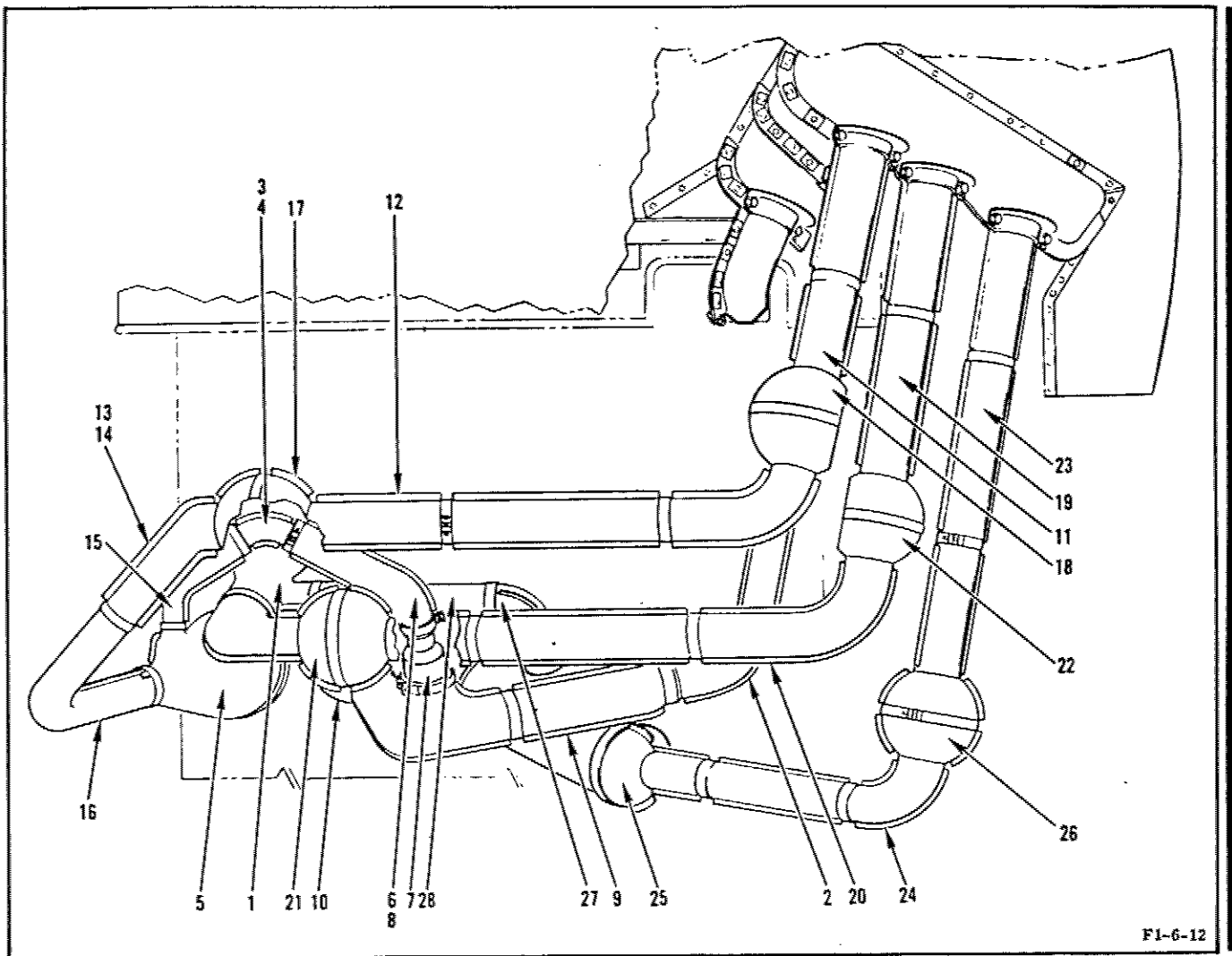
Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
41	145393 (Cont)				RD153-0115-0023	3	Washer
	RD114-5002-0002	10	Clip		MS21279-10	3	Bolt 26 ±2
	MS21279-06	10	Bolt 26 ±2		Attaches to thrust chamber insulator 145928-11.		
	Attaches to thrust chamber insulator 145909-21.				RD114-5002-0002	9	Clip
	145925-11 (33)	1	Insulator		MS21279-06	9	Bolt 26 ±2
	(Figure 4-7.)				Attaches to thrust chamber insulator 145911-21.		
	Attaches to thrust chamber insulators 145928-11 and 145911-21.						
	RD153-0115-0023	8	Washer				
	MS20500-1032	8	Nut 26 ±2				
	Attaches to thrust chamber studs.						

Figure 4-8. Cocoon Thermal Insulation (Sheet 23 of 23)

4-19. INSTALLING HEAT EXCHANGER LINE INSULATORS.

4-20. Heat exchanger line insulators are installed in the order shown in figure 4-9, except for insulators indexed (2, 11, 19, 23), which are installed during installation of cocoon insulators (28, 29, 30) in figure 4-8. Special instructions applicable to this procedure are as follows:

- a. Using inconel lockwire MS20995N32, safetywire screws of all insulator clamps.
- b. Fold flanges of insulators.



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Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
1	145207	1	Insulator	3	145217-51	1	Insulator
	RE127-7001-0566 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>	4	145217-61	1	Insulator
	RE127-7001-0206 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>	5	145210	1	Insulator
2	145211	1	Insulator		RE127-7001-0646 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>
	RE127-7001-0156 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>				

(a) Clamp screws: 8 ± 3 inch-pounds above running torque.

(b) A component of insulator.

Figure 4-9. Heat Exchanger Lines Thermal Insulation (Sheet 1 of 2)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
6	145220 <sup>(c)</sup>	1	Insulator	18	145202-21 <sup>(c)</sup>	1	Insulator
	RE127-7001-0194 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>		145202-61 <sup>(d)</sup>		
7	145222 <sup>(d)</sup>	2	Insulator		RE127-7001-0500 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>
	RE127-7001-0194 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>	19	145205	1	Insulator
8	145221 <sup>(d)</sup>	1	Insulator		RE127-7001-0206 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>
9	145213	1	Insulator	20	145206	1	Insulator
	RE127-7001-0250 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>		RE127-7001-0206 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>
	RE127-7001-0263 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>	21	145202	1	Insulator
10	145214	1	Insulator		RE127-7001-0438 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>
	RE127-7001-0650 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>	22	145202 <sup>(c)</sup>	1	Insulator
	RE127-7001-0278 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>		145202-81 <sup>(d)</sup>		
11	145208	1	Insulator		RE127-7001-0438 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>
	RE127-7001-0206 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>	23	145201	1	Insulator
12	145209	1	Insulator		RE127-7001-0181 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>
	RE127-7001-0206 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>	24	145203	1	Insulator
13	145219-11	1	Insulator		RE127-7001-0182 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>
14	145219-21	1	Insulator	25	145204	1	Insulator
15	145218	1	Insulator		RE127-7001-0566 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>
	RE127-7001-0192 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>		RE127-7001-0438 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>
	RE127-7001-0131 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>	26	145202-11	1	Insulator
16	145212	1	Insulator		RE127-7001-0438 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>
	RE127-7001-0206 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>	27	145215	1	Insulator
17	145202-21	1	Insulator		RE127-7001-0206 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>
	RE127-2001-0500 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>	28	145216	1	Insulator
					RE127-7001-0206 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>

(a) Clamp screws: 8 ±3 inch-pounds above running torque.

(b) A component of insulator.

(c) On thermal insulation sets 13-5 and 13-8.

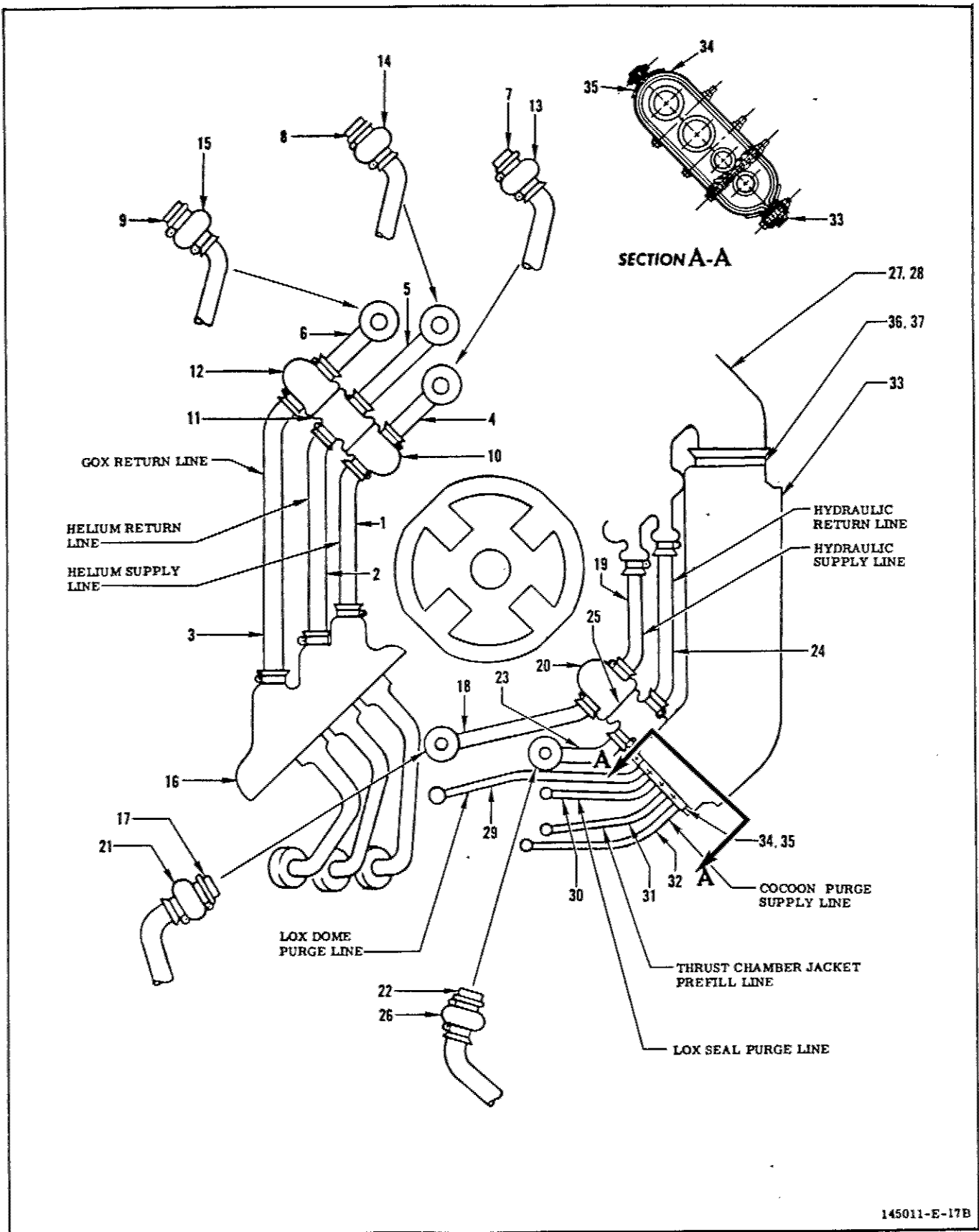
(d) On thermal insulation sets 12-1 through 13-4, 13-6, 13-7, and 14-1 and subsequent.

Figure 4-9. Heat Exchanger Lines Thermal Insulation (Sheet 2 of 2)

4-21. INSTALLING WRAP-AROUND LINE INSULATORS.

4-22. The wrap-around line insulators are installed in the order shown in figure 4-10 except for insulators indexed (1 through 16), which are installed during installation of cocoon insulation in figure 4-8. Safetywiring is required for clamps RE127-7001 used in this procedure. If clamp RD127-7001 is replaced, clamp

RE127-7001 is an allowable alternate. As an aid to installing clamps, foil insulator halves may be held together with lockwire MS20995N and cloth insulators may be held with cord. Cord must be removed following clamp installation. Safetywire clamp screws for clamps RE127-7001 using Inconel lockwire MS20995N32. If screw NAS-1100C3-16 is damaged when installing clamp RD127-7001, replace screw with bolt MS21279-16.



145011-E-17B

Figure 4-10. Wrap-Around Lines Thermal Insulation (Sheet 1 of 4)

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Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
1	145089	1	Insulator	13	RD153-0115-0019	16	Washer
	RD127-7001-0196 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>	(cont)	RD114-8003-1003	8	Nut
2	145090	1	Insulator	14	145145 <sup>(c)</sup>	1	Insulator
	RD127-7001-0222 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>		RE127-7001-0234	1	Clamp <sup>(a)</sup>
3	145088	1	Insulator		RE127-7001-0409	1	Clamp <sup>(a)</sup>
	RD127-7001-0222 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>		MS21279-10	10	Bolt
4	145118	1	Insulator		RD153-0115-0019	20	Washer
	RD127-7001-0196 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>		RD114-8003-1003	10	Nut
5	145119	1	Insulator	15	145147 <sup>(c)</sup>	1	Insulator
	RD127-7001-0222 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>		RE127-7001-0234	1	Clamp <sup>(a)</sup>
6	145117	1	Insulator		RE127-7001-0409	1	Clamp <sup>(a)</sup>
	RD127-7001-0222 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>		MS21279-10	10	Bolt
7	145120-21 <sup>(d)</sup> , 145120-51 <sup>(e)</sup>	2	Insulator		RD153-0115-0019	20	Washer
8	145120-31 <sup>(d)</sup> , 145120-61 <sup>(e)</sup>	2	Insulator		RD114-8003-1003	10	Nut
9	145120-41 <sup>(d)</sup> , 145120-71 <sup>(e)</sup>	2	Insulator	16	145150-11	1	Boot
10	145193 <sup>(c)</sup>	1	Insulator		RE127-7001-0186	1	Clamp <sup>(a)</sup>
	RE127-7001-0206	2	Clamp <sup>(a)</sup>		RE127-7001-0210	2	Clamp <sup>(a)</sup>
	MS21279-10	10	Bolt		MS21279-11	28	Bolt
	RD153-0115-0019	20	Washer		RD153-1003-0010	56	Washer
	RD114-8003-1003	10	Nut		RD111-1010-6310	9	Bolt 27 ±3
11	145194 <sup>(c)</sup>	1	Insulator		RD153-0115-0019	9	Washer
	RE127-7001-0234	2	Clamp <sup>(a)</sup>		RD114-8003-1003	28	Nut 27 ±3
	MS21279-10	10	Bolt		NAS1003-12A	2	Bolt 27 ±3
	RD153-0115-0019	20	Washer		RD153-0115-0019	2	Washer
	RD114-8003-1003	10	Nut		NAS1057T3-045	2	Spacer
12	145192 <sup>(c)</sup>	1	Insulator		Install spacers between insulator and bracket (9).		
	RE127-7001-0234	2	Clamp <sup>(a)</sup>	17	145120-11	2	Insulator
	MS21279-10	10	Bolt	18	145135-41	1	Insulator
	RD153-0115-0019	20	Washer		RD127-7001-0234 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>
	RD114-8003-1003	10	Nut	19	145095	1	Insulator
13	145148 <sup>(c)</sup>	1	Insulator		RD127-7001-0234 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>
	RE127-7001-0397	1	Clamp <sup>(a)</sup>	20	145195 <sup>(c)</sup>	1	Insulator
	RE127-7001-0206	1	Clamp <sup>(a)</sup>		RE127-7001-0222	2	Clamp <sup>(a)</sup>
	MS21279-10	8	Bolt		MS21279-10 <sup>(b)</sup>	12	Screw
					RD153-0115-0119 <sup>(b)</sup>	24	Washer
					RD114-8003-1003 <sup>(b)</sup>	12	Nut

(a) Clamp screws: 8 ±3 inch-pounds above running torque.

(b) A component of insulator.

(c) Flange fasteners torque: 27 ±3 inch-pounds.

(d) Used on thermal insulation sets 12-1 through 13-6.

(e) Used on thermal insulation sets 13-7, 14-2, 14-4, 14-5, 15-2 through 15-5, 16-1, 16-3, and subsequent.

Figure 4-10. Wrap-Around Lines Thermal Insulation (Sheet 2 of 4)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)				
21	145137 <sup>(c)</sup>	1	Insulator	NOTE							
	RE127-7001-0222	1	Clamp <sup>(a)</sup>	Strut (40) figure 4-4 must be temporarily disconnected to facilitate installation of insulator.							
	RE127-7001-0366	1	Clamp <sup>(a)</sup>								
	MS21279-10 <sup>(b)</sup>	10	Screw								
	RD153-0115-0019 <sup>(b)</sup>	20	Washer								
	RD114-8003-1003 <sup>(b)</sup>	10	Nut								
22	145120-11	2	Insulator	RD111-1009-0310	2	Bolt 27 ±3					
23	145134	1	Insulator	RD153-0115-0019	2	Washer					
	RD127-7001-0234 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>	Install in 2 remaining holes at outboard end of bracket. Safetywire boltheads.							
24	145096	1	Insulator	RE127-7001-0199	2	Clamp <sup>(a)</sup>					
	RD127-7001-0234 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>	Install around insulators at line outlets.							
25	145196 <sup>(c)</sup>	1	Insulator	RD153-1003-0010	60	Washer					
	RE127-7001-0222	2	Clamp <sup>(a)</sup>	MS21279-11	30	Bolt					
	MS21279-10 <sup>(b)</sup>	10	Screw	RD114-8003-1003	30	Nut 27 ±3					
	RD153-0115-0019 <sup>(b)</sup>	20	Washer	MS21279-11	4	Bolt					
	RD114-8003-1003 <sup>(b)</sup>	10	Nut	RD153-1003-0010	8	Washer					
26	145136 <sup>(c)</sup>	1	Insulator	RD114-8003-1003	4	Nut 27 ±3					
	RE127-7001-0222	1	Clamp <sup>(a)</sup>	Install in 4 grommeted holes between line outlets.							
	RE127-7001-0366	1	Clamp <sup>(a)</sup>	NOTE							
	MS21279-10 <sup>(b)</sup>	10	Screw	Following installation of insulators (29 through 32), lockwire may be used at the ends nearest clamp (34) to prevent gapping of the insulators.							
	RD153-0115-0019 <sup>(b)</sup>	20	Washer								
	RD114-8003-1003 <sup>(b)</sup>	10	Nut								
27	145149-21	1	Insulator					29	145124	1	Insulator
	RD111-1010-6312	12	Bolt 27 ±3					RD127-7001-0172 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>	
	RD153-1003-0010	12	Washer	RD127-7001-0228 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>					
28	145149-11	1	Insulator	30	145123	1	Insulator				
	RD111-1010-6310	13	Bolt 27 ±3	RD127-7001-0172 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>					
	RD153-0115-0019	13	Washer	RD127-7001-0228 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>					
	Attach insulator to bracket except at 2 outboard holes.										

(a) Clamp screws: 8 ±3 inch-pounds above running torque.

(b) A component of insulator.

(c) Flange fasteners torque: 27 ±3 inch-pounds.

Figure 4-10. Wrap-Around Lines Thermal Insulation (Sheet 3 of 4)

Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)	Index No.	Part No.	Quantity	Name and Torque (Inch-Pounds)
31	145122	1	Insulator	<p>i. Secure remaining end of blanket (33) by first overlapping flaps of previously installed adjacent insulators under inner clamping area of blanket. Install clamps (36, 37) and secure, using hardware listed with clamp (37). Make sure layers of adjacent insulators are sandwiched between layers of blanket at outer clamping area.</p> <p>j. Secure edges of blanket (33), using hardware listed with it.</p>			
	RD127-7001-0172 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>				
	RD127-7001-0210 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>				
32	145125	1	Insulator				
	RD127-7001-0148 <sup>(b)</sup>	2	Clamp <sup>(a)</sup>				
	RD127-7001-0186 <sup>(b)</sup>	1	Clamp <sup>(a)</sup>				
NOTE							
The following special instructions install parts (33 through 37).							
a. Position blanket (33) in place.							
b. See section A-A of this figure and insert aft rubber cushion of blanket over and between lines.							
c. Install clamp (34) at aft side of blanket. Using 3 screws 10-32 approximately 5 inches in length, aline clamp and blanket cushion holes. Do not completely install screws.							
d. Fold forward side of blanket in place and install clamp (35). Aline by pushing screws through forward cushion of blanket and holes of clamp.							
e. Compress assembly by using applicable washers and nuts on screws.							
f. Secure ends of clamps, using hardware listed with clamp (35). See section A-A for direction of installation.							
g. Push screws 10-32 out, using applicable screw listed with clamp (35).							
h. Tighten nuts to compress assembly with approximately equal torque for each nut.							
33	145097	1	Blanket				
	RD114-8003-1003	29	Nut 27 ±3				
	MS21279-13	29	Bolt				
	RD153-1003-0010	58	Washer				
34	145130	1	Clamp				
35	145131	1	Clamp				
	MS21279-18	1	Bolt				
	MS21279-11	1	Bolt				
	RD153-0115-0020	4	Washer				
	RD114-8003-1003	2	Nut 27 ±3				
	NAS1101C3-48	3	Screw				
	RD153-0115-0020	6	Washer				
	RD114-8003-1003	3	Nut <sup>(a)</sup>				
36	145139	1	Clamp				
37	145138	1	Clamp				
	MS21279-11	1	Bolt				
	MS21279-22	1	Bolt				
	RD153-0115-0020	4	Washer				
	RD114-8003-1003	2	Nut 27 ±3				

(a) Clamp screws: 8 ±3 inch-pounds above running torque.  
 (b) A component of insulator.

Figure 4-10. Wrap-Around Lines Thermal Insulation (Sheet 4 of 4)



**4-23. REMOVING THERMAL INSULATION INSULATORS.**

4-24. Thermal insulation insulators are removed in the reverse order of installation. Applicable tools and equipment required are listed in section II.

**4-25. REMOVING AND REINSTALLING THERMAL INSULATION BRACKETS FOR ENGINE MAINTENANCE.**

4-26. These procedures provide removal and reinstallation instructions for certain thermal insulation brackets to provide access for removing and installing engine components during engine maintenance. Only the parts required to remove the portion of the bracket that is blocking access to the component are disconnected or disassembled. Removal and reinstallation of brackets not covered in these procedures are in the applicable engine component removal and installation procedures.

4-27. REMOVING STIFFENER 145408. (See figure 4-11.)

- a. Remove parts indexed (1 through 17).
- b. Support stiffener, if necessary, and remove parts indexed (18 through 21).
- c. Carefully remove stiffener.

4-28. REINSTALLING STIFFENER 145408. (See figure 4-11.)

**NOTE**

Torque values for fasteners are in figure 4-11.

- a. Install stiffener and secure ends with parts indexed (1 through 8) and (18 through 21).
- b. Install parts indexed (9 through 17).

4-29. REMOVING SUPPORT BOW 145499. (See figure 4-12.)

**CAUTION**

The adjusted lengths of the support bow struts must not be disturbed.

a. Remove parts indexed (1 through 18), details A through E.

b. Remove parts indexed (19 through 26), details F and G.

**NOTE**

If the support bow will be reinstalled, parts indexed (18 through 26) may be left installed and the struts disconnected from brackets (19, 23) by removing bolt NAS1004-14A, washers LD153-0013-0002 and RD153-1002-0004, and nut RD114-8003-1004. (Torque value for the nut is 15 ±2 in-lb.)

c. Remove parts indexed (27 through 29), detail H.

d. If static-firing instrumentation is installed, disconnect rod end of tube (30) from bracket (31) by removing parts indexed (32 through 35). If static-firing instrumentation is not installed, disconnect bracket (31) by removing bolt (36) and washer (37).

