Part N Vol 76

R-3896-9

TECHNICAL MANUAL

TRANSPORTATION

F-1 ROCKET ENGINE

(ROCKETDYNE)

CHANGE NOTICE

LATEST CHANGED PAGES SUPERSEDE THE SAME PAGES OF PREVIOUS DATE

Insert changed pages into basic publication. Destroy superseded pages.

PUBLISHED UNDER AUTHORITY OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

24 JULY 1967

CHANGE NO. 7 — 4 FEBRUARY 1972

LIST OF EFFECTIVE PAGES

NOTE The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 90 **CONSISTING OF THE FOLLOWING:**

Page No.	Change No.	Issue	Page No.	Change No.	Issue	Page No.	Change No.	Issue
Title	7	4 Feb 72						
A	7	4 Feb 72						
i thru ii	7	4 Feb 72						
iii/iv	6	25 Jun 71						
v thru vi/vii	5	4 Nov 69						
1-1 thru 1-2A/1-2B	7	4 Feb 72						
1-3	4	15 Nov 68						
1-4 thru 1-6	5	4 Nov 69						
1-7 thru 1-10	6	25 Jun 71						
1-11/1-12	5	4 Nov 69						
1-13	6	25 Jun 71						
1-14 thru 1-14B	5	4 Nov 69						
1-15	5	4 Nov 69						
1-16	1	9 Nov 67						
1-17 thru 1-18	6	25 Jun 71						
1-18A/1-18B	2	5 Apr 68						
1-19 thru 1-21		Original						
1-22 thru 1-23/1-24	2	5 Apr 68						
2-1	7	4 Feb 72						
2-2	2	5 Apr 68						
2-3	5	4 Nov 69						
2-4	2	5 Apr 68						
2-4A/2-4B	7	4 Feb 72						
2-5 thru 2-8	6	25 Jun 71						
3-1	7	4 Feb 72						
3-2		Original						
3-2A/3-2B	7	4 Feb 72						
3-3 thru 3-13/3-14		Original						
4-1	7	4 Feb 72						
4-2	2	5 Apr 68						
4-3	5	4 Nov 69						
4-4	2	5 Apr 68						
4-4A/4-4B	7	4 Feb 72						
4-5	5	4 Nov 69						
4-6	6	25 Jun 71						
4-7/4-8	5	4 Nov 69						
4-9	5	4 Nov 69						
4-10	2	5 Apr 68						
4-11 thru 4-12	3	3 Jul 68						
4-13 thru 4-15/4-16	5	4 Nov 69						
A-1	3	3 Jul 68						
A-2	5	4 Nov 69						

Upon receipt of the second and subsequent changes to this technical manual, personnel responsible for maintaining this publication in current status will ascertain that all previous changes have been received and incorporated. Action should be taken promptly if the publication is incomplete.
This page reflects the current status of the complete manual. All pages listed must be in the manual to make this publication current and complete.

TABLE OF CONTENTS

Underlined numbers denote figures.
Underlined titles denote primary paragraphs.

TABLE OF CONTENTS
(Continued)

Underlined numbers denote figures.
Underlined titles denote primary paragraphs.

LIST OF ILLUSTRATIONS

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-2029 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 Product Manuals & Training Department of Rocketdyne.

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

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

The manuals' contents and support functions 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 manual. Thus, information on the description, operation, and maintenance of a particular piece of ground support equipment is found in R-3896-5, Volume I, F-1 Rocket Engine Ground Support Equipment Maintenance and Operation manual. However, the actual instructions for servicing the engine using that piece of ground support equipment is in R-3896-3, Volume I, F-1 Rocket Engine Maintenance and Repair manual.

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 II III	Description and Operation Interface Design Criteria 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 Fuel Purge Check Valve 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 XVII Liquid Level Detector XVIII Electrical Harness XIX Hypergol Manifold XX Ignition Monitor Valve XXI Checkout Valve XXII Engine Control Valve

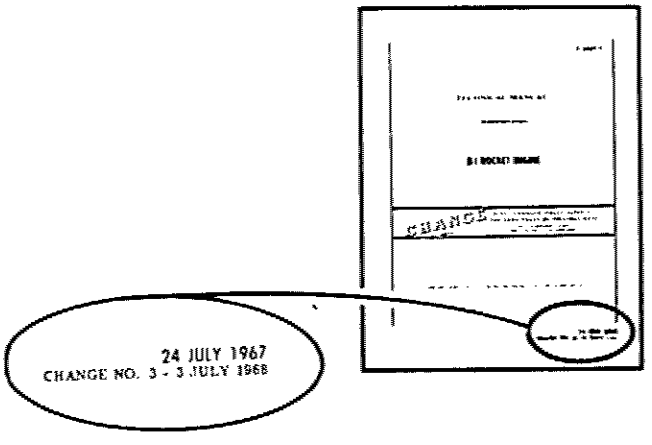
Manual	Contents and Support Function	Section and Title	
R-3896-3, Volume II (cont)		XXIII	Four-Way Solenoid Valve
		XXIV	Thrust Chamber Nozzle Extension
		XXV	Pressure Transducer
		XXVI	Temperature Transducer
		XXVII	Flight Instrumentation Junction Boxes
		XXVIII	Rigid Ducts, Flexible Lines, and Braided 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.	I	Introduction
		II	Group Assembly Parts List
		III	Numerical Index
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	Safety Requirements, General Maintenance, and Handling and Shipping Equipment
		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
		XI	Cryogenic Supply Unit G3146
		XII	Pneumatic Flow Testers G3104 and G3104MD1
		XIII	High-Voltage Igniter Tester G3153 and Inert Igniter 9026622

Manual	Contents and Support Function	Section and Title
R-3896-5, Volume I (cont)		XIV Impact Recorder Unit G4090 and 99-9014031 XV Components Welding Sets 9026560, 9026561, and 9026570
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
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.	I Description II Special Tools and Equipment III Installation and Removal (Engines F-2003 Through F-2016) IV Installation and Removal (Engines F-2017 and Subsequent) V Access Provisions VI Storage and Handling
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.	See detailed table of contents for this manual.
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.

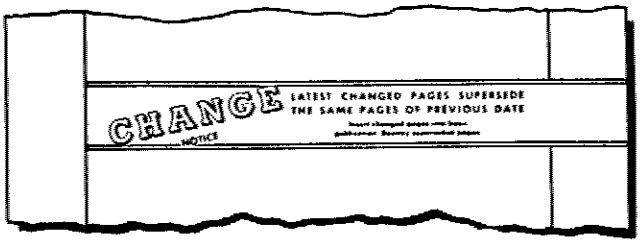


B. DETERMINING COMPLETENESS. To be sure that your manual is complete, make a page-by-page comparison of its pages to those listed in the List of Effective Pages. The List of Effective Pages, which shows the change status since the basic issue or last revision, is found on the alphabetically lettered page(s) immediately following the title page. All pages, except supplements, are listed, whether they are original, changed, added, or deleted. The dates of changed and added pages and the date pages were deleted are listed in the Issue column. 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 newly issued List of Effective Pages and proceed as follows:

1. In the Page No. column, on lines identified with an asterisk (*), locate page numbers listed as deleted. Remove these numbered pages from the manual and destroy them. Do not concern yourself with the data on the opposite side of the deleted page since, if this data is not deleted, it is replaced in the change package. (Asterisks identify all pages affected by the current change.)

2. Insert all new pages in sequence, removing and destroying like-numbered older pages. 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-1

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

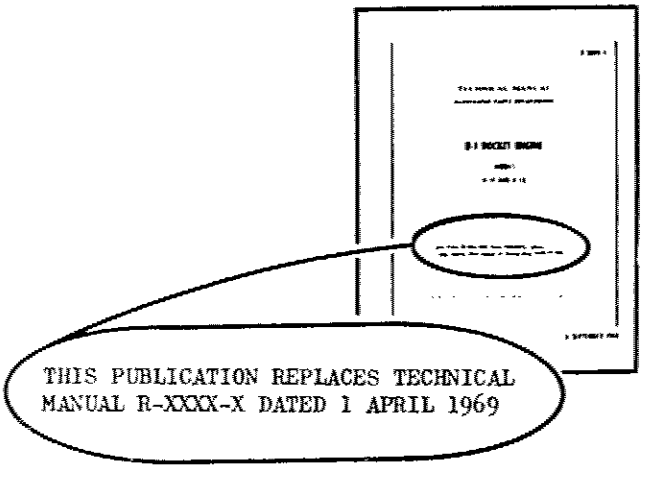
3. If you are unsure of the status of any page or pages, refer to the List of Effective Pages and make sure your manual contains pages (with the corresponding change dates) listed in the List of Effective Pages.

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)

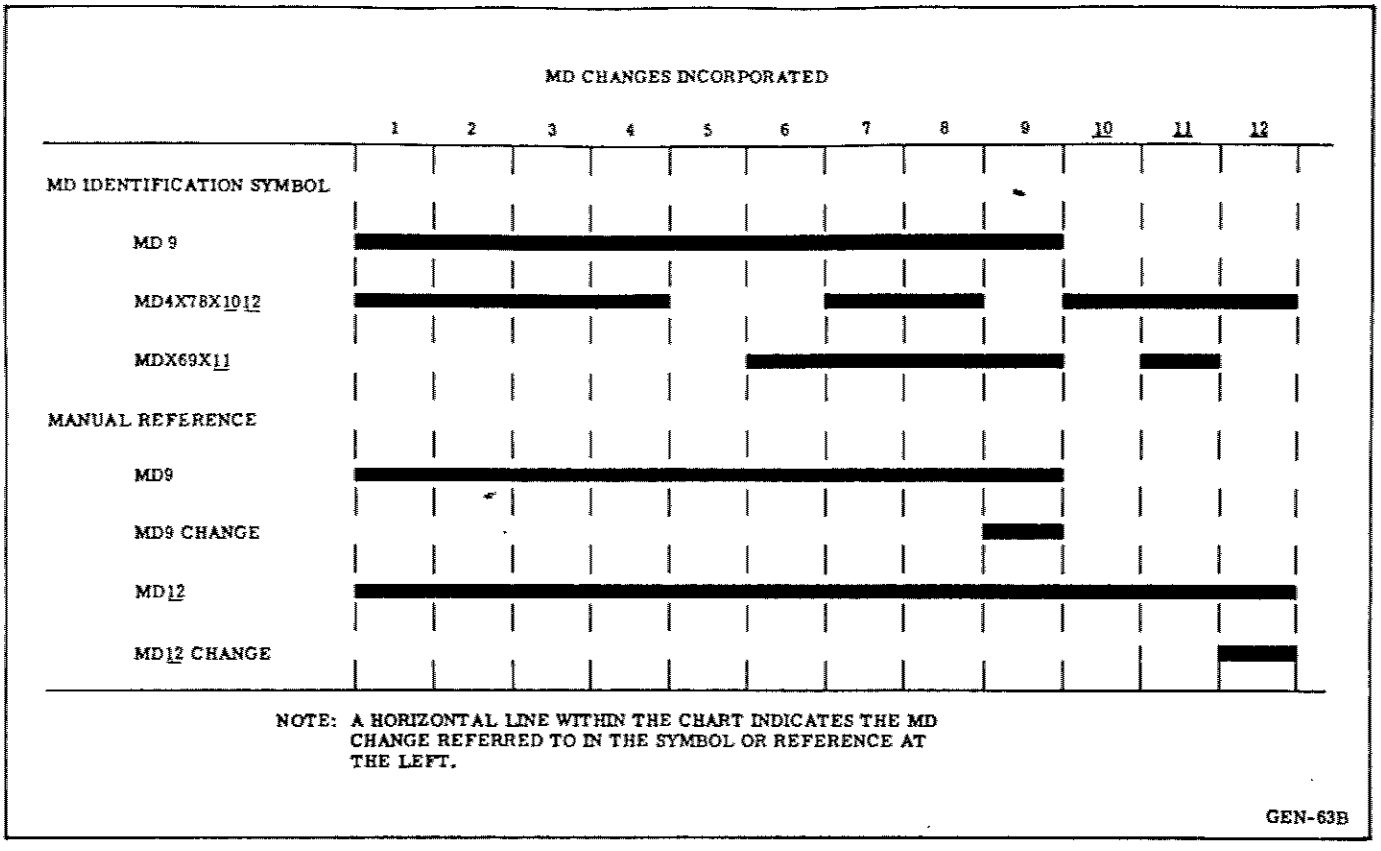


Figure 2. MD System

2. CONFIGURATION IDENTIFICATION.

EQUIPMENT CONFIGURATION. The MD identification symbol and the equipment model designation indicate the configuration of the equipment and distinguish it from models incorporating different changes and from basic models. A basic, unchanged configuration of the equipment has no MD identification symbol. MD identification symbols are added as changes affecting configuration are incorporated into the equipment. The MD identification symbol is stamped on the MD plate, which is mounted near the engine nameplate.

MD IDENTIFICATION SYMBOLS. The MD identification symbol is a composite number representing all the changes affecting configuration (MD changes) that are incorporated or not incorporated into the equipment. The symbol represents a consecutively numbered series of MD changes. Any MD change, or series of MD changes, not incorporated is represented by an "X." Multi-digit numbers are underlined. Two figures together represent the limits of a series of incorporated MD changes. Figure 2 illustrates how MD changes incorporated in the equipment are represented by the MD identification symbol.

MANUAL REFERENCE. A reference that appears in the manual may refer to a series of MD changes or to an individual MD change; for example, "MD9" refers to MD1 through MD9, but "MD9 change," refers to the individual MD change 9. This latter type of reference, which is illustrated in figure 2, identifies separate sets of information required by differences in configuration. When an MD reference appears in this manual, examine that MD identification symbol on the equipment to determine which set of information is applicable.

3. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

Refer to R-3896-5, Volume I, and R-3896-3, Volume I, for a list of approved ECPs (Engineering Change Proposals) and associated MD numbers applicable to equipment covered in this manual. Configuration information is in R-5857, Saturn F-1 Configuration Identification & Status Report.

SECTION I

PREPARATION FOR SHIPPING

WARNING

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

G4044, Air Transport Engine Handler
G4050, Engine Rotating Sling
G4051, Roadable Vertical Engine Dolly
G4052, Engine Handler Sling
G4058, Engine Handling Dolly
G4080, Nozzle Extension Handling Fixture
G4081, Nozzle Extension Handling Adapter
G4088, Turbopump Shaft Preload Fixture
99-9026814, Turbopump Shaft Preload Fixture
99-9026815, Thrust Chamber Throat Security Closure

1-1. SCOPE. This section contains procedures required to prepare the engine, nozzle extension, loose equipment, and thermal insulation for shipping. In addition to the equipment described in this section, a 30,000-pound-monorail or bridge-crane facility hoist, capable of lifting the handling equipment with the engine installed, is required. Only the operating personnel should be allowed in the immediate area when equipment is suspended.

1-2. HANDLING EQUIPMENT.

1-3. ENGINE ROTATING SLING.

1-4. Engine Rotating Sling G4050 is required to lift and rotate the engine. The sling has six different load conditions (figure 1-1), indicated by a one-inch-wide black strip on the underside of the beam with corresponding numbers on each side of the beam. On the engine rotating sling that incorporates MD3 change, the sling has seven different load-condition strips. An Operating Instructions plate, attached to the control cable and located just above the control station, lists the strip positions and briefly describes load conditions for each position. An arrow on the carriage drive bracket should be alined with the numbered strip positions on the beam for load conditions.

NOTE

The load condition numbered strip positions are used for initial positioning of the engine rotating sling beam. Minor adjustments of the beam to either side of a strip position may be required to level the load.

1-5. PREPARING ENGINE ROTATING SLING.

WARNING

Engine Rotating Sling G4050 must be operated by authorized personnel trained in the use of the equipment.

a. Position Engine Rotating Sling G4050 beneath facility hoist capable of lifting 30,000 pounds minimum.

b. Remove tow bar from sling.

c. Connect sling electrical cable to facility electrical power source (440-vac, 3-phase, 60-cycle, 15-ampere), utilizing handle RPE417-002K069D and connector RPX317-912S04A (Crouse-Hinds). Turn facility electrical power source on.

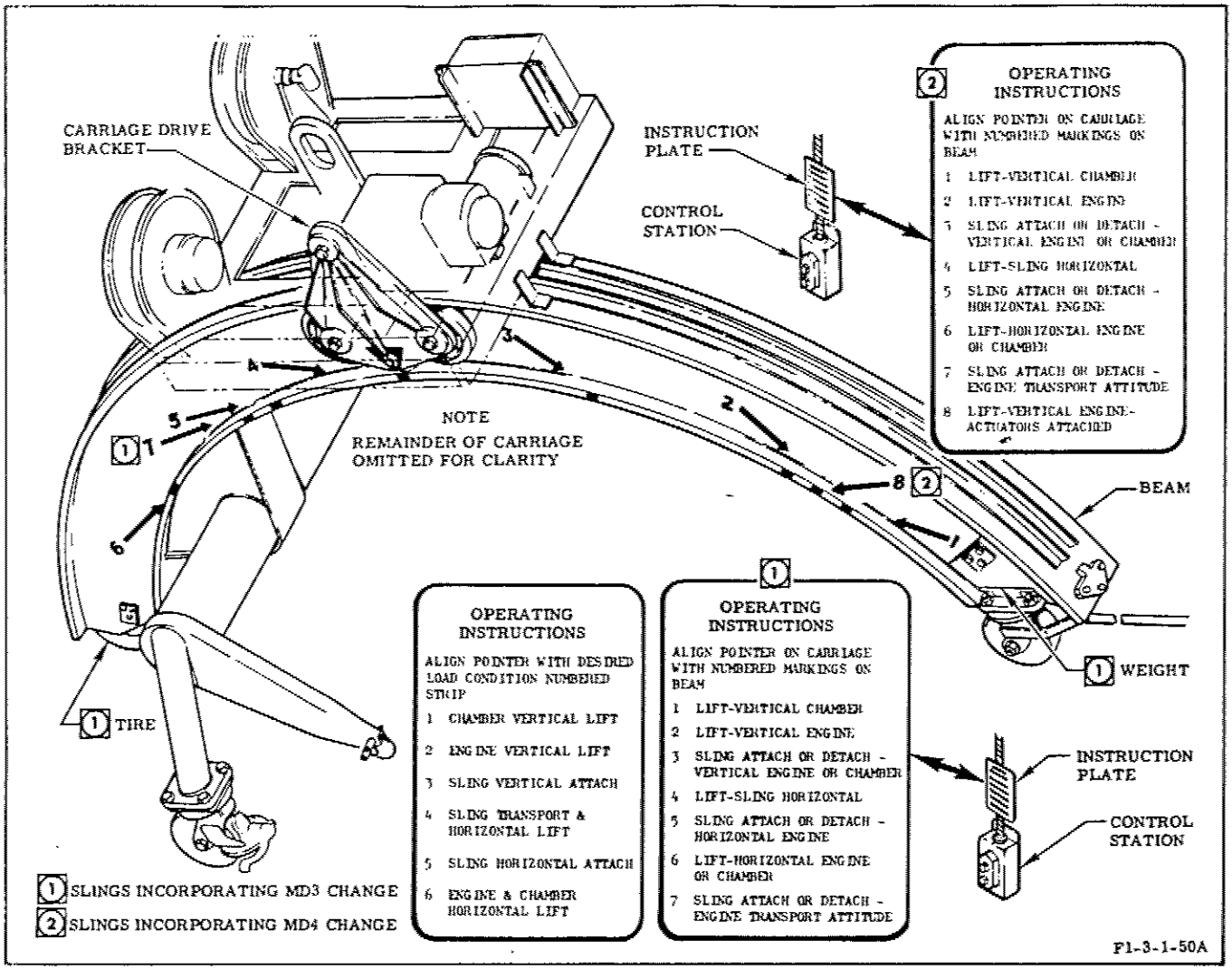


Figure 1-1. Engine Rotating Sling Load Condition Numbered Strip Positions

d. Press sling control station FORWARD button and position sling carriage to load condition number 6 strip position.

e. Connect facility hoist hook to sling lifting lug.

f. Press sling control station REVERSE button and position sling carriage to load condition number 4 strip position.

NOTE

The facility hoist hook must be raised and centered over the sling carriage as step f is performed.

1-6. ATTACHING ENGINE ROTATING SLING TO ENGINE. (See figure 1-2.)

WARNING

Engine Rotating Sling G4050 must be operated by authorized personnel trained in the use of the equipment.

a. Prepare Engine Rotating Sling G4050 for use as outlined in paragraph 1-5.

b. Remove strut from stored position on sling.

c. Remove clevises from sling aft lift arms.

d. Using facility hoist, raise sling until sling beam can be rotated to all positions without interference.

e. If attaching sling to an engine in horizontal position, press sling control station FORWARD button and position sling beam to load condition number 5 strip position.

NOTE

If engine is in shipping position, readjustment of sling beam may be necessary to facilitate installation.

eA. If attaching sling to an engine in lowered (shipping) position, position sling beam between 5 and 6 strip positions. On engine rotating sling incorporating MD3 change, press sling control station FORWARD button and position sling beam to load condition number 7 strip position.

f. If attaching sling to an engine in vertical position, press sling control station REVERSE button and position sling beam to load condition number 3 strip position.

g. If thermal insulation bracketry is installed on engine, remove outboard trunnion nuts and washers. Remove serrated collars and brackets as assemblies. Retain for reinstallation.

h. Verify that heat exchanger bellows cover is installed, position sling on engine, and carefully mate aft lift arms with turbopump mount pins.

NOTE

Readjustment of the sling may be necessary to facilitate installation.

i. Install clevises, securing aft lift arms to pins, with attaching lockpins.

j. Secure sling strut to turbopump stabilizing strut with attaching lockpin. On engines incorporating MD32 change, install adapter 9017823 between strut and oxidizer dome clevis.

k. Reposition sling beam, as required, to mate strut with stud at sling forward end. Secure with attached lockpin.

1-7. SECURING ENGINE ROTATING SLING.

a. Check that Engine Rotating Sling G4050 is hoisted to a sufficient height to allow sling beam to be positioned to load condition number 4 strip position, without interference.

b. Press sling control station FORWARD or REVERSE button, as applicable, to position sling beam to load condition number 4 strip position.

c. Using facility hoist, lower sling to floor.

d. Lock sling wheel brakes.

e. Install clevises on aft lift arms and store strut.

f. Press sling control station FORWARD button and position sling carriage to load condition number 6 strip position.

NOTE

The facility hoist hook must be lowered and repositioned as step f is performed.

g. Disconnect hoist hook from sling lifting lug. Secure hoist.