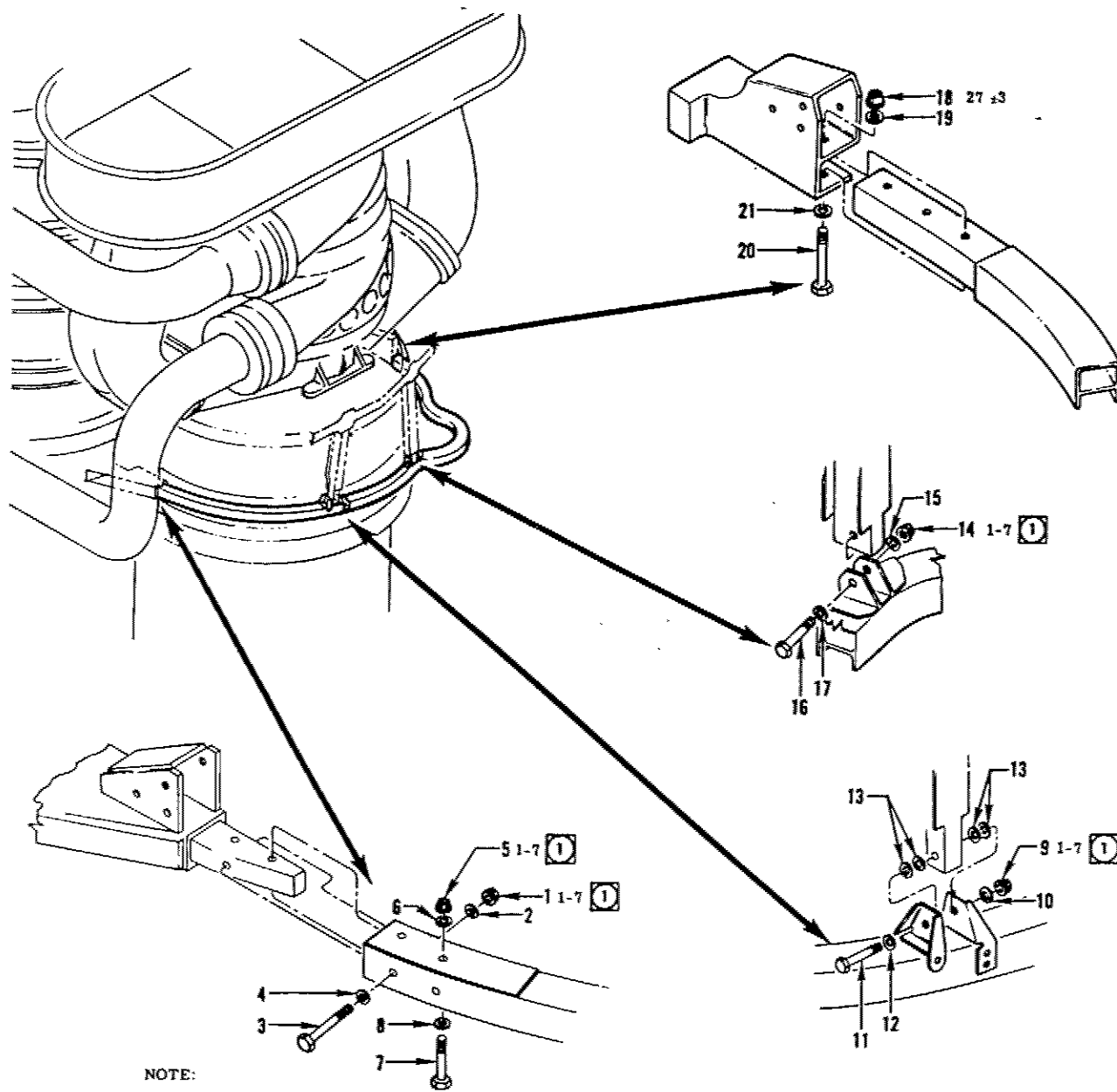
e. Remove parts indexed (38 through 53), details J and K.

**WARNING**

If the engine is not in the horizontal position with the support bow uppermost, the support bow must be supported during the following steps, to prevent injury to personnel or damage to equipment. The support bow weighs approximately 37 pounds.

f. Remove parts indexed (54 through 79), details L through N.

g. Carefully remove support bow.



NOTE:  
 ALL TORQUE VALUES ARE IN IN-LB.  
 ① ABOVE RUNNING TORQUE

F1-6-19

Index No.	Part Name	Part No.	Index No.	Part Name	Part No.
1	Nut	RD114-8003-1005	12	Washer	LD153-0010-0009
2	Washer	RD153-1002-0005	13	Washer	RD153-1002-0004
3	Bolt	NAS1005-27A	14	Nut	RD114-8003-1004
4	Washer	RD153-0013-0003	15	Washer	RD153-1002-0004
5	Nut	RD114-8003-1005	16	Bolt	NAS1004-17A
6	Washer	RD153-1002-0005	17	Washer	RD153-5004-0004
7	Bolt	NAS1005-20A	18	Nut	RD114-8003-1004
8	Washer	LD153-0013-0003	19	Washer	RD153-1002-0004
9	Nut	RD114-8003-1004	20	Bolt	NAS1004-29A
10	Washer	LD153-0010-0009	21	Washer	LD153-0013-0002
11	Bolt	NAS1004-19A			

Figure 4-11. Thermal Insulation Stiffener 145408

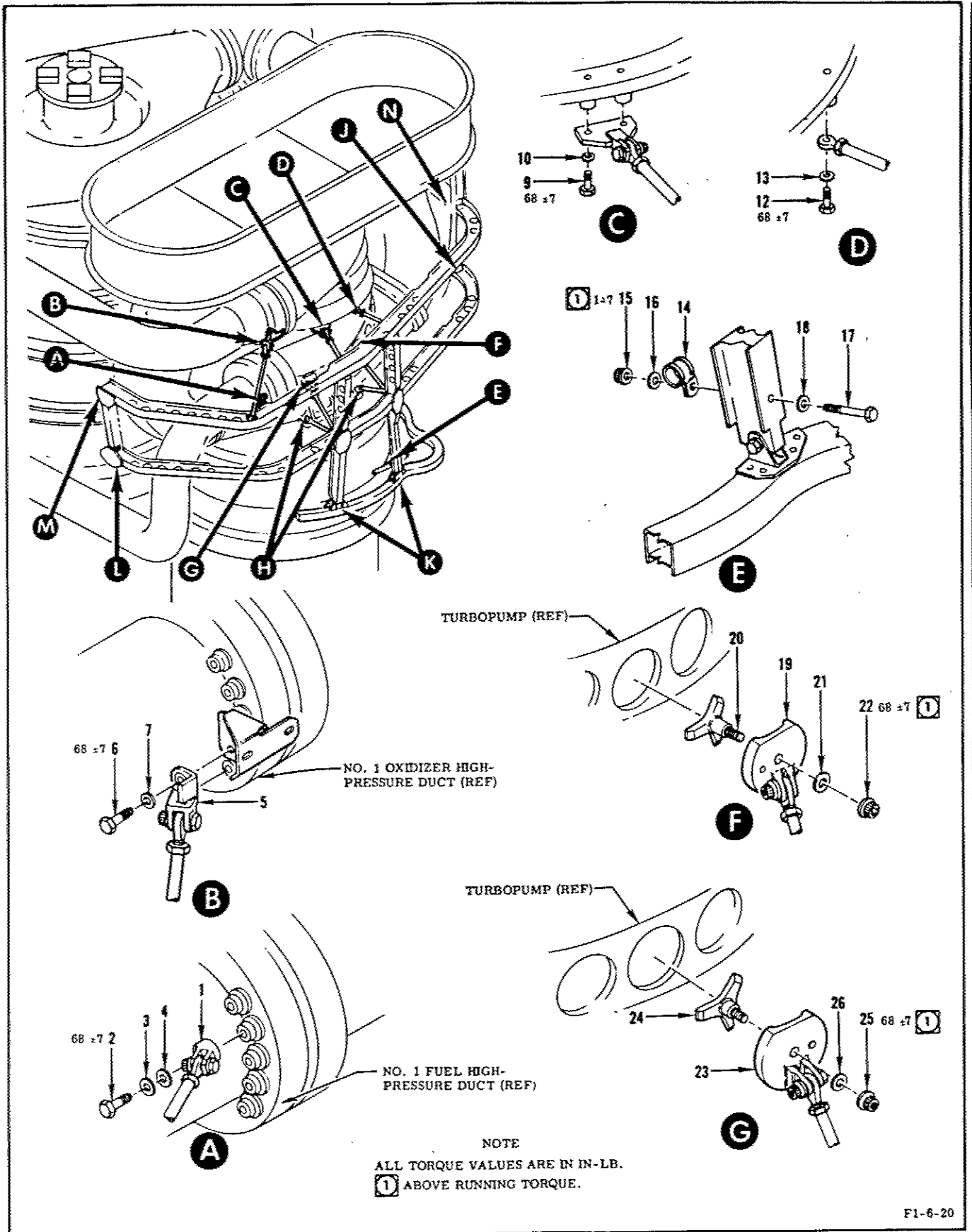


Figure 4-12. Thermal Insulation Support Bow 145499 (Sheet 1 of 3)

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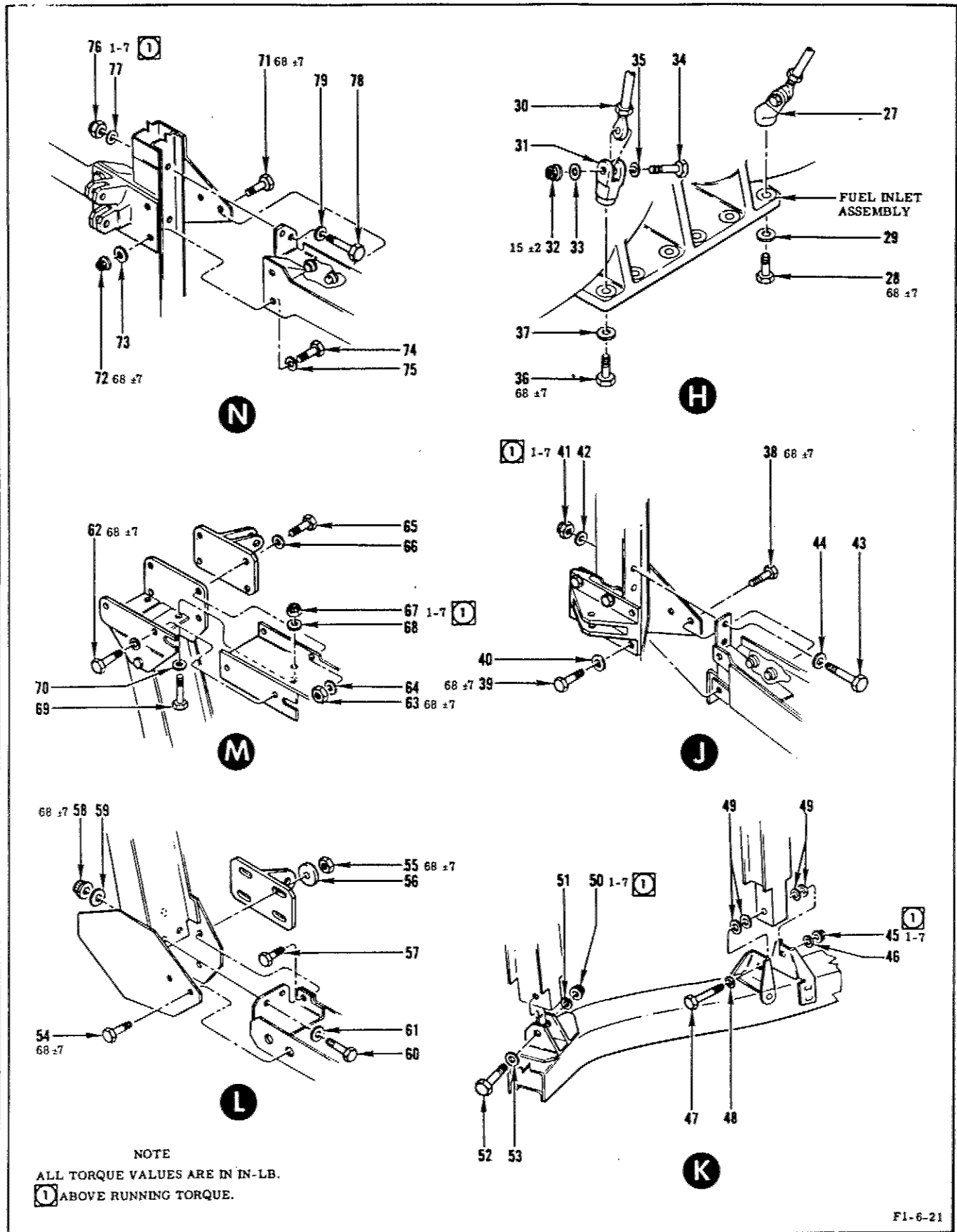


Figure 4-12. Thermal Insulation Support Bow 145499 (Sheet 2 of 3)

Index No.	Part Name	Part No.	Index No.	Part Name	Part No.
1	Bracket	145437	41	Nut	NAS679C4W
2	Bolt	NAS1005-1H	42	Washer	LD153-0010-0010
3	Washer	LD153-0013-0003	43	Bolt	NAS1004-21A
4	Washer	RD153-1002-0005	44	Washer	LD153-0013-0002
5	Bracket	145468	45	Nut	RD114-8003-1004
6	Bolt	NAS1005-1H	46	Washer	LD153-0010-0009
7	Washer	LD153-0013-0003	47	Bolt	NAS1004-19A
8	Bracket	145280	48	Washer	LD153-0010-0009
9	Bolt	NAS1004-2H	49	Washer	RD153-1002-0004
10	Washer	LD153-0013-0002	50	Nut	RD114-8003-1004
11	Rod end	KE4-22	51	Washer	RD153-1002-0004
12	Bolt	NAS1004-4H	52	Bolt	NAS1004-17A
13	Washer	LD153-0013-0002	53	Washer	RD153-5004-0004
14	Clamp	RE127-2004-0009	54	Bolt	RD111-1016-0405
15	Nut	NAS679C3W	55	Nut	NAS679C4W
16	Washer	LD153-0010-0007	56	Washer	RD153-5005-0005
17	Bolt	NAS1003-30A	57	Bolt	RD111-1016-0405
18	Washer	LD153-0013-0001	58	Nut	RD114-8003-1004
19	Bracket	145435	59	Washer	RD153-1002-0004
20	Bracket	145233	60	Bolt	NAS1004-16A
21	Nut	RD114-8003-1006	61	Washer	LD153-0013-0002
22	Washer	RD153-1002-0006	62	Bolt	RD111-1016-0405
23	Bracket	145436	63	Nut	NAS679C4W
24	Bracket	145233	64	Washer	LD153-0010-0010
25	Nut	RD114-8003-1006	65	Bolt	RD111-1016-0407
26	Washer	RD153-1002-0006	66	Washer	LD153-0013-0002
27	Bracket	145428	67	Nut	NAS679C4W
28	Bolt	RD111-1016-0415	68	Washer	LD153-0010-0010
29	Washer	LD153-0013-0002	69	Bolt	NAS1004-15A
30	Tube	145279-9	70	Washer	LD153-0013-0002
31	Bracket	145427	71	Bolt	RD111-1016-0405
32	Nut	RD114-8003-1004	72	Nut	RD114-8003-1004
33	Washer	RD153-1002-0004	73	Washer	RD153-1002-0004
34	Bolt	NAS1004-14A	74	Bolt	RD111-1016-0407
35	Washer	LD153-0013-0002	75	Washer	LD153-0013-0002
36	Bolt	RD111-1016-0415	76	Nut	NAS679C4W
37	Washer	LD153-0013-0002	77	Washer	LD153-0010-0010
38	Bolt	RD111-1016-0405	78	Bolt	NAS1004-21A
39	Bolt	RD111-1016-0407	79	Washer	LD153-0013-0002
40	Washer	LD153-0013-0002			

Figure 4-12. Thermal Insulation Support Bow 145499 (Sheet 3 of 3)

4-30. REINSTALLING SUPPORT BOW 145499.  
(See figure 4-12.)

WARNING

If the engine is not installed in the horizontal position with the support bow uppermost, the support bow must be supported until secured in place, to prevent injury to personnel or damage to equipment. The support bow weighs approximately 37 pounds.

NOTE

Torque values for fasteners are in figure 4-12.

- Frames 145497 and 145498 must be installed before installing support bow.
- a. Install support bow and secure members at junctures to frames 145497 and 145498 using the following indexed parts, noted with their detail locations.
  - (1) Detail N; parts indexed (71 through 79).
  - (2) Detail M; parts indexed (62 through 70).
  - (3) Detail L; parts indexed (54 through 61).
  - (4) Detail J; parts indexed (38 through 44).
- b. Loosen bolts indexed (38, 54, 62, 71) and measure gap between plates of frames 145497 and 145498 and members of support bow. If gap does not exceed 0.032 inch, torque applicable bolts to value indicated. If gap is between 0.032 and 0.064 inch, place a washer LD153-0010-0009 on the bolt between the plate and frame member, and torque bolt to applicable torque value. Gaps exceeding 0.064 inch are not acceptable and require rework of the plate.
- c. Install parts indexed (45 through 53), detail K.
- d. Lubricate bolts (2, 6, 9, 12) with thread compound Fe1-Pro C-5A (Felt Products) as follows:
  - (1) Apply lubricant in a streak 1/8 inch to 1/4 inch wide across all threads and flush with top of threads.
  - (2) Distribute lubricant streak uniformly around fastener threads with a clean nylon brush. Remove excess lubricant.
- e. See details A through D, and attach brackets (1, 5, 8) and rod end (11) to engine using attaching hardware shown. Safetywire bolts.
- f. Install clamp (14) using parts indexed (15 through 18), detail E.
- g. If struts were disconnected from brackets (19, 23) details F and G, connect struts using bolts NAS1004-14A, washers LD153-0013-0002 and RD153-1002-0004, and nuts RD114-8003-1004. Torque nuts to 15 ±2 in-lb.
- h. If parts indexed (19 through 22), detail F, were removed, loosely assemble parts in casting hole of turbopump. Position bracket (20) with one leg toward front of engine. Place chamfered edge of forward bracket leg into deepest recess of forward 1/3 of inner edge of casting holes. Approximately one-half of chamfer at end of leg must extend under edge of casting. Retain bracket in this position when torquing nut (21). A maximum tilt gap of 0.050 inch between nut and washer is acceptable.
- i. If parts indexed (23 through 26), detail G were removed, install them using same method outlined in step h.
- j. See detail H, and connect bracket (27) to engine using bolt (28) and washer (29).
- k. If rod end of tube (30) was disconnected from bracket (31), detail H, connect rod end of tube to bracket using parts indexed (32 through 35). Torque nut to 15 ±2 in-lb. If bracket was disconnected from engine, attach bracket to engine using bolt (36) and washer (37).

4-31. REMOVING FRAME 145497. (See figure 4-13.)

CAUTION

The adjusted lengths of the frame struts must not be disturbed.

- a. If support bow 145499 is installed, disconnect support bow members attached to frame. (Refer to paragraph 4-29.)

- b. Remove parts indexed (1 through 15).

**NOTE**

If the fuel inlet elbow is not being removed, brackets (8, 11, 15) may be left attached to the elbow and the frame strut rod ends disconnected.

- c. Disconnect frame from interface panel by removing parts indexed (16 through 23).

**WARNING**

The frame must be supported during the following steps, to prevent injury to personnel or damage to equipment. The frame weighs approximately 34 pounds.

- d. Support frame and remove parts indexed (24 through 28).

- e. Carefully remove frame.

#### 4-32. REINSTALLING FRAME 145497. (See figure 4-13.)

**WARNING**

The frame must be supported until secured in place, to prevent injury to personnel or damage to equipment. The frame weighs approximately 34 pounds.

**NOTE**

Torque values for fasteners are in figure 4-13.

- a. Lubricate bolts (24, 27) with thread compound Fel-Pro C-5A (Felt Products) as follows:

(1) Apply lubricant in a streak 1/8 inch to 1/4 inch wide across all threads and flush with top of threads.

(2) Distribute lubricant streak uniformly around fastener threads with a clean nylon brush. Remove excess lubricant.

- b. Position frame on engine, aline with members of support bow 145499, and attach frame to interface panel using parts indexed (16 through 23).

- c. Attach frame at oxidizer duct flange using bolt (24) and washers (25, 26).

- d. Attach frame at fuel duct flange using bolt (27) and washer (28).

- e. Attach frame at saddle using parts indexed (1 through 5).

**NOTE**

Steps f through h are performed only if brackets (8, 11, 15) were removed.

- f. Position bracket (8) between fuel inlet elbow and existing panel. Attach bracket and panel using bolts (6) and washers (7).

- g. Attach bracket (11) to fuel inlet elbow using bolt (9) and washer (10).

- h. Attach support (14) and bracket (15) to fuel inlet elbow using bolts (12) and washers (13).

- i. If struts were disconnected from brackets (8, 11, 15), connect rod ends of struts to brackets using bolt NAS1004-13A, washers LD153-0013-0002 and RD153-1002-0004, and nut RD114-8003-1004. Torque nut to  $27 \pm 3$  in-lb above running torque.

- j. Safetywire bolts (6, 9, 12, 24, and 27).

- k. Connect frame to support bow 145499 as outlined in paragraph 4-30.

#### 4-33. REMOVING FRAME 145498. (See figure 4-14.)

- a. Remove stiffener 145408. (Refer to paragraph 4-27.)

- b. If support bow 145499 is installed, disconnect support bow members attached at frame 145498. (Refer to paragraph 4-29.)

- c. Remove bracket (1) and brace (2) as a unit by removing parts indexed (3 through 14), detail A.

- d. Disconnect frame from support (15) by removing bolts (16) and washers (17), detail B.

- e. Disconnect frame from No. 1 fuel high-pressure duct flange boltheads by removing bolts (18) and washers (19), detail C.

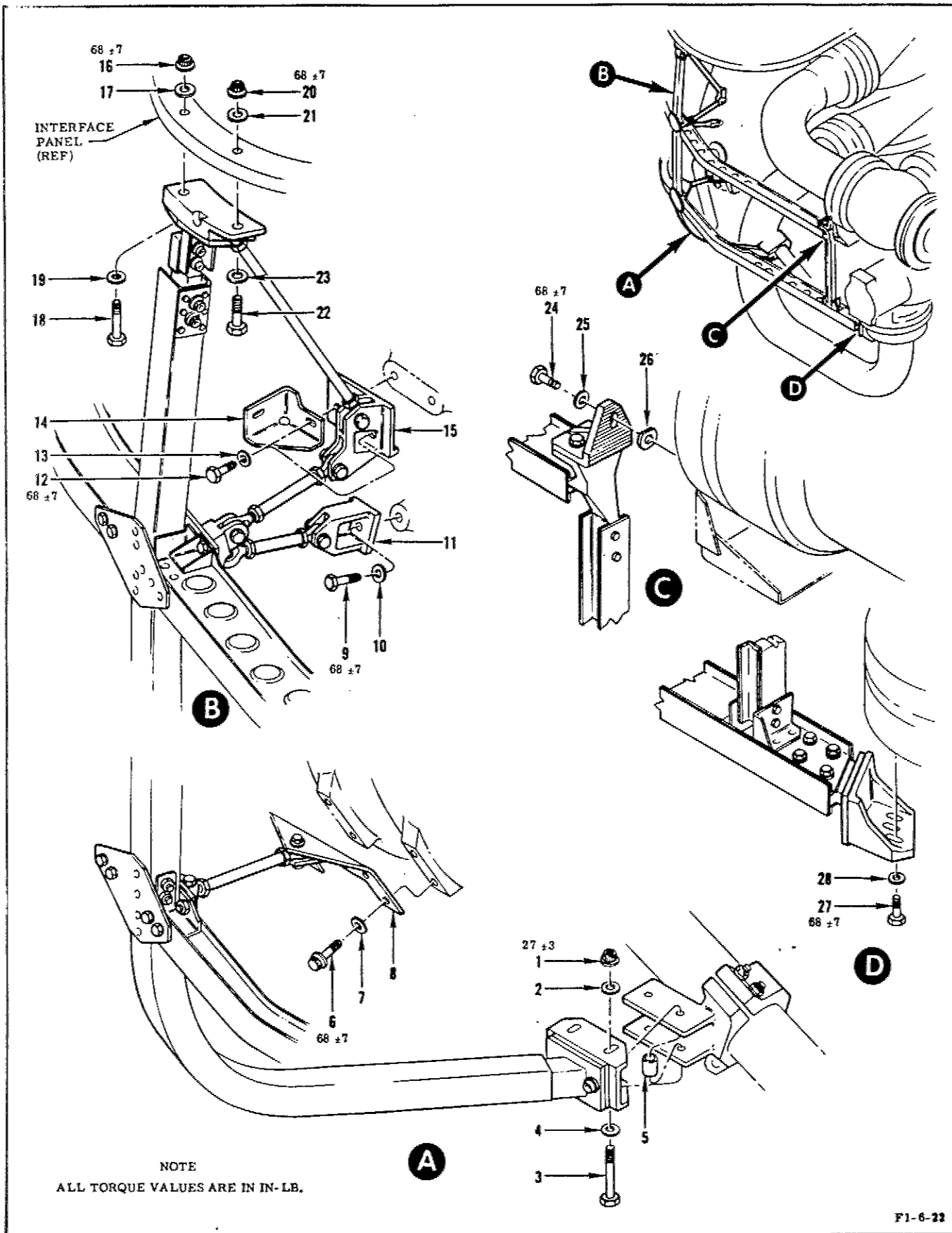


Figure 4-13. Thermal Insulation Frame 145497 (Sheet 1 of 2)

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Index No.	Part Name	Part No.	Index No.	Part Name	Part No.
1	Nut	RD114-8003-1004	15	Bracket	145452
2	Washer	RD153-9004-0001	16	Nut	RD111-8003-1004
3	Bolt	NAS1004-30A	17	Washer	RD153-1002-0004
4	Washer	RD153-9004-0001	18	Bolt	NAS1004-26A
5	Spacer	NAS1057T4-117	19	Washer	LD153-0013-0002
6	Bolt	RD111-4010-6411	20	Nut	RD114-8003-1004
7	Washer	LD153-0013-0002	21	Washer	RD153-1002-0004
8	Bracket	145582	22	Bolt	NAS1004-14A
9	Bolt	NAS1006-2H	23	Washer	LD153-0013-0002
10	Washer	LD153-0013-0004	24	Bolt	NAS1005-5H
11	Bracket	145451	25	Washer	LD153-0013-0003
12	Bolt	NAS1004-1H	26	Washer	RD153-9004-0002
13	Washer	LD153-0013-0002	27	Bolt	NAS1005-4H
14	Support	703901-1	28	Washer	RD153-9004-0002

Figure 4-13. Thermal Insulation Frame 145497 (Sheet 2 of 2)

f. Disconnect bracket (20) from bracket (21) by removing parts indexed (22 through 25), detail D. If fuel inlet elbow will be removed, remove bolt (26), washer (27), and bracket (21).

g. Remove parts indexed (28 through 32), detail E. Rotate plate and bracket around trunnion to clear frame member.

h. Remove parts indexed (33 through 36), detail E.

**WARNING**

The frame must be supported during the following steps, to prevent injury to personnel or damage to equipment. The frame weighs approximately 60 pounds.

i. Support frame and disconnect it from No. 1 oxidizer high-pressure duct flange bolt-heads by removing parts indexed (37 through 40) detail F.

j. Support frame and disconnect bracket (41) at the No. 1 fuel inlet elbow by removing bolts (42) and washers (43), detail G.

k. Carefully remove frame.

4-34. REINSTALLING FRAME 145498. (See figure 4-14.)

**WARNING**

The frame must be supported until secured in place, to prevent injury to personnel or damage to equipment. The frame weighs approximately 60 pounds.

**NOTE**

Torque values for fasteners are in figure 4-14.

a. Lubricate 3 bolts (18) and 2 bolts (39) with thread compound Fel-Pro C-5A (Felt Products). Apply lubricant as follows:

(1) Apply lubricant in a streak 1/8 inch to 1/4 inch wide across all threads and flush with top of threads.

(2) Distribute lubricant streak uniformly around fastener threads with a clean nylon brush. Remove excess lubricant.

b. Carefully install frame on engine and aline frame with members of support bow 145499.

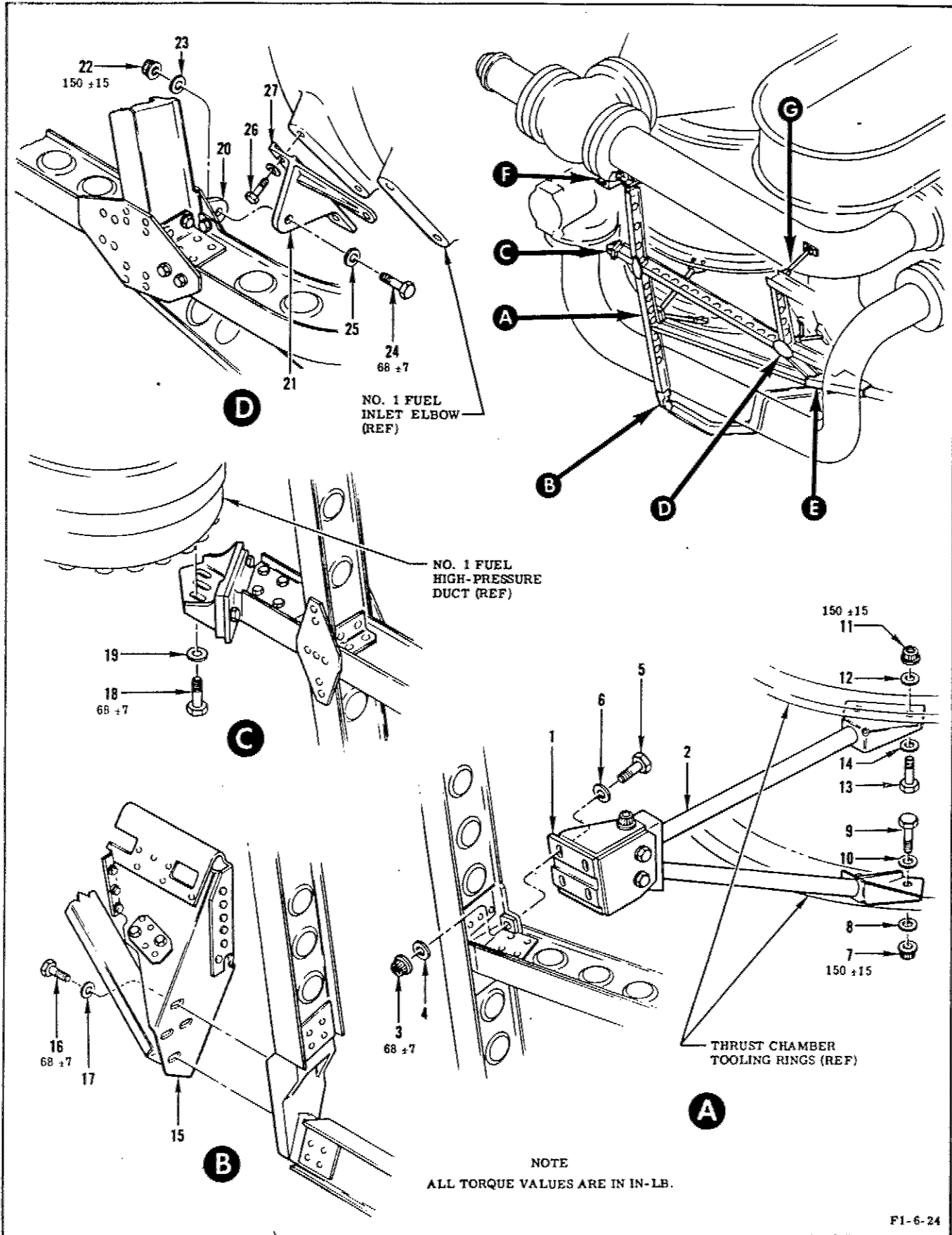
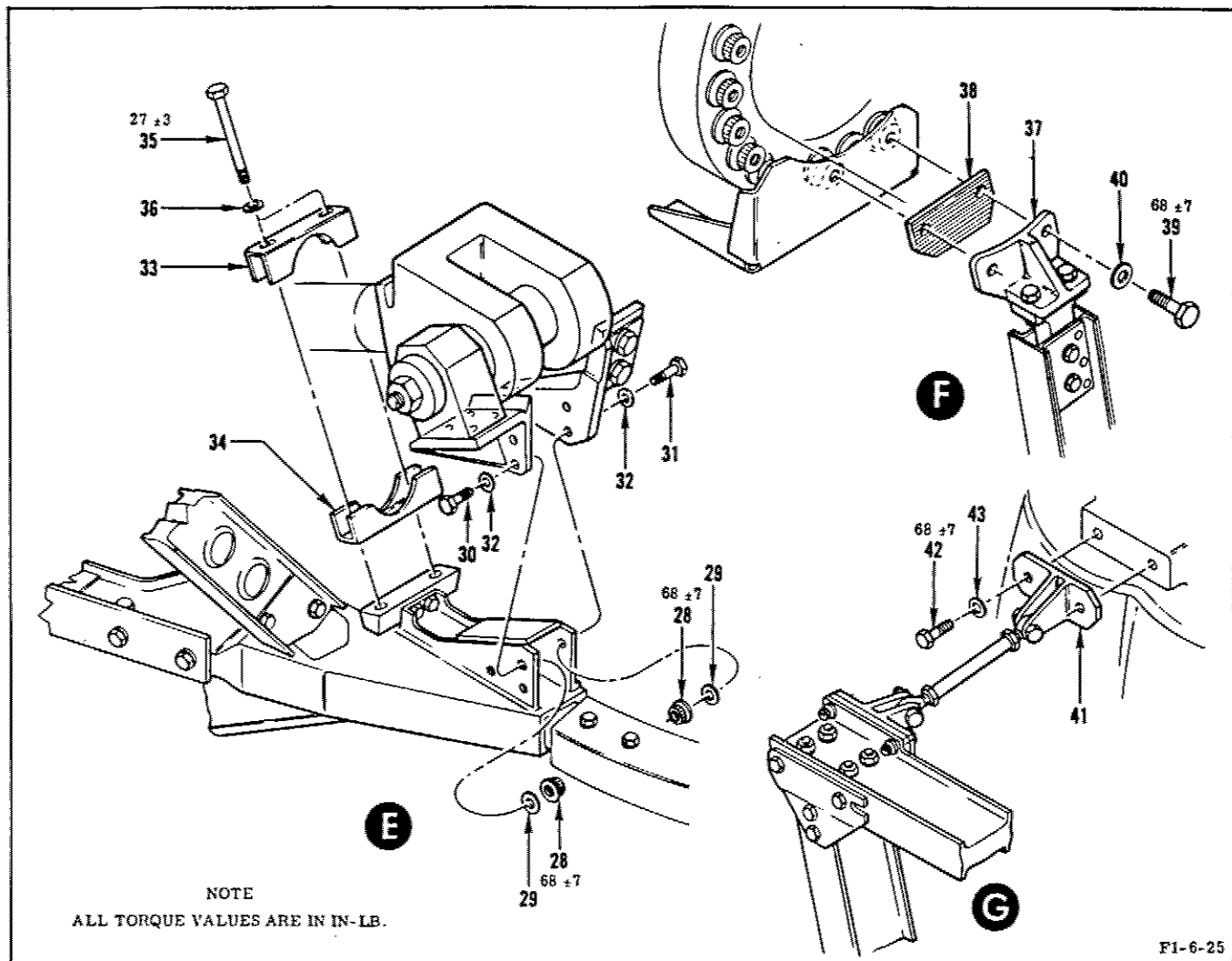


Figure 4-14. Thermal Insulation Frame 145498 (Sheet 1 of 2)

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NOTE  
ALL TORQUE VALUES ARE IN IN.-LB.

F1-6-25

Index No.	Part Name	Part No.	Index No.	Part Name	Part No.
1	Bracket	145494	23	Washer	RD153-9004-0003
2	Brace	145458	24	Bolt	NAS1006-9A
3	Nut	NAS679C4W	25	Washer	LD153-0013-0004
4	Washer	RD153-9004-0001	26	Bolt	NAS1004-3H
5	Bolt	NAS1004-12A	27	Washer	LD153-0013-0002
6	Washer	LD153-0013-0002	28	Nut	RD114-8003-1004
7	Nut	RD114-8003-1006	29	Washer	RD153-1002-0004
8	Washer	RD153-1002-0006	30	Bolt	RD111-1010-6420
9	Bolt	RD111-1010-6624	31	Bolt	NAS1004-8A
10	Washer	RD153-5004-0006	32	Washer	LD153-0013-0002
11	Nut	RD114-8003-1006	33	Clamp	145606
12	Washer	RD153-1002-0006	34	Channel	145607
13	Bolt	RD111-1010-6624	35	Bolt	RD111-1009-0412
14	Washer	RD153-5004-0006	36	Washer	LD153-0013-0002
15	Support	145496	37	Bracket	145617
16	Bolt	RD111-1009-0412	38	Plate	145618
17	Washer	RD153-9004-0001	39	Bolt	NAS1005-4H
18	Bolt	NAS1005-4H	40	Washer	LD153-0013-0003
19	Washer	RD153-9004-0002	41	Bracket	145450
20	Bracket	145456	42	Bolt	NAS1004-4H
21	Bracket	145466	43	Washer	LD153-0013-0002
22	Nut	RD114-8003-1006			

Figure 4-14. Thermal Insulation Frame 145498 (Sheet 2 of 2)

- c. Install plate (38) and attach bracket (37) using bolts (39) and washers (40), detail F.
- d. Attach frame to support (15) using bolts (16) and washers (17), detail B.
- e. Install bolts (18) and washers (19). Safety-wire bolts (16, 18, and 39), detail C.
- f. Install assembled bracket (1) and brace (2) using parts indexed (3 through 14), detail A.
- g. Attach bracket (41) to fuel inlet elbow using bolts (42) and washers (43), detail G. Safetywire bolts.
- h. Attach bracket (20) to bracket (21) using parts indexed (22 through 25), detail D. If bracket (21) was removed, reinstall bracket using 3 bolts (26) and washers (27). Safetywire bolts.
- i. Attach extension of frame between plate and bracket at turbopump trunnion using parts indexed (28 through 32), detail E.
- j. Install parts indexed (33 through 36), detail E. Safetywire bolts (35).
- k. Connect frame to support bow as outlined in paragraph 4-30.
- l. Install stiffener 145408 as outlined in paragraph 4-28.

4-35. REMOVING FRAME 145477. (See figure 4-15.)

NOTE

Steps a through d remove the No. 1 side portion of the frame. Step b and steps e through g remove the engine centerline portion of the frame.

- a. Remove bolts (1) and washers (2).
- b. Remove parts indexed (3 through 6).

WARNING

The major portions of the frame must be supported during steps c through f, to prevent injury to personnel or damage to equipment. Each major portion of the frame weighs approximately 16 pounds.

- c. Support frame and disassemble clamps (7).
- d. Remove bolts (8) and washers (9) and carefully remove No. 1 side portion of frame.
- e. Remove parts indexed (10 through 16).
- f. Support frame and remove bolts (18) and washers (19). Carefully remove engine centerline portion of frame.
- g. Remove bushing (20) from thrust chamber spherical bearing.

4-36. REINSTALLING FRAME 145477. (See figure 4-15.)

WARNING

The major portions of the frame must be supported until secured in place, to prevent injury to personnel or damage to equipment. Each major portion of the frame weighs approximately 16 pounds.

NOTE

Torque values for fasteners are in figure 4-15.

- Steps a through f install the engine centerline portion of the frame. Steps g through k install the No. 1 side portion of the frame.
- a. Lubricate 2 bolts (18) with thread compound Fel-Pro C-5A (Felt Products) as follows:
  - (1) Apply lubricant in a streak 1/8 inch to 1/4 inch wide across all threads and flush with top of threads.

(2) Distribute lubricant streak uniformly around fastener threads with a clean nylon brush. Remove excess lubricant.

b. Install bushing (20) in spherical bearing of thrust chamber.

c. Position engine centerline portion of frame on engine and install parts indexed (10 through 12).

d. If No. 1 side portion of frame is installed, attach tie-rod to bracket (12) using parts indexed (3 through 6).

e. Attach frame to tooling ring using parts indexed (14 through 16).

f. Install bolts (18) and washers (19).

g. Lubricate bolts (1, 8) as outlined in step a.

h. Position No. 1 side portion of frame on engine and install bolts (8) and washers (9).

i. Install bolts (1) and washers (2). Safety-wire bolts.

j. Attach clamps (7) around thrust chamber strut.

k. If engine centerline portion of frame is installed, attach tie-rod to bracket (12) using parts indexed (3 through 6).

4-37. REMOVING FRAME 145325. (See figure 4-16.)

a. Disconnect insulator 145532-11 from frame.

b. Remove 8 bolts (1) and saddle (2).

c. Disconnect bracket (3) by removing bolts (4) and washers (5).

d. Remove oxidizer duct insulators, if installed, disassemble clamps (6), and remove frame. Retain clamp hardware.

4-38. REINSTALLING FRAME 145325. (See figure 4-16.)

#### NOTE

Torque values for fasteners are in figure 4-16.

a. Lubricate 2 bolts (4) with thread compound Fel-Pro C-5A (Felt Products) as follows:

(1) Apply lubricant in a streak 1/8 inch to 1/4 inch wide across all threads and flush with top of threads.

(2) Distribute lubricant streak uniformly around fastener threads with a clean nylon brush. Remove excess lubricant.

b. Position frame on engine and install saddle (2) with 8 bolts (1).

c. Attach bracket (3) to oxidizer dome bolt-heads using bolts (4) and washers (5). Safety-wire bolts.

d. Fasten clamps (6) around oxidizer duct.

e. Reinstall oxidizer duct insulators.

f. Attach insulator 145532-11 to frame, if required.

4-39. REMOVING BRACKET 145290. (See figure 4-17.)

#### NOTE

Steps a through f disassemble the bracket enough to remove the hydraulic supply and return wrap-around ducts.

a. Remove bolts (1) and washers (2) at No. 1 side oxidizer dome flange boltheads.

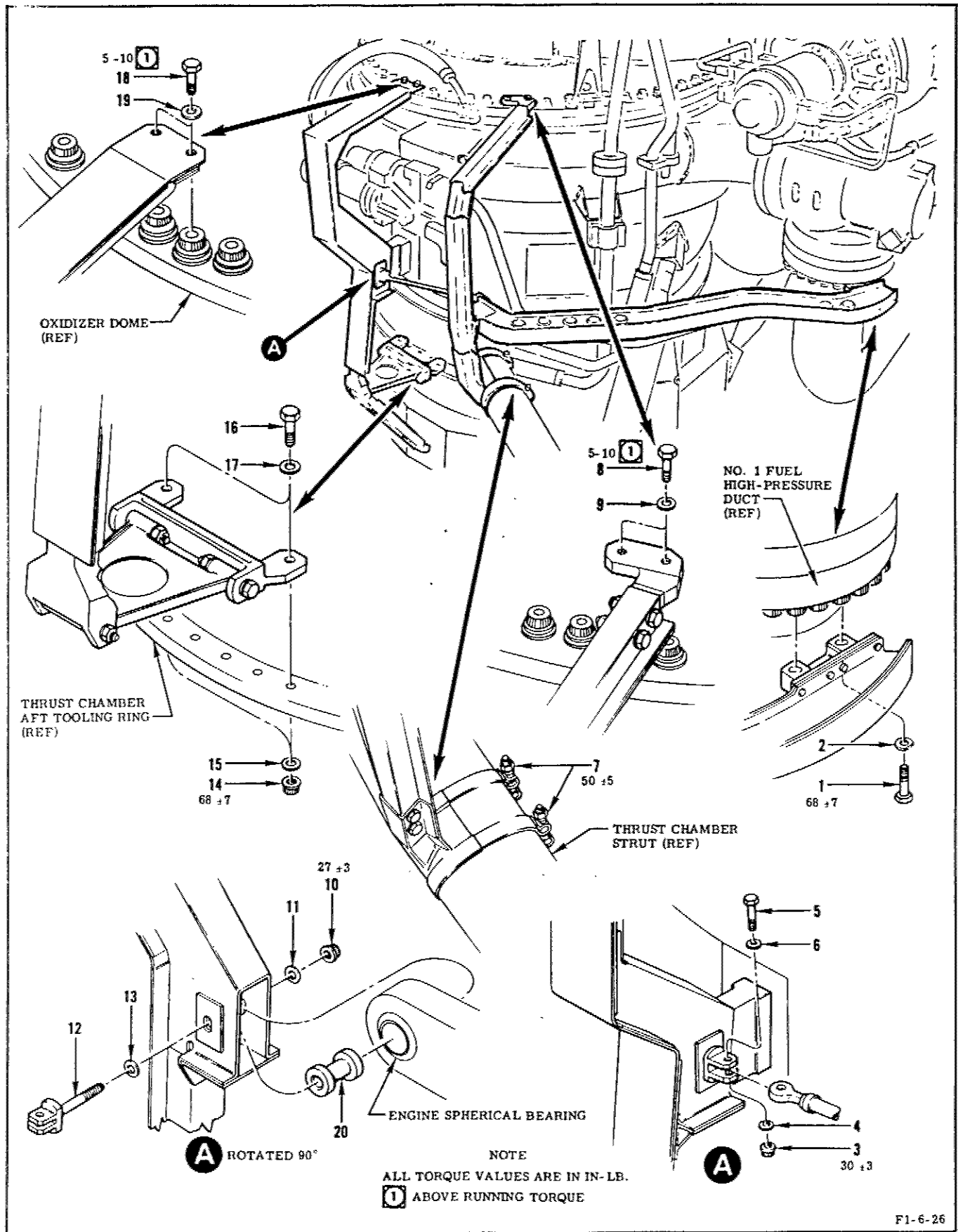
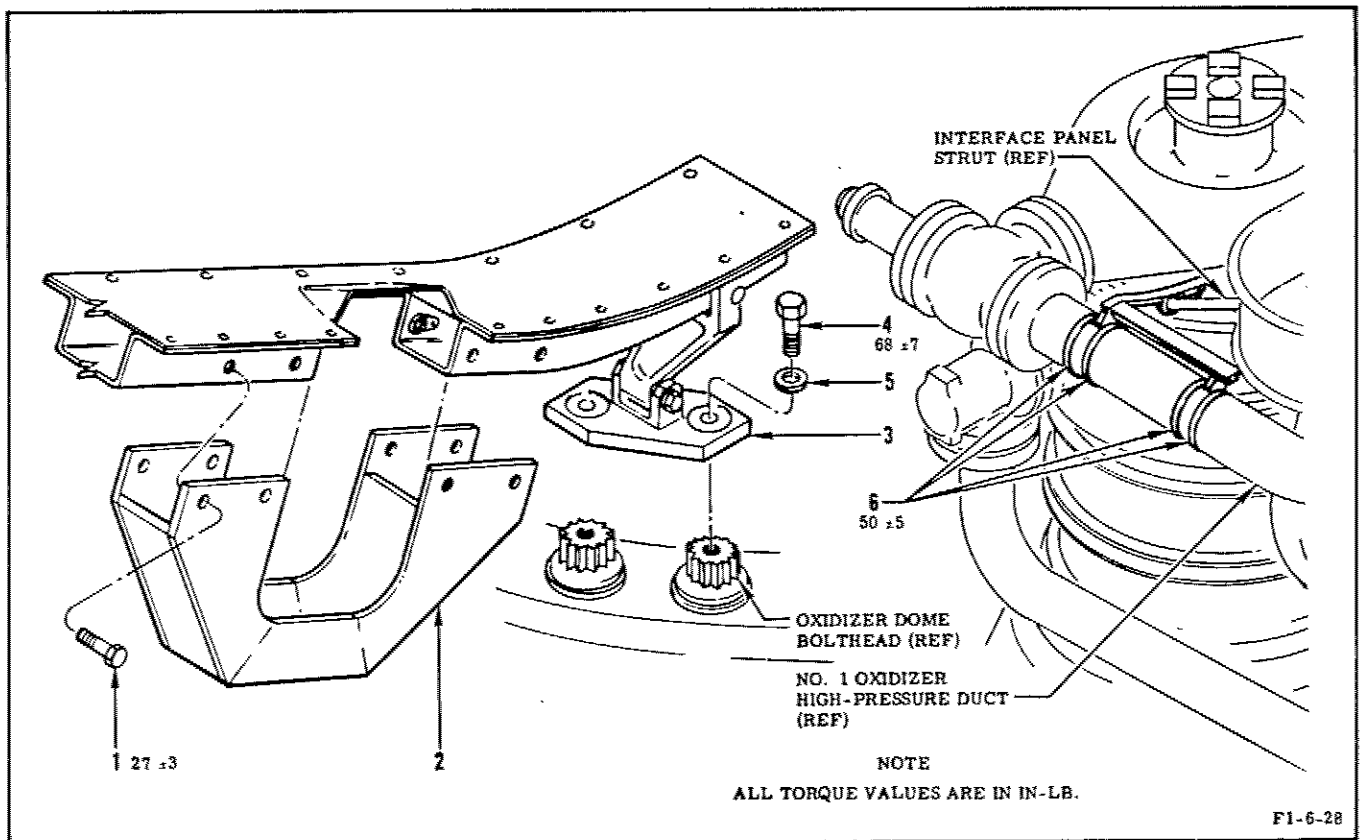


Figure 4-15. Thermal Insulation Frame 145477 (Sheet 1 of 2)