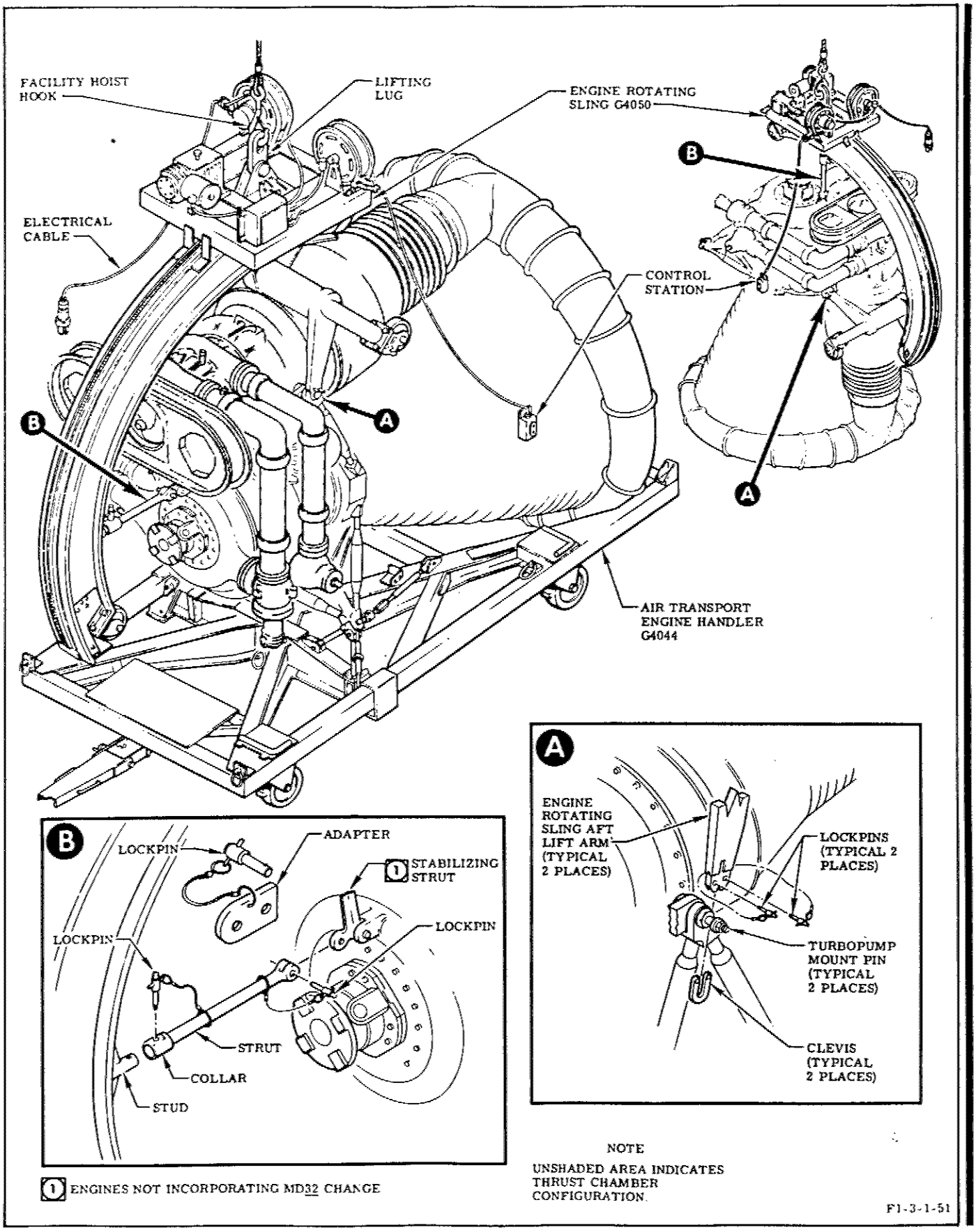


Figure 1-2. Attaching Engine Rotating Sling to Engine

h. Press sling control station REVERSE button and position sling carriage to load condition number 4 strip position.

i. Turn off facility electrical power source, and disconnect electrical cable from facility power source.

j. Reel in and secure sling electrical cable.

k. Install tow bar on sling.

l. Unlock sling wheel brakes and move sling to handling-equipment storage area. Lock sling wheel brakes.

1-8. PREPARING ENGINE FOR SHIPPING.

1-9. The engine is prepared for shipping when it is installed on the Air Transport Engine Handler G4044 and in the engine lowered (shipping) position, closures and desiccant are installed, the gimbal bearing is immobilized with Gimbal Bearing Locks G4059, the thrust chamber throat security closure G4089 installed in the thrust chamber (paragraph 1-12), and Engine Cover G4047 is installed with the necessary forms sealed in the cover security pouch. When the engine is shipped cross-country by truck transport, the turbopump shaft preload fixture G4088 must be installed on the turbopump oxidizer inlet (paragraph 1-11). When shipping an individual turbopump cross-country by truck transport, the turbopump shaft preload fixture must be installed on the turbopump oxidizer inlet (paragraph 1-11).

1-10. INSTALLING ENGINE ON AIR TRANSPORT ENGINE HANDLER. The oxidizer pump seal must be purged any time the engine is rotated from the vertical to the horizontal position and whenever the engine is rotated from the horizontal to the lowered (shipping) position. When rotating engine from vertical to horizontal position, purge oxidizer pump seal during rotation and for a minimum of 30 minutes after rotation. When rotating engine from horizontal to lowered position, maintain purge throughout rotating procedure. (See figure 1-3.)

a. Position engine beneath facility hoist capable of lifting 30,000 pounds.

b. Prepare Engine Rotating Sling G4050 for use as outlined in paragraph 1-5.

c. Attach engine rotating sling to engine as outlined in paragraph 1-6.

d. Loosen and remove any engine tiedowns.

dA. Remove or verify that closures are removed from nitrogen overboard and oxidizer overboard drain lines.

dB. Remove pressure cap from oxidizer pump seal purge interface connect point, and connect a source of gaseous nitrogen (MIL-P-27401) capable of supplying 80 ±20 psig.

dC. When rotating engine from vertical to horizontal position, purge oxidizer pump seal as follows:

(1) Turn on purge before rotating engine. Verify purge operation and that pressure is 80 ±20 psig.

(2) Maintain purge during engine rotation and for a minimum of 30 minutes with engine in horizontal position.

(3) Turn purge off, disconnect gaseous nitrogen supply, and install closures on overboard drain lines and interface connect point.

dD. When rotating engine from horizontal to lowered position, perform steps dA and dB.

dE. Turn on oxidizer pump seal purge before rotating engine. Verify purge operation and that pressure is 80 ±20 psig.

dF. Maintain purge during rotation operation.

dG. Turn purge off, disconnect gaseous nitrogen supply, and install closures on overboard drain lines and interface connect point.

e. Using hoist, lift engine until it can be rotated to a horizontal position.

f. Press sling control station FORWARD button and position sling beam to load condition number 6 strip position.

NOTE

The load condition numbered strip positions noted in this procedure are used for initial positioning of the engine rotating sling. Minor adjustments of the beam carriage to either side of a strip position may be required to level the load.

g. Using hoist, lower engine until truss can be installed on thrust chamber without use of special stands.

h. Remove yokes from storage on Air Transport Engine Handler G4044; then remove clamps from yokes.

i. Place clamps on thrust chamber exit flange at the 9, 10, 12, and 13 holes located above and below center line of engine. In each clamp installation, insert pin without cam in hole first. Adjust cam pins to fit remaining holes.

j. Secure each clamp with a block. Torque block bolt to 275-325 inch-pounds.

jA. Remove nut from truss compensator linkage. Remove lockpins securing truss to handler.

k. Position handler so that engine can be installed. Make sure wheels of handler are alined in fore and aft direction and wheel brakes are unlocked.

l. Attach a hoist capable of lifting 250 pounds to truss at painted lift points on truss.

m. Using hoist, remove truss from handler and suspend it at aft end of engine.

n. Install yokes on truss and secure with lockpins.

o. Position truss so that upper ends of yokes can be secured to upper clamps on thrust chamber exit flange. Secure yokes to clamps with 4 bolts. Torque bolts to 275-325 inch-pounds.

CAUTION

Front mount drag braces must not be used for centering truss.

p. Secure lower ends of yokes to lower clamps, adjusting yoke cams as necessary. Torque bolts to 275-325 inch-pounds. Center truss (side to side within 1/4 inch) relative to yokes. Maintain this condition after mating with handler.

q. Insert truss compensator linkage through hole in thrust chamber exit flange. Install nut securing linkage to exit flange. Torque nut to 40-50 inch-pounds.

r. Remove support blocks from handler, and install blocks on gimbal outriggers. Torque support block wedge screws to 25-40 foot-pounds and jamnuts to 100-140 inch-pounds.

s. Position socket support blocks to BLOCK LOCATION ENGINE HORIZONTAL (aft position).

t. Remove left-hand strut and sway bar from stored position and position strut in socket support block. Secure sway bar to handler with attached lock pin.

u. Remove right-hand strut from stored position and prepare to install as engine is lowered.

v. Remove pin and screw from truss support on aft end of handler.

NOTE

Installing engine on handler requires a minimum of three men to monitor lowering of the engine.

w. Using hoist, position engine over handler.

x. Aline truss plug with hole in truss support, aline left-hand strut with support block, aline right-hand strut with support block and socket support block, and slowly lower engine until support blocks firmly engage struts. Maintain tension on sling.

y. Install screw securing truss plug in truss support. Torque screw to 20-40 inch-pounds and secure with attached lockpin. Install safety pin in plug.

z. Lower engine only enough to fully mate support blocks with struts. Make sure that compensator is in approximately neutral position.

aa. Adjust drag braces until braces can be attached to support blocks with lockpins. Torque brace jamnut to 75-100 foot-pounds.

ab. Prior to lifting engine, station a man to remove right-hand strut. Raise engine until support blocks just clear struts. Remove and store right-hand strut.

CAUTION

Drag braces must not be loosened or adjusted, since damage to load compensator spring on truss can result.

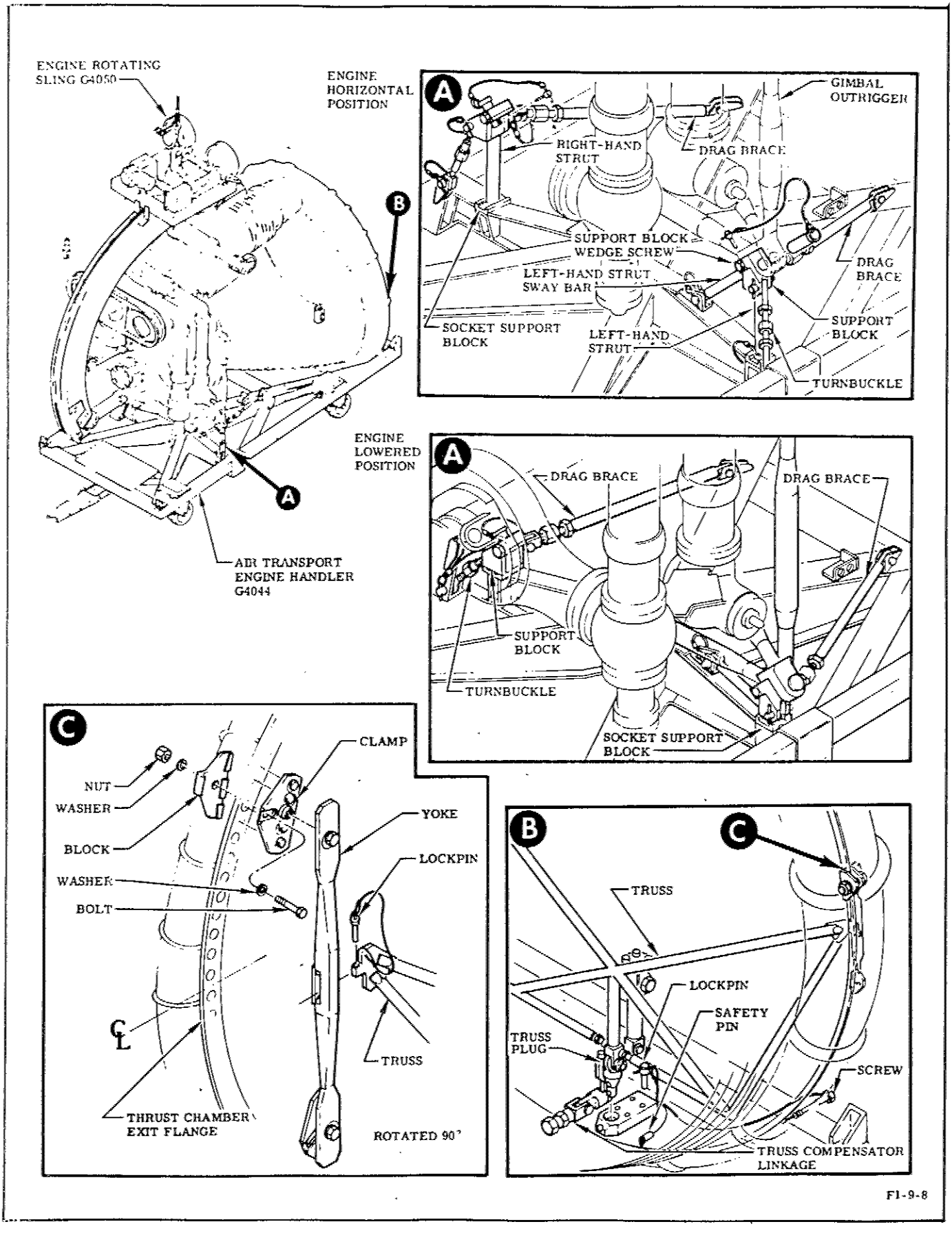


Figure 1-3. Installing Engine on Air Transport Engine Handler

ac. Disconnect, remove, and store left-hand strut and sway bar.

ad. Position socket support blocks to BLOCK LOCATION ENGINE LOWERED (forward position).

ae. Attach turnbuckles to support blocks.

af. Slowly lower engine onto support blocks and socket support blocks.

ag. Adjust turnbuckles with lower attach points on handler, secure with lockpins, and torque turnbuckles to 60-70 foot-pounds. Torque turnbuckle jamnuts to 340-460 inch-pounds.

ah. Press sling control station REVERSE button, and position sling carriage between load conditions number 5 and 6 strip positions. On engine rotating sling incorporating MD3 change, press sling control station REVERSE button, and position sling carriage to load condition number 7 strip position.

ahA. Remove lockpin that secures sling strut collar to stud at sling forward end, remove lock-pin that secures sling strut to adapter 9017823, and stow adapter and strut.

ai. Remove lockpins that secure clevises to aft lift arms.

aj. Lift sling clear of engine. Move sling away from engine area and secure sling as outlined in paragraph 1-7.

ak. Reinstall collars and brackets as assembled at turbopump trunnions. Torque nuts of bracket to 61-75 inch-pounds. Install washer and trunnion nuts. Torque trunnion nuts to 840-860 inch-pounds.

1-11. INSTALLING TURBOPUMP SHAFT PRELOAD FIXTURE. (See figure 1-4.)

WARNING

The following procedure specifies denatured alcohol, 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.

NOTE

Closure RK395-44034-21 must be installed on the turbopump oxidizer inlet when the turbopump shaft preload fixture is used.

a. Clean exterior surfaces of installed oxidizer inlet closure using a clean, hemmed nylon cloth moistened with unused denatured ethyl alcohol (MIL-A-6091).

b. Remove closure from Turbopump Shaft Preload Fixture 99-9026814 or G4088, remove snapring, and disassemble closure. Clean closure surfaces for liquid oxidizer service; then reassemble closure.

c. Remove cup ST3950173RKL001 from center of installed closure, and attach cup to fixture.

d. Install closure from fixture using 4 bolts AN4-7A and 4 washers LD153-0010-0010. Torque bolts to 30 (+10, -0) inch-pounds.

e. See figure 1-4 for positioning of fixture on closure plate and remove 4 applicable bolts and washers. Store bolts and washers in bracket of fixture.

f. Install fixture with preload screw backed off. Secure fixture to plate and inlet flange using 4 bolts MS20007H22 and 4 washers LD153-0013-0005. (Stored in fixture.) Torque bolts to 60-120 inch-pounds.

g. Tighten fixture preload screw until slack is removed from spring washers and mating surfaces. Then torque preload screw to 60-100 inch-pounds. Note slot in plate nearest pawl; then tighten preload screw an additional 8 slots ±1/2 slot. Engage pawl and torque pawl bolt to 36-47 inch-pounds. Safetywire pawl to preload screw.

h. Final-torque bolts attaching fixture to closure flange 400-450 inch-pounds. Tighten remaining bolts on closure plate fingertight plus one-quarter turn. Safetywire bolts.

i. Clean and package cup removed in step c for liquid oxygen service and retain cup for reinstallation when shipment is completed.

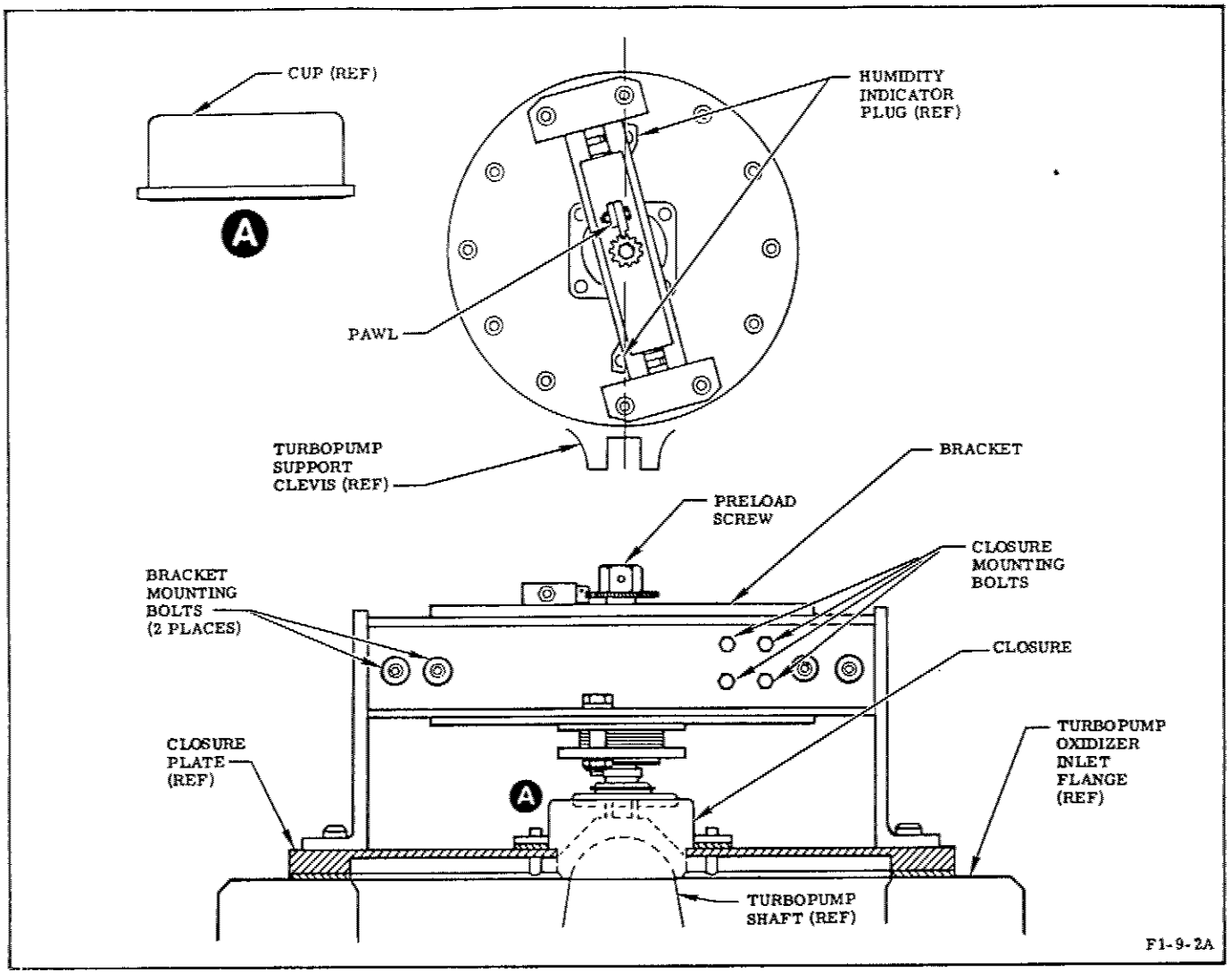


Figure 1-4. Installing Turbopump Shaft Preload Fixture

1-12. INSTALLING THRUST CHAMBER THROAT SECURITY CLOSURE. (See figure 1-5.)

a. If installed, remove thrust chamber exit closure and thrust chamber throat closure.

b. Obtain shaft from Thrust Chamber Throat Security Closure 99-9026815 or G4089; retract handle and secure in detent.

c. Install shaft in hole in center of thrust chamber injector until shaft bottoms, aline pin between baffles on injector face by loosening shaft, and release handle from detent position.

d. Install 48 units of desiccant, that meets the desiccant requirements specified in R-3896-11, in cover of closure. Inspect humidity indicator after 24 hours. If 30-percent relative humidity indicator shows color other than blue, replace desiccant and repeat inspection after 24 hours.

e. Install closure on shaft. Aline hole in closure handle with hole in shaft, and install cable RD191-2002-1100, or equivalent through closure handle and shaft hole. Secure cable with a serialized seal RD199-0001-0001 stamped by Rocketdyne Inspection. Record seal serial number on Government Bill of Lading.

eA. Verify that closure gage indicates zero with closure tube deflated.

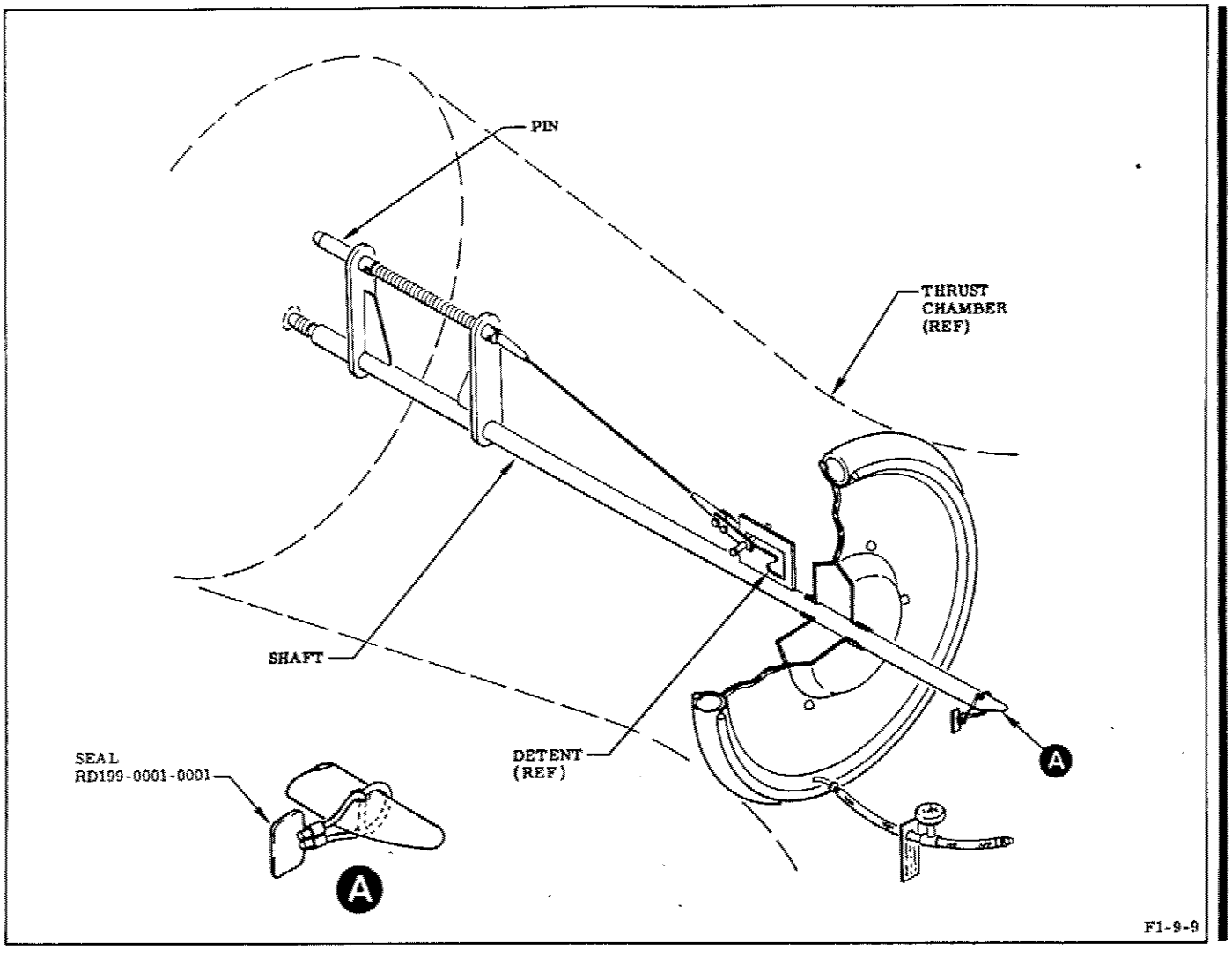


Figure 1-5. Installing Thrust Chamber Throat Security Closure

Figure 1-5A deleted.

f. Inflate closure tube to 5-7 psig pressure with air. Wrap hose around closure extension and secure in place with tape.

g. Reinstall thrust chamber exit closure.

1-12A. REMOVING THRUST CHAMBER THROAT SECURITY CLOSURE.

a. Deflate closure tube and remove seal and cable from hole in closure handle and shaft.

b. Slide tube and closure off shaft.

c. Retract handle and secure in detent, and unscrew shaft from injector.

d. Prepare thrust chamber throat security closure for return shipment in accordance with Rocketdyne Automated Packaging System (RAPS).

NOTE

The thrust chamber throat security closure is a rotatable item and must be returned to Rocketdyne. Contact responsible Rocketdyne representative for required shipping information.

1-13. REMOVING ENGINE FROM AIR TRANSPORT ENGINE HANDLER. (See figure 1-3.)

CAUTION

The engine must not be removed from the air transport engine handler in any position other than horizontal or maintenance position, since damage to equipment can result.

a. Remove engine cover as outlined in paragraph 1-16.

b. Attach Engine Rotating Sling G4050 to engine as outlined in paragraph 1-6. Make sure wheels of handler are alined in fore and aft direction and wheel brakes are unlocked.

c. Press sling control station FORWARD button and position sling carriage to load condition number 6 strip position. Using hoist, raise hook to remove slack and to maintain tension on engine.