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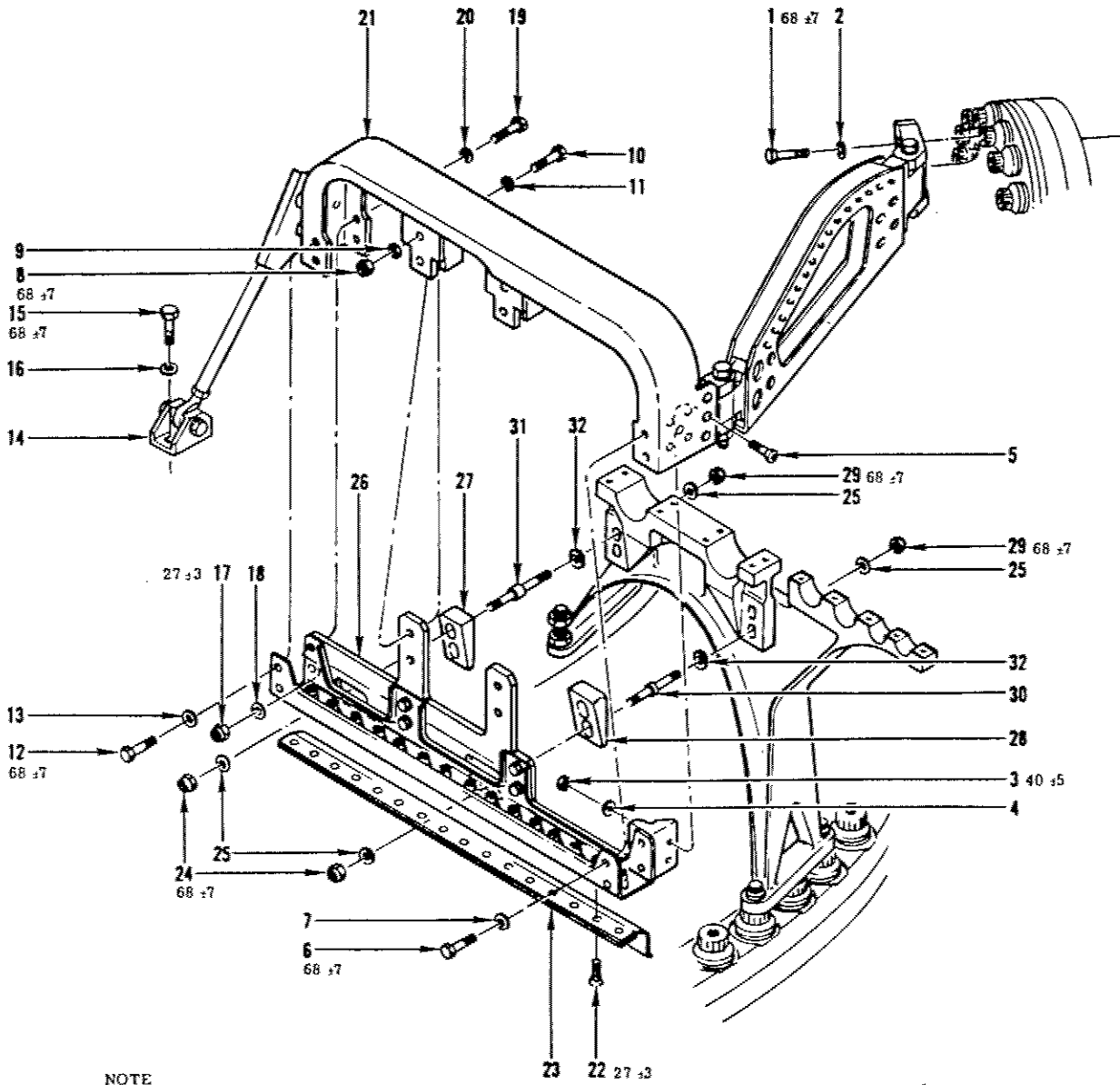
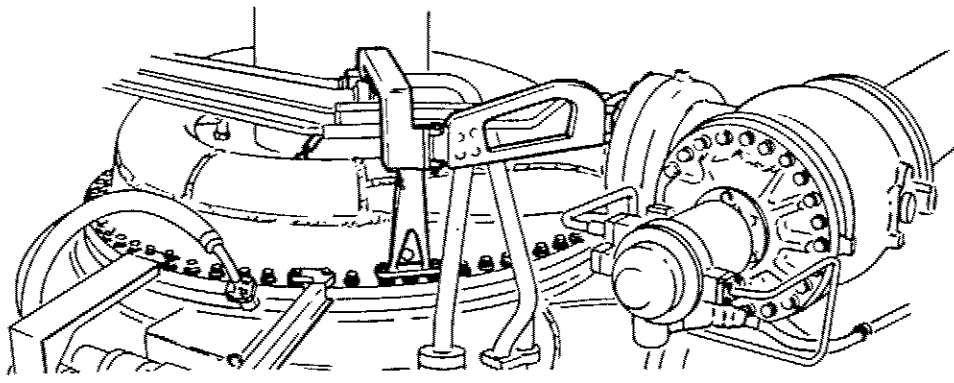
Index No.	Part Name	Part No.	Index No.	Part Name	Part No.
1	Bolt	NAS1005-19H	11	Washer	RD153-9004-0002
2	Washer	RD153-9004-0002	12	Bracket	145465
3	Nut	RD114-8003-0004	13	Washer	RD153-9004-0002
4	Washer	RD153-1002-0004	14	Nut	NAS679C6
5	Bolt	NAS1004-13A	15	Washer	LD153-0010-0014
6	Washer	LD153-0013-0002	16	Bolt	NAS1006-11A
7	Clamp	RD127-7008-0406	17	Washer	RD153-5004-0006
8	Bolt	RD111-1009-6610	18	Bolt	RD111-1009-6610
9	Washer	LD153-0013-0004	19	Washer	LD153-0013-0004
10	Nut	RD114-8003-1005	20	Bushing	145265

Figure 4-15. Thermal Insulation Frame 145477 (Sheet 2 of 2)



Index No.	Part Name	Part No.	Index No.	Part Name	Part No.
1	Bolt	NAS333CPA4	4	Bolt	NAS1004-3H
2	Saddle	145631	5	Washer	RD153-5004-0006
3	Bracket	145261	6	Clamp	551-88-790

Figure 4-16. Thermal Insulation Frame 145325



NOTE  
ALL TORQUE VALUES ARE IN IN-LB

23 22 27 ±3  
ROTATED 45°

F1-6-29

Figure 4-17. Thermal Insulation Bracket 145290 (Sheet 1 of 2)

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Index No.	Part Name	Part No.	Index No.	Part Name	Part No.
1	Bolt	RD111-1007-0506	17	Nut	NAS679C3W
2	Washer	LD153-0013-0003	18	Washer	LD153-0010-0008
3	Nut	NAS679C3W	19	Bolt	NAS1003-12A
4	Washer	RD153-1002-0003	20	Washer	RD153-5004-0003
5	Bolt	NAS333CPA10	21	Bracket	145187
6	Bolt	RD111-1007-0305	22	Bolt	NAS333CPA4
7	Washer	RD153-9003-0002	23	Angle	145273
8	Nut	NAS679C4W	24	Nut	NAS679C4W
9	Washer	RD153-1002-0004	25	Washer	RD153-5002-0004
10	Bolt	NAS1004-12A	26	Bracket	145275
11	Washer	RD153-5004-0004	27	Plate	145274-1
12	Bolt	RD111-1006-0305	28	Plate	145274-2
13	Washer	RD153-9003-0002	29	Nut	NAS679C4W
14	Bracket	145299	30	Stud	145252-3
15	Bolt	RD111-4010-0408	31	Stud	145252-5
16	Washer	RD153-5004-0004	32	Washer	145303

Figure 4-17. Thermal Insulation Bracket 145290 (Sheet 2 of 2)

b. Remove 2 nuts (3), washers (4), and bolts (5).

c. Remove 4 nuts (8), washers (9, 11), and bolts (10).

d. Remove 2 bolts (12) and washers (13).

e. Disconnect bracket (14) by removing bolt (15) and washers (16).

f. Remove 2 nuts (17), washers (18, 20), bolts (19), and bracket (21).

#### NOTE

Steps g through j remove parts indexed (22 through 32). However, if the oxidizer dome will be removed these parts may be left attached to the hydraulic customer connect ducts support 602063 and removed with the support.

g. Remove 3 bolts (22) and angle (23).

h. Remove 4 nuts (24), washers (25), bracket (26), and plates (27, 28).

#### CAUTION

Loosening studs (31) before replacing studs (30) with noted hardware will disturb alinement of bracket 601912 to support 602063.

i. Remove nuts (29) and washers (25) for 2 studs (30). Remove studs and washers (32). Install bolts RD111-4010-6424, washers MS15795-310 and RD153-5002-0004, and nut RD114-8005-1004 in place of studs. Torque nuts to 95 ± 5 in-lb.

j. Repeat step i to remove studs (31).

4-40. REINSTALLING BRACKET 145290.  
(See figure 4-17.)

NOTE

Torque values for fasteners are in figure 4-17.

- If parts indexed (22 through 32) were not removed, parts indexed (1 through 21) may be installed as outlined in steps h through l.

CAUTION

Removing more than 2 bolts will disturb alinement of bracket to support.

a. Remove 2 of 4 bolts attaching bracket 601912 to hydraulic customer connect ducts support 602063.

b. Install a washer (32) on 2 studs (30, 31) as applicable, and install studs through bracket and support.

c. Install washers (25) and nuts (29) on studs. Make sure flat sides of washer (32) aline with flat sides of studs; then torque nuts to  $68 \pm 7$  in-lb.

d. Repeat steps a through c to replace the 2 remaining bolts.

e. Install parts indexed (24 through 28). Make sure washers (32) fit in recesses of plates (27, 28). Do not torque nuts (24) at this time.

f. Aline bracket (21) to installed parts and adjust bracket (26) to aline hole in bracket (14) with hole in oxidizer dome. Torque nuts (24) to  $68 \pm 7$  in-lb.

g. Install angle (23) using bolts (22).

h. Lubricate 2 bolts (1) with thread compound Fel-Pro C-5A (Felt Products) as follows:

(1) Apply lubricant in a streak  $1/8$  inch to  $1/4$  inch wide across all threads and flush with top of threads.

(2) Distribute lubricant streak uniformly around fastener threads with a clean nylon brush. Remove excess lubricant.

i. Install bracket (21) and attach hinged portion to boltheads at oxidizer dome to valve flange using bolts (1) and washers (2). Safetywire bolts.

j. Install parts indexed (17 through 20).

k. Attach bracket (14) to oxidizer dome using bolt (15) and washer (16). Safetywire bolt.

l. Install parts indexed (6 through 13). Safetywire bolts (6, 12).

m. Install parts indexed (3 through 5).

4-41. REMOVING BRACKETS 145286, 145188, 145614, TIE ROD 145305, AND CLAMPS 145255. (See figure 4-18.)

NOTE

If the pressurization wrap-around ducts are not installed, brackets 145286, 145188, and 145614 can be removed in an assembled condition by performing steps a, b, e, g, and h.

a. Disconnect ends of tie rod (1) by removing nuts (2), washers (3), bolts (4), and washers (5). Remove tie rod.

b. Disconnect support (6) by removing 4 bolts (7) and washers (8).

c. Remove parts indexed (9 through 16).

d. Disconnect insulator from leg of bracket (19) by removing bolt RD111-1010-6308 and washer RD153-1003-0006.

- e. Remove 2 bolts (17) and washers (18). Remove bracket (19).
- f. Remove bolt (20), washer (21), and 2 bolts (22) and washers (23). Remove bracket (24).
- g. Remove 2 clamps (29) by removing nuts (25), washers (26), bolts (27), and washers (28).
- h. Bracket (30) is attached to insulator 145532-11. If bracket must be removed remove 9 bolts RD111-1010-6311.

4-42. REINSTALLING BRACKETS 145286, 145188, 145614, TIE ROD 145305, AND CLAMPS 145255. (See figure 4-18.)

#### NOTE

Torque values for fasteners are in figure 4-18.

- If the pressurization wrap-around ducts are not installed, and brackets 145286, 145188, and 145614 were not disassembled, the assembled brackets may be reinstalled by positioning the assembly on the engine and performing steps a, b, h, i, k, and l.

- a. If bracket (30) was disconnected from insulator 145532-11 attach bracket to insulator using 9 bolts RD111-1010-6311. Torque bolts to 45 ±5 in-lb.

#### NOTE

Fasteners installed in steps b through h must be installed loosely.

- b. Install bracket (19) using bolts (17) and washers (18).
- c. Install bracket (30) and attach to bracket (19) using 2 bolts (14) and washers (15, 16).
- d. If wrap-around pressurization ducts are installed, remove protective covers from gimbal joints.
- e. Install bracket (24), 2 bolts (9), and washers (10).
- f. Attach bracket (19) to bracket (24) using 3 bolts (11) and washers (12, 13).

- g. Attach bracket (24) to bracket (30) using bolt (20), washer (21), and 2 bolts (22) and washers (23).

- h. Install 2 clamps (29) using bolts (27), washers (26, 28), and nuts (25).

- i. Torque fasteners installed in steps b through h. Safetywire bolts (17).

- j. Attach corner hole of insulator 145532-11 to bracket (19) using bolt RD111-1010-6308 and washer RD153-1003-0006. Torque bolt to 45 ±5 in-lb.

- k. Attach support (6) to bracket (30) using 4 bolts (7) and washers (8).

- l. Install tie rod (1) using parts indexed (2 through 5).

4-43. REMOVING FRAME 145324-11. (See figure 4-19.)

- a. Disconnect insulator 145532-11 from frame.
- b. Disconnect bracket (1) from bracket (2) by removing 4 bolts (3) and washers (4).

- c. Remove oxidizer duct insulation, if installed, disassemble clamps (5), and remove frame. Retain clamp hardware.

4-44. REINSTALLING FRAME 145324-11. (See figure 4-19.)

#### NOTE

Torque values for fasteners are in figure 4-19.

- a. Position frame on engine and attach bracket (1) to bracket (2) using 4 bolts (3) and washers (4).

- b. Fasten clamps (5) around oxidizer duct.

#### NOTE

Maximum spacing between clamps must be at outer curvature of duct.

- c. Reinstall oxidizer duct insulators, if required.

- d. Attach insulator 145532-11 to frame, if required.

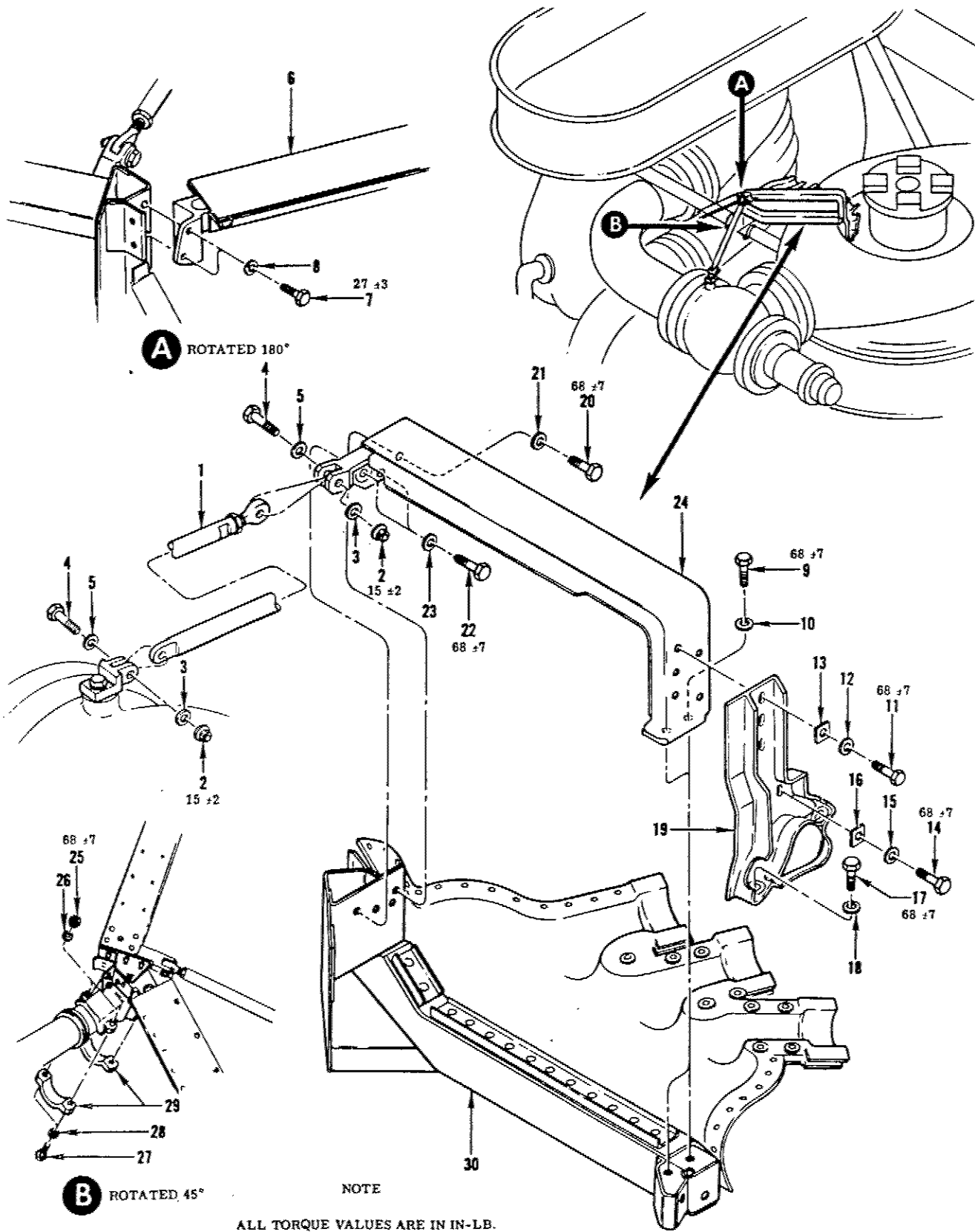
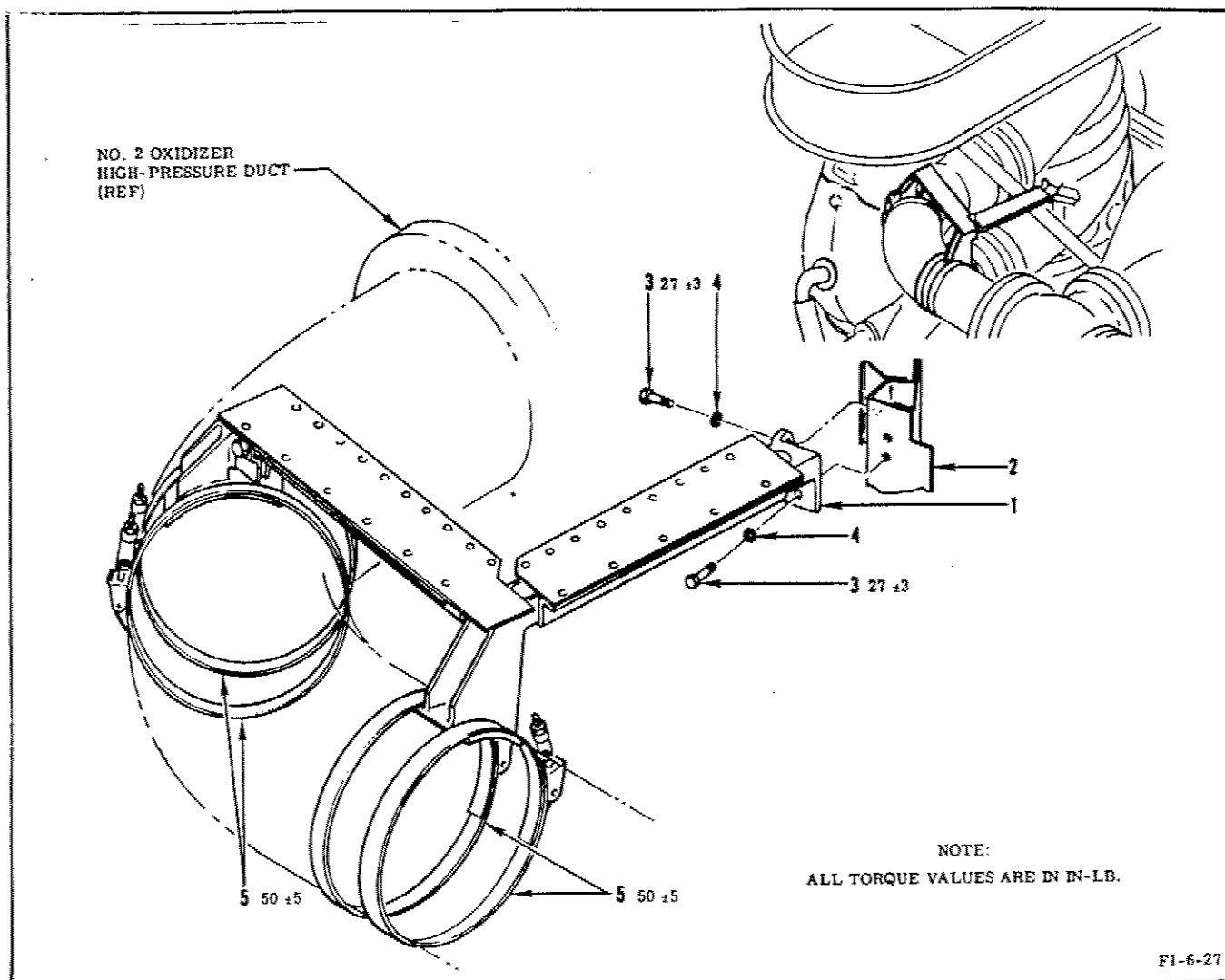


Figure 4-18. Thermal Insulation Brackets 145286, 145188, 145614, Tie Rod 145305, and Clamps 145255 (Sheet 1 of 2)

4-106 Change No. 7 - 30 June 1970

Index No.	Part Name	Part No.	Index No.	Part Name	Part No.
1	Tie rod	145305	16	Washer	145288-7
2	Nut	RD111-8003-1005	17	Bolt	RD111-4010-0408
3	Washer	RD153-1002-0005	18	Washer	RD153-5002-0004
4	Bolt	RD111-1010-6526	19	Bracket	145286
5	Washer	RD153-5004-0005	20	Bolt	NAS1004-4A
6	Support	145324-11	21	Washer	RD153-5004-0004
7	Bolt	NAS1003-3A	22	Bolt	NAS1004-3A
8	Washer	RD153-5004-0003	23	Washer	RD153-5004-0004
9	Bolt	NAS1004-2A	24	Bracket	145188
10	Washer	LD153-0013-0002	25	Nut	NAS679C4W
11	Bolt	NAS1004-4A	26	Washer	RD153-1002-0004
12	Washer	RD153-5004-0004	27	Bolt	NAS1004-20A
13	Washer	145288-7	28	Washer	RD153-5004-0004
14	Bolt	RD111-4009-0406	29	Clamp	145255
15	Washer	RD153-5002-0004	30	Bracket	145614

Figure 4-18. Thermal Insulation Brackets 145286, 145188, 145614, Tie Rod 145305, and Clamps 145255 (Sheet 2 of 2)



Index No.	Part Name	Part No.	Index No.	Part Name	Part No.
1	Bracket	145256	4	Washer	RD153-5004-0003
2	Bracket	145614	5	Clamp <sup>(a)</sup>	551-88-790
3	Bolt	NAS1003-3A			

(a) Aeroquip Corp.

Figure 4-19. Thermal Insulation Frame 145324-11

SECTION V  
ACCESS PROVISIONS

5-1. SCOPE. This section identifies and locates insulator access doors and covers and designates the engine system equipment

accessible through the accesses. See figure 5-1 or 5-2, as applicable.

Insulator Part No.	Access Door Part No.	Access to
145074	145075	Hypergol Cartridge Container
145078 <sup>(a)</sup> 145540 <sup>(b)</sup>	145078-11	No. 2 Main Fuel Valve Purge Quick-Disconnect
145081 <sup>(a)</sup> 145329 <sup>(b)</sup>	145081-21	Igniter Fuel Supply Line Quick-Disconnect
145082	145072	Hypergol Drain Quick-Disconnect
145084 <sup>(a)</sup> 145543 <sup>(b)</sup>	145072 145084-21	Hypergol Purge Quick-Disconnect Fuel Manifold Drain Quick-Disconnect No. 2 Main Fuel Valve Upstream Drain Quick-Disconnect
145091	145101 145091-21	Checkout Valve Quick-Disconnect Turbopump Torque Check Access No. 2 Fuel Pump Cavity Drain Quick-Disconnect
145092	145092-21	Lube Coolant Valve Quick-Disconnect Lube Manifold Drain Quick-Disconnect No. 1 Fuel Pump Cavity Drain Quick-Disconnect
145099 <sup>(a)</sup> 145542 <sup>(b)</sup>	145072 145101 145101	No. 1 Main Fuel Valve Purge Quick-Disconnect No. 1 Main Fuel Valve Upstream Drain Quick-Disconnect No. 1 Main Fuel Valve Downstream Drain Quick-Disconnect
145100 <sup>(a)</sup> 145545 <sup>(b)(c)</sup> 145545-11 <sup>(b)(d)</sup>	145100-21 145332-11 145332-11	Gas Generator Igniters and Quick-Disconnects
145102 <sup>(a)</sup> 145333 <sup>(b)</sup>	145200	Hydraulic Fuel Supply Drain Quick-Disconnect Hydraulic Control Valve Supply Line Quick-Disconnect
145156 <sup>(a)</sup> 145173 <sup>(b)</sup>	145176	Thrust Chamber Drain and Extension Skirt Igniters
145159 <sup>(a)</sup> 145907	145101	Checkout Valve Return Line Quick-Disconnect
145160 <sup>(a)</sup> 145908 <sup>(b)</sup>	145101	Thrust Chamber Drain
145162 <sup>(a)</sup> 145910 <sup>(b)</sup>	145101	Thrust Chamber Drain
145164 <sup>(a)</sup> 145912 <sup>(b)</sup>	145101	Thrust Chamber Drain

(a) On engines F-2003 through F-2010.

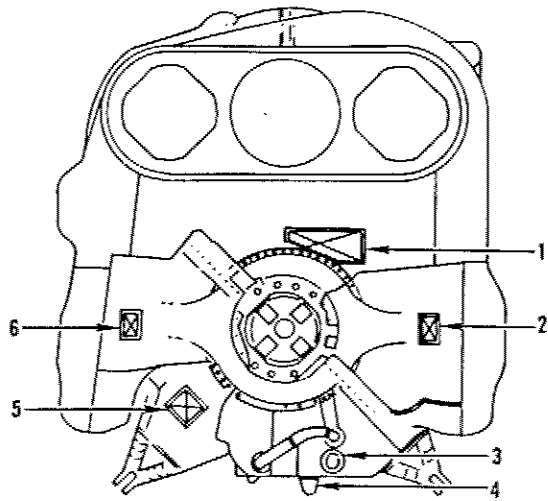
(b) On engines F-2011 through F-2016.

(c) On inboard engines.

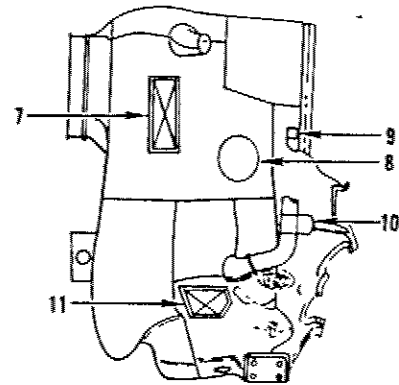
(d) On outboard engines.

Figure 5-1. Insulator Access Doors (Engines F-2003 Through F-2016)

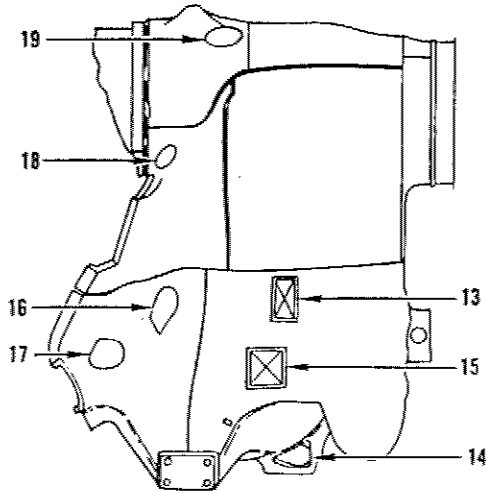
Change No. 1 - 27 January 1967 5-1



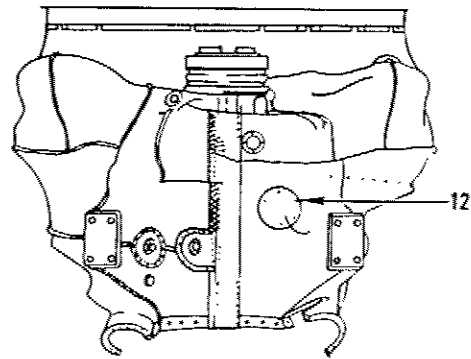
FRONT



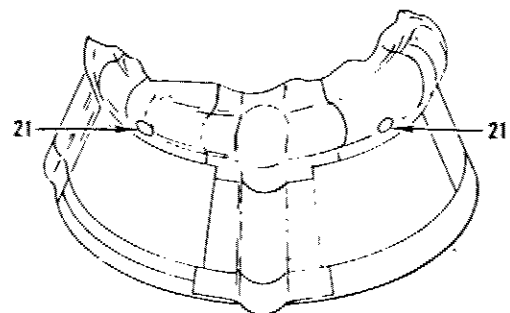
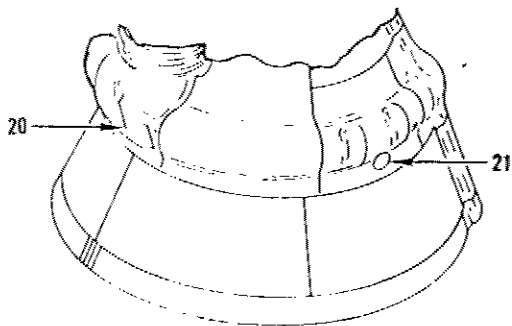
NO. 1 SIDE



NO. 2 SIDE



LOWER SIDE



THRUST CHAMBER AND NOZZLE EXTENSION

F1-6-13A

Figure 5-2. Insulator Access Doors (Engines F-2017 and Subsequent) (Sheet 1 of 2)

5-2 Change No. 5 - 6 September 1968



Index No.	Door Part No.	Location Insulator Part No.	Access to	Index No.	Door Part No.	Location Insulator Part No.	Access to
1(a)		145532-11	Thrust OK pressure switches and oxidizer dome purge and flush ports.	12	145101-21	145511-21	Ignition monitor valve quick-disconnect
2(a)		145524-21	No. 1 oxidizer dome flush and purge ports	13(a)		145514-21	No. 2 main fuel valve purge quick-disconnect
3	145072-21	145082	Hypergol purge quick-disconnect	14	145533-11	145534-21	Hypergol cartridge container
4	145072-21	145082	Hypergol drain quick-disconnect	15(a)		145514-21	No. 2 thrust chamber fuel inlet manifold drain quick-disconnect
5(a)		145520-21	Checkout valve	16	145528-11	145515-11	Engine hydraulic supply and return line quick-disconnects
6(a)		145522-21	No. 2 oxidizer dome flush and purge ports	17	145529-11	145515-11	No. 2 fuel high-pressure duct drain quick-disconnect
7(a)		145503-21	Gas generator oxidizer purge check valve	18	145530-11	145517-11	Instrumentation
8	145527-11	145503-21	Gas generator igniters	19	145101-21	145519-11	Turbopump torque adapter and No. 2 fuel turbopump inlet drain quick-disconnect
9	145526-11	145504-11	Gas generator drain	20	145918-11	145173-21	Thrust chamber drain and nozzle extension igniters
10	145525-21		No. 1 fuel high-pressure duct drain quick-disconnect	21	145101-21	145908-21, 145910-21, 145912-21	Thrust chamber drains
11(a)		145510-71, -81, -111	No. 1 thrust chamber fuel inlet manifold drain and No. 1 main fuel valve purge quick-disconnects				

(a) A component of insulator

Figure 5-2. Insulator Access Doors (Engines F-2017 and Subsequent) (Sheet 2 of 2)

SECTION VI  
REPAIR

## WARNING

THE FOLLOWING GROUND SUPPORT EQUIPMENT MUST BE OPERATED BY AUTHORIZED PERSONNEL TRAINED IN THE USE OF THE EQUIPMENT.

9026560, Welding Set, 100 watt-sec

9026561, Components Welding Set 10 kva  
9026570, Components Welding Set

6-1. **SCOPE.** This section contains field-maintenance-level repair procedures for thermal insulation insulators, brackets, and attaching hardware.

6-2. **WELDING.**6-3. **RESISTANCE SPOT WELDING.**

6-4. Resistance spot welding is used for spot-welding repair materials to insulation sheets and is used when designated by other procedures in this section. Welding set 9026560 (100 watt-sec) is provided for spot-welding repair materials that are less than 0.004 inch in thickness. Welding set 9026561 (10 kva) is provided for spot-welding repair materials 0.004 to 0.032 inch in thickness. Cables provided with welding set 9026561 permit welding to be performed up to 33 feet from the welding machine. Personnel must be certified to use the welding equipment. The following definitions are provided for clarity:

- a. Spot welds -- welds of structural importance.
- b. Indirect method of spot welding -- gun probe and ground probe applied to same side of material.
- c. Direct method of spot welding -- gun probe and ground probe applied to opposite sides of material.

6-5. **TEST SPECIMENS AND REPAIR SPOT WELDING.****WARNING**

The welding equipment used in this procedure must be operated by authorized personnel trained in the use of the equipment.

6-6. Three successive acceptable test specimens must be made prior to performing the actual repair welding. The test specimens must simulate the actual welding conditions and meet the required peel and/or pull test requirements. Test specimens spot welded by the direct method require a peel test only. Both a peel and a pull test are required for spot welding by the indirect method.

- a. If welding is by indirect method and repair area is flexible, simulate flexibility of areas to be repaired. (See figure 6-1.)

**WARNING**

The following procedure specifies isopropyl alcohol and methyl-ethyl-ketone, which are flammable and must not be used near heat, sparks, or open flame. Methyl-ethyl-ketone is a toxic solvent. Inhalation of the vapors or prolonged contact with these liquids can cause serious injury or death.

- b. Prepare repair and base materials, and clean surfaces of materials to be welded using a lint-free cloth dampened with isopropyl alcohol (Federal Specification TT-I-735) or methyl-ethyl-ketone (Federal Specification TT-M-261). Dry cleaned surfaces with a clean, lint-free cloth.

- c. See figure 6-2 and set welding equipment to settings specified for method and applicable combination of materials. Settings are approximate. Final settings are those used to obtain acceptable test specimens.

**WARNING**

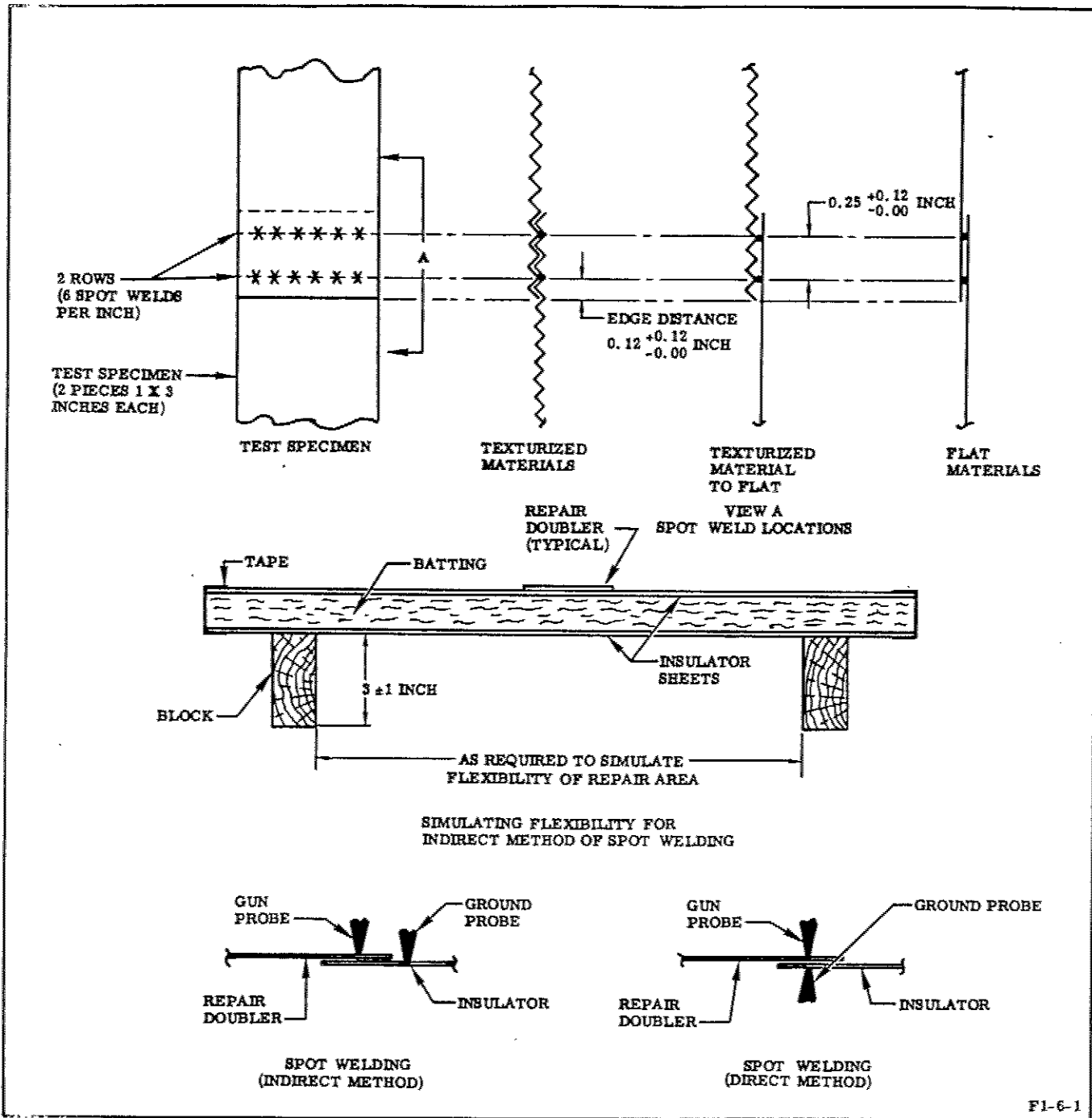
Personnel must not use welding equipment in wet areas or if any of the welder electrical equipment or the operator is wet. Electrical shock can cause serious injury or death.

**CAUTION**

Insulators saturated with combustible fluids must be replaced.

- d. Prior to welding test specimens or performing repair welding, make sure that welding cables are no more than 6 inches apart and that cables are not coiled. In addition, equipment used to obtain acceptable test specimen welds must be used for the actual repair weld. New test specimens must be made whenever any of the following events occur:

- (1) Whenever repair welding is not started within 2 hours after test specimens are accepted.



F1-6-1

Figure 6-1. Preparing and Spot-Welding Test Specimens

(2) Whenever material combinations change including combinations within the same repair.

(3) After 2 hours of welding at one setting of welder controls.

(4) Whenever welding equipment is changed.

(5) Whenever facility power source is changed.

e. See figure 6-1 and spotweld test specimens as indicated for the following material combination:

(1) Texturized material to texturized material. Make 2 parallel rows of spot welds (6 spot welds per inch) across overlap of pieces of test specimen. Locate each spot weld in low portion of material texture.

Condition No.	Welding Method	Repair Doubler or Nutplate Thickness (Inch)	Base Material Thickness (Inch)	Cycle (%)	Heat (%)	Tap No.	Electrode (Class 2) Diameter (Inch)	Gun Tip Pressure (Pounds)	Peel Test Req'd (b)	Pull Test (Pounds Minimum)
1	Indirect	0.004(c)	0.004(c)	2	96	6	1/8	6-1/4	yes	160
2	Indirect	0.006(c)	0.004(c)	1	96	8	1/8	8-1/4	yes	160
3	Indirect	0.006(c)	0.006(c)	2	94	8	1/8	9-1/4	yes	265
4	Indirect	0.006(c)	0.006(c), 0.004(c)	2	80	8	1/8	9-1/4	yes	265
5	Indirect	0.006(c)	0.006(c)	2	94	8	1/8	9-1/4	yes	265
6	Indirect	0.006(c)	0.006(c), 0.006(c)	2	94	8	1/8	9-1/4	yes	265
7	Indirect	0.010(d)	0.004(c)	3	96	8	1/8	6	yes	160
8	Indirect	0.010(d)	0.006(c)	2	96	8	1/8	9-1/4	yes	265
9	Indirect	0.010(d)	0.006(c)	2	96	8	1/8	9-1/4	yes	265
10	Indirect	0.010(d)	0.006(c), 0.006(c)	2	96	8	1/8	9-1/4	yes	265
11	Indirect	0.020(d)	0.006(c)	4	100	8	1/4	9-1/4	yes	265
12	Indirect	0.020(d)	0.006(c), 0.006(c)	5	80	8	1/4	9-1/4	yes	265
13	Indirect	0.020(d)	0.006(c), 0.006(c)	5	100	8	1/4	9-1/4	yes	265
14	Direct	0.020(d)	0.006(c), 0.006(c)	5	90	8	1/8	9-1/4	yes	none
15	Direct	0.020(d)	0.020(d), 0.006(c)	5	100	8	1/4	9-1/4	yes	none
16	Direct	0.025(d)	0.025(d), 0.006(c)	15	100	8	1/4	9-1/4	yes	none
17	Direct	0.032(d)	0.032(d)	15	100	8	1/4	9-1/4	yes	none
18	Direct	0.032(d)	0.032(d), 0.006(c)	10	90	8	1/4	9-1/4	yes	none

(a) Pressure may be set using force gage 7-003-02 (Unitek).

(b) Nuggets must peel through thinner material or either material if materials are same thickness.

(c) Texturized nickel-base alloy AMS5540

(d) Flat nickel-base alloy AMS5540

Figure 6-2. Repair Materials and Basic Settings for Spot Welding (Sheet 1 of 2)

Condition No.	Welding Method	Repair Doubler or Nutplate Thickness (Inch)	Base Material Thickness (Inch)	Cycle	Heat (%)	Tap No.	Electrode (Class 2) Diameter (Inch)	Gun Tip Pressure (a) (Pounds)	Peel Test Req'd (b)	Pull Test (Pounds Minimum)
19(e)	Direct	0.020 thru 0.055(g)	0.015 thru 0.032(d)(f)	8	100	8	1/8	9-1/4	yes	none
20(e)	Direct	0.020 thru 0.055(g)	0.025(d), 0.025(d)(f)	8	100	8	1/8	9-1/4	yes	none
21(e)	Direct	0.020 thru 0.055(g)	0.025(d), 0.032(d)(f)	8	100	8	1/8	9-1/4	yes	none
22	Direct	0.020(d)	0.006(c), 0.006(c), 0.020(d)	5	90	8	1/8	9-1/4	yes	none
23	Direct	0.020(d)	0.025(d), 0.025(d)	15	100	8	1/4	9-1/4	yes	none
24	Direct	0.020(d)	0.025(d), 0.032(d)	15	100	8	1/4	9-1/4	yes	none
25	Direct	0.020(d)	0.032(d)	15	100	8	1/4	9-1/4	yes	none
26	Direct	0.020(d)	0.032(d), 0.006(c), 0.006(c)	15	100	8	1/4	9-1/4	yes	none
27	Direct	0.020(d)	0.032(d), 0.006(c), 0.006(c), 0.006(c)	15	100	8	1/4	9-1/4	yes	none

(a) Pressure may be set using force gage 7-003-02 (Unitek).

(b) Nuggets must peel through thinner material or either material if materials are same thickness.

(c) Texturized nickel-base alloy AMS5540

(d) Flat nickel-base alloy AMS5540

(e) Applicable only when spot-welding through projection weld nib of nutplate.

(f) Base material thickness may have up to three 0.006-inch texturized doublers on side opposite nutplate in addition to listed thickness range.

(g) Nutplate CRES nib material: A286, AMS5525, AMS5735, or AMS5737

Figure 6-2. Repair Materials and Basic Settings for Spot Welding (Sheet 2 of 2)

(2) Flat material to texturized material. Make 2 parallel rows of spot welds (6 spot welds per inch) across overlap of pieces of test specimen. Locate each spot weld where texturization is nearest flat material.

(3) Flat material to flat material. Make 2 parallel rows of spot welds (6 spot welds per inch) across overlap of pieces of test specimen.

f. Perform peel test on test specimens only as designated in figure 6-2. Test specimens are acceptable if they meet or exceed peel and/or pull test requirements of figure 6-2. Tensile testing machine TH-5 (Pacific Scientific Co), or equivalent, may be used for pull testing.

g. When test specimens are acceptable, clean repair doubler and repair area as outlined in step b.

h. Spot-weld repair doubler in place using pattern shown in figure 6-3. Make sure spot welds made on texturized material are located in low portion of material texture as shown in figure 6-1.

#### 6-7. PERCUSSION STUD WELDING.

6-8. Stud welding is utilized to replace damaged or missing threaded studs on the thrust chamber, insulator doublers, and brackets when designated by other procedures in this section. Equipment required consists of welding set 9026570 and holding fixture T-5039534. Personnel must be certified to use the welding set.

#### NOTE

The fusion welding (TIG) method outlined in paragraph 6-11 may be used to install threaded studs in the area between the heat exchanger and the thrust chamber where space limitations do not permit the use of the stud welding equipment.

#### 6-9. TEST SPECIMENS AND REPAIR STUD WELDING.

6-10. Three successive acceptable test specimens must be made prior to performing the actual stud-welding repair. The specimens must

simulate the actual repair and meet the requirements of figure 6-4. New test specimens must be made whenever combinations of materials or welding conditions change.

a. Make sure that weld surface of base material is free of nicks and scratches in weld area. Use a belt sander equipped with 300-grit emery cloth where base materials are sufficiently exposed. Use suitable rotating tools, such as hones or rotary files, in repair areas where access to base material is limited.

#### WARNING

The following procedure specifies isopropyl alcohol and methyl-ethyl-ketone, which are flammable and must not be used near heat, sparks, or open flame. Methyl-ethyl-ketone is a toxic solvent. Inhalation of the vapors or prolonged contact with these liquids can cause serious injury or death.

b. Clean base material weld area with a clean, lint-free cloth dampened with isopropyl alcohol (Federal Specification TT-I-735) or methyl-ethyl-ketone (Federal Specification TT-M-261). Dry surface with a clean, lint-free cloth.

c. Install applicable stud in stud-welding gun for condition being simulated. Unthreaded studs may be used for test specimens. Use stud-welding gun VP-G or DS-G for 3/16-inch-diameter studs. Use stud-welding gun S6-G for 1/4-inch-diameter studs. When installing replacement studs through grommeted openings of installed insulators, ground stud-welding gun using approximately 3 feet of size 6 or size 8 insulated, multistranded, copper wire. Attach wire securely to steel collet allen screw of gun and to nearest adjacent threaded stud on engine. Use care to prevent damaging stud threads. Insulate grommets and gun tripod or steel collet with a suitable tape to prevent shorting to insulator during welding.

d. Coat face of stud and weld area of base material with leak-test compound (MIL-L-25567).

e. Position stud against base material with gun perpendicular to base material weld surface.

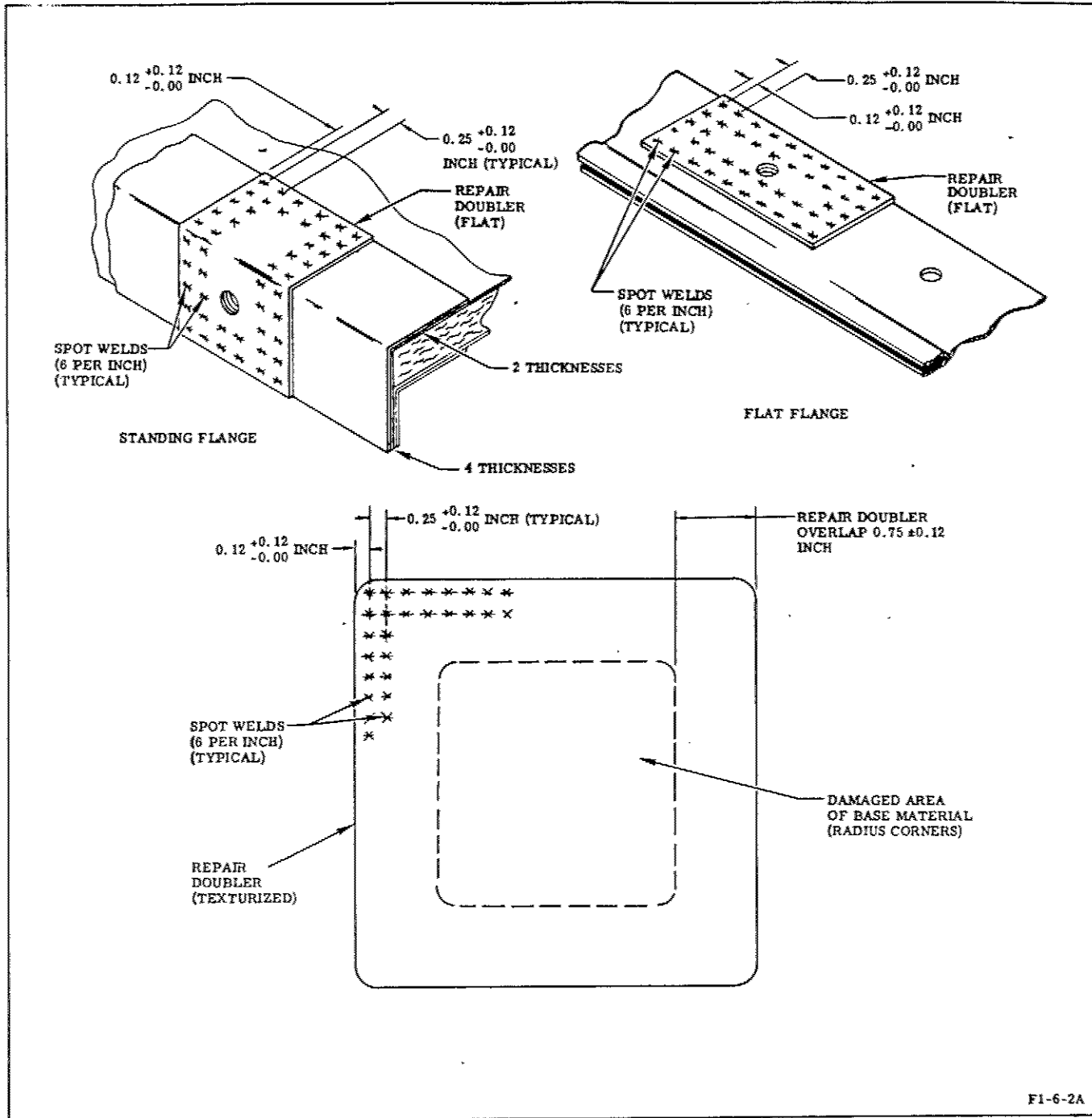


Figure 6-3. Installing Repair Doublers (Typical)

f. Weld stud to base material. Use care in removing gun from stud to prevent applying side load to stud.

g. Perform a pull test and-torque test on test specimens as outlined in figure 6-4. Use holding fixture T-5039534, or equivalent, for pull testing. Perform torque test only on repair welds.