CAUTION

Engine must not be lifted at this time, since damage to engine can result.

d. Relieve tension from turnbuckles and remove lockpins that secure turnbuckle to support blocks.

e. Remove lockpins that secure drag braces to support blocks.

f. Remove lockpin at rear support. Loosen and remove screw that secures truss plug to handler.

g. Remove safety pin from truss plug. The engine is now disconnected from handler.

NOTE

Minor adjustment to specified strip positions on engine rotating sling may be required to level load.

h. Prior to lifting engine, station a man to remove right-hand strut. Carefully lift engine and remove and store right-hand strut. Raise engine until it clears handler.

i. Using hoist, move engine away from handler.

j. Attach a facility hoist and sling, capable of lifting 250 pounds, to truss. Connect sling to painted lift points on truss.

k. Using hoist, support weight of truss.

l. Disconnect truss compensator linkage from bottom of thrust chamber exit ring.

m. Remove the 4 bolts holding yokes to engine.

n. Remove truss from engine.

o. Remove yokes from truss.

NOTE

Performing steps p through aa secures the handler.

p. Using hoist, lower truss into stored position on handler.

q. Disconnect and secure sling and facility hoist.

r. Install clamps securing truss to handler. Install attached nut on truss compensator linkage.

s. Remove bolts securing blocks on thrust chamber exit flange. Remove blocks and clamps.

t. Attach blocks and clamps to yokes. Store yokes on handler.

u. Remove lockpin securing left-hand sway bar to handler. Store strut and sway bar.

v. Position socket support blocks to BLOCK LOCATION ENGINE LOWERED (forward position).

w. On engine, loosen support block wedge screw locknut. Back out screw, relieving tension on attaching lockpin.

x. Remove pins and support blocks from gimbal outriggers. Reinstall pins in support blocks.

y. Position support blocks in the socket support blocks on handler.

z. Attach drag braces and turnbuckles to support blocks.

aa. Attach turnbuckles to lower attach point on handler with lockpins. Tighten turnbuckle and jamnut handtight.

ab. Using facility hoist, raise engine until it can be rotated to vertical position with interference. Press sling control station REVERSE button and position sling beam to load condition number 2 strip position.

ac. Using hoist, position engine above Roadable Vertical Engine Dolly G4051 or Engine Dolly G4058 with turbopump facing aft end of dolly.

ad. Using hoist, slowly lower and center engine onto dolly. Check that thrust chamber exit ring evenly contacts dolly shock pads.

ae. Install 2 tiedown cables on engine gimbal outriggers. Tighten cables until snug.

CAUTION

Step af must be performed prior to steps ag through ai, since the incorrect lift point with respect to the center of gravity will cause the sling beam to swing toward the engine, possibly damaging the heat exchanger.

af. Lower hoist hook and simultaneously position sling carriage to load condition number 3 strip position, or as required to relieve tension on the forward lift strut.

ag. Remove lockpin that secures sling strut collar to stud at sling forward end, remove lockpin that secures sling strut to adapter 9017823, and stow adapter and strut.

ah. Remove lockpins that secure clevises to aft lift arms of sling.

ai. Using hoist, carefully move sling away from engine.

aj. Remove turbopump mount-pin nuts and washers. Install remaining 2 tiedown cables between turbopump mount pins and dolly tiedown rings. Reinstall nuts and washers, and tighten cables until snug.

ak. Press sling control station FORWARD button and position sling beam to load condition number 4 strip position.

al. Secure sling as outlined in paragraph 1-7.

am. Prepare air transport engine handler for return shipment in accordance with R-3896-5.

NOTE

The air transport engine handler is a rotatable item and must be returned to Rocketdyne. Contact responsible Rocketdyne representative for required shipping information.

1-14. ENGINE COVERS AND CLOSURES.

a. Refer to R-3896-4 for part numbers of closures and engine effectivity shown in figures 1-6 and 1-6A.

b. Check that no loose equipment or foreign material is in any engine opening.

c. Check that all desiccant used in preservation of the engine meets the desiccant requirements specified in R-3896-11 and check that bags are secured, to prevent movement or possible rupture of bags.

d. (Deleted)

NOTE

Desiccant must not be removed from its airtight container until just prior to installation.

- The fuel and LOX closures that have a desiccant cover with a single gasket require only 12 units of desiccant.

e. Check that closures are clearly marked to indicate quantity and date desiccant was installed.

f. Inspect humidity indicator plugs. Activated desiccant must be replaced if humidity indicator shows color other than blue in the 30-percent relative humidity range.

g. Make sure that 425 aluminum-foil tape (Minnesota Mining and Mfg) is installed over space between thrust chamber and thrust chamber turbine exhaust manifold.

gA. Inspect exposed machined areas of engine outriggers, turbopump mounts, and bearing surfaces of dome attach point and lower thrust chamber lug for voids in preservative coating. If necessary, apply corrosion preventative RB0210-016 (Rocketdyne) to void areas to control corrosion.

h. Check that all openings to engine are covered with suitable closures to protect engine from moisture and contaminants at all times. (See figures 1-6 and 1-6A.)

NOTE

Tape does not constitute a closure. Tape must not be used on threads or mating surfaces.

i. Check that gimbal action has been immobilized with Gimbal Bearing Locks G4059.

j. If engine is to be shipped cross-country by truck transport, the turbopump shaft preload fixture (paragraph 1-11) and thrust chamber throat security closure (paragraph 1-12) must be installed. If engine is to be shipped by air or water transport, thrust chamber throat security closure (paragraph 1-12) must be installed or thrust chamber throat closure installed as follows:

(1) Install 48 units of desiccant in desiccant compartment of closure.

(2) Install thrust chamber throat closure pole RX20708 in throat closure and install throat closure in thrust chamber.

(3) Inflate throat closure tube to 5-7 psig pressure with air.

(4) Remove throat closure pole.

(5) Inspect closure humidity indicator after 24 hours. If 30-percent relative humidity indicator shows color other than blue, replace desiccant and repeat inspection after 24 hours.

(6) If thrust chamber exit closure is reinstalled, slip hose end and gage of thrust chamber throat closure through applicable opening in exit closure.

1-15. INSTALLING ENGINE COVER. (See figure 1-7.)

a. Using facility hoist, position frame on engine and strap it to engine at following points:

(1) No. 1 oxidizer inlet.

(2) No. 2 oxidizer inlet.

(3) Thrust chamber exhaust manifold.

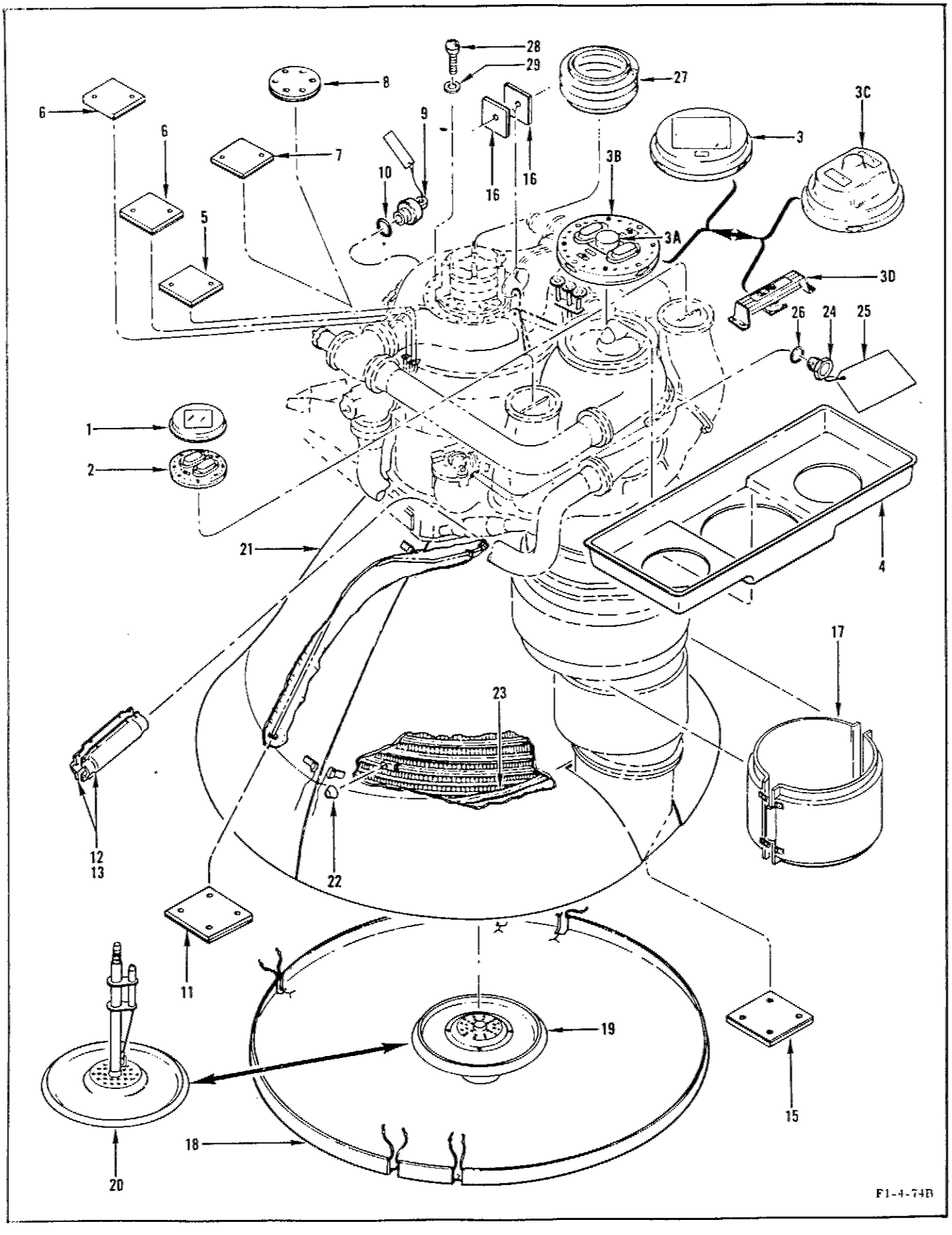


Figure 1-6. Engine Covers and Closures (Sheet 1 of 2)

Index Number	Name	Use
1	Cover	Fuel inlet
2	Closure	Fuel inlet
3	Closure	Oxidizer inlet
3A	Cup	Oxidizer inlet
3B	Closure	Oxidizer inlet
3C	Cover	Oxidizer inlet closure
3D	Fixture	Turbopump shaft preload
4	Panel	Substitution interface
5	Plate	Gas generator fuel injector purge line
6	Plate	Oxidizer purge line for oxidizer dome or gas generator
7	Plate	Ground supply line
8	Closure	Hydraulic return line
9	Closure	Hypergol container
10	Gasket	Hypergol closure
11	Plate	Oxidizer overboard drain line
12	Cover	Fuel overboard drain line bellows
13	Cover	Fuel overboard drain line bellows
14 deleted		
15	Plate	Fuel overboard drain line
16	Plate	Turbopump stabilizing strut
17	Cover	Heat exchanger bellows
18	Closure	Thrust chamber exit
19	Closure	Thrust chamber throat
20	Closure	Thrust chamber throat security
21	Cover	Thrust chamber exterior
22	Protector	Thrust chamber studs
23	Tape	Close space between thrust chamber and turbine exhaust manifold
24	Plug	Gas generator igniter port
25	Streamer	Gas generator igniter port
26	Gasket	Gas generator igniter port
27	Boot	Gimbal
28	Screw	Component mounting holes
29	Washer	Component mounting holes

Figure 1-6. Engine Covers and Closures (Sheet 2 of 2)

aA. Adjust forward support as required to obtain a good fit between engine and frame.

b. Tighten adjustment bolt on aft support of top frame, at thrust chamber exhaust manifold, until snug. Torque jamnut to 160-210 inch-pounds.

c. If engine cover has not been reinforced to prevent chafing, use pressure-sensitive tape (Federal Specification PPP-T-60) to secure a single layer of 1/4-inch-thick Ethafoam (Dow Corning Corp) around the rounded corners of engine cover frame, truss yokes, and overtruss yoke attaching points at thrust chamber exit flange. Add this protection to any other engine areas that may cause chafing of engine cover.

d. Spread upper half of engine cover on floor over a suitable sling. Attach sling to a hoist.

e. Using hoist, carefully position upper half of engine cover over frame on engine.

f. Carefully remove sling from beneath cover.

g. Position lower half of engine cover beneath engine.

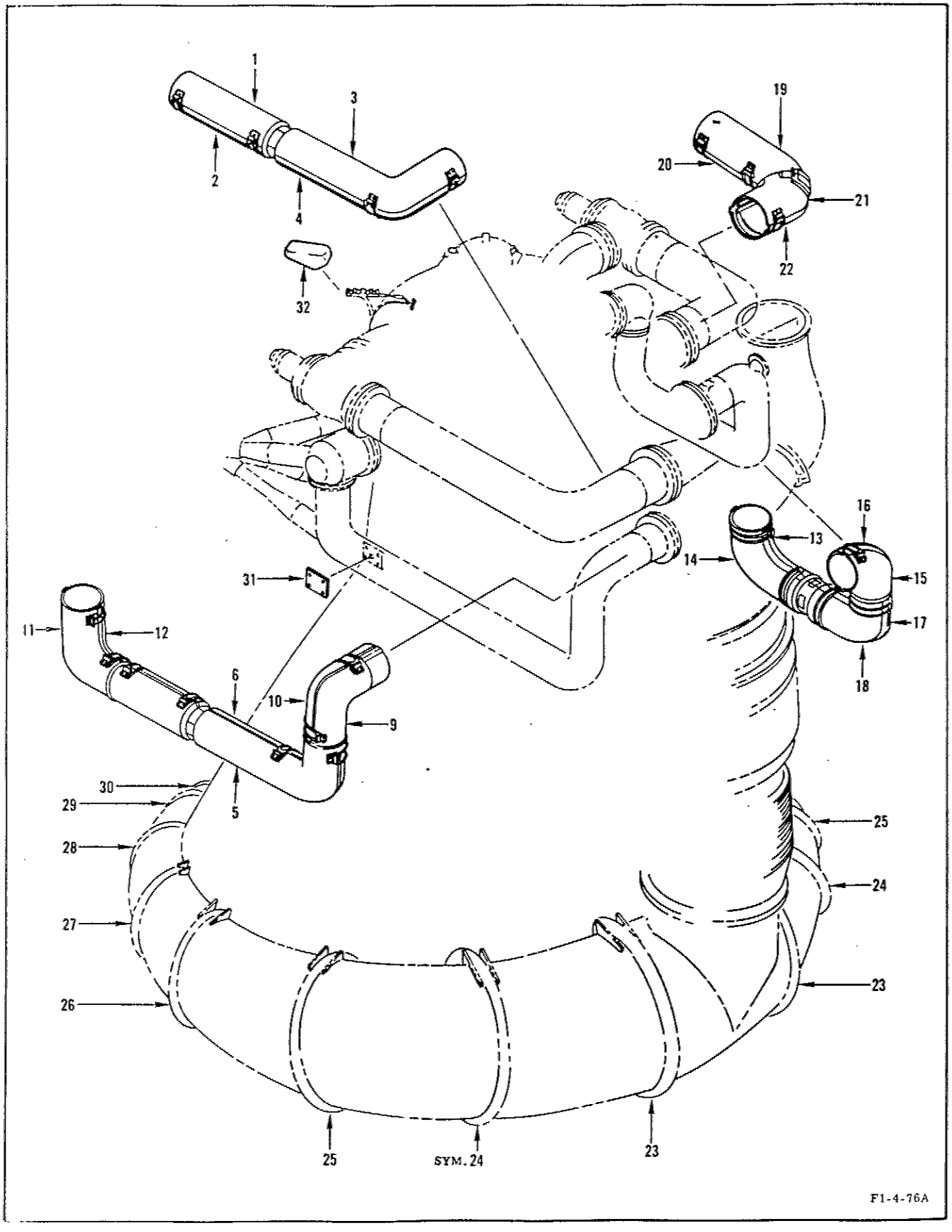


Figure 1-6A. Engine Thrust Chamber Manifold and Propellant Duct Closures (Sheet 1 of 2)

Index Number	Name	Use
1	Cover	No. 1 oxidizer duct
2	Cover	No. 1 oxidizer duct
3	Cover	No. 1 oxidizer duct
4	Cover	No. 1 oxidizer duct
5	Cover	No. 1 fuel duct
6	Cover	No. 1 fuel duct
7	deleted	
8	deleted	
9	Cover	No. 1 fuel duct (pump end)
10	Cover	No. 1 fuel duct (pump end)
11	Cover	No. 1 fuel duct
12	Cover	No. 1 fuel duct
13	Cover	No. 2 fuel duct
14	Cover	No. 2 fuel duct
15	Cover	No. 2 fuel duct (pump end)
16	Cover	No. 2 fuel duct (pump end)
17	Cover	No. 2 fuel duct
18	Cover	No. 2 fuel duct
19	Cover	No. 2 oxidizer duct
20	Cover	No. 2 oxidizer duct
21	Cover	No. 2 oxidizer duct
22	Cover	No. 2 oxidizer duct
23	Protector	Omega joint
24	Protector	Omega joint
25	Protector	Omega joint
26	Protector	Omega joint
27	Protector	Omega joint
28	Protector	Omega joint
29	Protector	Omega joint
30	Protector	Omega joint
31	Plate	Mounting pad
32	Pad	Hydraulic duct support bracket

Figure 1-6A. Engine Thrust Chamber Manifold and Propellant Duct Closures (Sheet 2 of 2)

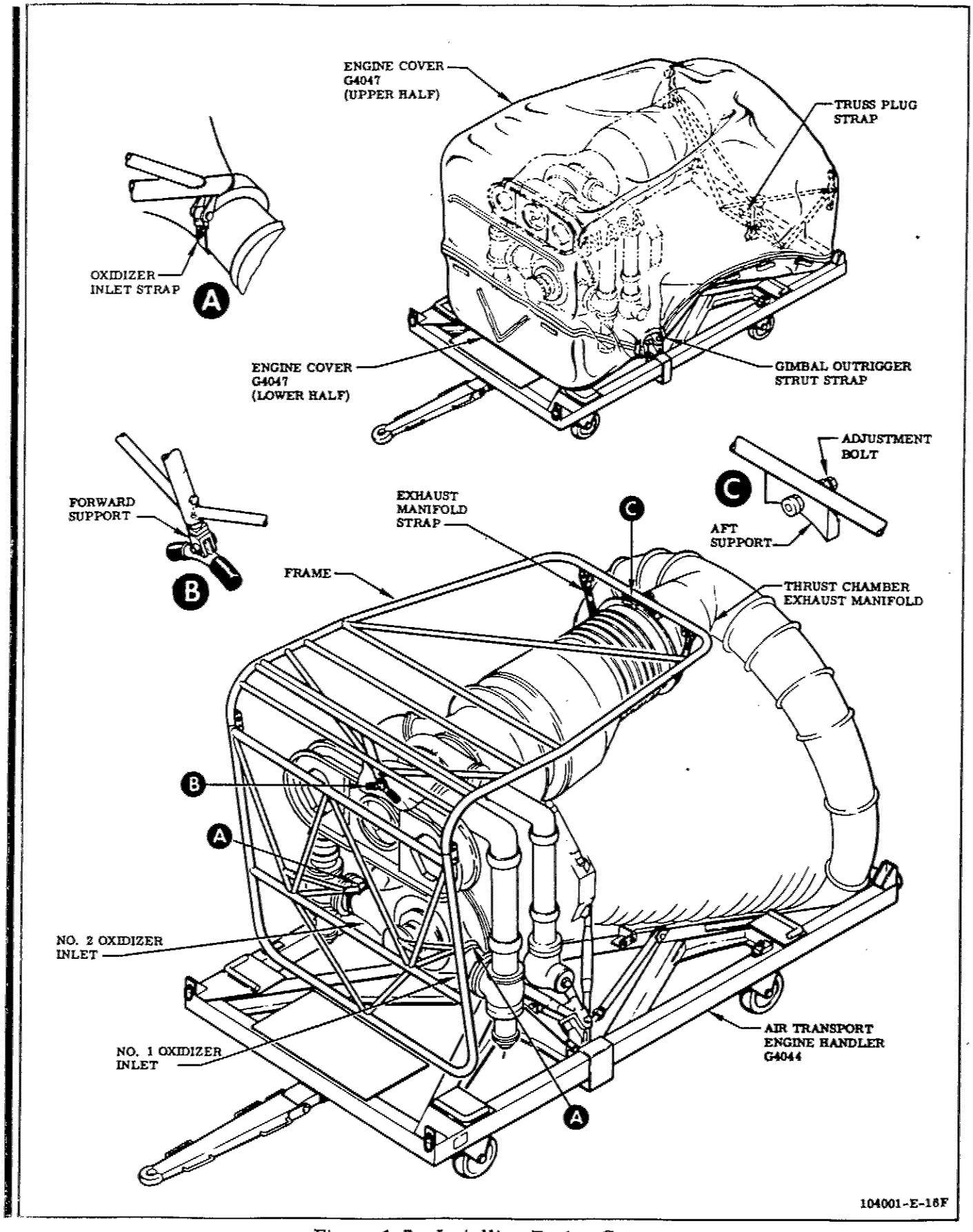


Figure 1-7. Installing Engine Cover

h. Support lower half of engine cover and zip it to upper half of engine cover. Close forward zipper first.

CAUTION

The forward zipper must be closed prior to closing of the aft zippers, to prevent zipper damage during cover installation.

i. Fasten strap on each side of gimbal actuator struts and at truss plug.

iA. On covers incorporating MD2 change, accordion-fold pleats and fasten straps on each side, front, and rear of cover.

j. The Engine Log Book may be mailed or can accompany the engine, whichever is suitable.

jA. Package all engine record forms in 2 clean vinyl or polyethylene (minimum thickness of 0.004 inch) bags, and heat-seal bags. Before sealing, remove excess air from bags.

jB. Place packaged forms into sealable security pouch at aft end of engine cover. Secure with a cable RD191-2002-1100, or equivalent, and a serialized seal RD199-0001-0001 stamped by Rocketdyne inspection. Record seal serial number on Government Bill of Lading.

NOTE

Envelope dimensions are 11 feet 10 inches high, 10 feet 11 inches wide, and 16 feet 4 inches long when the engine is on the handler and in shipping position with the cover installed.

k. Using cables RD191-2002-1100, or equivalent, and serialized seals RD199-0001-0001 stamped by Rocketdyne inspection and backed up by seals 28-1-C (National Telephone Supply Co), or equivalent stamped by Air Force Quality Control, secure engine cover to handler so that unauthorized entry can be determined. Record seal serial numbers on Government Bill of Lading.

1-16. REMOVING ENGINE COVER. (See figure 1-7.)

a. Position facility hoist above engine.

aA. On covers incorporating MD2 change, unfasten straps at pleats on each side, front, and rear of cover.

b. Unfasten straps on each side of gimbal actuator struts and at truss plug. Unzip and remove lower half of engine cover.

CAUTION

Adequate support of cover must be maintained during removal, to prevent zipper damage.

c. Store lower half of engine cover in a suitable container.

d. Carefully insert a suitable sling between upper half of engine cover and frame.

e. Attach sling to facility hoist. Carefully lift cover from engine and store with lower half of engine cover.

NOTE

Due to differences in manufacturer's installation of zippers on covers, the upper and lower covers must be retained as a set. For future procurement and rework of covers, the upper and lower covers will have the same serial numbers.

f. Loosen adjustment bolt on back of top frame at thrust chamber exhaust manifold flange.

g. Using hoist, support weight of frame. Unstrap frame from engine at the following places:

(1) No. 1 oxidizer inlet.

(2) No. 2 oxidizer inlet.

(3) Thrust chamber exhaust manifold.

h. Carefully hoist frame away from engine and lower to floor.

i. Prepare engine cover for return shipment in accordance with R-3896-5 and Rocketdyne Rapid Automated Packaging System (RAPS).

NOTE

The engine cover is a rotatable item and must be returned to Rocketdyne. Contact responsible Rocketdyne representative for required shipping information.

1-17. PREPARING NOZZLE EXTENSION FOR SHIPPING.

1-18. The nozzle extension is prepared for shipping when the nozzle extension is installed on the Nozzle Extension Handling Fixture G4080 and Nozzle Extension Handling Adapter G4081, or when it is installed on the nozzle extension shipping container RK392-40013-11. Protect nozzle extension attach flange and igniter boss threads for shipping as follows:

a. Cover nozzle extension attach flange to auxiliary shingle area with Ethafoam (Dow Chemical Corp), or equivalent. Secure Ethafoam with pressure-sensitive-tape RB0195-002 (Rocketdyne), or equivalent.

b. Install plug RD265-2001-0008 in each igniter boss. Tighten plug handtight.

1-19. INSTALLING NOZZLE EXTENSION ON NOZZLE EXTENSION HANDLING FIXTURE. (See figure 1-8.)

a. Place Nozzle Extension Handling Fixture G4080 on a flat, paved surface.

b. Using a facility hoist capable of lifting 5,000 pounds, suspend Engine Handler Sling G4052 until sling spreader bars clear floor.

c. Remove nozzle handling cables (short cables) stored on sling spreader bars.

d. Attach nozzle handling cables to spreader bars in place of engine handling cables (long cables).

e. Connect cables to 4 lifting lugs near upper end of nozzle extension.

f. Check that nozzle flange struts on fixture are in retracted position.

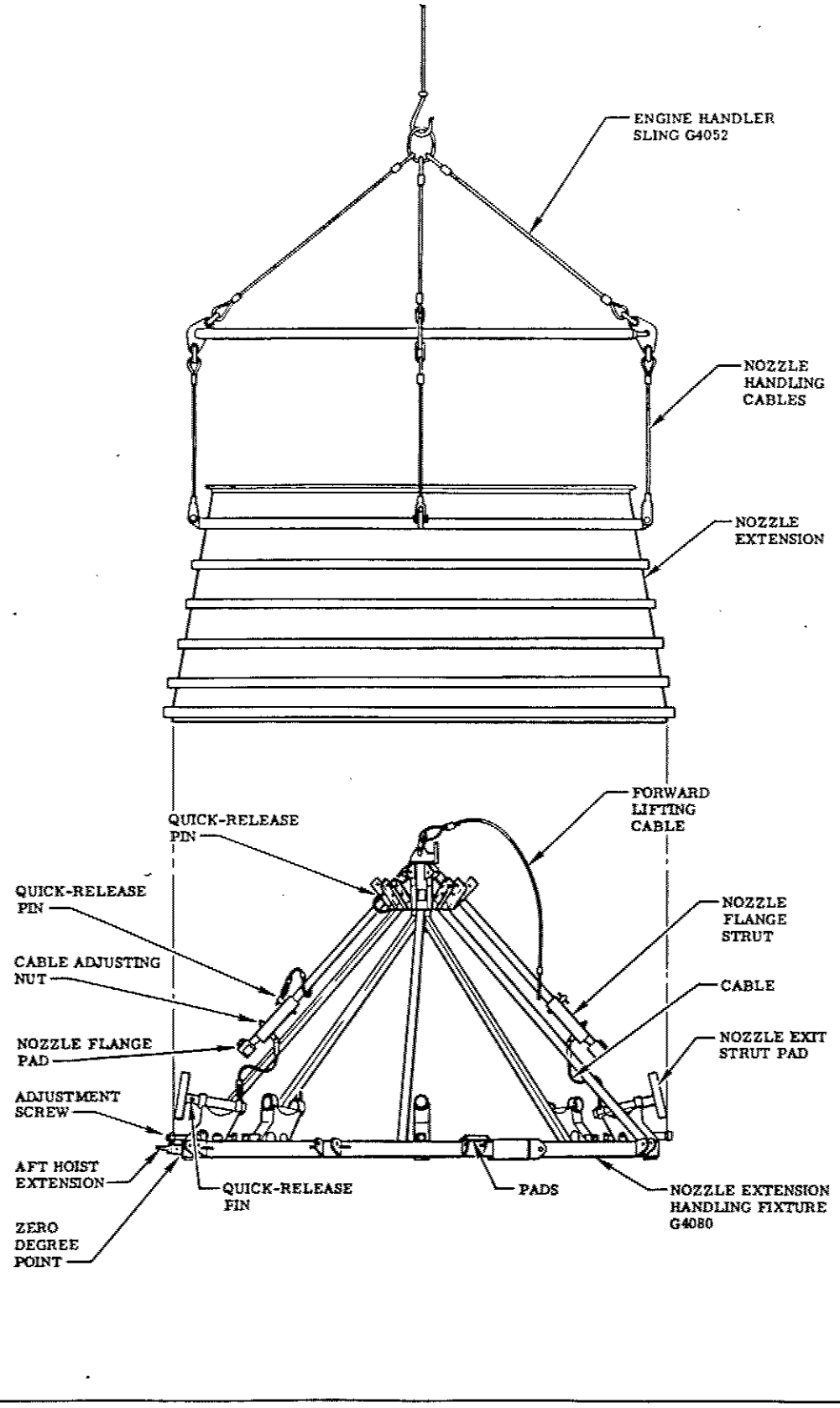


Figure 1-8. Installing Nozzle Extension on Nozzle Extension Handling Fixture

g. On nozzle flange struts, turn cable adjusting nut to upper end of screw.

h. Remove quick-release pin from apex end of each nozzle flange strut, lift strut until pin can be inserted through upper hole under strut, and then lower strut against pin.

i. Temporarily secure forward lifting cable near pad end of one nozzle flange strut.

NOTE

Securing cable to the strut makes the cable accessible after the nozzle extension is installed on the fixture.

j. Remove quick-release pin from adjustment screw on nozzle exit strut located to the left and right of fixture zero-degree index point. Turn adjustment screw until strut is in neutral position. Install quick-release pin.

k. Using procedure in step j excepting reinstallation of quick-release pin, retract all remaining nozzle exit struts.

l. Using hoist, slowly lift nozzle extension approximately 7 feet. Suspend extension over fixture and adjust until zero-degree index point on nozzle extension and fixture aline.

m. Slowly lower nozzle extension until it simultaneously contacts the 2 neutral nozzle exit strut pads, and the 8 base ring pads. Allow full weight of nozzle extension to rest on base ring pads.

CAUTION

To avoid damaging internal skins of nozzle extension, guide extension carefully over fixture.

NOTE

If nozzle extension is out-of-round and gap between it and any of the strut pads exceeds 5 inches, readjust neutral pad strut to provide a more concentric placement of the extension on the fixture.

n. Starting with the 2 nozzle exit struts opposite the 2 neutral struts, turn adjustment screw until all strut pads lightly contact nozzle extension.

o. Torque adjustment screws on 3 nozzle exit struts, located between and opposite the 2 neutral struts, to 300-450 inch-pounds. Torque adjustment screws on remaining 3 struts to 300-450 inch-pounds. Install quick-release pins in adjustment screws.

p. Remove quick-release pin from adjustment screw on the 2 neutral nozzle exit struts. Torque adjustment screw to 300-450 inch-pounds. Install quick-release pin.

q. Lift each nozzle flange strut and remove quick-release pin. Extend strut until flange pad engages extension flange, with alinement pin of pad in appropriate hole in flange, and insert quick-release pin in hole in strut.

NOTE

To find appropriate flange hole, move flange strut sideways in each direction until it stops; then determine hole nearest center of full travel.

r. Torque each nozzle flange strut cable pre-load nut to 35-40 inch-pounds. Torque each jamnut to 170-230 inch-pounds.

s. Disconnect cables from lifting lugs and remove sling.

1-20. INSTALLING LOADED NOZZLE EXTENSION HANDLING FIXTURE ON NOZZLE EXTENSION HANDLING ADAPTER. (See figure 1-9.)

a. Check that Nozzle Extension Handling Fixture G4080 is properly attached to nozzle extension (paragraph 1-19).

b. Connect forward lifting cable of fixture to facility hoist capable of lifting 5,000 pounds. Slowly lift loaded fixture approximately 4 feet above floor.

c. Extend aft hoist extension from fixture and secure with quick-release pin.

d. Attach a 3/4-inch shackle to aft hoist extension.

e. Connect hook from second facility hoist to shackle and slowly lift aft end of fixture until nozzle extension is in a horizontal position.

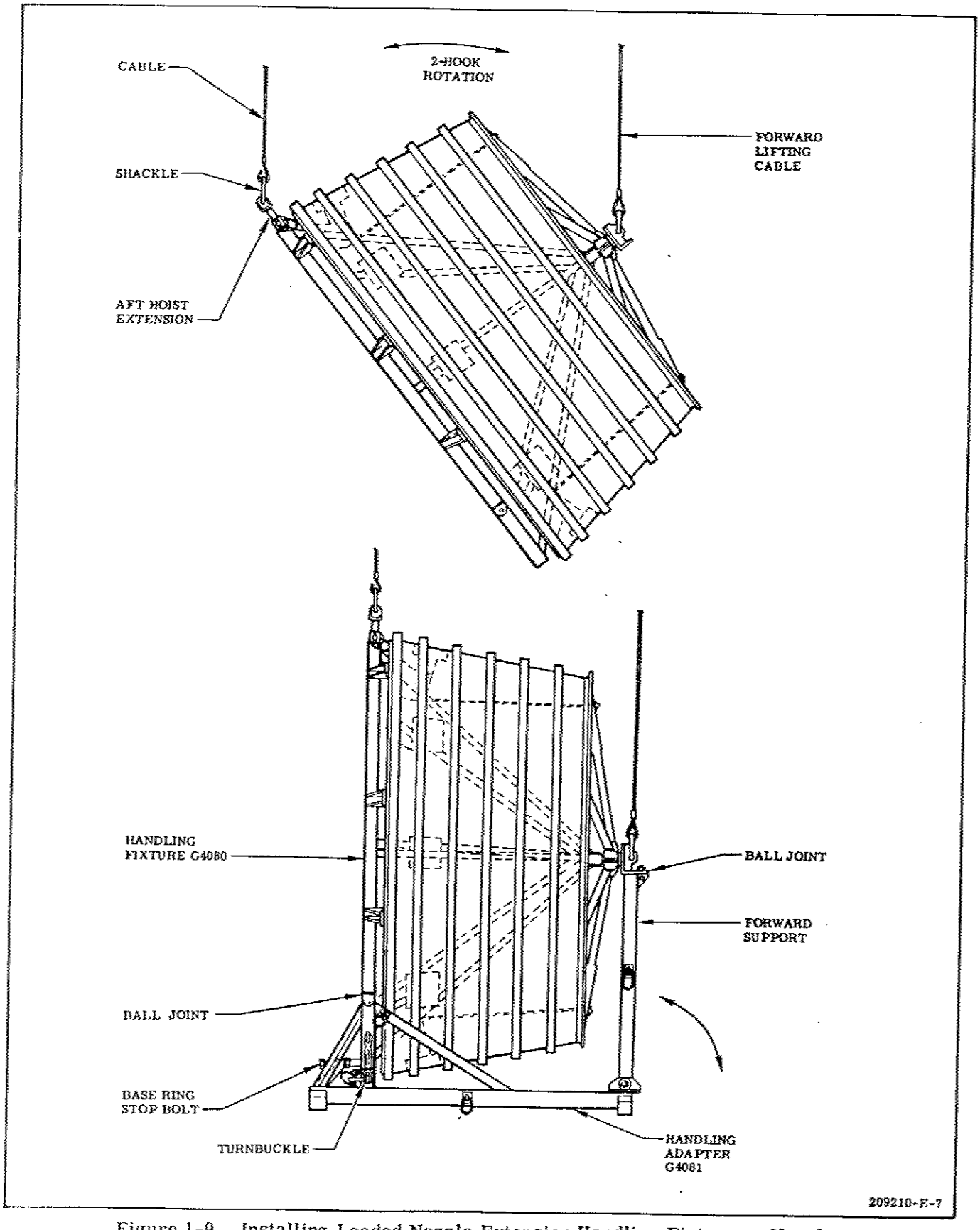


Figure 1-9. Installing Loaded Nozzle Extension Handling Fixture on Nozzle Extension Handling Adapter

f. On Nozzle Extension Handling Adapter G4081, disengage forward support from stored position and swing it forward until end rests on floor.

g. Back out base ring stop bolt.

h. Position loaded fixture over adapter until ball joints on fixture and adapter aline.

i. Slowly lower loaded fixture until ball joints are mated. Do not relieve tension on cables.

j. On adapter, swing forward support to vertical position and aline ball joints on fixture and adapter.

k. Slowly lower fixture until all ball joints are properly seated. Secure forward support ball joint with T-bolt. Torque nut to 240-300 inch-pounds.

CAUTION

Do not allow loaded fixture to rotate from the horizontal position after ball joints are seated, since damage to equipment can result.

l. Remove lower end of each turnbuckle from brackets on adapter. Attach turnbuckles to fixture ball joint bracket.

m. Torque turnbuckles to 240-300 inch-pounds and turnbuckle stopnuts to 60-120 inch-pounds.

n. Adjust base ring stop bolt until it contacts fixture. Torque stopnut to 360-480 inch-pounds.

o. Disconnect hoist cables from aft hoist extension and forward lifting cable. Store forward lifting cable to forward support of adapter and aft hoist extension in retracted position.

1-21. INSTALLING NOZZLE EXTENSION ON SHIPPING CONTAINER.

a. Lift and rotate nozzle extension to a horizontal position. Use a facility hoist capable of lifting 5,000 pounds and a sling designed to lift and rotate the nozzle extension.

b. Position nozzle extension over shipping container. Carefully lower extension into cradle of container.

c. Secure nozzle extension to shipping container with strapping. Pad areas where strapping contacts nozzle with Ethafoam (Dow Chemical Co).

d. Insert shipping support RK399-00010 into nozzle extension.

NOTE

The shipping support plates may not necessarily fit flush against the inside of the nozzle extension.

e. Bolt 2 outside cross supports to center gusset and to plates of shipping support. Tighten bolts until shipping support is firmly secured in place inside nozzle extension.

1-22. REMOVING LOADED NOZZLE EXTENSION HANDLING FIXTURE FROM NOZZLE EXTENSION HANDLING ADAPTER. (See figure 1-9.)

1-23. Two facility hoists capable of lifting a minimum of 5,000 pounds are required to remove the nozzle extension handling fixture from the handling adapter and to rotate it to the vertical position for nozzle extension removal.

a. Attach forward lifting cable on Nozzle Extension Handling Fixture G4080 to a facility hoist capable of lifting 5,000 pounds.

b. Check that aft hoist extension on handling fixture is in extended position and is secured with quick-release pin.

c. Attach a 3/4-inch shackle to aft hoist extension.

d. Connect hook from second facility hoist to shackle.

e. Using hoists, remove slack from forward and aft cables.

f. Back out base ring stop bolt.

g. Loosen and disconnect end of each turnbuckle at fixture ball joint bracket. Store turnbuckle on bracket of Nozzle Extension Handling Adapter G4081.

CAUTION

Do not allow loaded fixture to rotate from the horizontal position, since damage to equipment can result.

h. Loosen and disconnect T-bolt securing forward support ball joint.

i. Slowly raise forward lifting cable until forward support can be disengaged. Swing support forward until end rests on floor.

j. Slowly raise cables until loaded fixture is approximately 4 feet above floor.

k. Lower aft cable until nozzle extension is in vertical position.

l. Remove cable hook and shackle from aft hoist extension. Retract extension and secure with quick-release pin.

m. Slowly lower forward lifting cable until loaded fixture rests on floor. Disconnect cable from hoist.

1-24. REMOVING NOZZLE EXTENSION FROM NOZZLE EXTENSION HANDLING FIXTURE. (See figure 1-8.)

a. Using a facility hoist capable of lifting 5,000 pounds, suspend Engine Handling Sling G4052 above nozzle extension. Check that nozzle handling cables (short cables) are attached to spreader bars.

b. Connect sling cables to 4 lifting lugs near upper end of nozzle extension.

c. On nozzle flange struts, turn cable adjusting nut to upper end of screw.

d. Remove quick-release pin from each nozzle flange strut, lift strut until flange pad clears extension flange, retract strut, and install quick-release pin.

e. Lower each flange strut until it contacts quick-release pin at apex of strut.

f. Remove quick-release pin from each nozzle exit strut adjustment screw. Turn adjustment screw until exit strut is in retracted position. Install quick-release pin in adjustment screw.

g. Slowly raise extension clear of handling fixture.

CAUTION

To avoid damaging internal skins of nozzle extension, guide extension carefully over fixture.

h. Using hoist, move nozzle extension away from fixture and lower to floor.

1-25. REMOVING NOZZLE EXTENSION FROM SHIPPING CONTAINER.

a. Connect a facility hoist capable of lifting 5,000 pounds and a sling designed to lift and rotate the nozzle extension.

b. Remove bolts attaching 2 outside cross supports to center gusset and to plates of shipping support.

c. Remove shipping support RK399-00010 from nozzle extension.

d. Remove strapping securing nozzle extension to shipping container.

e. Using hoist, lift and rotate nozzle extension to vertical position.

f. Move nozzle extension away from shipping container. Slowly lower extension to the floor.

g. Disconnect sling and hoist from nozzle extension.

1-26. PACKAGING LOOSE EQUIPMENT AND THERMAL INSULATION FOR SHIPPING.

1-26A. PREPARING LOOSE EQUIPMENT FOR SHIPPING.

a. Package nuts, bolts, and washers in envelopes, grouping them according to their part numbers. Staple envelopes closed and identify by part name, part number, and quantity.

b. Package gaskets, seals, disks, shims, and similar items in separate packages. Use packaging method which maintains degree of cleanness required for that part and prevents flexing of those parts subject to damage from bending. Identify each package by part name, part number, and quantity.

c. Install caps, plugs, or protective closures on all items which could be contaminated by entry of foreign material.

d. Protect flexible sections of ducting with closures or wrap in polyurethane or polyethylene foam and secure with tape.

e. Package ducts and miscellaneous loose equipment in suitable shipping containers to prevent damage to packaged items. Use cushioning material, as required, to fill void spaces.

f. List contents of each shipping container and attach list to exterior of container.

1-27. PREPARING THERMAL INSULATION FOR SHIPPING.

a. Check that thermal insulation parts are packaged in accordance with packing sheet included with each thermal insulation set.

b. Check that each container is marked with thermal insulation set serial number and assembly container number, and marked to indicate top up.

SECTION II

SHIPPING BY TRUCK TRANSPORT

WARNING

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

G4044, Air Transport Engine Handler
G4052, Engine Handler Sling
G4080, Nozzle Extension Handling Fixture
G4081, Nozzle Extension Handling Adapter

2-1. SCOPE. Truck transportation is used to transport the engine, nozzle extension, and loose equipment cross-country. The following paragraphs provide instructions for loading and off-loading the engine, nozzle extension, and loose equipment using Engine Handler Sling G4052 and a low-bed trailer, air-ride equipped. A truck transport checklist is also included to be used as a guide for verifying that necessary procedures have been accomplished.

2-2. LOADING TRUCK TRANSPORT.

2-3. LOADING ENGINE ON LOW-BED TRAILER. (See figure 2-1.)

WARNING

Air Transport Engine Handler G4044 and Engine Handler Sling G4052 must be operated by authorized personnel trained in the use of the equipment.

a. Check that engine is properly installed on Air Transport Engine Handler G4044. (Refer to section I.)

b. Attach Engine Handler Sling G4052 to a facility hoist capable of lifting 30,000 pounds. Attach guide lines to sling.

c. Remove 2 forward lift/tiedown rings from Air Transport Engine Handler G4044 and install 2 forward lift adapters (stored on forward platform). Store lift-tiedown rings on forward platform.

d. Using hoist, position sling above handler. Lower sling, guiding sling cables down over engine to prevent possible damage to engine cover.

e. Connect sling cables to handler at 2 forward lift adapters and 2 aft lift rings (located forward of rear stacking adapters).

CAUTION

Cables must not be connected to the extreme aft lift/tiedown rings, since cables can damage the engine thrust chamber exit when the handler is lifted.

- Eyebolts of lift rings and bolts of lift adapters must have full thread engagement and must be positioned so that lift rings and adapters are in the line of lift before the sling is connected.

f. Position low-bed trailer next to handler.

g. Using hoist, install handler on trailer. (See figure 2-1.)

NOTE

Front of engine must face front of low-bed trailer.

h. Lock handler wheel brakes, and disconnect sling from handler.

i. Remove 2 forward lift adapters from handler and install 2 forward lift/tiedown rings. Store lift adapters on forward platform.

j. Secure handler to bed of trailer with tiedown chains to prevent movement of handler. (See figure 2-1.)

k. Unlock handler wheel brakes.

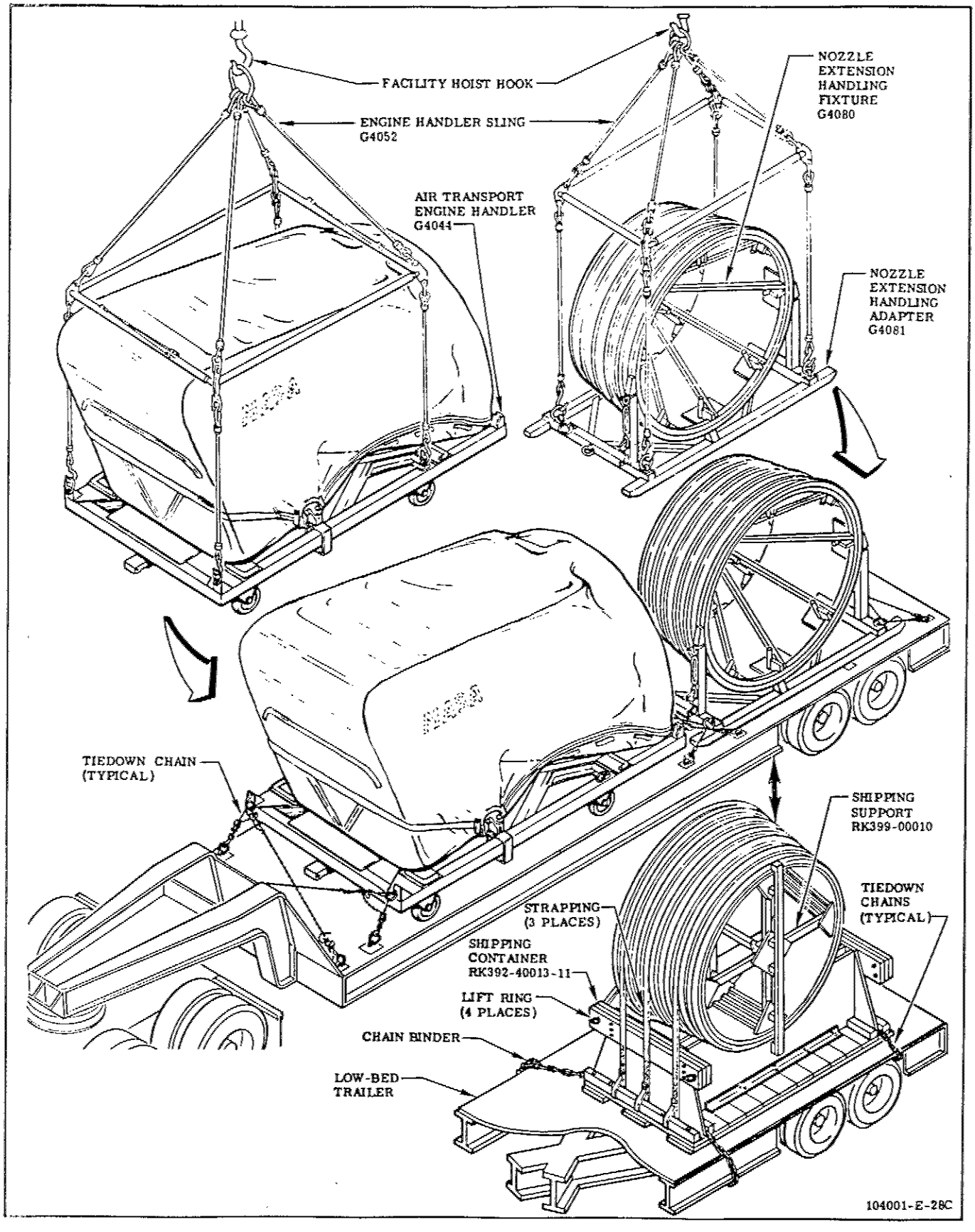
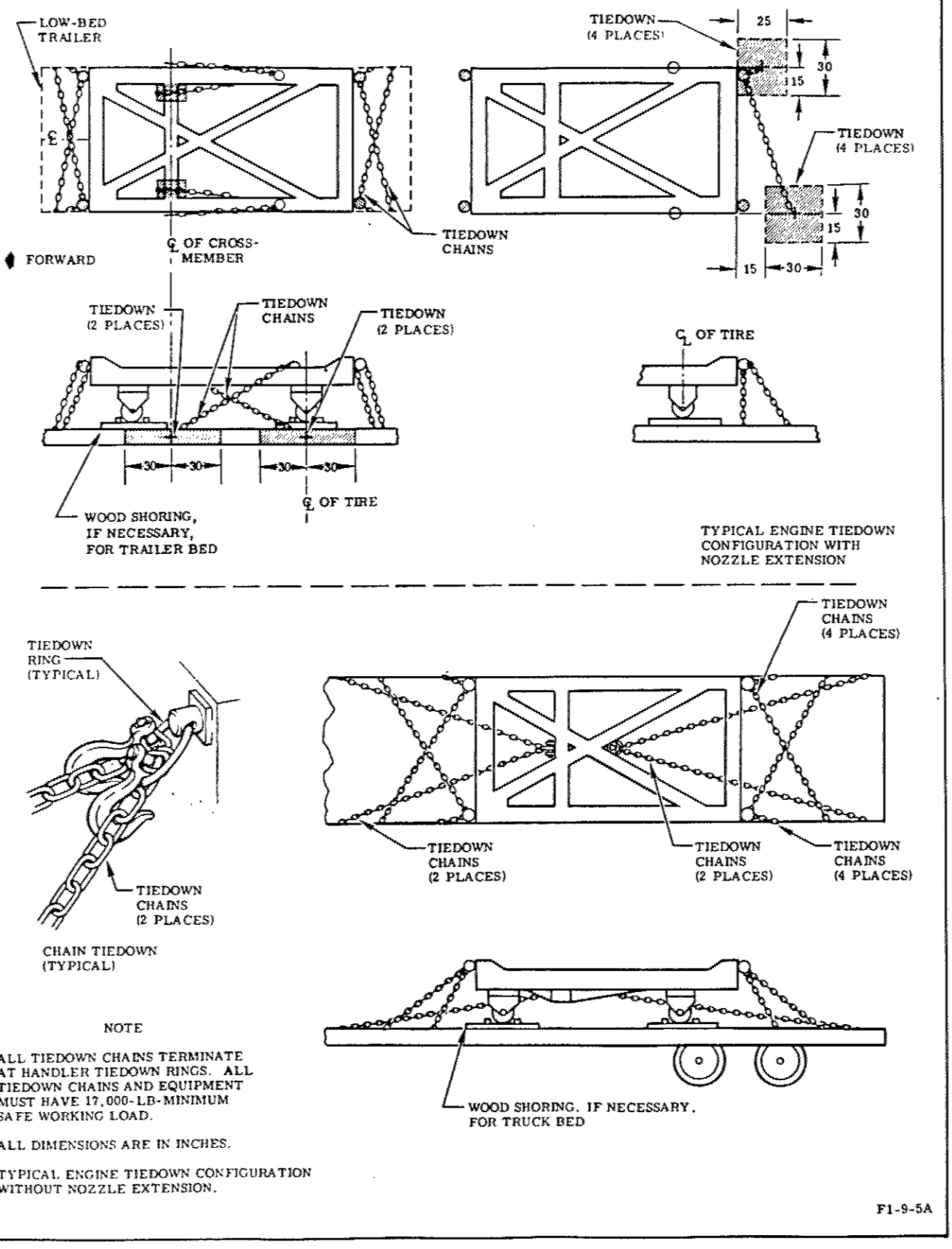


Figure 2-1. Loading Engine and Nozzle Extension on Low-Bed Trailer (Sheet 1 of 3)



NOTE

ALL TIEDOWN CHAINS TERMINATE AT HANDLER TIEDOWN RINGS. ALL TIEDOWN CHAINS AND EQUIPMENT MUST HAVE 17,000-LB-MINIMUM SAFE WORKING LOAD.