Stud Diameter (Inch)	Base Material <sup>(a)</sup> Thickness (Inch)	Pull Test <sup>(b)</sup> (Pounds)	Torque Test <sup>(c)</sup> (in-lb)
3/16	0.020	485	30
	0.030	730	30
	0.060 and above	1,450	30
1/4	0.030	975	75
1/4	0.060 and above	1,970	75

(a) CRES 321 and 347 and nickel-base alloy AMS5540

(b) Used for test specimens only

(c) Applied for 30 seconds on installed repair studs only.

Figure 6-4. Stud-Welding Materials and Test Requirements

#### 6-11. FUSION WELDING FOR THREADED STUDS.

6-12. This procedure installs threaded studs in the area between the heat exchanger and the thrust chamber where space limitations do not permit the use of the stud-welding equipment used in the procedures outlined in paragraph 6-7.

a. Grind off tip from base of replacement stud. Use stud RD113-1002-14XX (Inconel 600) to replace 1/4-inch-diameter studs and stud RD113-1001-03XX (321 CRES) to replace 3/16-inch-diameter studs.

#### WARNING

The following procedure specifies isopropyl alcohol and methyl-ethyl-ketone, which are flammable and must not be used near heat, sparks, or open flame. Methyl-ethyl-ketone is a toxic solvent. Inhalation of the vapors or prolonged contact with these liquids can cause serious injury or death.

b. Prepare base material; then clean base material and stud using a clean, lint-free cloth dampened with isopropyl alcohol (Federal Specification TT-I-735) or methyl-ethyl-ketone (Federal Specification TT-M-261). Dry surfaces with a clean lint-free cloth.

c. Fusion-weld stud in place using filler wire AMS5786 for studs RD113-1002-14XX and filler wire ST0170GB0001-347 (Rocketdyne) for studs RD113-1001-03XX. Lengths of weld fillet legs must be 0.170 inch minimum for studs RD113-1002-14XX and 0.120 inch minimum for studs RD113-1001-03XX.

d. Torque-test stud using applicable torque for stud size as shown in figure 6-4.

#### 6-13. REPAIRING THERMAL INSULATION INSULATORS.

6-14. Repairing insulators consists of performing the applicable repair outlined in paragraphs 6-15 through 6-68.

#### 6-15. INSTALLING REPAIR DOUBLERS.

6-16. Repair doublers are installed on foil insulators when required to repair damage. Doubler sizes and materials are determined by the area and condition to be repaired. Repairs must meet the following applicable requirements.

a. Doublers must not overlap each other unless one doubler is fully contained in another doubler.

b. Small holes in the inner sheet of insulators not exceeding 1/16 inch in diameter, need not be repaired unless there is more than one hole in a square foot of surface area and there is less than 12 inches between holes.



c. On cocoon insulators, a doubler installed within 2 inches of an insulator edge must be at least 2-1/2 inches from any adjacent doubler in the edge area. Where damage is closely grouped, one large doubler may be used in place of several small doublers.

d. Sharp corners of repair doublers must be rounded.

e. Size 30 holes must be drilled at ends of all cracks in area to be repaired.

f. Materials removed to facilitate a repair must be replaced. Replace damaged batting with batting RB0135-001 (Rocketdyne). If necessary to hold batting away from an area, use steel tape (MIL-S-6721, Type 321, 1 by 0.001 inch). Spotweld tape in place.

g. If doubler requires forming, it must be backed by a lead shot-filled bag, or equivalent, and formed using a rubber mallet. Skin texturization must be maintained; however, loss of texture due to normal working processes (forming, folding, welding, etc) is not a cause for rejection.

h. The pattern of texturized repair doublers must be the same as the pattern of the texturized material to be repaired.

i. See figure 6-3 for typical repair doubler locations; then select repair doubler material (nickel-base alloy, AMS5540, flat or texturized) for the applicable condition as follows:

(1) Insulator inner and outer sheets: 0.006-inch texturized material; size as necessary for repair.

(2) Insulator inner and outer sheets at flange doublers: 0.010-inch flat material; size as necessary for repair.

(3) Standing flanges: 0.020-inch flat material extending from top of flange to edge of inner-skin doubler; doubler width must extend midway between flange holes.

(4) Flat flanges: 0.020-inch flat material or same thickness as existing doubler if doubler exceeds 0.020 inch. Attach to existing doubler. Doubler width must extend midway between flange holes.

(5) Channels: flat material the same thickness as channel material or thickest member of channel materials. Install in channel.

j. Prepare test specimens and perform spot welding as outlined in paragraph 6-5.

#### 6-17. INSTALLING ASBESTOS PATCHES.

6-18. Asbestos patches are used on asbestos insulators to repair damage.

a. Using asbestos cloth RB0135-002, Type II (Rocketdyne), cut patch to overlap damaged area by 1-1/2 inches on all sides.

b. Position patch on damaged area with aluminized side of patch facing outward.

c. Position patch on asbestos insulator.

d. Using a sharp-pointed tool to prevent cutting wires in asbestos material, make 0.188 to 0.218 inch diameter holes through patch and insulator. Make holes approximately one inch from edge of patch and space them approximately 1-1/2 inches apart.

e. Secure patch to insulator using rivets RE120-2001-0003 and washers RD153-1003-0006. Position rivets with rivet heads at inner side of insulator.

#### 6-19. REMOVING DENTS.

6-20. Dents in foil insulators may be removed as follows:

a. Attach adhesive tape to dent and attempt to pull out dent. For more resistant dents, spot-weld Inconel sheet strip (0.006 inch thick) to area and pull out dent by pulling on strip.

b. Remove strip by pulling it loose; then inspect area for holes and cracks. Damage must be repaired as outlined in paragraph 6-15. If dent cannot be removed, install repair doubler as outlined in paragraph 6-15.

**6-21. REPLACING AND RELOCATING LACING STUDS OF FOIL INSULATORS.**

6-22. This procedure replaces lacing studs that have been pulled out of foil insulators and relocates lacing studs when their location prevents lockwire from being installed during installation of insulators. Steps a and b apply to replacing pulled-out studs; step c applies to relocating studs.

**NOTE**

In the cocoon area, replacing lacing studs is not required if an effective closing of the insulator joint can be made. However, the number of missing lacing studs must not exceed every other stud.

- Radial cracks and splits in the tubular area of an installed stud are acceptable.

a. Replace pulled-out lacing studs by spot-welding stud attachment pad RD121-3002-0001 over lacing stud location. If damage caused by pulled-out stud exceeds repair capability of pad, the area must be repaired as outlined in paragraph 6-15 prior to installing pad. Where spacing does not allow installation of pad, pad may be trimmed to within 7/8 inch of the centerline of the stud and positioned on the insulator as necessary to allow installation of lockwire.

b. Spot-weld pad in place using 2 parallel rows of spot welds as shown for repair doubler in figure 6-3. Outer spot-weld row must be at least 1/8 inch from edge of pad with the spot welds positioned in deepest part of texture. Inner row of spot welds must be approximately 1/4 inch from the outer row with spot welds located in deepest part of pad texture.

c. Relocate lacing studs when overlapping by an adjacent insulator prevents installation of lockwire. If the overlapping insulator is an asbestos insulator, the edge may be trimmed or folded back to within 1/2 inch of centerline of the asbestos insulator lacing studs. If this does not expose the underlapping insulator lacing studs sufficiently to install lockwire, relocate lacing studs, as required. Use stud attachment pad RD121-3002-0001 as outlined in step a and welding method outlined in step b. Overlapped studs must be cut off and smoothed down to the stud flange.

**6-23. REPLACING AND RELOCATING LACING STUDS OF ASBESTOS INSULATORS.**

6-24. This procedure replaces lacing studs pulled out of asbestos insulators and also relocates lacing studs when their location prevents lockwire from being installed during installation of insulators. Steps a through c apply to replacing pulled-out studs; step d applies to relocating studs.

**NOTE**

In the cocoon area, replacing lacing studs is not required if an effective closing of the insulator joint can be made. However, missing lacing studs cannot exceed every other stud.

- Radial cracks and splits in the tubular area of an installed stud are acceptable.

a. Replace pulled-out lacing studs by installing a new lacing stud at least 1/2 inch from damaged area of original stud position. Hole caused by pulled-out stud normally does not require repair; however, any extensive damage must be repaired prior to installing replacement stud.

b. Using a sharp-pointed tool to prevent cutting wiring in asbestos, make a 0.188 to 0.218 inch diameter hole for replacement stud.

c. Install stud through asbestos, install washer RD153-0115-0019 on stud, and swage stud base. Use stud RD121-3001-0001 for one thickness of asbestos and stud RD121-3001-0002 for 2 thicknesses.

d. Relocate lacing studs on an underlapping insulator when overlapping of an adjacent insulator prevents installation of lockwire during insulator installation. Install relocated studs as outlined in steps b and c.

**6-25. REPLACING LACING STUDS OF FIBER-GLASS INSULATORS.**

6-26. This procedure replaces lacing studs pulled out of fiberglass insulation.

**NOTE**

Radial cracks or splits in the tubular area of an installed stud are acceptable.

a. Replace pulled-out lacing stud by installing a new stud RD121-3001-0003 at least 1/2 inch from damaged area of original stud location. Damage caused by a pulled-out stud normally does not require repair.

b. Using a sharp-pointed tool, make a 0.188 to 0.218 inch diameter hole for new stud.

c. Place washers RD153-1003-0006 on each side of material; and install stud through washers and material. Swage stud in place. If repair area is severely contoured, the washers may be formed prior to installation.

#### 6-27. REPLACING AND RELOCATING GROMMETS.

6-28. Grommets are used in asbestos, foil, and fiberglass insulation. Grommets may be replaced as required, but they cannot be relocated without approval of Rocketdyne engineering. Steps a and b install grommets in asbestos insulation. Steps c and d install grommets in foil insulation. Steps e and f replace grommets in fiberglass insulation.

#### NOTE

A maximum of four radial cracks are allowed in the swaged area of the bushings and the grommets installed in foil or asbestos cloth insulators. A maximum of five radial cracks are allowed in the swaged area of the grommets installed in glass cloth insulators.

a. See figure 6-5 and install grommet on new asbestos cloth RB0135-002, Type II (Rocketdyne), large enough to overlap old area by 1-1/2 inches on each side.

b. Center assembly under damaged area and secure with a ring of rivets RE120-2001-0002 and washers RD153-1003-0006. Rivets must be spaced at approximately one-inch increments and within 3/4 inch of the outer edge of the patch.

c. See figure 6-5 and prepare grommet in applicable materials for foil insulators.

d. Prepare insulator, and install section containing grommet to meet requirements of repair doublers as outlined in paragraph 6-15.

e. Make 2 square washers of flat material (nickel-base alloy AMS5540 or 300-series CRES) to the following requirements:

- (1) Thickness: 0.020 inch
- (2) Hole diameter: 0.281 to 0.291 inch
- (3) Outer contour: 1.00 ±0.06 inch square with rounded corners

f. Place washers on each side of material, and install grommet through washers and material. Swage grommet in place. The washers may be formed to contoured areas prior to installation.

#### 6-29. REPAIRING AND RELOCATING HOLES IN INSULATOR STANDING FLANGES.

6-30. This procedure repairs and/or relocates holes in the standing flanges of foil insulators.

#### NOTE

Flange holes not exceeding 5/8 inch in length (parallel to flange) and 0.322 inch in diameter (horizontal to flange) do not require repair.

- During insulator installation, in lieu of repairing damaged holes, the flanges may be bent over and new holes (0.312 ±0.010 inch) drilled through both flanges midway between the damaged holes. Hole spacing must not exceed 3-3/4 inches between undamaged holes.

a. If a repair doubler is required, select material as outlined in paragraph 6-15.

b. Drill 0.312 ±0.010 inch holes through doubler. Locate holes as required for the particular repair maintaining original hole spacing.

c. Prepare materials and perform spot welding as outlined in paragraph 6-5.

#### 6-31. REPLACING THREADED INSERTS.

6-32. Thermal insulation insulators incorporating self-locking nutplates may be repaired by replacing the damaged insert with a new threaded insert 3591-3CNX-0190 (Heli-Coil Corp). Refer to R-3896-3 for applicable removal and installation tools for 10-32 locking inserts.

#### 6-33. REPLACING THREADED STUDS.

6-34. Threaded studs are percussion stud-welded to the engine, brackets, and insulators for installing thermal insulation. Replace damaged threaded studs using procedure outlined in paragraph 6-7.

#### 6-35. REPAIRING FOAM-LINED OXIDIZER DUCT INSULATORS.

6-36. This procedure repairs damaged foam and elastomer seals of oxidizer duct insulators.

a. Repair cracks in foam as follows:

- (1) Clean crack of loose material.

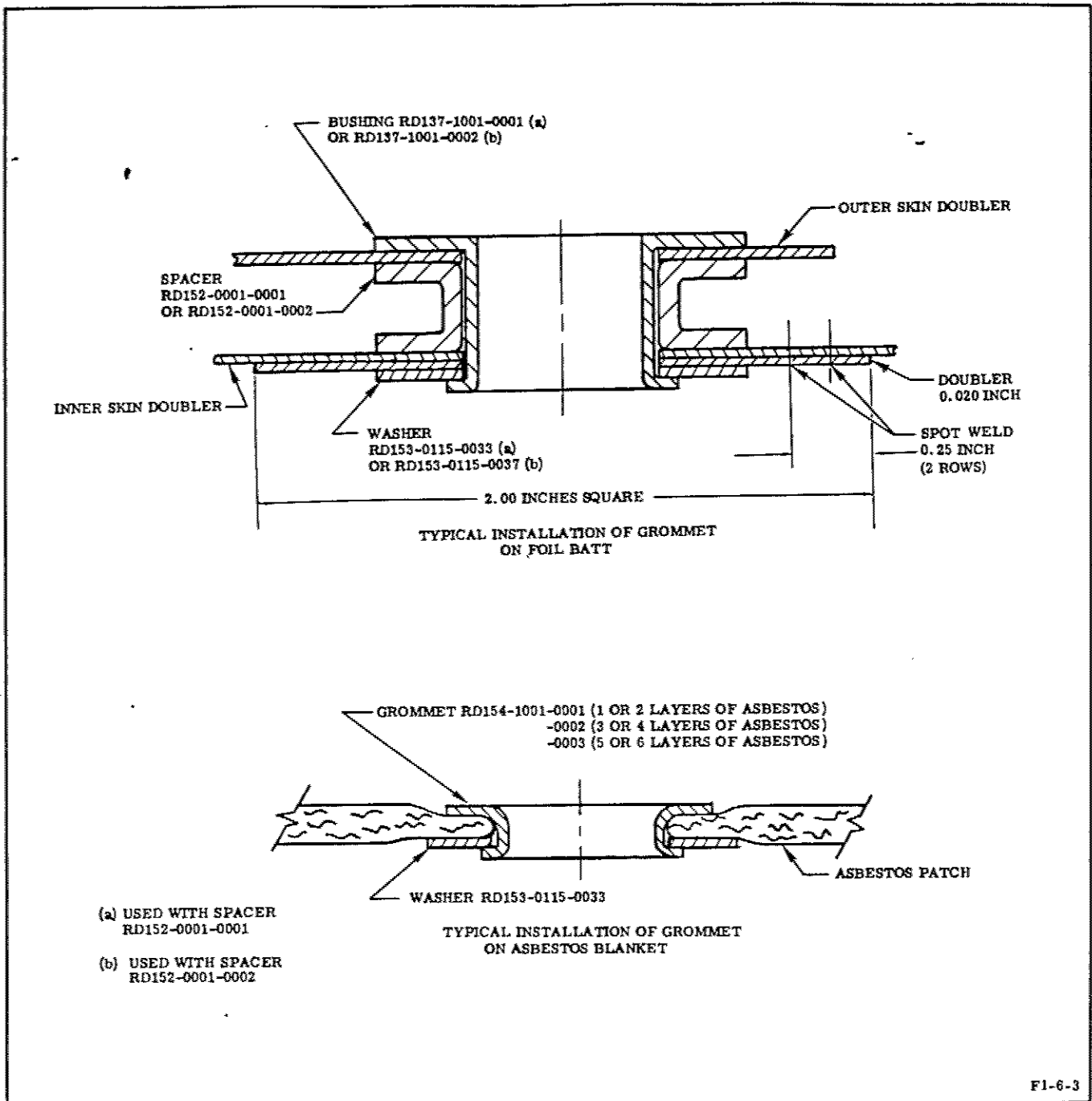


Figure 6-5. Installing Grommets

(2) Fill crack with white sealant RTV-102 (General Electric).

(3) Cover repaired area with a cloth dampened in water and allow sealant to cure for approximately 4 hours before using part.

b. Repair raised areas that interfere with insulator installation and areas where foam is missing, as follows:

## NOTE

Soft blisters (air pockets between elastomer seal and foam) do not require repair.

(1) Trim raised areas and contour to adjacent surface.

(2) Using procedure outlined in paragraph 6-37, replace foam in voids occurring within 1/2 inch of edges of foam. Replace foam in other areas only if total voids exceed the following limitations: (Only sufficient foam is required to be added to bring the voids within the applicable limitation.)

(a) The total voids cannot exceed 20 percent of surface area of foam when the voids extend to the foil.

(b) The total voids cannot exceed 40 percent of the surface area of the foam, and the remaining foam in the void areas must be at least 1/8 inch thick (average). Exposed foil is not allowable.

c. Coat exposed foam with elastomer seal using procedure outlined in paragraph 6-38.

6-37. REPLACING FOAM OF FOAM-LINED INSULATORS. This procedure repairs damaged areas of foam-lined insulators where the foam requires replacement.

#### WARNING

The following procedure specifies Isonate CPR 302-1.5 (The Upjohn Co). The resin and catalyst are skin irritants. Contact and inhalation of the vapors must be avoided. The resin and catalyst must be used in a well-ventilated area.

a. Maintain a temperature of  $75^{\circ} \pm 5^{\circ}$  F and prepare a test sample of Isonate CPR 302-1.5 (The Upjohn Co), to determine usage acceptability, as follows:

(1) Prepare a  $100 \pm 3$  gram sample of foam in a one-quart cylindrical container using one part of component R or part B catalyst to 2 parts of component TA or part A resin by weight.

(2) Mix sample for 10 seconds within one minute of combining catalyst and resin.

(3) If foam produced by the sample overfills the one-quart container within 5 minutes after combining the catalyst and resin, proceed to step aA.

(4) If foam produced by the sample does not overfill the container within 5 minutes after combining the catalyst and resin, obtain a new supply of Isonate CPR 302-1.5 (The Upjohn Co) and prepare a new sample.

aA. Maintain a temperature of  $75^{\circ} \pm 5^{\circ}$  F and prepare the proper quantity of Isonate CPR 302-1.5 (The Upjohn Co), needed to make the repair. Use one part of component R or part B catalyst to 2 parts of component TA or part A resin by weight. Mix material for 10 seconds within one minute of combining catalyst and resin; then pour immediately into center of repair area. Do not allow material to foam in mixing container.

#### NOTE

One-half gram of mix is required for each cubic inch of space to be filled. A 20-percent excess may be mixed to compensate for material retained on mixing equipment.

b. As soon as pouring is completed, cover repair area with clear plastic sheet and form sheet to contour desired. Hold or secure plastic sheet in place until mixture stops expanding. Leave contouring material installed for at least 15 minutes. A small, partially inflated plastic bag held against the plastic sheet while the mixture is expanding will assist in forming and will help eliminate air bubbles.

c. Remove contouring material, and allow foam to cure at room temperature ( $75^{\circ}$  to  $80^{\circ}$  F) for 1.5 hours minimum.

d. Using suitable tools (sharp blade, wire brush, coarse sandpaper, wire screening, or other abrasive material), remove excess foam to contour part.

**WARNING**

The following procedure uses methyl-ethyl-ketone, which is flammable and must not be used near heat, sparks, or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

**CAUTION**

Excessive use of solvent can damage insulator foam.

e. Remove spilled resin from areas surrounding repair area, using a cloth dampened (not saturated) with methyl-ethyl-ketone (Federal Specification TT-M-261).

6-38. REPLACING ELASTOMER SEAL OF FOAM-LINED INSULATORS. This procedure repairs the elastomer seal used for foam-lined insulators. If the foam is not damaged, only the seal requires repairing. If the foam is replaced, the seal for the repaired area must be replaced.

a. Prepare Viton elastomer C-328 RTV (Connecticut Hard Rubber Co) as follows:

(1) Add one drop of C-328 catalyst from a standard eye dropper to each 10 grams of C-328 base compound.

(2) Mix catalyzed compound thoroughly for 5 minutes. Do not mix more compound than is needed. Pot life is 6-8 hours.

b. Repair surfaces using the following applicable procedure:

(1) Seal surface of repaired foam areas by applying a thin brush coat of compound to area. Allow initial coat to dry for at least 1/2 hour and until coat is no longer tacky. Finish area by applying additional sealing compound to match contour of surrounding area. Maximum thickness is 0.030 inch.

(2) Repair damaged sealing compound in areas where foam is undamaged by removing loose pieces of seal and applying a thin brush coat of sealing compound to the area. Allow initial coat to dry for at least 1/2 hour and until coat is no longer tacky. Finish area by applying additional sealing compound to match contour of surrounding area. Maximum thickness is 0.030 inch.

c. Allow part to cure until seal material has set. Parts may be handled when material has set. Do not expose repaired area to solvents for at least 24 hours.

#### 6-39. REPAIRING SILICONE RUBBER COATING OF GLASS CLOTH INSULATION.

6-40. This procedure repairs cracks and tears in silicone rubber coating used on glass cloth insulation.

a. Clean loose matter from damaged area.

b. Fill damaged area with red sealant RTV-156 (General Electric). Red sealant RTV-106 (General Electric) may be substituted.

c. Work any loose fibers of glass cloth into sealant.

d. Cover repair area with a cloth dampened in water, and allow sealant to cure for approximately 4 hours before using part.

#### 6-41. REPAIRING FRAYED GLASS CLOTH INSULATION.

6-42. This procedure repairs frayed areas of glass cloth insulation.

a. Clean loose matter from damaged area.

#### WARNING

The following procedure specifies toluene, which is flammable and must not be used near heat, sparks, or open flame. It is a toxic solvent. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury or death.

b. Coat damaged area with white sealant RTV-102 (General Electric). Sealant may be thinned to brushing consistency using toluene (Federal Specification TT-T-548).

c. Fold cloth fibers into sealant.

d. Cover repaired area with a cloth dampened in water, and allow sealant to cure for approximately 4 hours before using part.

#### 6-43. RETAINING CAPTIVE BOLTS IN ASBESTOS ACCESS DOORS.

6-44. This procedure provides a positive method for retaining captive bolts of insulator asbestos access doors.

a. Install washer LD153-0010-0007 under bolthead, and install bolt through grommeted hole in door.

b. Hold bolthead and, using special retaining ring tool provided by local Rocketdyne representative, screw retaining ring 5560-18 on bolt until ring reaches recessed grip of bolt.

#### NOTE

Retaining ring may be installed over existing retaining washers.

#### 6-45. NUTPLATE REPLACEMENT.

6-46. Nutplates used on thermal insulation brackets and insulators may be replaced as indicated in the following applicable procedures:

(1) Thermal insulation brackets, paragraphs 6-47 through 6-54

(2) Thermal insulation insulators, paragraphs 6-55 through 6-66

6-47. COCOON AREA BRACKETS.

6-48. This procedure provides an alternate fastener to replace damaged or missing nutplates installed on thermal insulation attach brackets. Steps a through d apply to closed box sections of attach brackets. Steps e through g apply to bracket areas where both sides of the bracket material are accessible. Steps h and i replace damaged or missing nutplates with a nut clip on bracket areas where the nut clip can be installed.

- a. Remove damaged nutplate from hole.
- b. Enlarge diameter of hole in bracket from present 0.375 inch to 0.391 to 0.397 inch using a standard rail drill with an air motor set at approximately 200 rpm. Make sure that constant pressure is applied during drilling.
- c. Using the following tools (Hi-Shear Corp), install blind nut BN523-428-1 (Hi-Shear Corp) on mandrel and secure in hole:
  - (1) Electrical-hydraulic power unit BP4000
  - (2) Gun BG2500
  - (3) Anvil A27-428
  - (4) Chuck C2-12
  - (5) Mandrel M3-12
- d. Remove tool.
- e. Remove damaged nutplate.
- f. Drill 2 holes to match attaching holes of applicable replacement nutplate NAS1023C3, NAS1023C4, MS21070-3, MS21070-4, MS21072-3, MS21076-3, or MS21076-4.
- g. Install new plate using 2 rivets MS20427M3.
- h. Remove damaged nutplate.
- i. Install nut clip RD114-5003-0001 or RD114-5003-0002 on bracket, and align nut clip with hole in bracket. Nut clip may be formed or trimmed, as necessary, to maintain its location.

6-49. THRUST CHAMBER AND NOZZLE EXTENSION BRACKETS.

6-50. This procedure replaces damaged or missing nutplates on thrust chamber and nozzle extension brackets, with a nut clip.

- a. Remove damaged nutplate.
- b. Install nut clip RD114-5003-0001 or RD114-5003-0002 on bracket. Nut clip may be formed or trimmed, as necessary, to maintain its location.

6-51. NOZZLE EXTENSION END RING.

6-52. Nutplates in the end ring of the nozzle extension are used to attach thermal insulation insulators. Damaged nutplates in this area must be replaced using the applicable component repair procedure for the nozzle extension as outlined in R-3896-3.

6-53. NOZZLE EXTENSION TUNNEL BRACKETS.

6-54. This procedure replaces damaged or missing nutplates on nozzle extension brackets 145178 and 145179.

- a. Remove damaged nutplate.
- b. Using a size 40 drill, make 2 holes in bracket to match attaching holes of nutplate MS21070L3.
- c. Install nutplate using 2 rivets MS20427F3, or equivalent.

6-55. COCOON INSULATOR NUTPLATE REPAIRS (RIVETING METHOD).

6-56. This procedure replaces damaged or missing nutplates of cocoon insulators. Steps a through c install a riveted nutplate. Steps d and e install a nut clip.

- a. Remove damaged nutplate.
- b. Using a size 40 drill, make 2 holes in insulator to match attaching holes of applicable replacement nutplate MS21070-3, MS21070-4, MS21076-3, MS21076-4, or NAS1023C3.



c. Install nutplate using 2 rivets MS20427F3, or equivalent.

d. Remove damaged nutplate.

e. Install nut clip RD114-5003-0001 or RD114-5003-0002, as required, and align nut clip with hole in insulator. Nut clip may be formed or trimmed to maintain its location.

#### 6-57. COCOON INSULATOR NUTPLATE REPAIRS (SPOT-WELDING METHOD).

6-58. The procedures outlined in paragraphs 6-59 through 6-62 cover the applicable spot welding for nutplate replacement on cocoon insulators. Extensive damage in an area must be repaired as outlined in paragraph 6-15 prior to performing this procedure. Refer to paragraph 6-4 for equipment requirements. The requirements outlined in paragraph 6-5 are applicable to all spot-welding methods for replacing nutplates.

#### 6-59. SPOT-WELDING NUTPLATE REPAIR DOUBLER TO BASE MATERIALS.

6-60. This procedure is performed only when required to replace a nutplate on texturized base materials or on flat base materials where the flat material has been torn. See figure 6-2 for materials and welder settings.

#### NOTE

Steps a through f prepare test specimens. Steps g through l fabricate and install the repair doubler (with nutplate attached) to the component.

a. Prepare test specimen repair doubler of Inconel sheet AMS5540, 0.020 inch thick, 1 inch wide, and 3 inches long. (See figure 6-6.)

b. Prepare materials to simulate repair area.

c. Clean materials as outlined in paragraph 6-6.

d. Overlap repair doubler on base material 1/2 inch, and make one row of spot welds (6 spot welds per inch) across center of overlap. If base material is texturized, spot welds must be made where texture and doubler touch.

e. Perform peel test. Test specimen must meet peel test requirements of figure 6-2.

f. Following completion of 3 successive acceptable test specimens, record equipment settings for use when attaching repair doubler to insulator. Procedures outlined in paragraph 6-61 spot-weld nutplate to repair doubler.

g. If flat base material in repair area is torn, use a size 30 drill to drill stop-holes at ends of tear.

h. Fabricate a repair doubler of Inconel sheet AMS5540, 0.020 inch thick, to dimensions required. (See figure 6-6.)

i. Drill or punch bolt clearance hole in center of doubler. Hole diameter must be  $0.031 \pm 0.010$  inch larger than nominal bolt size.

j. Install nutplate on repair doubler using procedure outlined in paragraph 6-61. Use applicable nutplate MS21070-3W, MS21070-4W, or RE114-5002-0001.

k. Clean repair area and repair doubler surfaces as outlined in paragraph 6-6.

l. Position completed repair doubler on repair area, center nutplate over existing bolt clearance hole, and spot-weld in place using pattern shown in figure 6-6.

#### 6-61. SPOT-WELDING REPAIR NUTPLATE TO REPAIR DOUBLER OR BASE MATERIAL.

6-62. This procedure is performed to attach a repair nutplate to a repair doubler or to flat base material.

#### NOTE

Steps a through e prepare test specimens. Steps f through h install a nutplate on a repair doubler. Steps i and j install a nutplate on flat base material.

a. Prepare repair doubler or base material test specimens as follows:

(1) Repair doubler: Inconel sheet AMS5540, 0.020 inch thick, 1 inch wide, 3 inches long

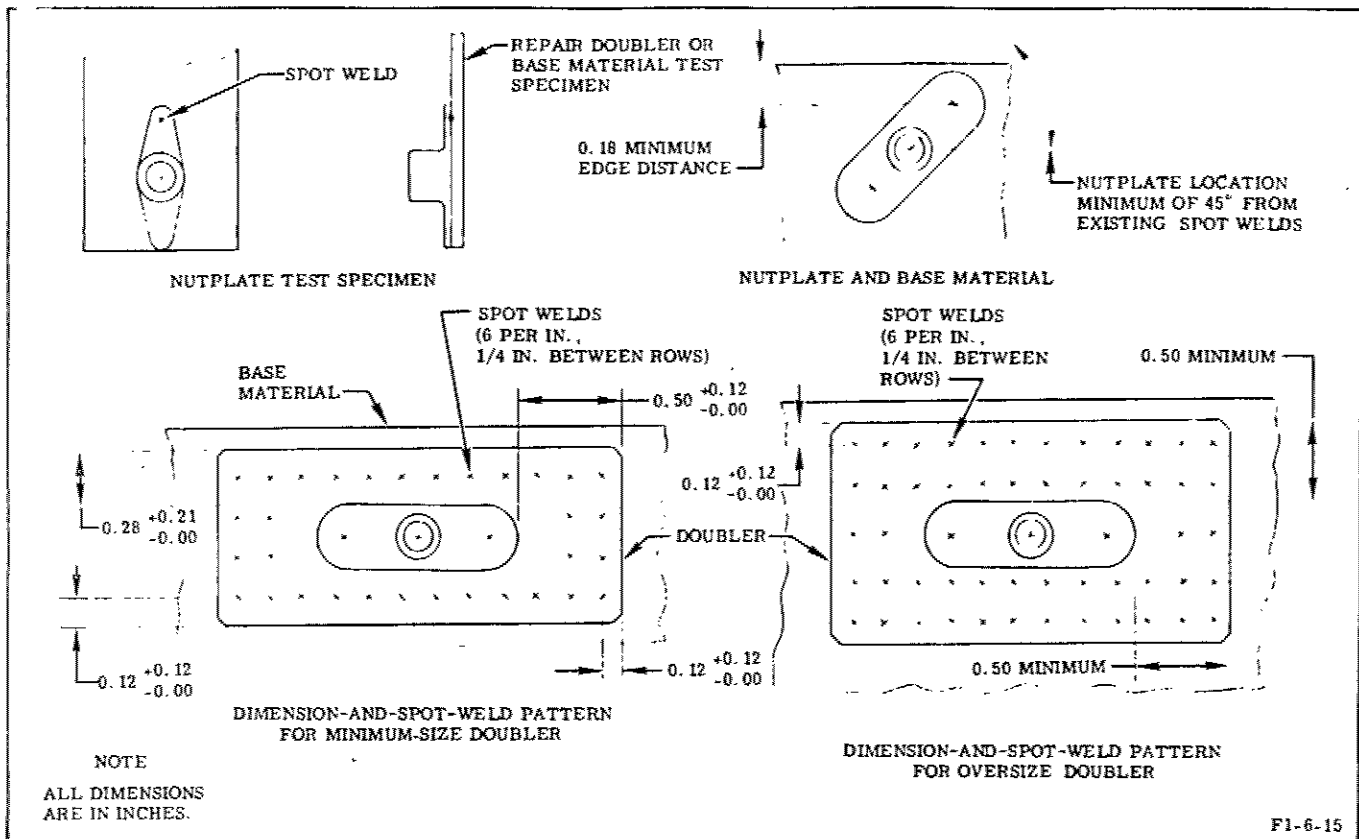


Figure 6-6. Nutplate Replacement and Spot Welding

(2) Base material: Simulate materials and thickness of repair area.

b. Clean surfaces of nutplate and materials as outlined in paragraph 6-6.

c. Position applicable nutplate MS21070-3W, MS21070-4W, or RE114-5002-0001 on test specimen of repair doubler or base material as shown in figure 6-6. Use equipment settings specified for materials as outlined in figure 6-2, and spot-weld one nib of nutplate to doubler or base material. Use gun probe on nutplate nib. Nib thicknesses may vary depending on the manufacturer.

d. Perform peel test of nutplate. Peel test must meet requirements of figure 6-2.

e. Following completion of 3 successive acceptable test specimens, record thickness of nutplate nibs and equipment settings for use when attaching nutplate to repair doubler or base material repair.

f. Prepare repair doubler as outlined in paragraph 6-59.

g. Clean surfaces of materials as outlined in paragraph 6-6.

h. Center nutplate over clearance hole, and spot-weld nutplate to repair doubler using applicable equipment settings for materials. Use gun probe on nutplate nib and make one spot weld for each nib of nutplate. Make sure that nutplate selected has same thickness nibs as nutplate used for test specimens.

i. Clean surfaces of base material and nutplate as outlined in paragraph 6-6.

j. Spot-weld nutplate to base material using settings recorded for test specimen. Use gun probe on nutplate nib, and make one spot weld for each nib of nutplate. Make sure that nutplate selected has same thickness nibs as nutplate used for test specimens.

**6-63. COCOON INSULATOR NUTPLATE REPAIRS (NUT SUBSTITUTION METHOD).**

6-64. This procedure allows a damaged or missing nutplate used for attaching insulators in the cocoon area, to be replaced with a self-locking nut NAS679C3W or NAS679C4W when the condition meets the following requirements:

(1) The basic part number of the specified bolt or screw is NAS1003, NAS1004, MS21279, RD111-1010-63XX, or RD111-1010-64XX.

(2) Adequate clearance exists for installing and torquing the fastener to the value specified in the applicable procedure.

(3) Washer RD153-1002-0003 or RD153-1002-0004, as required, is used under the nut.

**6-65. REPLACING NUTPLATES OF INSULATOR 145144.**

6-66. This procedure replaces damaged or missing nutplates of insulator 145144 used at the heat exchanger water shield.

a. Remove damaged nutplate.

b. Using a suitable tool, pierce holes through asbestos for access to area to install rivets for replacement nutplate.

c. Using a size 40 drill, make holes to match attaching holes of replacement nutplate MS21070-3.

d. Install nutplate using 2 rivets MS20427M3.

**6-67. USING DAMAGED PREPUNCHED HOLES IN ASBESTOS AND FIBERGLASS INSULATION.**

6-68. This procedure provides alternate methods of installing attaching hardware when prepunched holes in asbestos and fiberglass insulation are damaged to the extent that washers used with attaching bolts pull through the insulating material.

a. Replace existing washer used with 1/4-inch-diameter bolts with a square washer fabricated from nickel-base alloy AMS5540 or 300-series CRES to the following requirements:

(1) Thickness: 0.020 inch

(2) Hole diameter: 0.281 to 0.291 inch

(3) Outer contour: 1.00 ±0.06 inch square with rounded corners

b. Replace existing washer used with 3/16-inch-diameter bolts with washer RD153-0115-0021 or a washer as fabricated in step a.

**6-69. REPAIRING PURGE LINES.**

6-70. This procedure provides instructions to add a fillet weld at the junction of the tube and fitting for purge lines 145388 and 145523 when leakage exists between the tube and the fitting.

a. Wire-brush repair area to produce a bright finish.

b. Weld manually using CRES 347 bare filler wire (MIL-R-5031, class 5A) and tungsten inert gas welding method (MIL-W-8611). The fillet leg size must be 0.045 to 0.090 inch. Drop-through must not exceed 0.030 inch. Excessive drop-through may be removed by mechanical method.

c. Inspect weld using dye penetrant inspection method. Surface porosity larger than 0.030 inch or the existence of any cracks in the weld are cause for rejection and rewelding.

**6-71. REWORK FOR THERMAL INSULATION BRACKETS.**

6-72. Rework of certain thermal insulation brackets is allowed only when a specified condition occurs during installation. These conditions are noted in the installation procedures for the pertinent brackets.

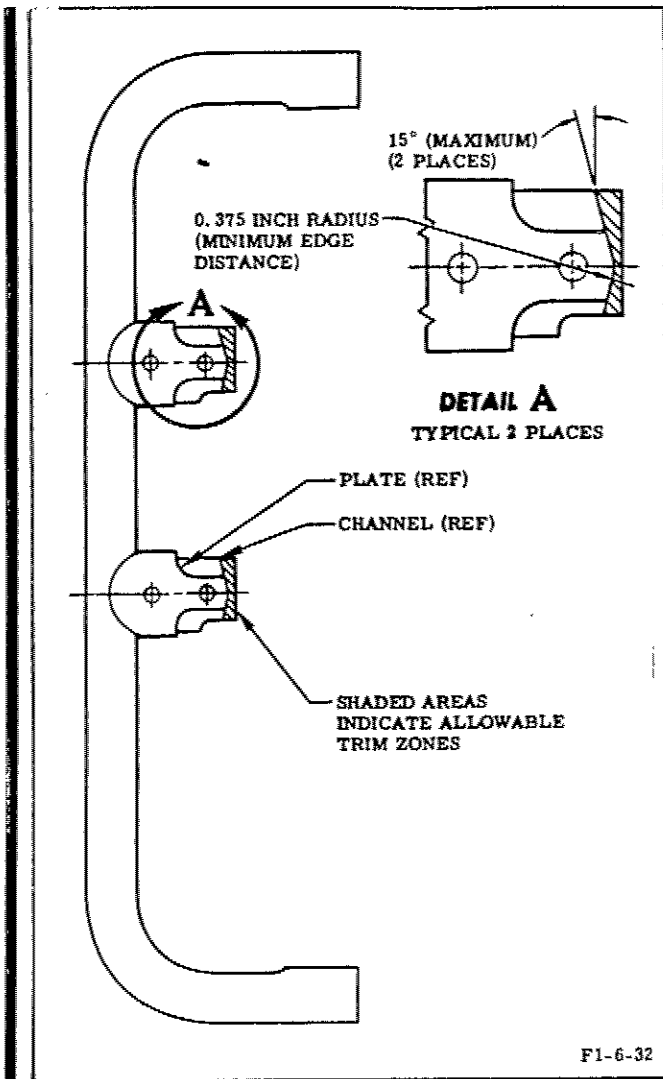


Figure 6-7. Rework for Thermal Insulation Bracket 145187

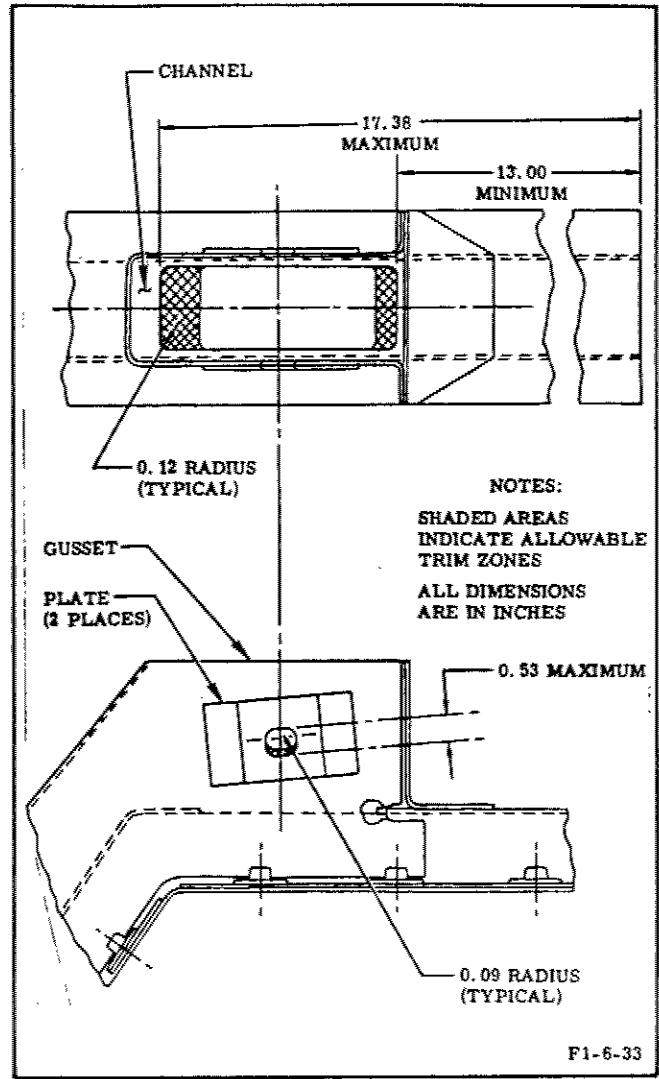


Figure 6-8. Rework for Thermal Insulation Bracket 145103

6-73. REWORK FOR BRACKET 145187.

6-74. Bracket 145187 is a detail part of bracket 145290. It may be reworked, when required, by trimming the areas indicated in figure 6-7.

6-75. REWORK FOR BRACKET 145103.

6-76. Bracket 145103 is a detail part of frame 145477. It may be reworked, when required, by trimming the areas indicated in figure 6-8.

6-77. REWORK FOR BRACKET 145344.

6-78. Bracket 145344 may be reworked, when required, by trimming the areas indicated in figure 6-9.

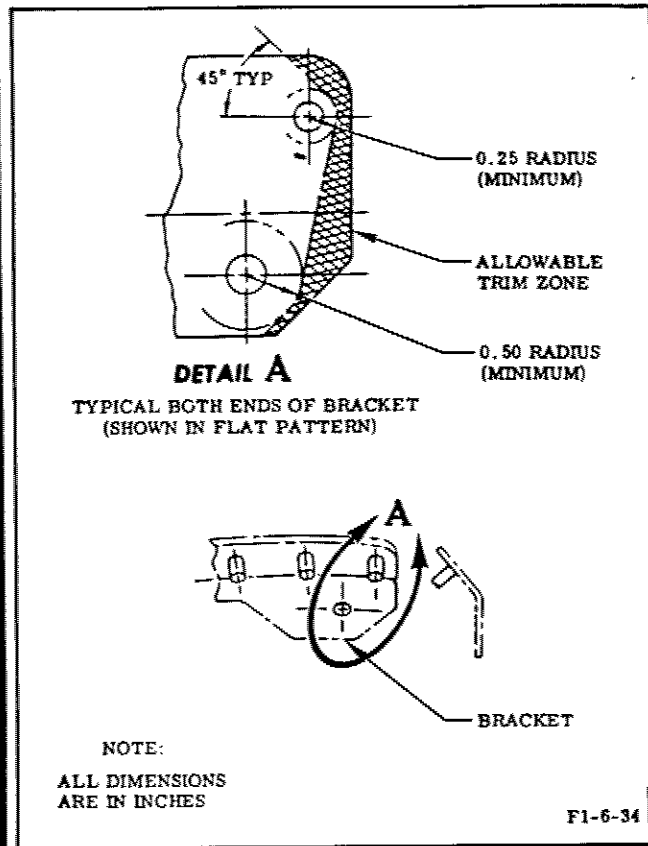


Figure 6-9. Rework for Thermal Insulation Bracket 145344

6-79. REWORK FOR COUPLING 145268.

6-80. Coupling 145268 is a detail part of frame 145477. It may be reworked, when required, by trimming the areas indicated in figure 6-10.

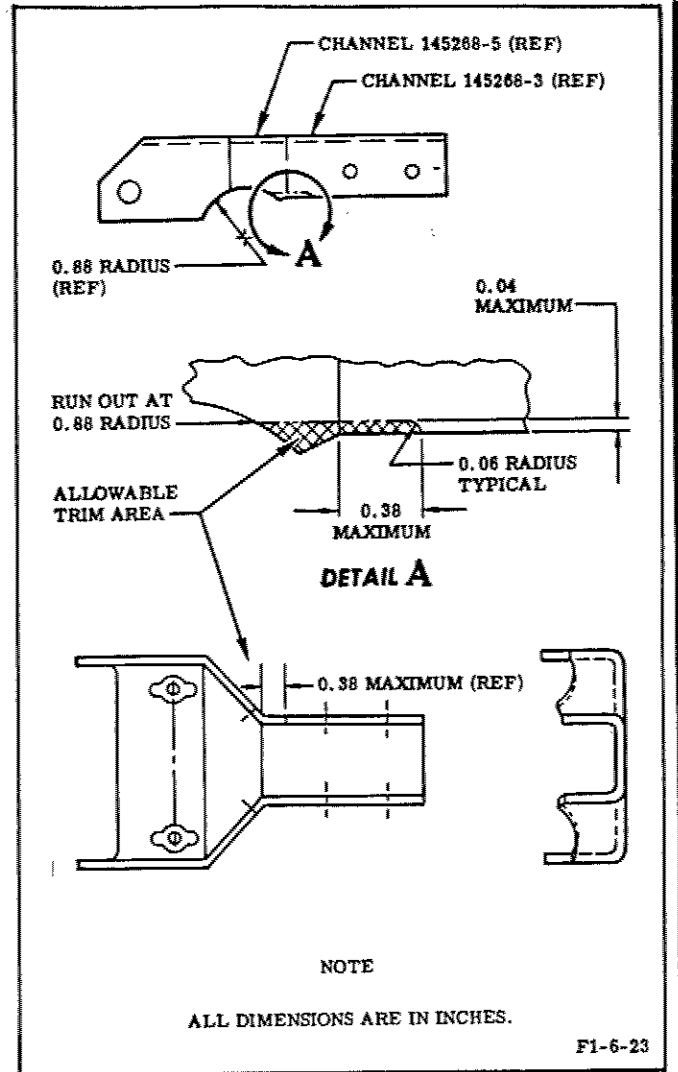


Figure 6-10. Rework for Thermal Insulation Coupling 145268

SECTION VII

STORAGE AND HANDLING

7-1. **SCOPE.** This section includes packaging, storage, and handling information for thermal insulation components.

7-2. **PACKAGING.**

7-3. Thermal insulation components are packaged and shipped in cleated plywood or paper-overlaid veneer (POV) boxes. Boxes are identified by thermal insulation set serial number, and the contents of each box are identified by component part numbers. See figure 7-1 or 7-2 for part locations.

7-4. **STORAGE.**

7-5. One engine set of thermal insulation requires approximately 1,500 cubic feet of storage space.

7-6. **HANDLING.**

7-7. There are no special procedures required for handling thermal insulation beyond observing safety precautions outlined in section III or IV.