- ALL DIMENSIONS ARE IN INCHES.
- TYPICAL ENGINE TIEDOWN CONFIGURATION WITHOUT NOZZLE EXTENSION.

F1-9-5A

Figure 2-1. Loading Engine and Nozzle Extension on Low-Bed Trailer (Sheet 2 of 3)

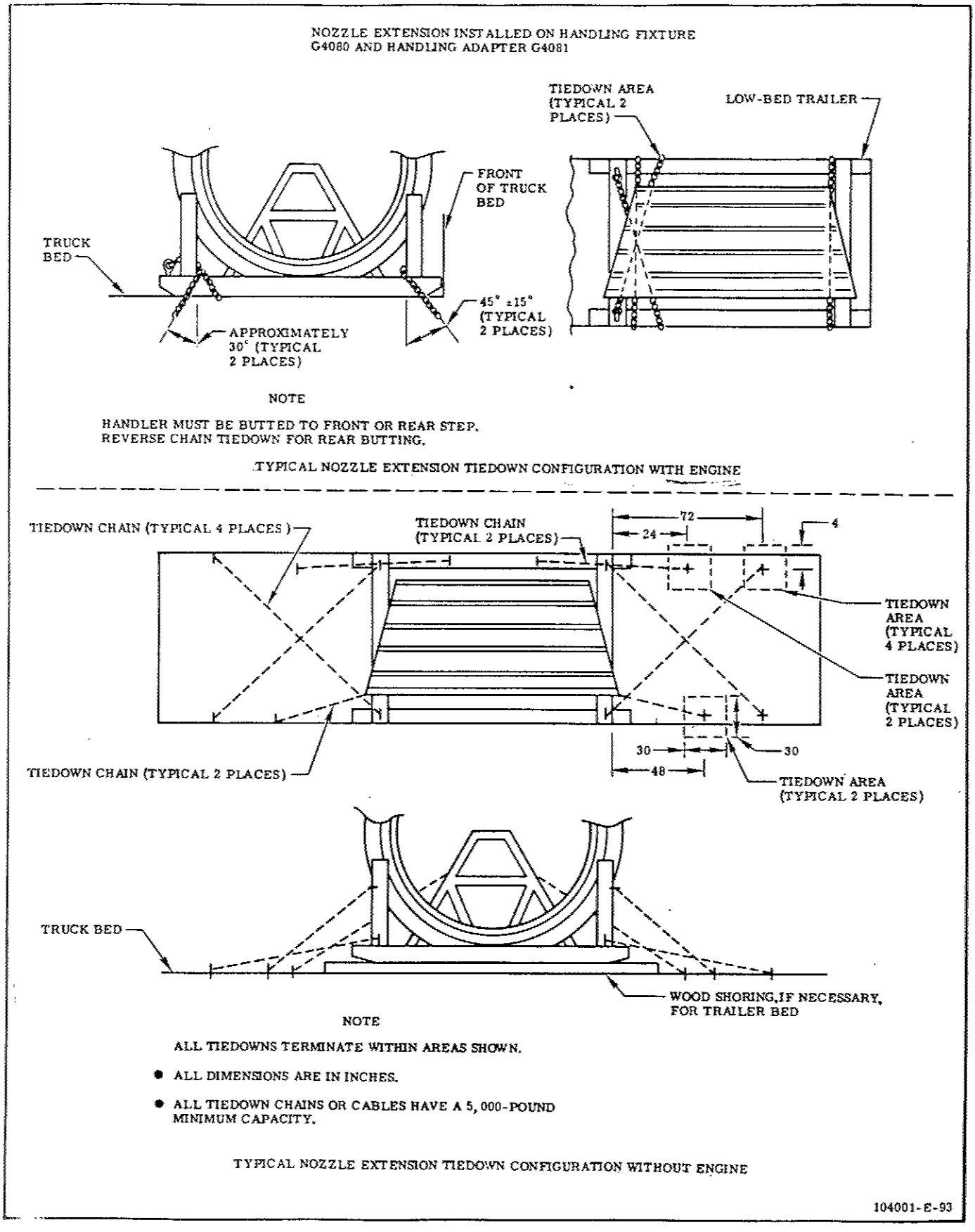


Figure 2-1. Loading Engine and Nozzle Extension on Low-Bed Trailer (Sheet 3 of 3)

2-4. LOADING NOZZLE EXTENSION ON LOW-BED TRAILER. (See figure 2-1.)

WARNING

Nozzle Extension Handling Fixture G4080 and Nozzle Extension Handling Adapter G4081 must be operated by authorized personnel trained in the use of the equipment.

a. Make sure that nozzle extension is properly installed on Nozzle Extension Handling Fixture G4080 and that loaded handling fixture is secured to Nozzle Extension Handling Adapter G4081, or that nozzle extension is properly installed on shipping container RK392-40013-11. (Refer to section I.)

b. Using a facility hoist capable of lifting 5,000 pounds, position Engine Handler Sling G4052 for attachment to adapter or shipping container. Attach guide lines to sling.

c. Connect sling cables (long cables) to 4 lift rings on adapter frame or to 4 lift rings on shipping container.

d. Hoist adapter or container with nozzle extension into place on trailer.

e. Secure adapter or container to bed as shown in figure 2-1.

f. Remove sling.

2-5. LOADING LOOSE EQUIPMENT. Loose equipment may be transported on the low-bed trailer with the engine and nozzle extension, or it may be transported on a separate truck. In either case, equipment is loaded as follows:

a. Using a forklift, position containers of loose equipment on trailer or truck bed to equally distribute weight.

b. Secure containers with rope or chains to truck/trailer bed.

CAUTION

Rope or chains must be tightened snugly, but care must be taken to prevent overbinding since damage to shipping containers can result.

2-6 through 2-8. (Deleted)

2-9. TRUCK TRANSPORT CHECKLIST (CROSS-COUNTRY).

2-10. The truck transport checklist (figure 2-5) is to be used as a guide to verify that all necessary procedures have been accomplished prior to truck departure and that specified requirements are met during cross-country shipping.

2-11. OFF-LOADING TRUCK TRANSPORT.

2-12. REMOVING LOOSE EQUIPMENT FROM TRUCK/TRAILER.

a. Remove tiedowns that secure loose equipment containers.

b. Using a forklift, remove containers from trailer or truck.

2-13. REMOVING NOZZLE EXTENSION FROM LOW-BED TRAILER.

a. Using a facility hoist capable of lifting 5,000 pounds, position Engine Handling Sling G4052 for attachment to Nozzle Extension Handling Adapter G4081 or to shipping container RK392-40013-11. Attach guide lines to sling.

b. Connect sling handling cables (long cables) to 4 lift rings on adapter frame or to 4 lift rings on shipping container.

c. Remove tiedowns that secure adapter to container to trailer or truck.

d. Hoist adapter or container with nozzle extension clear of trailer or truck and lower to ground.

e. Remove sling.

2-14. REMOVING ENGINE FROM LOW-BED TRAILER.

a. Attach Engine Handling Sling G4052 to a facility hoist capable of lifting 30,000 pounds.

b. Remove 2 forward lift/tiedown rings from Air Transport Engine Handler G4044 and install 2 forward lift adapters (stored on forward platform). Store lift/tiedown rings on forward platform.

c. Using hoist, position sling above handler. Lower sling, guiding sling cables down over engine to avoid any possible damage to engine.

CAUTION

Cables must not be connected to the extreme aft lift/tiedown rings, since cables can damage the engine thrust chamber exit when the handler is lifted.

- Eyebolts of lift rings and bolts of lift adapters must have full thread engagement and must be positioned so that lift rings and adapters are in line of lift before the sling is connected.

d. Connect sling cables to handler at 2 forward lift adapters and 2 aft lift rings (located forward of rear stacking adapters).

e. Remove all tiedown chains that secure handler to low-bed trailer.

Figures 2-2 through 2-4 deleted.

Check Required	Initial or Stamp
BEFORE LOADING ON TRUCK	
a. No visible engine damage.	
b. Engine prepared for shipping in accordance with R-3896-9.	
(1) Engine in lowered (shipping) position on Air Transport Engine Handler G4044.	
(2) Desiccant installed in closures.	
(3) Closures installed.	
(4) Gimbal bearing locks installed.	
(5) Turbopump shaft preload fixture installed.	
(6) Thrust chamber throat security closure installed and sealed.	
(7) Engine cover installed and sealed.	
(8) Engine forms sealed in waterproof material in security pouch.	
(9) Serial numbers of seals recorded in Government Bill of Lading.	
(10) Engine Log Book may be mailed or can accompany the engine, whichever is suitable.	
c. No visible nozzle extension damage.	
d. Nozzle extension prepared for shipping in accordance with R-3896-9.	
(1) Nozzle extension installed on Nozzle Extension Handling Fixture G4080 and Nozzle Extension Handling Adapter G4081, or shipping container RK392-40013-11.	
e. Loose equipment properly packaged for shipping in accordance with R-3896-9.	
LOADING ON TRUCK	
a. Engine loaded on low-bed trailer in accordance with R-3896-9.	
(1) Engine faces front of trailer.	
(2) Handler secured to trailer.	
(3) Handler wheel brakes unlocked.	
(4) No visible engine damage.	
b. Nozzle extension loaded on low-bed trailer or truck in accordance with R-3896-9.	
(1) Adapter or shipping container secured to trailer or truck.	
(2) No visible nozzle extension damage.	

Figure 2-5. Truck Transport Checklist (Cross-Country) (Sheet 1 of 2)

Check Required	Initial or Stamp	Check Required	Initial or Stamp
c. Loose equipment containers loaded on trailer or truck in accordance with R-3896-9. (1) Containers properly secured to trailer or truck. (2) No visible container damage. IN-TRANSIT REQUIREMENTS a. Consignor must notify consignee by TWX of the following: (1) Departure time and date. (2) Estimated arrival time. (3) Seal numbers. (4) Drivers' names. b. Consignor must notify consignee by telephone of arrival time at least 2 hours prior to arrival.		c. Drivers must comply with the following: (1) Two drivers required (minimum) for each shipment. (2) Be informed of their responsibilities. (3) Notify consignee of breakdown, delay, or any deviation from planned transit. (4) Use reputable accommodations with truck secured in an adjacent area least accessible to unauthorized persons and least subject to damage. (5) Check seals after each overnight stop and whenever load has not been under surveillance. (6) Report any evidence of tampering immediately by fastest communication available. (7) Observe any additional requirements designated by transportation officer, as annotated on Government Bill of Lading.	

Figure 2-5. Truck Transport Checklist (Cross-Country) (Sheet 2 of 2)

f. Check that handler wheel brakes are unlocked.

g. Using hoist, lift engine and handler clear of low-bed trailer and carefully lower to ground.

h. Disconnect sling from handler and store in appropriate equipment storage area.

2-15. (Deleted)

2-16. REMOVING TURBOPUMP SHAFT PRELOAD FIXTURE FROM ENGINE.

a. Unzip forward zipper of engine cover. (Refer to section I.)

b. Remove turbopump shaft preload fixture bracket from closure plate on turbopump oxidizer inlet.

CAUTION

The original cup of the closure must be cleaned for liquid oxygen service to prevent turbopump contamination.

c. Remove fixture closure, and install cup ST3950173RKL001 (retained when fixture was installed). Tighten captive bolts of cup finger-tight; then turn bolts an additional 1/4 turn.

d. Install 4 bolts NAS1007-13H and 4 washers LD153-0010-0016 (retained when bracket of fixture was installed) in vacant holes of closures, and reinstall engine cover.

e. Store bolts of bracket and closure into holes provided in bracket.

f. Prepare turbopump shaft preload fixture for return shipment in accordance with Rocketdyne Automated Packaging System (RAPS).

NOTE

The turbopump shaft preload fixture is a rotatable item and must be returned to Rocketdyne. Contact the responsible Rocketdyne representative for required shipping information.

Pages 2-9 through 2-12 deleted.

SECTION III

SHIPPING BY AIR TRANSPORT

WARNING

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

G4044, Air Transport Engine Handler
G4052, Engine Handler Sling
G4080, Nozzle Extension Handling Fixture
G4081, Nozzle Extension Handling Adapter

3-1. SCOPE. The engine, nozzle extension, and miscellaneous loose equipment are shipped by air transport on aircraft B-377-PG or B-377-SG, or as designated. Aircraft B-377-PG is aft-loaded and a lightweight aluminum shipping pallet is used. Aircraft B-377-SG is front-loaded and a heavyweight steel or a lightweight aluminum pallet is used. The following paragraphs provide instructions for loading and off-loading the engine, nozzle extension, and miscellaneous loose equipment using Engine Handler Sling G4052, cargo lift trailer, and a low-bed trailer. An air transport checklist is also included to be used as a guide prior to and during aircraft loading.

3-2. SHIPPING BY AIR TRANSPORT.

3-3. LOADING ENGINE ON LOW-BED TRAILER. (See figure 3-1.)

WARNING

Air Transport Engine Handler G4044 and Engine Handler Sling G4052 must be operated by authorized personnel trained in the use of the equipment.

a. Check that engine is properly installed on Air Transport Engine Handler G4044. (Refer to section I.)

b. Attach Engine Handler Sling G4052 to a facility hoist capable of lifting 30,000 pounds. Attach guide lines to sling.

c. Remove 2 forward lift/tiedown rings from Air Transport Engine Handler G4044 and install 2 forward lift adapters (stored on forward platform). Store lift/tiedown rings on forward platform.

d. Using hoist, position sling above handler. Lower sling, guiding sling cables down over engine to prevent possible damage to engine cover.

e. Connect sling cables to handler at 2 forward lift adapters and 2 aft lift rings (located forward of rear stacking adapters).

CAUTION

Cables must not be connected to the extreme aft tiedown/lift rings, since cables can damage the engine thrust chamber exit when handler is lifted.

- Eyebolts of lift rings and bolts of lift adapters must have full thread engagement and must be positioned so that lift rings and adapters are in line of lift before sling is connected.

f. Position low-bed trailer next to handler.

g. Using hoist, install handler on trailer.

NOTE

Front of engine must face front of low-bed trailer.

h. Check that handler wheel brakes are locked.

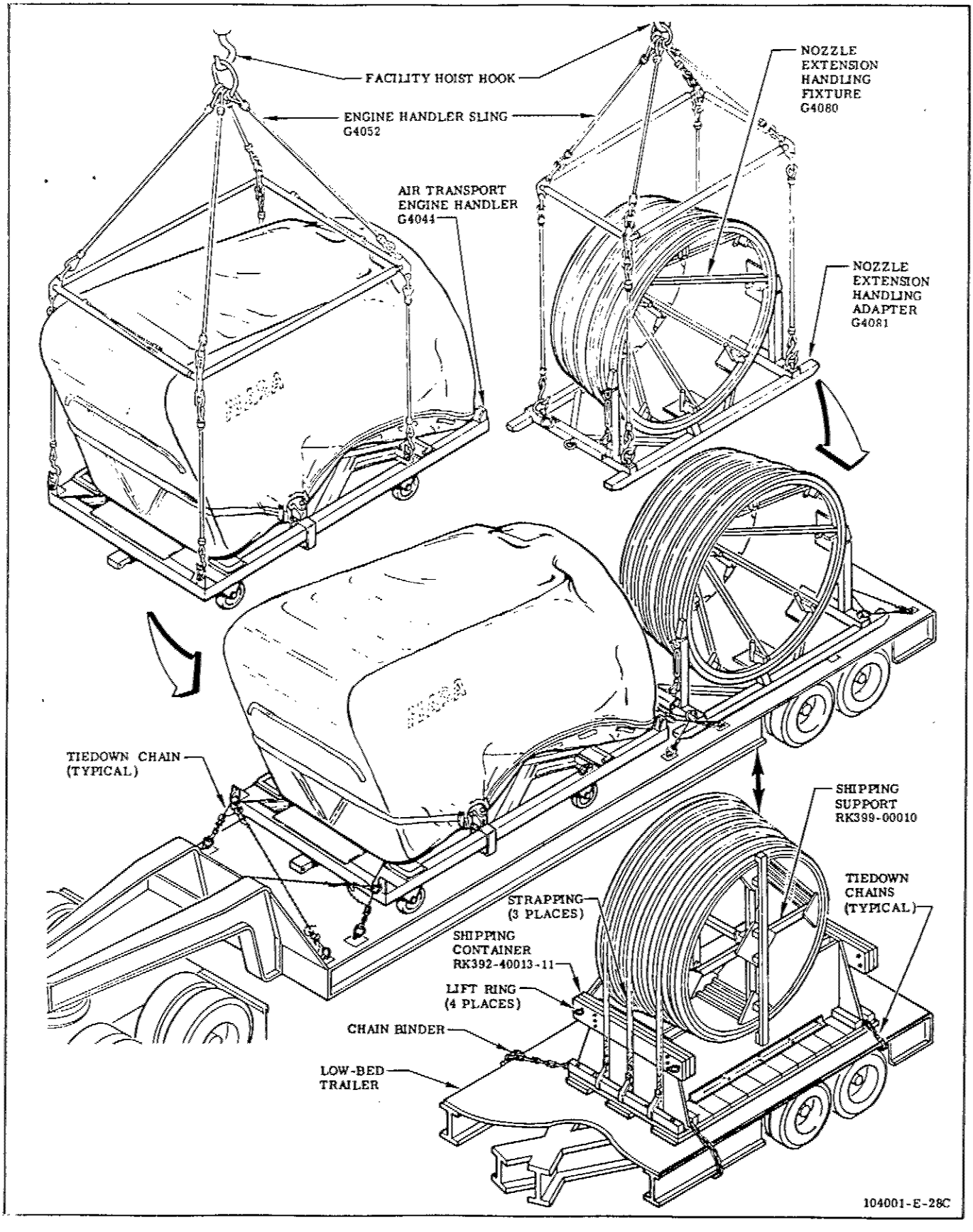


Figure 3-1. Loading Engine and Nozzle Extension on Low-Bed Trailer

i. Remove 2 forward lift adapters from handler and install 2 forward lift/tiedown rings. Store lift adapters on forward platform.

j. Secure handler to bed of trailer with tiedown chains to prevent movement of handler.

k. Unlock handler wheel brakes and disconnect sling from handler.

3-4. LOADING NOZZLE EXTENSION ON LOW-BED TRAILER. (See figure 3-1.)

WARNING

Nozzle Extension Handling Fixture G4080 and Nozzle Extension Handling Adapter G4081 must be operated by authorized personnel trained in the use of the equipment.

a. Check that nozzle extension is properly installed on Nozzle Extension Handling Fixture G4080 and that loaded handling fixture is secured to Nozzle Extension Handling Adapter G4081, or that nozzle extension is properly installed on shipping container RK392-40013-11. (Refer to section I.)

b. Using a facility hoist capable of lifting 5,000 pounds, position Engine Handler Sling G4052 for attachment to adapter or shipping container. Attach guide lines to sling.

c. Connect sling cables (long cables) to 4 lift rings on adapter frame, or to 4 lift rings on shipping container.

d. Hoist assembly into place on trailer.

e. Secure assembly to trailer bed as shown in figure 3-1.

f. Remove sling.

3-5. LOADING MISCELLANEOUS LOOSE EQUIPMENT.

a. Using a forklift, position containers of loose equipment on trailer to equally distribute weight.

b. Secure containers to trailer with high-strength rope or chains.

CAUTION

Tighten rope or chains snugly but do not overbind, since damage to shipping containers can occur.

3-6. PREPARING CARGO LIFT TRAILER FOR USE. The following steps outline preoperational inspection tasks required to prepare the cargo lift trailer for use in loading and unloading cargo from aircraft B-377-PG and B-377-SG.

a. Visually inspect trailer for any damage that can impair operation of the trailer.

b. Check tires for proper inflation (90-psig pressure).

c. Set parking brakes, and check for proper operation.

d. Check hydraulic reservoir level. Oil must be visible in sight gage.

e. Check fuel tank supply. If necessary, fill fuel tank with regular gasoline.

f. Remove portable operator control panel from stored position at aft end of trailer.

g. Turn on battery switch, place engine switch in upper position, and press starter button (manually choke if necessary) until engine starts.

h. Check hydraulic pressure gage. When pressure reaches 1,300 to 1,500 psi, engine should idle.

i. Using controls on portable control panel, raise platform. Platform cylinders may be controlled in pairs (front and rear) by separate switches to jog lagging cylinders.

j. Check engine oil level. Add oil as required by indication on dipstick. (Use SAE 30 in summer; SAE 10 in winter.)

k. Operate leveling jacks and check for proper operation. Inspect for hydraulic leakage.

3-7. INSTALLING SHIPPING PALLET ON CARGO LIFT TRAILER.

3-8. If shipping pallet is to be transferred from a location other than that of the aircraft onto cargo lift trailer, load pallet as outlined in steps a through h. If pallet is to be transferred from aircraft B-377-PG or B-377-SG, transfer pallet as outlined in steps i through aa.

a. Prepare cargo lift trailer for use as outlined in paragraph 3-6.

b. Attach a suitable prime mover to tow bar of trailer, and tow trailer into position next to pallet.

c. Set trailer parking brakes.

d. Attach Engine Handler Sling G4052 (or equivalent) to a facility hoist capable of lifting 4,000 pounds (for heavyweight pallet) or 2,700 pounds (for lightweight pallet)..

e. Install suitable eyebolts, with lift rings attached, to pallet.

f. Using hoist, position sling above pallet, and connect sling to lift rings of pallet.