Part No.	Figure No.	Index No.	Location (Box No.)	Part No.	Figure No.	Index No.	Location (Box No.)
NOTE				145086	3-7	21	6
Cocoon, heat exchanger lines, and wrap-around lines loose hardware is located in boxes 1, 2, and 3.				145087	3-7	20	9
• Thrust chamber and nozzle extension loose hardware is located in boxes 11 and 12.				145088	3-9	3	10
145059	3-7	28	9	145089	3-9	1	10
145065	3-5	2	3	145090	3-9	2	10
145066	3-5	3	3	145091	3-7	27	7
145067	3-5	4	3	145092	3-7	14	7
145068	3-5	1	3	145095	3-9	19	10
145072	3-7	5,12	3	145096	3-9	24	10
145073	3-7	9	7	145097	3-9	33	10
145074	3-7	22	6	145098	3-7	3	4
145075	3-7	23	3	145099	3-7	4	4
145076	3-7	19	5	145100	3-7	13	7
145077	3-7	7	5	145101	3-6,3-7	29,6,16	3,12
145078	3-7	18	5	145102	3-7	25	6
145079	3-7	8	5	145117	3-9	6	10
145080	3-7	10	6	145118	3-9	4	10
145081	3-7	2	4	145119	3-9	5	10
145082	3-7	11	6	145120-11	3-9	17,22	10
145083	3-7	24	7	145120-21	3-9	8	10
145084	3-7	15	4	145120-31	3-9	8	10
145085	3-7	17	4	145120-41	3-9	9	10
				145122	3-9	31	10
				145123	3-9	30	10
				145124	3-9	29	10
				145125	3-9	32	10
				145130	3-9	34	2
				145131	3-9	35	2
				145134	3-9	23	10

Figure 7-1. Shipping Box Locations for Thermal Insulation Parts (Engines F-2003 Through F-2016) (Sheet 1 of 3)

Part No.	Figure No.	Index No.	Location (Box No.)	Part No.	Figure No.	Index No.	Location (Box No.)
145135	3-9	18	10	145196	3-9	25	10
145136	3-9	26	10	145200	3-9	26	3
145137	3-9	21	10	145201	3-8	17	8
145138	3-9	37	2	145202	3-8	16	8
145139	3-9	36	2	145202-11	3-8	20	8
145144	3-7	1	3	145202-21	3-8	13	8
145145	3-9	14	10	145203	3-8	18	8
145147	3-9	15	10	145204	3-8	19	8
145148	3-9	13	10	145205	3-8	14	8
145149-11	3-9	28	10	145206	3-8	15	8
145149-21	3-9	27	10	145207	3-8	1	8
145150-11	3-9	16	10	145208	3-8	8	8
145151	3-6	16	19	145209	3-8	9	8
145152	3-6	23	19	145210	3-8	11	8
145153	3-6	4	13	145211	3-8	2	8
145154	3-6	5	13	145212	3-8	12	8
145155	3-6	6	13	145213	3-8	6	8
145156	3-6	8	15	145214	3-8	7	8
145157	3-6	26	22	145215	3-8	21	8
145158	3-6	27	22	145216	3-8	22	8
145159	3-6	28	22	145217-11	3-8	3	8
145160	3-6	11	17	145217-21	3-8	3	8
145161	3-6	12	17	145218	3-8	4	8
145162	3-6	13	18	145219-11	3-8	10	8
145163	3-6	14	18	145219-21	3-8	10	8
145164	3-6	15	18	145220	3-8	5	8
145165	3-6	10	17	145225	3-6	9	16
145166	3-6	20	21	145227	3-5	11	2
145167	3-6	19	21	145255	3-5	85	2
145168	3-6	22	21	145269	3-5	63	2
145169	3-6	17	20	145286	3-5	83	2
145170	3-6	18	20	145288-7	3-5		1
145171	3-6	24	20	145290	3-5	69	2
145171-11	3-6	24	20	145292	3-5	84	2
145172	3-6	25	20	145292-11	3-5	84	2
145172-11	3-6	25	20	145295	3-5	44	2
145173	3-6	8	15	145304	3-5	87	2
145174	3-6	7	14	145305	3-5	88	2
145175	3-6	7	14	145310	3-5	51	2
145176	3-6	30	18	145311	3-5	55	2
145177	3-6	3	13	145312	3-5	77	2
145178	3-6	1	12	145313	3-5	35	2
145179	3-6	2	12	145314	3-5	39	2
145180	3-6	21	21	145315	3-5	5	2
145180-11	3-6	21	21	145316	3-5	59	2
145188	3-5	86	2	145317	3-5	104	2
145190	3-5		1	145320	3-5	39	2
145192	3-9	12	10	145328	3-7	29	2
145193	3-9	10	10	145329	3-7	2	4
145194	3-9	11	10	145330	3-7	15	4
145195	3-9	20	10	145331	3-7	3	4

Figure 7-1. Shipping Box Locations for Thermal Insulation Parts  
(Engines F-2003 Through F-2016) (Sheet 2 of 3)

Part No.	Figure No.	Index No.	Location (Box No.)	Part No.	Figure No.	Index No.	Location (Box No.)
145332	3-7	13	7	145399	3-7		3
145333	3-7	25	6	145523	3-4	2	11
145337	3-5	95	2	145535-31	3-7	24	7
145338	3-5	99	2	145540	3-7	18	5
145339	3-5	90	2	145541	3-7	17	4
145342	3-5	91	2	145542	3-7	4	4
145343	3-5	103	2	145543	3-7	15	15
145344	3-5	89	2	145544	3-7	3	3
145345	3-7	10	6	145545	3-7	13	13
145346	3-7	20	9	145545-11	3-7	13	13
145348	3-5	4F	3	145546	3-7	8	8
145349	3-5	4G	3	145901	3-6	4	13
145350	3-5	4H	3	145902	3-6	3	13
145351	3-5	4E	3	145903	3-6	5	13
145356	3-7	30	3	145904	3-6	6	13
145357	3-7	28	9	145905	3-6	26	22
145458	3-5	4C	2	145906	3-6	27	22
145359	3-5	4B	2	145907	3-6	28	22
145364	3-2	10		145908	3-6	11	17
145365	3-2	12		145909	3-6	12	17
145366	3-2	11		145910	3-6	13	18
145367	3-2	13		145911	3-6	14	18
145368	3-2	14		145912	3-6	15	18
145369	3-2	1		145913	3-6	20	21
145370	3-2	2		145914	3-6	19	21
145371	3-2	3		145915	3-6	22	21
145372	3-2	4		145916	3-6	17	20
145373	3-2	5		145917	3-6	18	18
145374	3-2	6		145918	3-6	30	18
145375	3-2	7		145929	3-6		11
145376	3-2	8		145930	3-6		11
145377	3-2	9		145931	3-6	23A	19
145388	3-4	4	11	145932	3-6	23	19
145392	3-7	8	5	19-145112-1	3-1		3
145393	3-7	24A	3	19-145112-2	3-1		3
145394	3-7		2	19-145112-3	3-1		3
145395	3-7	29	2	19-145113-1	3-1		3
145396	3-5		1	19-145113-3	3-1		3
145397	3-5	4A	2	19-145113-4	3-1		3
145398	3-5	4D	2	19-145114	3-1		3

Figure 7-1. Shipping Box Locations for Thermal Insulation Parts  
(Engines F-2003 Through F-2016) (Sheet 3 of 3)



Part No.	Figure No.	Index No.	Location (Box No.)	Part No.	Figure No.	Index No.	Location (Box No.)
NOTE				145149-11	4-10	28	5
Transducer and oxidizer lines insulators are located in box 3.				145149-21	4-10	27	5
• Cocoon, heat exchanger lines, and wrap-around lines loose hardware is located in boxes 1, 2, and 11.				145150-11	4-10	16	5
• Thrust chamber and nozzle extension loose hardware is located in box 8.				145165	4-7	10	9
145072-21	4-8	31	3	145171-11	4-7	24	9
145082-21	4-8	5	4	145172-11	4-7	25	9
145088	4-10	3	5	145173-21	4-7	8	9
145089	4-10	1	5	145174-21	4-7	7	9
145090	4-10	2	5	145178	4-7	1	8
145095	4-10	19	5	145179	4-7	2	8
145096	4-10	24	5	145180-11	4-7	21	9
145097	4-10	33	5	145188	4-4	9	2(a), 12(b)
145101-21	4-7	26	8	145192	4-10	12	5
145101-21	4-8	32	3	145193	4-10	10	5
145117	4-10	6	5	145194	4-10	11	5
145118	4-10	4	5	145195	4-10	20	5
145119	4-10	5	5	145196	4-10	25	5
145120-11	4-10	17, 22	5	145201	4-9	23	7
145120-21	4-10	7	5	145202	4-9	21, 22	7
145120-31	4-10	8	5	145202-11	4-9	26	7
145120-41	4-10	9	5	145202-21	4-9	17, 18	7
145120-51	4-10	7	5	145202-61	4-9	18	7
145120-61	4-10	8	5	145202-81	4-9	24	7
145120-71	4-10	9	5	145203	4-9	22	7
145122	4-10	31	5	145204	4-9	25	7
145123	4-10	30	5	145205	4-9	19	7
145124	4-10	29	5	145206	4-9	20	7
145125	4-10	32	5	145207	4-9	1	7
145130	4-10	34	2(a), 1(b)	145208	4-9	11	7
145131	4-10	35	2	145209	4-9	12	7
145134	4-10	23	5	145210	4-9	5	7
145135-41	4-10	18	5	145211	4-9	2	7
145136	4-10	26	5	145212	4-9	16	7
145137	4-10	21	5	145213	4-9	9	7
145138	4-10	37	2(a), 1(b)	145214	4-9	10	7
145139	4-10	36	2(a), 1(b)	145215	4-9	27	7
145144	4-8	1	4	145216	4-9	28	7
145145	4-10	14	5	145217-51	4-9	3	7
145147	4-10	15	5	145217-61	4-9	4	7
145148	4-10	13	5	145218	4-9	15	7
				145219-11	4-9	13	7
				145219-21	4-9	14	7
				145220	4-9	5	7
				145221	4-9	8	7
				145222	4-9	7	7
				145225-61	4-7	9	9

(a) Thermal insulation sets 12-1 through 15-1, 15-3, 15-6, 15-7, 16-2, and 17-1.

(b) Thermal insulation sets 15-2, 15-4, 15-5, 16-1, 16-3 through 16-7, and 17-2 and subsequent.

Figure 7-2. Shipping Box Locations for Thermal Insulation Parts  
(Engines F-2017 and Subsequent) (Sheet 1 of 3)

Part No.	Figure No.	Index No.	Location (Box No.)	Part No.	Figure No.	Index No.	Location (Box No.)
145255	4-4	8	2(a), 12(b)	145502-11	4-8	15	4
145286	4-4	6	2(a), 12(b)	145503-11	4-8	14	4
145288-7	4-4		1(a), 12(b)	145503-21	4-8	14	4
145290	4-4	25	2(a), 12(b)	145504-11	4-8	13	4
145304	4-4	10	2	145505-11	4-8	6	4
145305	4-4	11	2(a), 12(b)	145506-11	4-8	9	4
145324	4-4	12	2(a), 12(b)	145507-21	4-8	8	4
145324-11	4-4	12	12	145507-31	4-8	8	4
145325	4-4	18	2	145508-11	4-8	10	4
145344	4-4	5	2(a), 12(b)	145509-11	4-8	3	4
145352	4-4	1	2	145510-41	4-8	11	4
145353	4-4	3	2	145510-71	4-8	11	4
145354	4-4	2	2	145510-81	4-8	11	4
145355	4-4	4	2	145510-111	4-8	11	4
145369-11	4-5	1	3(a), 2(b)	145511-11	4-8	7	4
145370-11	4-5	2	3(a), 2(b)	145512-11	4-8	19	6
145371	4-5	3	3(a), 2(b)	145513-11	4-8	22	6
145372	4-5	4	3(a), 2(b)	145514-11	4-8	26	6
145380	4-5	9	3	145514-21	4-8	26	6
145381	4-5	10	3	145515-11	4-8	20	6
145382	4-5	7	3	145516-11	4-8	17	6
145383	4-5	6	3	145517-11	4-8	18	6
145384	4-5	5	3	145518-11	4-8	16	6
145385	4-5	8	3	145519-11	4-8	27	6
145388	4-2	4	11	145520-11	4-8	23	6
145393	4-8	41	3	145520-21	4-8	23	6
145394	4-8	29	2(a), 1(b)	145521-11	4-8	24	6
145399	4-8	30	3	145522-11	4-8	21	6
145408	4-4	151	2	145522-21	4-8	21	6
145423	4-4	159	2	145523	4-2	2	11
145432-2	4-4	94	2	145524-11	4-8	4	4
145445	4-4	75	2	145524-21	4-8	4	4
145446	4-4	74	2	145525-21	4-8	40	3
145447	4-4	158	2	145526-11	4-8	33	3
145454	4-4	101	2	145527-11	4-8	34	3
145471-2	4-4	95	2	145528-11	4-8	37	3
145477	4-4	41	2(a), 12(b)	145529-11	4-8	36	3
145489	4-4	156	2	145530-11	4-8	35	3
145490	4-4	155	2	145531	4-8	28	7
145491	4-4	154	2	145532	4-8	2	4(a), 12(b)
145493	4-4	98	2	145532-11	4-8	2	4(a), 12(b)
145496	4-4	86	2	145533-11	4-8	38	3
145497	4-4	102	2	145534-11	4-8	25	6
145498	4-4	56	2	145534-21	4-8	25	6
145499	4-4	125	2	145535-71	4-8	39	7
145501-11	4-8	12	4	145535-121	4-8	39	7

(a) Thermal insulation sets 12-1 through 15-1, 15-3, 15-6, 15-7, 16-2, and 17-1.

(b) Thermal insulation sets 15-2, 15-4, 15-5, 16-1, 16-3 through 16-7, and 17-2 and subsequent.

Figure 7-2. Shipping Box Locations for Thermal Insulation Parts  
(Engines F-2017 and Subsequent) (Sheet 2 of 3)

Part No.	Figure No.	Index No.	Location (Box No.)	Part No.	Figure No.	Index No.	Location (Box No.)
145601	4-4	96	2	145921-11	4-7	5	9
145614	4-4	7	2(a), 12(b)	145922-11	4-7	6	9
145615	4-4	97	2	145923-11	4-7	31	10
145616	4-4	103	2	145924-11	4-7	32	10
145618	4-4	69	2	145925-11	4-7	33	10
145626	4-4	93	2	145926-11	4-7	28	10
145627	4-4	152	2	145927-11	4-7	29	10
145630	4-4	78	1(a), 2(b)	145928-11	4-7	30	10
145903-21	4-7	11	9	145929	4-7		8
145909-21	4-7	12	9	145930	4-7		8
145910-21	4-7	13	9	145931	4-1	23	9
145911-21	4-7	14	9	145932	4-1	22	9
145912-21	4-7	15	9	19-145112-1	4-1		3
145913-21	4-7	19	9	19-145112-2	4-1		3
145914-21	4-7	18	9	19-145112-3	4-1		3
145915-21	4-7	20	9	19-145113-1	4-1		3
145916-21	4-7	16	9	19-145113-3	4-1		3
145917-21	4-7	17	9	19-145113-4	4-1		3
145918-11	4-7	27	8	19-145114	4-1		3
145919-11	4-7	4	9	303228	4-4	157	2
145920-11	4-7	3	9	601932	4-4	153	2

(a) Thermal insulation sets 12-1 through 15-1, 15-3, 15-6, 15-7, 16-2, and 17-1.

(b) Thermal insulation sets 15-2, 15-4, 15-5, 16-1, 16-3 through 16-7, and 17-2 and subsequent.

Figure 7-2. Shipping Box Locations for Thermal Insulation Parts  
(Engines F-2017 and Subsequent) (Sheet 3 of 3)

## MANUAL DATA SUPPLEMENTS

Manual Data Supplements are issued from time to time to communicate important and urgent information concerning the equipment covered in this manual. These supplements bear an identifying number and should be filed in this Appendix.

Manual Data Supplements directly affect the data in this manual and will be incorporated into this manual during a future updating effort.

A Supplement Record is issued periodically to indicate the status of supplements issued for this manual. The status of each supplement is

indicated in the "Supplement Status" column. For active supplements, no status is entered. For incorporated Supplements "Incorporated" is entered.

Upon receipt of a Manual Data Supplement, make an appropriate reference to the supplement in the margin next to the data supplemented and enter the number, date, and subject matter of the supplement on the Manual Data Supplement Record.

## MANUAL DATA SUPPLEMENT RECORD

This Supplement Record indicates the status of Supplements issued for Technical Manual R-3896-6. Supplements which have been

incorporated into the manual shall be removed from the Appendix and destroyed.

Supplement Number	Dated	Description	Supplement Status
R-3896-6-1	28 July 1966	Adds lubricating requirements for fasteners.	Incorporated
R-3896-6-2	4 August 1966	Adds purge manifold torque procedure.	Incorporated
R-3896-6-3	12 August 1966	Adds hardware callout.	Incorporated
R-3896-6-4	18 August 1966	Adds alternate method for securing cocoon insulators and hardware corrections.	Incorporated
R-3896-6-5	19 September 1966	Adds hardware corrections and substitutions.	Incorporated
R-3896-6-6	18 October 1966	Adds special instructions for substitutions, installation, and hardware callouts.	Incorporated
R-3896-6-7	28 November 1966	Adds hardware changes, corrections, and procedure changes.	Incorporated
R-3896-6-8	31 May 1967	Adds improved safety-wiring methods.	Incorporated
R-3896-6-9	25 July 1967	Adds repair procedure for purge lines.	Incorporated
R-3896-6-10	23 October 1967	Adds moisture detection and operating instructions.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3896-6-11	23 October 1967	Adds alternate fasteners and changes in installation methods.	Incorporated
R-3896-6-12	2 November 1967	Adds stud-welding information.	Incorporated
R-3896-6-13	3 November 1967	Adds adapter for use in offsetting misalignment.	Incorporated
R-3896-6-14	10 November 1967	Adds allowance to reposition igniter harness clamps.	Incorporated
R-3896-6-15	17 November 1967	Adds repair method for nozzle extension band nutplates.	Incorporated
R-3896-6-16	5 December 1967	Adds improved safetywiring methods.	Incorporated
R-3896-6-17	13 December 1967	Adds procedures for replacing and relocating lacing studs.	Incorporated
R-3896-6-18	19 December 1967	Adds requirements to clean threads of nozzle extension nutplates and alignment of tunnel straps.	Incorporated
R-3896-6-19	18 April 1968	Changes safetywiring requirements.	Incorporated
R-3896-6-20	28 May 1968	Adds repair procedure for foam-lined insulators.	Incorporated
R-3896-6-21	18 August 1968	Adds additional repair procedures.	Incorporated
R-3896-6-22	22 October 1968	Adds repair procedure for foam-lined oxidizer duct insulators.	Incorporated
R-3896-6-23	25 October 1968	Adds ECP F1-588 to configuration.	Incorporated
R-3896-6-24	3 December 1968	Adds attaching hardware, nutplate replacement information, and part numbers.	Incorporated
R-3896-6-25	31 January 1969	Adds torque value for clamp fasteners.	Incorporated
R-3896-6-26	25 February 1969	Adds positioning procedure for brackets.	Incorporated
R-3896-6-27	6 March 1969	Adds part number correction.	Incorporated
R-3896-6-28	23 April 1969	Adds tilt gap allowance for certain nuts.	Incorporated
R-3896-6-29	7 May 1969	Adds revised replacement criteria for insulators exposed to water, and deletes moisture detection procedure.	Incorporated
R-3896-6-30	24 February 1970	Changes torque value.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3896-6-31	22 October 1971	Provides for rework of elongated holes in thermal insulation insulators.	Incorporated
R-3896-6-32	20 April 1971	Adds acceptance criteria for installed lacing studs.	Incorporated
R-3896-6-33	19 November 1971	Allows use of bolt MS21279-16 as an alternate for screw NAS-1100C3-16 during installation of clamp RD127-7001 on wrap-around line thermal insulation.	Incorporated
R-3896-6-34	24 November 1971	Adds a test to determine usage acceptability of Isonate CPR 302-1.5 (The Upjohn Co) for repair of foam-lined insulators and clarifies the identification of the Isonate catalyst and resin.	Incorporated

This supplement affects the data in Technical Manual R-3896-6. Make a reference to this supplement in the margin next to the data being supplemented; enter the number, date, and subject matter of the supplement on the Manual Data Supplement Record; and file this supplement in the Appendix to this manual.

This supplement replaces an existing warning with a more comprehensive warning about potential hazards when using urethane foam.

On page 6-12, paragraph 6-37, replace existing warning with the following:

WARNING

The following procedure specifies urethane foam, the components of which, must not be allowed to contact any part of the body. Face shield and gloves must be worn by personnel handling urethane foam. Urethane foam must be mixed and applied in a well-ventilated area since the vapors are extremely hazardous. Part A in the uncured condition can react as soon as the container is opened. In case of contact, the skin or eyes must be immediately flushed with water for at least 15 minutes and given medical attention.

This supplement affects the data in Technical Manual R-3896-6. Make a reference to this supplement in the margin next to the data being supplemented; enter the number, date, and subject matter of the supplement on the Manual Data Supplement Record; and file this supplement in the Appendix to this manual.

This supplement corrects a typographical error and changes the part number of a washer.

On page 4-84, change existing parts group to read as follows:

16	145150-11	1	Boot
	RE127-7001-0186	1	Clamp <sup>(a)</sup>
	RE127-7001-0210	2	Clamp <sup>(a)</sup>
	MS21279-11	28	Bolt
	RD153-0115-0019	56	Washer
	RD111-1010-6310	9	Bolt 27 ±3
	RD153-0115-0019	9	Washer
	RD114-8003-1003	28	Nut 27 ±3
	NAS1003-12A	2	Bolt 27 ±3
	RD153-0115-0019	2	Washer
	NAS1057T3-045'	2	Spacer
	Install spacers between insulator and bracket (9).		

On page 4-84, change existing parts group to read as follows:

20	145195 <sup>(c)</sup>	1	Insulator
	RE127-7001-0222	2	Clamp <sup>(a)</sup>
	MS21279-10 <sup>(b)</sup>	12	Screw
	RD153-0115-0019 <sup>(b)</sup>	24	Washer
	RD114-8003-1003 <sup>(b)</sup>	12	Nut

On page 4-85, change existing parts group to read as follows:

27	145149-11	1	Insulator
	RD111-1010-6312	12	Bolt 27 ±3
	RD153-0115-0019	12	Washer



On page 4-85, change existing fourth and fifth parts groups for index 28 to read as follows:

MS21279-11	30	Bolt
RD153-0115-0019	60	Washer
RD114-8003-1003	30	Nut 27 ±3
MS21279-11	4	Bolt
RD153-0115-0019	8	Washer
RD114-8003-1003	4	Nut 27 ±3

Install in 4  
grommets holes  
between line outlets.

On page 4-86, change existing parts group to read as follows:

33	145097	1	Blanket
	RD114-8003-1003	29	Nut 27 ±3
	MS21279-13	29	Bolt
	RD153-0115-0019	58	Washer

This supplement affects the data in Technical Manual R-3896-6. Make a reference to this supplement in the margin next to the data being supplemented; enter the number, date, and subject matter of the supplement on the Manual Data Supplement Record; and file this supplement in the Appendix to this manual.

This supplement adds warnings for handling specific materials used in the manual.

On page 6-10, paragraph 6-36, add the following warning before step a:

WARNING

White sealant RTV-102 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

On page 6-12A/6-12B, paragraph 6-38, add the following warning before step a:

WARNING

Viton elastomer C-328 RTV is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the curing agent (catalyst) can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

On page 6-13, paragraph 6-40, add the following warning before step b:

WARNING

Red sealant RTV-106 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

This supplement affects the data in Technical Manual R-3896-6. Make a reference to this supplement in the margin next to the data being supplemented; enter the number, date, and subject matter of the supplement on the Manual Data Supplement Record; and file this supplement in the Appendix to this manual.

This supplement adds warnings for handling specific materials used in the manual.

On page 6-10, paragraph 6-36, add the following warning before step a:

WARNING

White sealant RTV-102 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

On page 6-12A/6-12B, paragraph 6-38, add the following warning before step a:

WARNING

Viton elastomer C-328 RTV is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the curing agent (catalyst) can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

On page 6-13, paragraph 6-40, add the following warning before step b:

WARNING

Red sealant RTV-106 is flammable and must not be used near heat, sparks, or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

On page 6-13, paragraph 6-42, add the following warning before step b:

- White sealant RTV-102 is flammable and must not be used near heat, sparks or open flame. It is toxic. Inhalation of its vapors or prolonged contact with the sealant can cause serious bodily harm. In case of prolonged exposure, immediately obtain fresh air and wash skin with soap and water.

This supplement affects the data in Technical Manual R-3896-6. Make a reference to this supplement in the margin next to the data being supplemented; enter the number, date, and subject matter of the supplement on the Manual Data Supplement Record; and file this supplement in the Appendix to this manual.

This supplement changes leak-test compound (MIL-L-25567) to leak-test compound (MSFC-SPEC-384).

Change leak-test compound (MIL-L-25567) to leak-test compound (MSFC-SPEC-384) in the following places:

<u>Page No.</u>	<u>Figure No.</u>	<u>Paragraph No.</u>	<u>Step</u>
2-2	2-3		
6-5		6-10	d