CAUTION

Eyebolts of pallet must have full thread engagement and must be positioned so that lift ring is in line with the lift before sling is connected.

g. Using facility hoist, install pallet on trailer between 2 guide rails.

NOTE

If loading aircraft B-377-PG, pallet is positioned with shipping buttress mount holes at aft end of cargo lift trailer. For loading aircraft B-377-SG, shipping buttress mount holes in pallet are on forward end of cargo lift trailer.

h. Secure each end of pallet to trailer with a chain capable of holding 20,000 pounds, to prevent longitudinal movement of pallet.

i. Prepare cargo lift trailer for use as outlined in paragraph 3-6.

j. Attach a suitable prime mover to tow bar of trailer, and tow trailer into position next to aircraft, alining guide rails on trailer with aircraft.

k. When trailer is correctly alined with aircraft, set trailer parking brakes.

l. Remove pyramid jack bases from their hangers and place under each leveling jack.

CAUTION

Make sure jack bases are centered exactly under jack cylinder rods.

m. Extend jack cylinders until load is resting on bases.

n. Raise platform to required height. Platform cylinders may be controlled in pairs (front and rear) by separate switches to jog lagging cylinders.

CAUTION

Scissor arm wheels must be in contact with the tracks at all times to make sure load is equalized.

o. Make final alinement of trailer platform to aircraft cargo floor by adjusting individual leveling jacks.

CAUTION

Platform cylinders must not be used to aline platform with aircraft.

p. If pallet is being transferred from aircraft B-377-SG, push pallet onto cargo lift trailer platform between 2 guide rails, using aircraft winching equipment.

q. If pallet is being transferred from aircraft B-377-PG, unload pallet as outlined in steps r through v.

r. Connect a cable to pallet and extend it down trailer platform and over roller end of platform.

s. Connect other end of cable to a winch on prime mover.

t. Using prime mover as a source of power, pull pallet onto cargo lift trailer platform between 2 guide rails.

u. Secure each end of pallet to trailer with a chain capable of holding 20,000 pounds, to prevent longitudinal movement of pallet.

v. Disconnect cable from pallet to prime mover.

w. Lower platform onto trailer chassis assembly.

x. Retract leveling jack cylinders.

y. Store pyramid jack bases on their hangers.

z. Release parking brakes.

aa. Tow trailer away from area.

3-9. INSTALLING ENGINE SHIPPING BUTTRESS ON SHIPPING PALLET. (See figure 3-2.) Engine Shipping Buttress G4067 is used during transportation of the engine in the aircraft to prevent forward movement of the engine and air transport engine handler during aircraft landing. The buttress is bolted directly to the shipping pallet.

a. Position engine shipping buttress on shipping pallet.

b. Secure buttress to pallet with bolts.

c. Torque bolts in accordance with Aero Spacelines or customer requirements.

3-10. LOADING ENGINE ON SHIPPING PALLET. (See figure 3-3.)

a. Position low-bed trailer next to cargo lift trailer.

b. Prepare cargo lift trailer for use as outlined in paragraph 3-6.

c. Stop trailer engine and turn off ignition switch and battery switch.

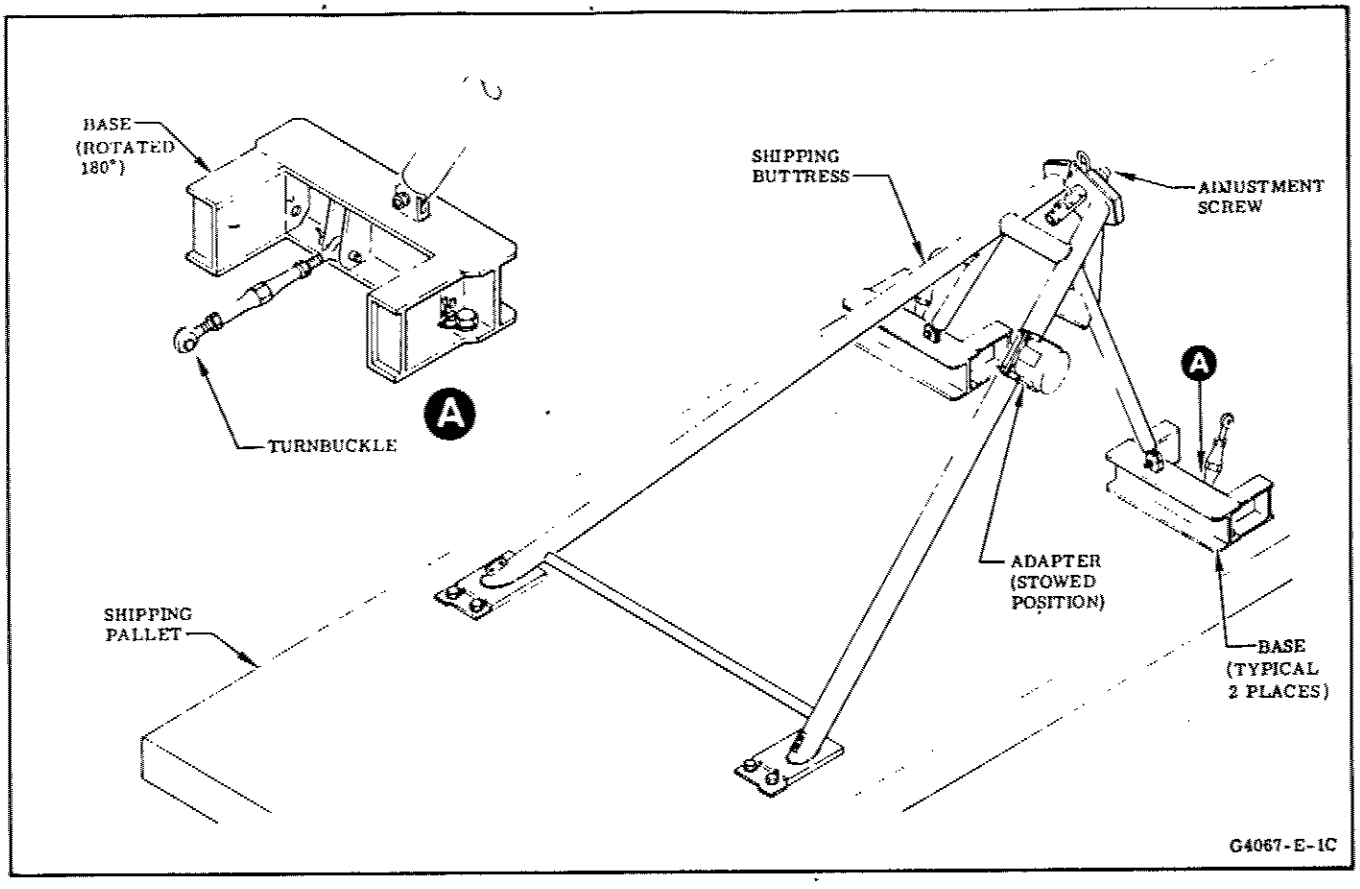


Figure 3-2. Installing Engine Shipping Buttress

d. Set trailer parking brakes.

e. Unzip engine cover flaps covering engine gimbal.

f. Remove adapter from engine shipping buttress and secure adapter to gimbal with attached pins.

NOTE

The pins go into the adapter from the adapter side.

g. On engine shipping buttress, back out adjustment screw.

h. Attach Engine Handler Sling G4052 to a facility hoist capable of lifting 30,000 pounds. Attach guide lines to sling.

i. Remove 2 forward lift/tiedown rings from Air Transport Engine Handler G4044 and install 2 forward lift adapters (stored on forward platform). Store lift/tiedown rings on forward plafeform.

j. Using hoist, position sling above handler.

k. Connect sling cables to handler at 2 forward lift adapters and 2 aft lift rings (located forward of rear stacking adapters).

CAUTION

Cables must not be connected to the extreme aft tiedown/lift rings, since this can damage the engine thrust chamber exit when the handler is lifted.

- Eyebolts of lift rings and bolts of lift adapters must have full thread engagement and must be positioned so that lift rings and adapters are in line of lift before sling is connected.

l. Using hoist, transfer engine and air transport engine handler from low-bed trailer to shipping pallet on cargo lift trailer. Position handler so that engine gimbal is alined with adjustment screw on buttress.

m. Check that handler wheel brakes are unlocked.

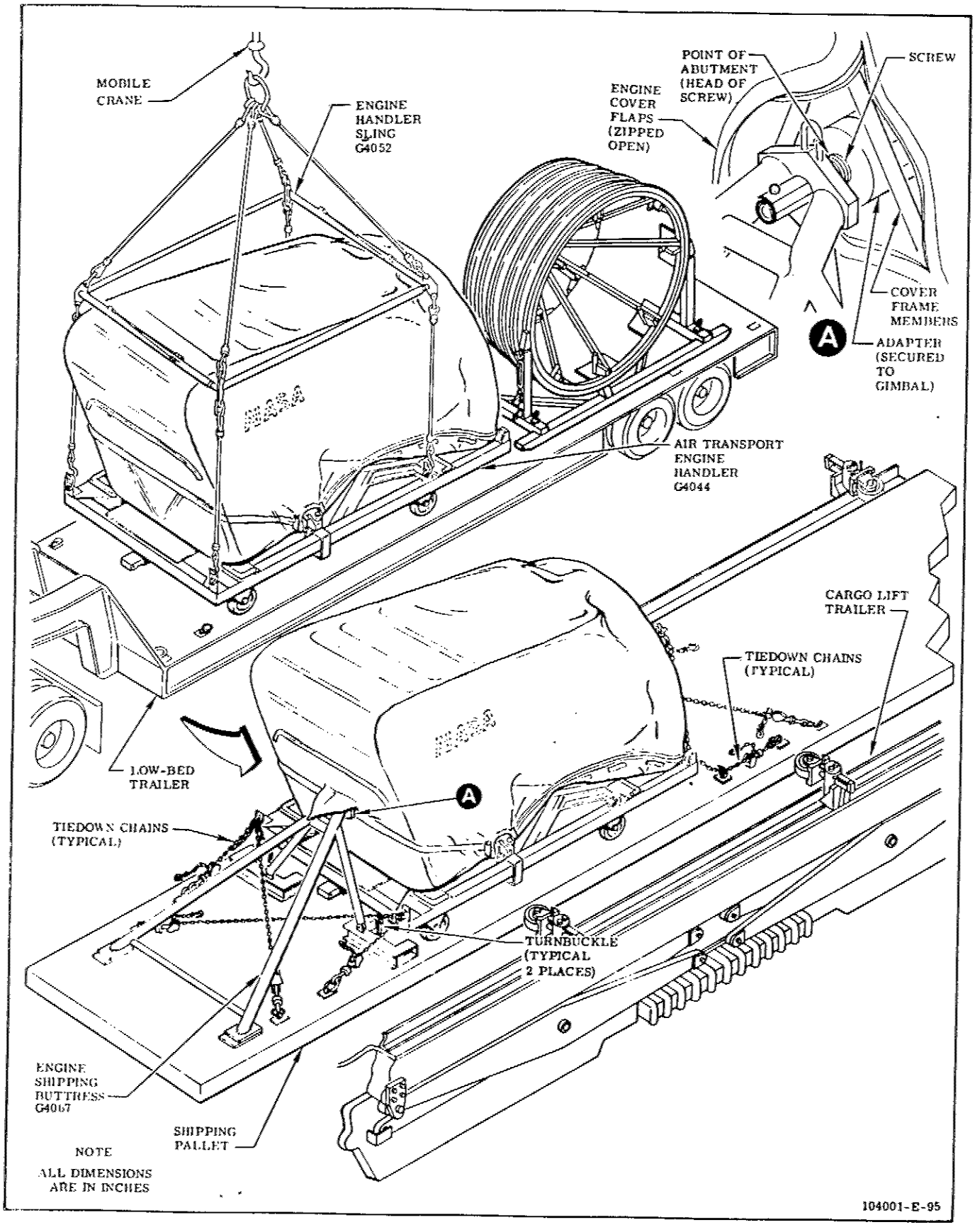


Figure 3-3. Loading Engine on Shipping Pallet (Sheet 1 of 2)

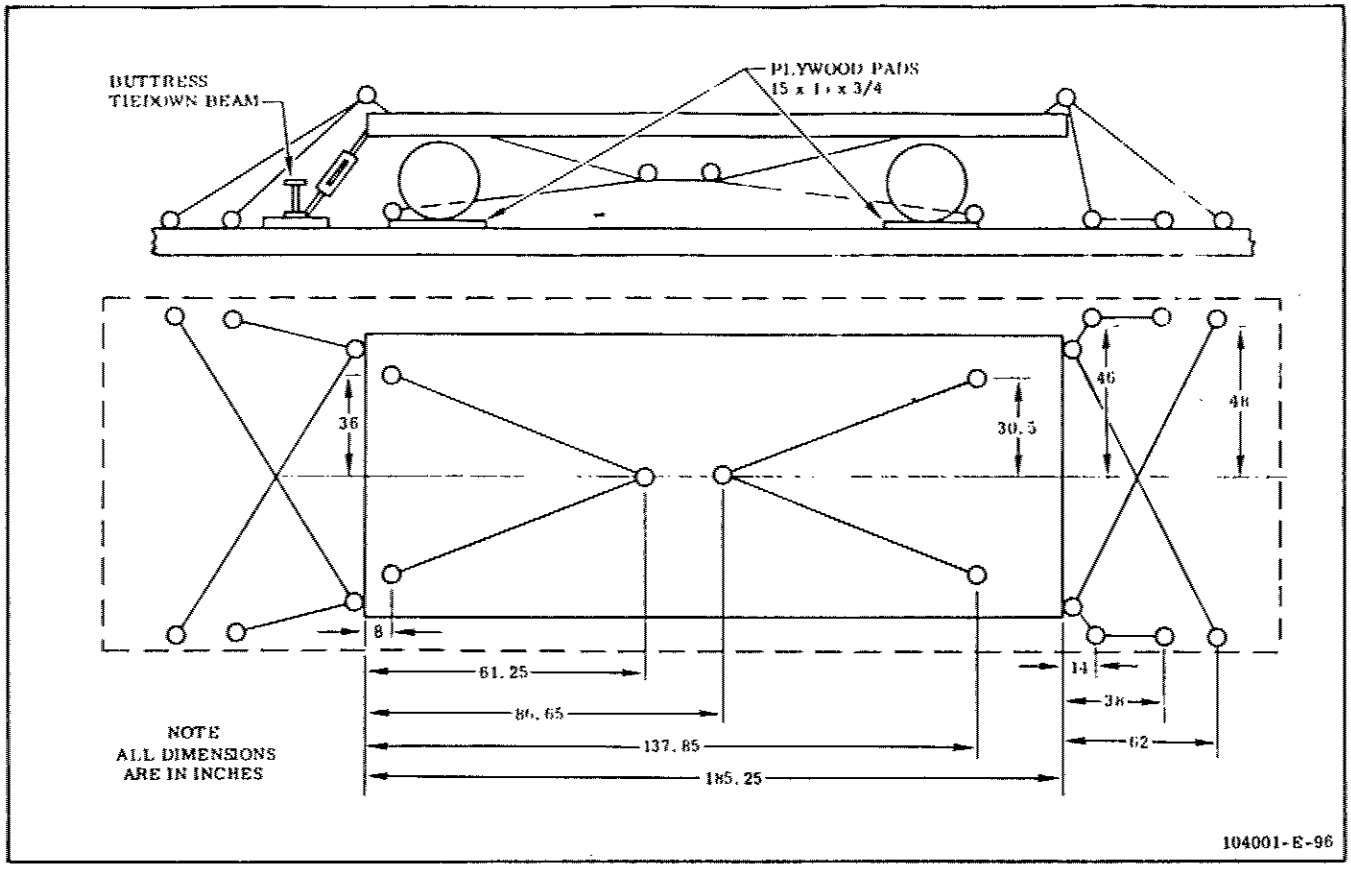


Figure 3-3. Loading Engine on Shipping Pallet (Sheet 2 of 2)

n. Connect buttress turnbuckles to handler.

o. Remove 2 forward lift adapters from handler and install 2 forward lift/tiedown rings. Store lift adapters on forward platform.

p. Secure handler to pallet as shown in figure 3-3.

q. Disconnect sling from handler.

r. Tighten shipping buttress adjustment screw until it contacts adapter on engine gimbal.

s. Secure screw with attached pin.

3-11. LOADING NOZZLE EXTENSION ON SHIPPING PALLET. (See figure 3-4.)

a. Check that nozzle extension is properly installed on Nozzle Extension Handling Fixture G4080 and that loaded handling fixture is secured to Nozzle Extension Handling Adapter G4081, or that nozzle extension is properly installed on shipping container RK392-40013-11. (Refer to section I.)

b. Using a facility hoist capable of lifting 5,000 pounds, position Engine Handler Sling G4052 for attachment to adapter or shipping container. Attach guide lines to sling.

c. Connect sling handling cables (long cables) to 4 lift rings on adapter frame, or to 4 lift rings on shipping container.

d. Hoist assembly into place on shipping pallet.

e. Secure assembly to pallet as shown in figure 3-4.

f. Remove sling.

3-12. LOADING MISCELLANEOUS LOOSE EQUIPMENT ON SHIPPING PALLET.

a. Using a forklift, center boxes of loose equipment on shipping pallet in front of shipping buttress.

b. Secure boxes to pallet with high-strength nylon webbing.

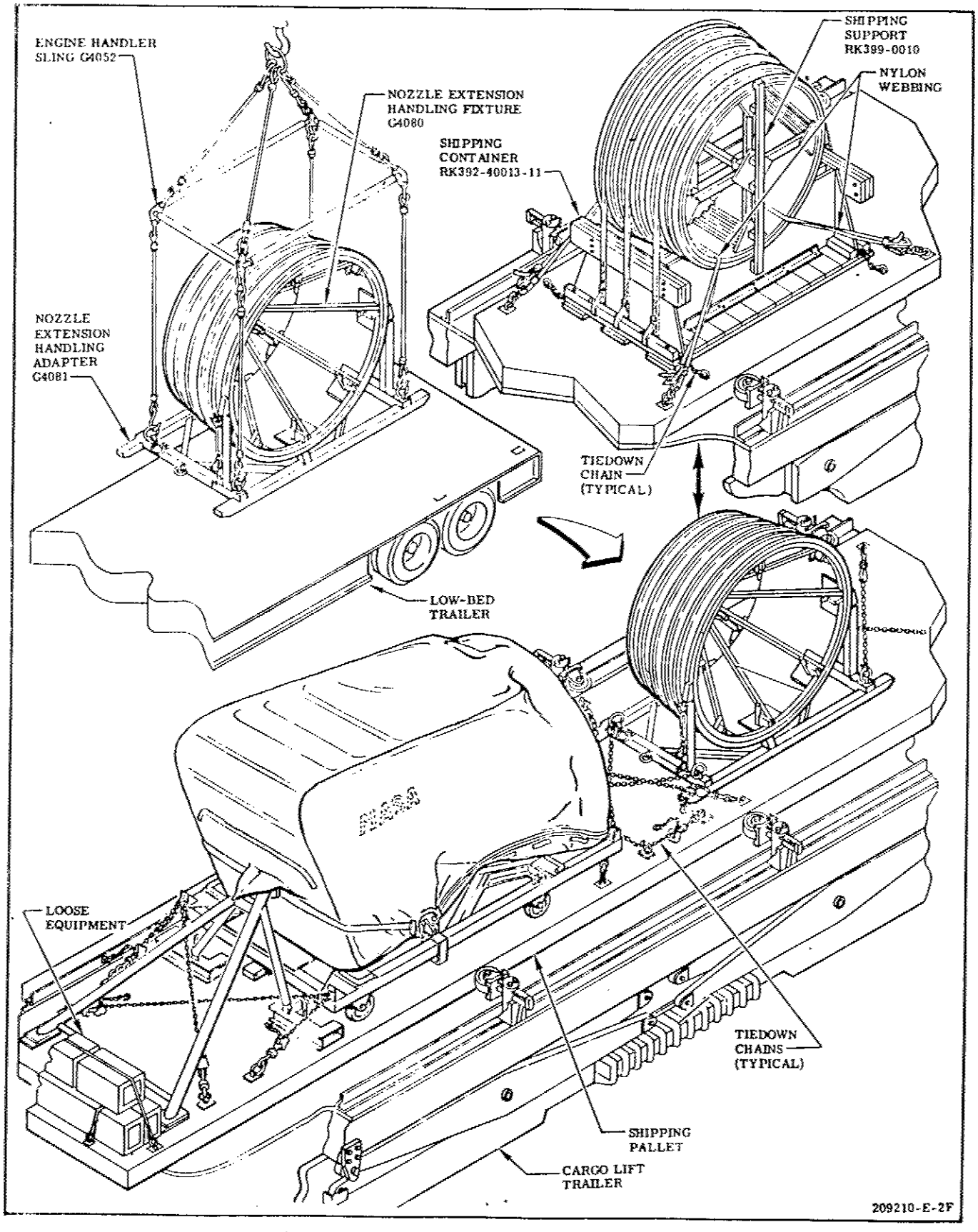


Figure 3-4. Loading Nozzle Extension and Miscellaneous Loose Equipment on Shipping Pallet

3-13. LOADING SHIPPING PALLET INTO AIRCRAFT. (See figure 3-4.)

a. Start cargo lift trailer engine.

b. Release parking brakes.

c. Using prime mover, position trailer so that aft of trailer is approximately 18 inches from aircraft and trailer guide rails are alined with guide rails in aircraft.

d. When trailer is correctly alined with aircraft, set trailer parking brakes.

e. Remove pyramid jack bases from their hangers and place under each leveling jack.

CAUTION

Make certain jack bases are centered exactly under jack cylinder rods.

f. Extend jack cylinders until load rests on bases.

g. Raise platform to required height. Platform cylinders may be controlled in pairs (front and rear) by separate switches to jog lagging cylinders.

CAUTION

When the platform is loaded, the scissor arm wheels must be in contact with the tracks at all times to equally distribute load.

h. Make final alinement of shipping pallet to aircraft cargo floor by adjusting individual leveling jacks.

CAUTION

Platform cylinders must not be used to aline platform with aircraft.

i. If engine with air transport engine handler is being loaded into aircraft B-377-SG, connect aircraft winching equipment to shipping pallet.

j. Release all tiedown connections between shipping pallet and cargo lift trailer.

k. Using aircraft winching equipment, pull pallet into aircraft.

l. If engine with air transport engine handler is being loaded into aircraft B-377-PG, load as outlined in steps m through o.

m. Connect one end of a cable to shipping pallet and extend it down the floor of aircraft and over roller in forward end of aircraft.

n. Connect other end of cable to a winch on prime mover.

o Release all tiedown connections between shipping pallet and cargo lift trailer.

p. Using prime mover as a source of power, pull shipping pallet off cargo lift trailer and into aircraft.

q. After shipping pallet is positioned in aircraft, visually inspect for damage. (See figure 3-5.)

r. Press front and rear platform switches on portable control panel of cargo lift trailer and allow platform to lower onto trailer chassis assembly.

s. Retract leveling jack cylinders.

t. Store pyramid jack bases on their hangers.

u. Release parking brakes.

v. Tow trailer away from area.

3-14. AIR TRANSPORT CHECKLIST.

3-15. The air transport checklist (figure 3-5) is to be used as a guide to verify that all necessary procedures have been accomplished prior to and during loading of the engine into the aircraft.

3-16. TRANSFERRING SHIPPING PALLET FROM AIRCRAFT TO CARGO LIFT TRAILER. (See figure 3-6.)

a. Prepare cargo lift trailer for use as outlined in paragraph 3-6.

b. Start cargo lift trailer engine.

c. Release parking brakes.

d. Using prime mover, position trailer so that aft of trailer is approximately 18 inches

Engine Serial Number _____ Date _____

Check Required	Initial Or Stamp	Check Required	Initial Or Stamp
BEFORE LOADING ON TRUCK a. No visible engine damage. b. Engine prepared for shipping per R-3896-9. (1) Engine in shipping position. (2) Desiccant installed. (3) Closures installed. (4) Gimbal bearing locks installed. (5) Engine cover installed. (6) Engine forms sealed in security pouch. c. Nozzle extension prepared for shipping per R-3896-9. LOADING ON TRUCK a. Engine loaded on low-bed trailer per R-3896-9. (1) Engine faces front of trailer. (2) Handler secured to trailer. (3) Handler wheel brakes unlocked. (4) No visible engine damage. b. Nozzle extension loaded on low-bed trailer per R-3896-9. BEFORE LOADING ON CARGO LIFT TRAILER (CLT) a. CLT prepared for use per R-3896-9. (1) CLT hydraulic system pressurized to 1,300 to 1,500 psig. (2) CLT controls operate freely. (3) CLT brakes locked. b. Pallet loaded on CLT per R-3896-9. (1) Pallet secured to CLT.		c. Shipping buttress installed per R-3896-9. LOADING ON CLT a. Engine loaded on pallet per R-3896-9. (1) Engine secured to pallet. (2) Handler wheel brakes unlocked. (3) No visible engine damage. b. Nozzle extension loaded on pallet per R-3896-9. BEFORE MOVING CLT a. CLT brakes unlocked. b. CLT hydraulic system pressurized to 1,300 to 1,500 psig. AFTER CLT IS POSITIONED TO AIRCRAFT a. CLT brakes locked. b. Leveling jacks fully support weight of CLT. c. Pallet alined with level of aircraft cargo deck. d. Winch connected to pallet. e. Pallet disconnected from CLT. f. Pallet loaded on aircraft. AFTER LOADING ON AIRCRAFT a. No visible engine damage. b. Move CLT from aircraft. (1) Pallet support lowered. (2) Leveling jacks retracted. (3) CLT towed from area.	

Figure 3-5. Air Transport Checklist

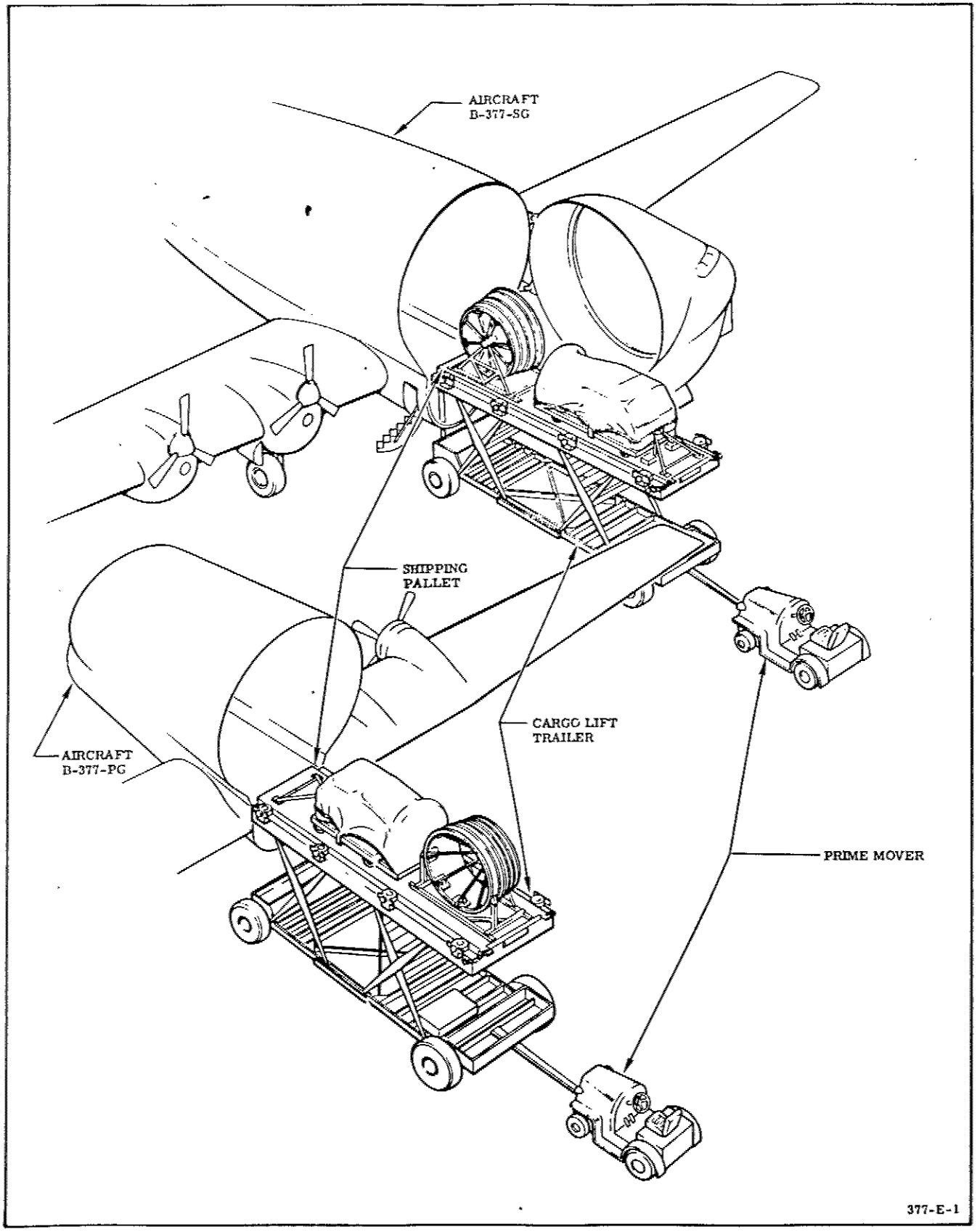


Figure 3-6. Positioning Cargo Lift Trailer to Aircraft

from aircraft and trailer guide rails are alined with guide rails in aircraft.

e. When trailer is correctly alined with aircraft, set trailer parking brakes.

f. Remove pyramid jack bases from their hangers and place under each leveling jack.

CAUTION

Make certain jack bases are centered exactly under jack cylinder rods.

g. Extend jack cylinders until load is resting on bases.

h. Raise platform to level of aircraft cargo deck. Platform cylinders may be controlled in pairs (front and rear) by separate switches to jog lagging cylinders.

CAUTION

When the platform is loaded, scissor arm wheels must be in contact with the tracks at all times to equally distribute load.

i. Make final adjustment of cargo lift platform to shipping pallet in aircraft by adjusting individual leveling jacks.

CAUTION

Platform cylinders must not be used to aline platform with aircraft.

j. Position a forklift at tongue end of trailer as a safety to prevent pallet from going over center or trailer platform.

k. If off-loading pallet from aircraft B-377-SG, connect aircraft winching equipment to pallet, remove tiedown connections between pallet and aircraft, and push pallet from aircraft onto cargo lift trailer platform.

l. If off-loading pallet from aircraft B-377-PG, connect one end of a cable to pallet, extend it over roller on tongue end of the cargo lift trailer, and connect other end to a prime mover.

m. Remove all tiedowns between pallet and aircraft and, using prime mover, pull pallet from aircraft onto cargo lift trailer platform.

n. Secure each end of pallet to trailer with a chain capable of holding 20,000 pounds, to prevent longitudinal movement of pallet.

o. Disconnect aircraft winching equipment or prime mover, as applicable, from pallet.

p. Remove forklift from end of trailer.

q. Lower platform onto trailer chassis assembly.

r. Using prime mover, take up slack between trailer and mover to obtain a slight amount of tension on trailer, away from aircraft.

s. Retract leveling jack cylinders and store pyramid jack bases on their hangers.

t. Release trailer parking brakes.

u. Tow trailer away from aircraft.

3-17. OFF-LOADING ENGINE, NOZZLE EXTENSION, AND MISCELLANEOUS LOOSE EQUIPMENT FROM SHIPPING PALLET. (See figures 3-3 and 3-4.)

a. Unzip engine cover and visually inspect engine for evidence of shipping damage.

b. Remove tiedown securing air transport engine handler to shipping pallet and load engine onto low-bed trailer as outlined in paragraph 3-3.

CAUTION

Do not remove tiedowns until engine handler sling is connected to handler.

c. Remove tiedowns securing nozzle extension to shipping pallet and load nozzle extension on low-bed trailer as outlined in paragraph 3-4.

d. Remove tiedowns securing miscellaneous loose equipment to shipping pallet and load equipment on trailer as outlined in paragraph 3-5.

3-18. REMOVING MISCELLANEOUS LOOSE EQUIPMENT FROM LOW-BED TRAILER.

a. Remove tiedowns securing loose equipment containers.

b. Using a forklift, remove containers from trailer.

3-19. REMOVING NOZZLE EXTENSION FROM LOW-BED TRAILER.

a. Using a facility hoist capable of lifting 5,000 pounds, position Engine Handling Sling G4052 for attachment to Nozzle Extension Handling Adapter G4081, or to shipping container RK392-40013-11. Attach guide lines to sling.

b. Connect sling handling cables (long cables) to 4 lift rings on adapter frame, or to 4 lift rings on shipping container.

c. Remove tiedowns securing assembly to trailer.

d. Hoist assembly clear of trailer and lower to ground.

e. Remove sling.

3-20. REMOVING ENGINE FROM LOW-BED TRAILER.

a. Attach Engine Handler Sling G4052 to a facility hoist capable of lifting 30,000 pounds. Attach guide lines to sling.

b. Remove 2 forward lift/tiedown rings from Air Transport Engine Handler G4044 and install 2 forward lift adapters (stored on forward platform). Store lift/tiedown rings on forward platform.

c. Using hoist, position sling above handler. Lower sling, guiding sling cables down over engine to prevent possible damage to engine cover.

d. Connect sling cables to handler at 2 forward lift adapters and 2 aft lift rings (located forward of rear stacking adapters).

CAUTION

Cables must not be connected to the extreme aft tiedown/lift rings, since cables can damage the engine thrust chamber exit when handler is lifted.

- Eyebolts of lift rings and bolts of lift adapters must have full thread engagement and must be positioned so that lift rings and adapters are in line of lift before sling is connected.

e. Remove all tiedown chains securing handler to low-bed trailer.

f. Check that handler wheel brakes are unlocked.

g. Using hoist, lift engine and handler clear of low-bed trailer and lower to ground.

h. Disconnect sling from handler and store in appropriate equipment storage area.

SECTION IV

SHIPPING BY WATER TRANSPORT

WARNING

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

G4044, Air Transport Engine Handler
G4052, Engine Handler Sling
G4080, Nozzle Extension Handling Fixture
G4081, Nozzle Extension Handling Adapter

4-1. SCOPE. Truck and water transportation are used to transport the engine, nozzle extension, loose equipment, and thermal insulation to their final destination. The following paragraphs provide instructions for loading and offloading the engine, nozzle extension, loose equipment, and thermal insulation on a low-bed trailer and ship, using Engine Handler Sling G4052 and a mobile hoist. Truck transport and water transport checklists are also included to be used as guides to make sure that necessary procedures have been accomplished.

4-2. LOADING TRUCK TRANSPORT.

4-3. LOADING ENGINE ON LOW-BED TRAILER. (See figure 4-1.)

WARNING

Air Transport Engine Handler G4044 and Engine Handler Sling G4052 must be operated by authorized personnel trained in the use of the equipment.

a. Make sure that engine is properly installed on Air Transport Engine Handler G4044. (Refer to section I.)

b. (Deleted)

c. Attach Engine Handler Sling G4052 to a hoist capable of lifting 30,000 pounds minimum. Attach guidelines to sling.

d. Remove 2 forward lift/tiedown rings from Air Transport Engine Handler G4044 and install 2 forward lift adapters (stored on forward platform). Store lift/tiedown rings on forward platform.

e. Using hoist, position sling above handler. Lower sling, guiding sling cables down over engine to prevent possible damage to engine cover.

CAUTION

Cables must not be connected to the extreme aft/tiedown rings, since cables can damage the engine thrust chamber exit when the handler is lifted.

- Lift ring eyebolts and lift adapter bolts must have full thread engagement and must be positioned so that lift rings and adapters are in line of lift before the sling is connected.

f. Connect sling cables to handler at 2 forware lift adapters and 2 aft lift rings (located forward of rear stacking adapters).

g. Position low-bed trailer next to handler.

h. Using hoist, install engine and handler on trailer. (See figure 4-1.)

NOTE

Front of engine must face front of low-bed trailer.

i. Lock handler wheel brakes, and disconnect sling from handler.

j. Remove 2 forward lift adapters from handler, and install 2 forward lift/tiedown rings. Store lift adapters on forward platform.

k. Secure handler to bed of trailer with tiedown chains to prevent movement of handler. (See figure 4-1.)

l. Unlock handler wheel brakes.

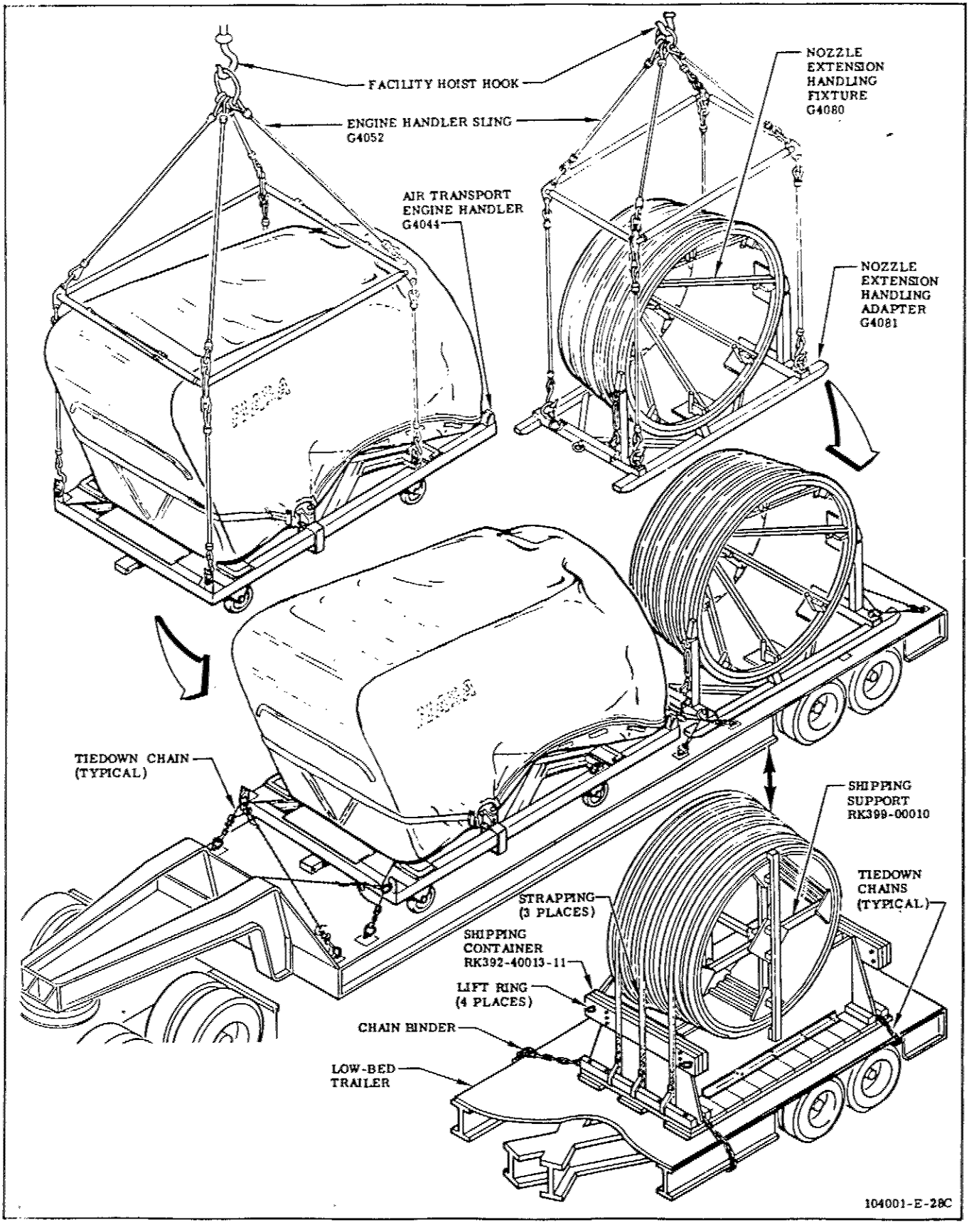


Figure 4-1. Loading Engine and Nozzle Extension on Low-Bed Trailer (Sheet 1 of 3)

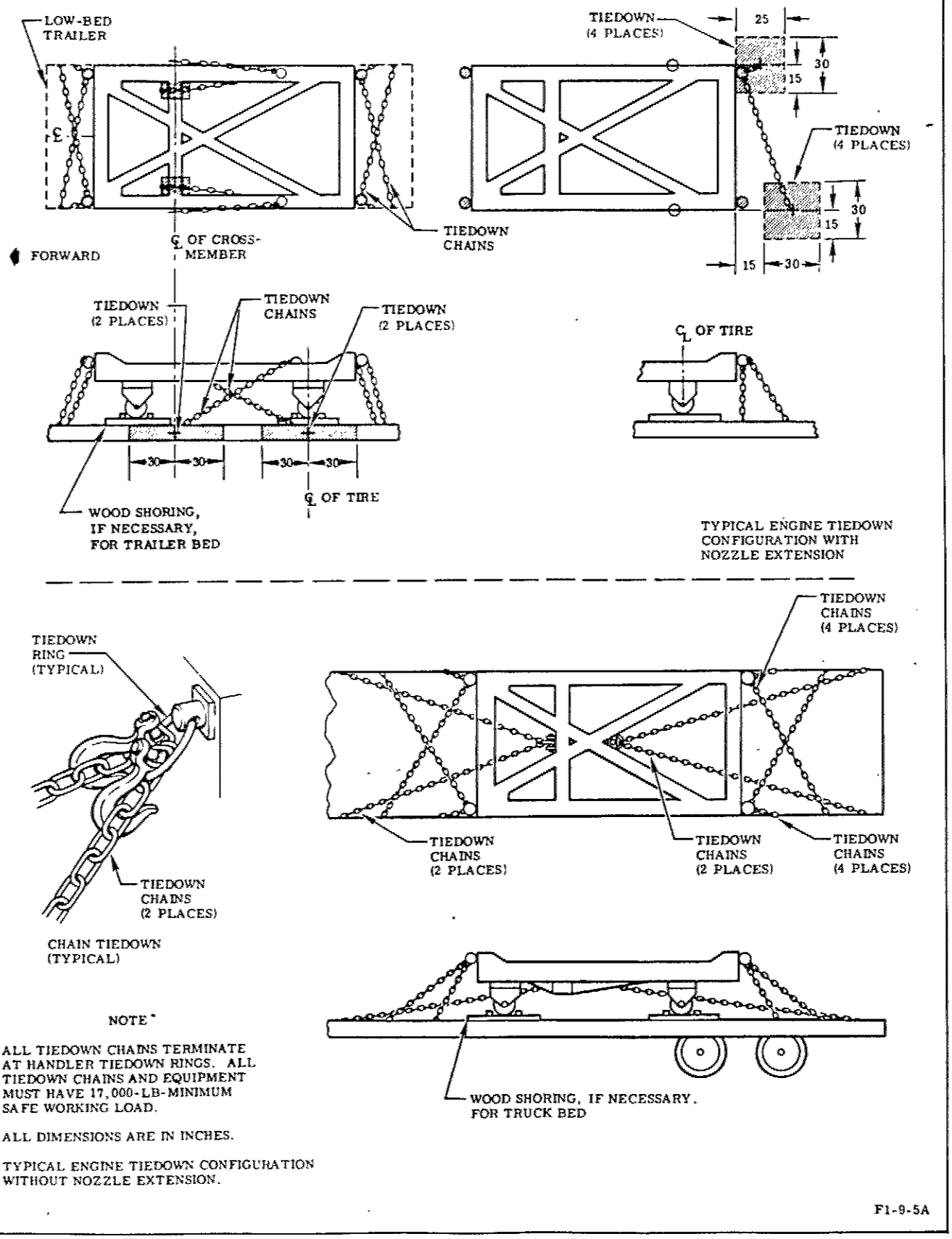


Figure 4-1. Loading Engine and Nozzle Extension on Low-Bed Trailer (Sheet 2 of 3)

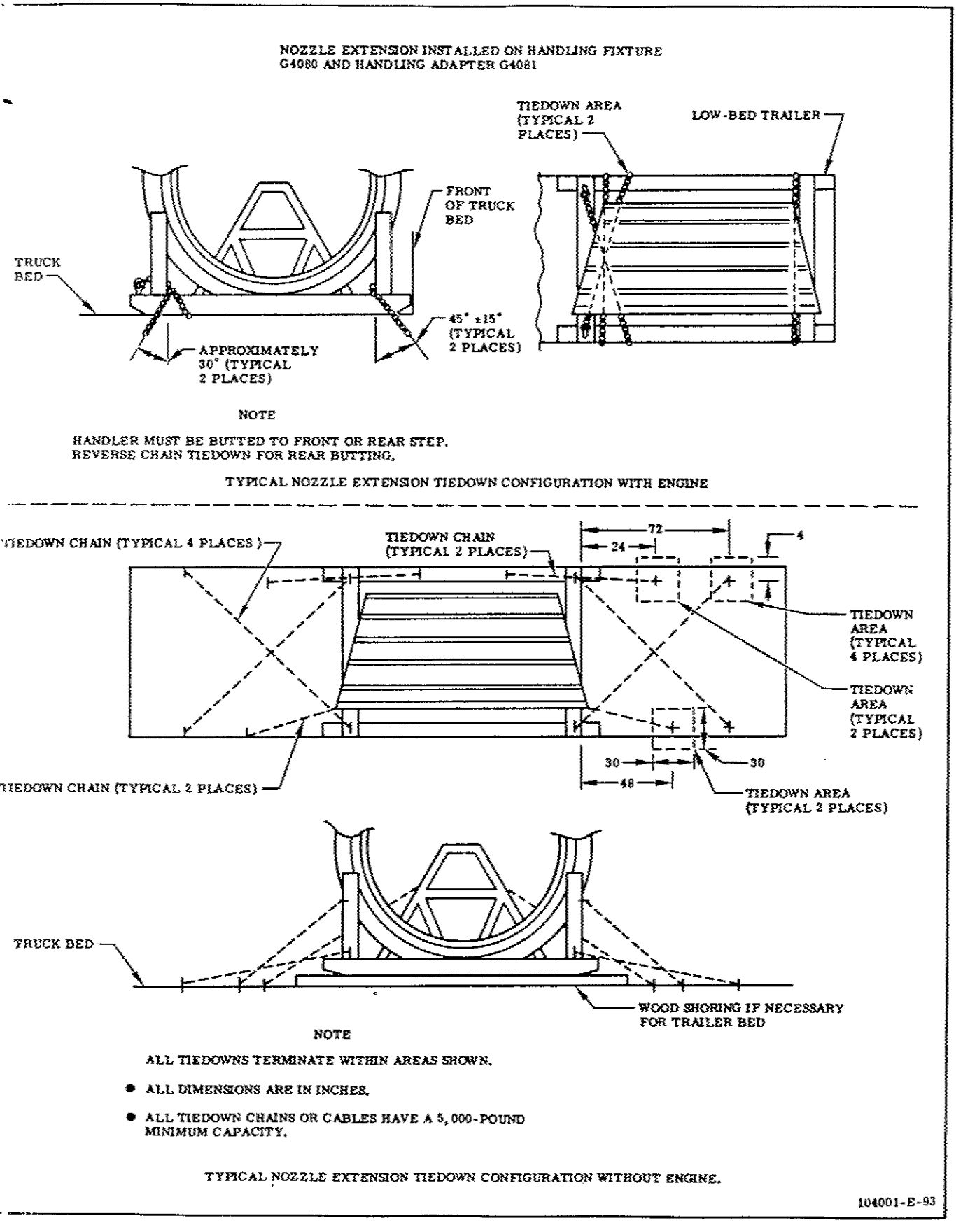


Figure 4-1. Loading Engine and Nozzle Extension on Low-Bed Trailer (Sheet 3 of 3)

4-4. LOADING NOZZLE EXTENSION ON LOW-BED TRAILER. (See figure 4-1.)

WARNING

Nozzle Extension Handling Fixture G4080 and Nozzle Extension Handling Adapter G4081 must be operated by authorized personnel trained in the use of the equipment.

a. Make sure that nozzle extension is properly installed on Nozzle Extension Handling Fixture G4080 and that handling fixture is secured to Nozzle Extension Handling Adapter G4081, or that nozzle extension is properly installed on shipping container RK392-40013-11. (Refer to section I.)

b. Using a facility hoist capable of lifting 5,000 pounds, position Engine Handler Sling G4052 for attachment to adapter or shipping container. Attach guidelines to sling.

c. Connect sling cables (long cables) to 4 lift rings on adapter frame or to 4 lift rings on shipping container.

d. Hoist adapter or container with nozzle extension into place on trailer.

e. Secure adapter or container to bed as shown in figure 4-1.

f. Remove sling.

4-5. LOADING LOOSE EQUIPMENT AND THERMAL INSULATION. Loose equipment may be transported on the low-bed trailer with the engine and nozzle extension, or it may be transported on a separate truck. Thermal insulation may be transported on a separate truck. In either case, equipment is loaded as follows:

a. Using a forklift, position containers of loose equipment or thermal insulation on trailer or truck bed to equally distribute weight.

CAUTION

Rope or chains must be tightened snugly, but care must be taken not to overbind since damage to shipping containers can result.

b. Secure containers with rope or chains to truck/trailer bed.

4-6 through 4-8. (Deleted)

4-9. TRUCK TRANSPORT CHECKLIST (LOCAL).

4-10. The truck transport checklist (figure 4-4) is to be used as a guide to make sure that all necessary procedures have been accomplished before the truck departs and that specified requirements are met in transit.

4-11. LOADING WATER TRANSPORT.

4-12. LOADING LOOSE EQUIPMENT AND THERMAL INSULATION ABOARD SHIP. The loose equipment requires approximately 105 cubic feet of shipping area, and thermal insulation requires approximately 1,315 cubic feet of shipping area. The loose equipment and thermal insulation containers may be stacked a maximum of 12 feet high.

a. Remove tiedowns that secure loose equipment and thermal insulation containers.

b. Using forklift, remove containers from trailer or truck and place aboard ship.

CAUTION

Rope or chains must be tightened snugly, but care must be taken not to overbind since damage to shipping containers can result.

c. Secure loose equipment and thermal insulation with chains or rope to cargo deck

4-13. LOADING NOZZLE EXTENSION ABOARD SHIP. (See figure 4-5.) The nozzle extension requires approximately 200 square feet of shipping area.

a. Position a mobile hoist capable of lifting 5,000 pounds, aboard ship to one side at aft end of cargo deck.

b. Position a tug with a towing capacity of 4,000 pounds aboard ship forward of hoist.

c. Position truck/trailer aboard ship next to hoist (preferably backed on).

d. Using mobile hoist, position Engine Handler Sling G4052 for attachment to Nozzle Extension Handling Adapter G4081 or to shipping container RK392-40013-11. Attach guidelines to sling.

e. Connect sling cables (long cables) to 4 lift rings on adapter frame or to 4 lift rings on shipping container.

f. Remove tiedowns that secure adapter or container to trailer.

g. Hoist adapter or container clear of trailer and lower to cargo deck.

Figures 4-2 and 4-3 deleted.

Check Required	Initial or Stamp	Check Required	Initial or Stamp
BEFORE LOADING ON TRUCK		c. No visible extension damage.	
a. No visible engine damage.		d. Nozzle extension prepared for shipping in accordance with R-3896-9.	
b. Engine prepared for shipping in accordance with R-3896-9.		(1) Nozzle extension installed on Nozzle Extension Handling Fixture G4080 and Nozzle Extension Handling Adapter G4081, or shipping container RK392-40013-11.	
(1) Engine in lowered (shipping) position on Air Transport Engine Handler G4044.		e. Loose equipment or thermal insulation set properly packaged for shipping in accordance with R-3896-9.	
(2) Desiccant installed in closures.		LOADING ON TRUCK	
(3) Closures installed.		a. Engine loaded on low-bed trailer in accordance with R-3896-9.	
(4) Gimbal Bearing locks installed.		(1) Engine faces front of trailer.	
(5) Thrust chamber throat closure installed or thrust chamber throat security closure installed and sealed.		(2) Handler secured to trailer.	
(6) Engine cover installed and sealed.		(3) Handler wheel brakes unlocked.	
(7) Engine forms sealed in waterproof material in security pouch.		(4) No visible engine damage.	
(8) Serial numbers of seals recorded in Government Bill of Lading.		b. Nozzle extension loaded on low-bed trailer or truck in accordance with R-3896-9.	
(9) Engine Log Book may be mailed or can accompany the engine, whichever is suitable.			

Figure 4-4. Truck Transport Checklist (Local) (Sheet 1 of 2)

Check Required	Initial or Stamp	Check Required	Initial or Stamp
(1) Adapter or shipping container secured to trailer or truck.		(2) Estimated arrival time.	
(2) No visible nozzle extension damage.		(3) Seal numbers.	
c. Loose equipment or thermal insulation containers loaded on trailer or truck in accordance with R-3896-9.		b. Consignor must notify consignee by telephone or radio of arrival time at least 2 hours before arrival.	
(1) Containers properly secured to trailer or truck.		c. Driver must comply with the following:	
(2) No visible container damage.		(1) Know his responsibilities.	
IN-TRANSIT REQUIREMENTS		(2) Notify consignee of breakdown, delay, or any deviation from planned transit.	
a. Consignor must notify consignee by TWX of the following:		(3) Observe any additional requirements designated by transportation officer, as annotated on Government bill of lading.	
(1) Departure time and date.			

Figure 4-4. Truck Transport Checklist (Local) (Sheet 2 of 2)

All data on page 4-8 deleted.

h. Remove sling, and drag nozzle extension on its skids to tiedown position.

NOTE

The recommended tiedown position for multiple nozzle extensions and engines aboard ship (figure 4-6) places the engines forward of the nozzle extensions. It may be necessary to position all engines before positioning the nozzle extensions.

- If alterations or deviations to recommended tiedown positions for multiple engines and nozzle extensions aboard ship (figure 4-6) are necessary, concurrence of Rocketdyne Engineering is required.

i. Secure adapter or container to cargo deck as illustrated in figure 4-6.

4-14. LOADING ENGINE ABOARD SHIP. (See figure 4-5.) The engine and handler require approximately 200 square feet of shipping area.

CAUTION

The engine must not, under any circumstances, be loaded aboard the ship by any transport other than the low-bed trailer since damage to engine and handler could result.

a. Position a mobile hoist capable of lifting 30,000 pounds, aboard ship to one side at aft end of cargo deck.

b. Position a tug with a towing capacity of 4,000 pounds aboard ship forward of hoist.

c. Position truck/trailer aboard ship next to hoist (preferably backed on).

d. Using mobile hoist, position Engine Handler Sling G4052 for attachment to Air Transport Engine Handler G4044, guiding sling cables down over engine to avoid any possible damage to engine.

e. Remove 2 forward lift-tiedown rings from Air Transport Engine Handler G4044, and install 2 forward lift adapters (stored on forward platform). Store lift/tiedown rings on forward platform.

CAUTION

Cables must not be connected to the extreme aft lift/tiedown rings, since cables can damage the engine thrust chamber exit when the handler is lifted.

- Lift ring eyebolts and lift adapter bolts must have full thread engagement and must be positioned so that lift rings and adapters are in line of lift before the sling is connected.

f. Connect sling cables to handler at 2 forward lift adapters and 2 aft lift rings (located forward of rear stacking adapters).

g. Remove all tiedown chains that secure handler to low-bed trailer, and attach 4 guide ropes to handler.

h. Check that handler wheel brakes are unlocked.

i. Using hoist, lift engine and handler clear of low-bed trailer and carefully lower to cargo deck. Disconnect sling.

j. Back or tow handler and engine to recommended tiedown position shown in figure 4-6.

k. Secure handler to cargo deck as illustrated in figure 4-6.

NOTE

If alterations or deviations to recommended tiedown positions for multiple engines and nozzle extensions aboard ship (figure 4-6) are necessary, concurrence of Rocketdyne Engineering is required.

4-15. WATER TRANSPORT CHECKLIST.

4-16. The water transport checklist (figure 4-7) is to be used as a guide to make sure that all necessary procedures have been accomplished before the ship departs and that specified requirements are met in transit and at final destination.

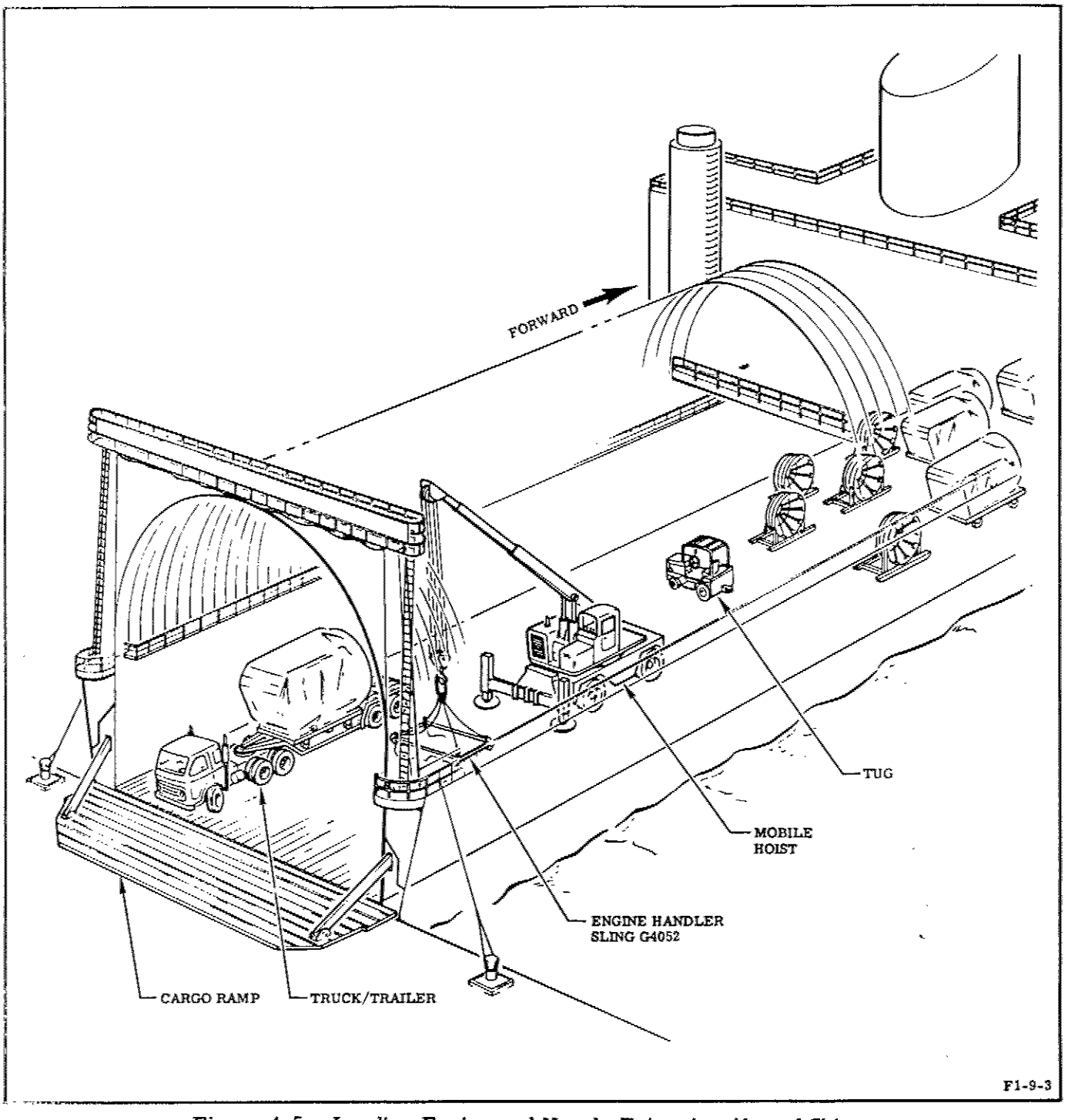


Figure 4-5. Loading Engine and Nozzle Extension Aboard Ship

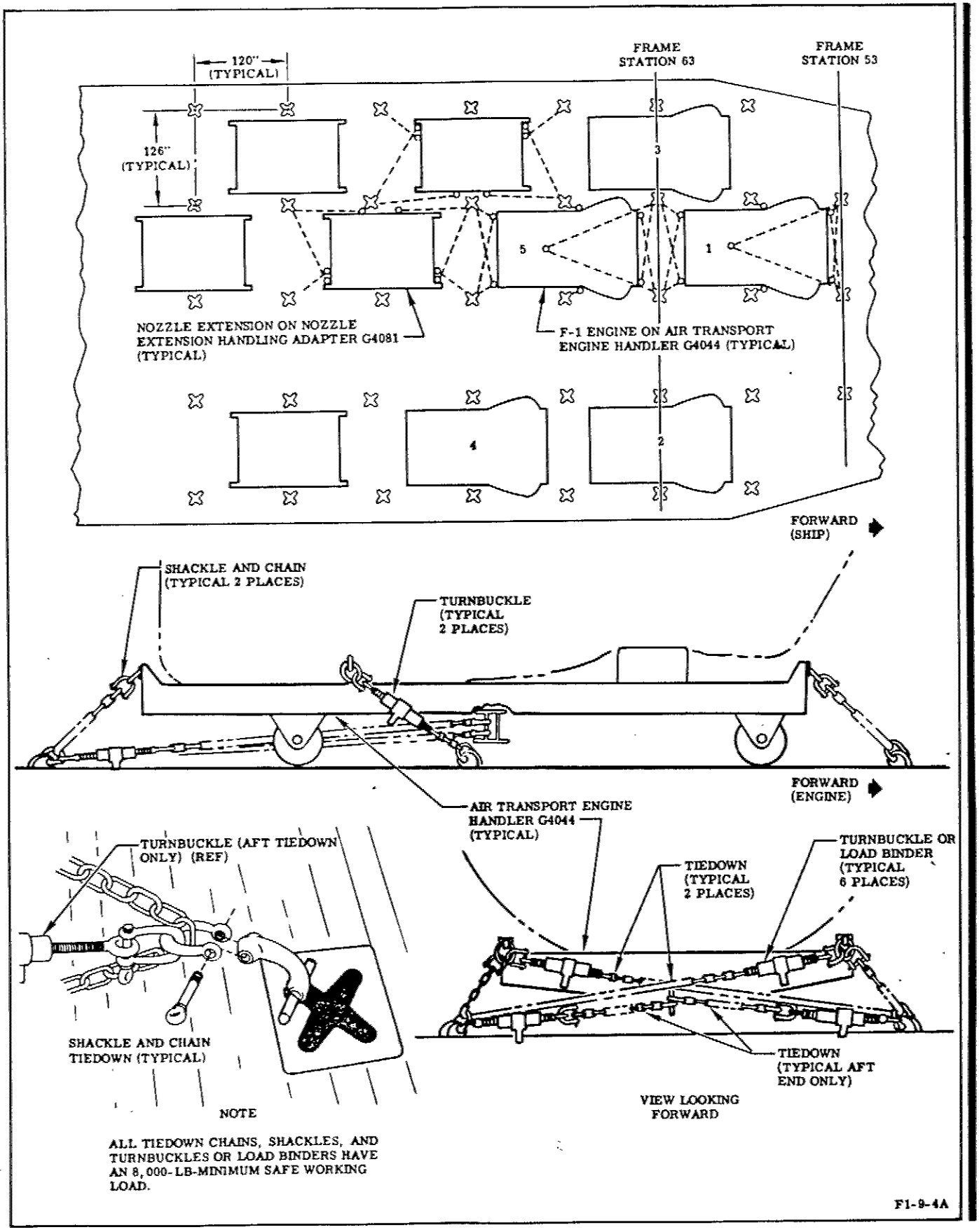


Figure 4-6. Recommended Tiedown Positions for Multiple Engines and Nozzle Extensions Aboard Ship (Sheet 1 of 2)

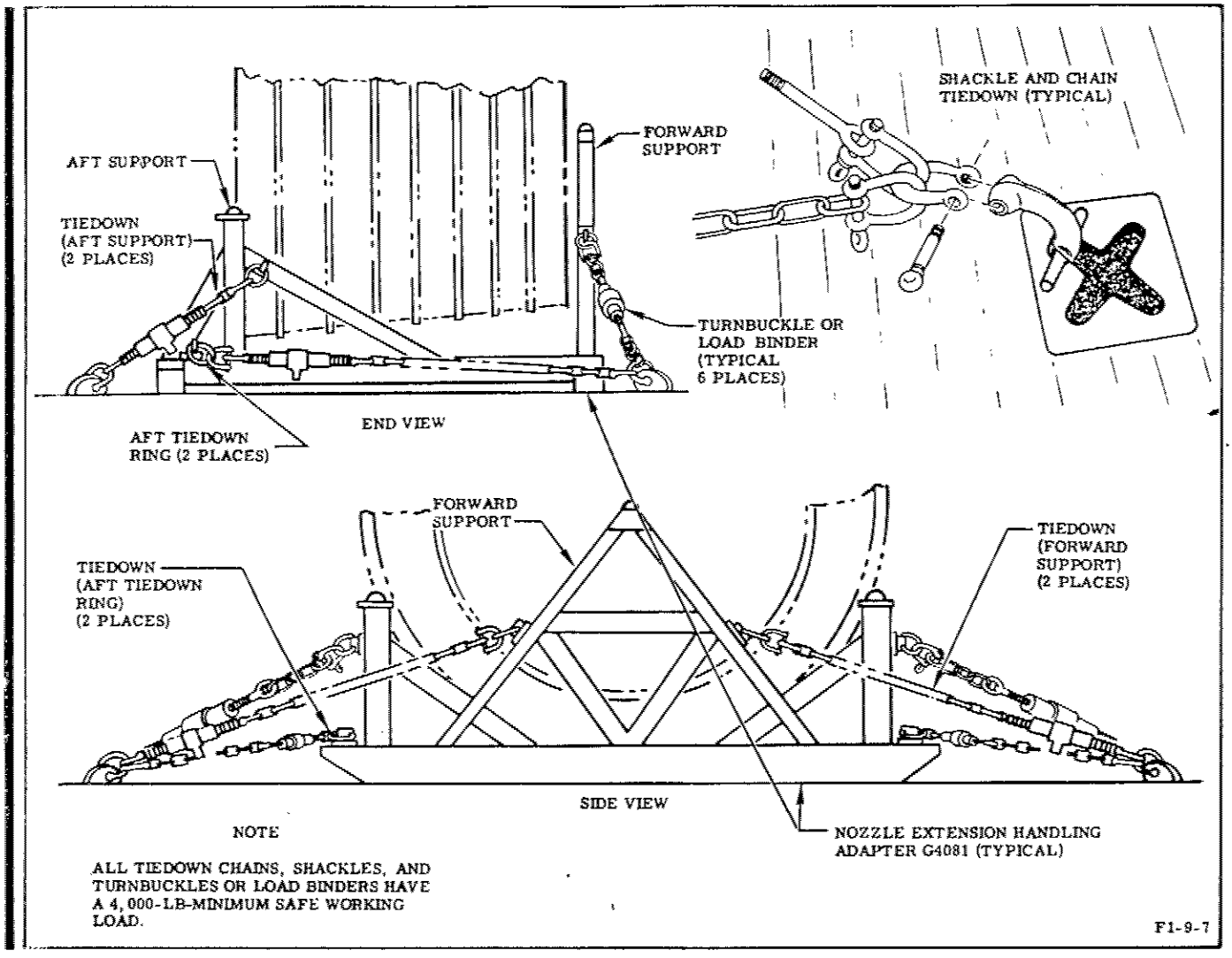


Figure 4-6. Recommended Tiedown Positions for Multiple Engines and Nozzle Extensions Aboard Ship (Sheet 2 of 2)

Check Required	Initial or Stamp
BEFORE LOADING ON SHIP	
a. No visible engine damage.	
b. Tug aboard ship in accordance with R-3896-9.	
c. Mobile hoist aboard ship in accordance with R-3896-9.	
d. Adequate supply of tiedown equipment.	
e. Engine Handler Sling G4052 accessible to hoist.	
f. No visible nozzle extension damage.	
g. Loose equipment and thermal insulation properly packaged for shipping in accordance with R-3896-9.	
LOADING ON SHIP	
a. Truck aboard ship in accordance with R-3896-9.	
b. Engine loaded aboard in accordance with R-3896-9.	
(1) Handler secured to cargo deck.	
(2) Handler wheel brakes unlocked.	
c. Nozzle extension loaded aboard ship in accordance with R-3896-9.	
(1) Adapter or shipping container secured to cargo deck.	
(2) No visible nozzle extension damage.	
d. Loose equipment and thermal insulation containers loaded aboard ship in accordance with R-3896-9.	
(1) Containers properly secured to cargo deck.	
(2) No visible container damage.	
IN-TRANSIT REQUIREMENTS	
a. Security of tiedown chains (twice daily).	
b. Consignor must notify consignee by telephone or radio 2 hours prior to arrival.	
OFF-LOADING REQUIREMENTS	
a. Engine loaded on low-bed trailer in accordance with R-3896-9.	
(1) Engine faces front of trailer.	
(2) Handler secured to trailer.	
(3) Handler wheel brakes unlocked.	
(4) No visible engine damage.	
b. Nozzle extension loaded on low-bed trailer or truck in accordance with R-3896-9.	
(1) Adapter or shipping container secured to trailer or truck.	
(2) No visible nozzle extension damage.	
c. Loose equipment or thermal insulation containers loaded on trailer or truck in accordance with R-3896-9.	
(1) Containers properly secured to trailer or truck.	
(2) No visible container damage.	

Figure 4-7. Water Transport Checklist

4-17. OFF-LOADING WATER TRANSPORT.

4-18. OFF-LOADING ENGINE FROM SHIP. (See figure 4-5.)

CAUTION

The engine must not, under any circumstances, be off-loaded from the ship by any transport other than the low-bed trailer since damage to engine and handler could result.

a. Position a mobile hoist capable of lifting 30,000 pounds, aboard ship to one side at aft end of cargo deck.

b. Position a tug with a towing capacity of 4,000 pounds aboard ship forward of hoist.

c. Position truck/trailer aboard ship next to hoist (preferably backed on).

d. Remove tiedown chains from handler, and back or tow handler and engine next to mobile hoist.

e. Using mobile hoist, position Engine Handler Sling G4052 for attachment to Air Transport Engine Handler G4044, guiding sling cables down over engine to avoid any possible damage to engine.

f. Remove 2 forward lift/tiedown rings from Air Transport Engine Handler G4044, and install 2 forward lift adapters (stored on forward platform). Store lift/tiedown rings on forward platform.

CAUTION

Cables must not be connected to the extreme aft lift/tiedown rings, since cables can damage the engine thrust chamber exit when the handler is lifted.

- Lift ring eyebolts and lift adapter bolts must have full thread engagement and must be positioned so that lift rings and adapters are in the line of lift before the sling is connected.

g. Connect sling cables to handler at 2 forward lift adapters and 2 aft lift rings (located forward of rear stacking adapters.

h. Using hoist, install handler on trailer (figure 4-1).

NOTE

Front of engine must face front of low-bed trailer.

i. Check that handler wheel brakes are locked, and disconnect sling from handler.

j. Remove 2 forward lift adapters from handler and install 2 forward lift/tiedown rings. Store lift adapters on forward platform.

k. Secure handler to bed of trailer with tiedown chains to prevent movement of handler. (See figure 4-1.)

l. Unlock handler wheel brakes.

CAUTION

The truck/trailer must be eased over off-ramp cleats to prevent excessive impact forces on the engine.

m. Drive truck/trailer with engine and handler loaded, off the ship.

4-19. OFF-LOADING NOZZLE EXTENSION FROM SHIP. (See figure 4-5.)

a. Position a mobile hoist capable of lifting 5,000 pounds, aboard ship to one side at aft end of cargo deck.

b. Position a tug with a towing capacity of 4,000 pounds aboard ship forward of hoist.

c. Position truck/trailer aboard ship next to hoist (preferably backed on).

d. Remove tiedowns that secure adapter or container to cargo deck.

e. Using tug, drag adapter or container on its skids next to mobile hoist.

f. Using mobile hoist, position Engine Handler Sling G4052 for attachment to adapter or shipping container. Attach guidelines to sling.

g. Connect sling cables (long cables) to 4 lift rings on adapter frame or to 4 lift rings on shipping container.

h. Hoist adapter or container with nozzle extension, into place on trailer.

i. Secure adapter or container to trailer bed as shown in figure 4-1.

j. Remove sling.

4-20. OFF-LOADING LOOSE EQUIPMENT AND THERMAL INSULATION FROM SHIP.

a. Remove tiedowns that secure loose equipment and thermal insulation containers to cargo deck.

b. Using a forklift, remove containers from ship and plate on truck/trailer.

CAUTION

The rope or chain must be snug but not overbound since damage to shipping containers can occur.

c. Secure containers with rope or chain to truck/trailer bed.

4-21. OFF-LOADING TRUCK TRANSPORT.

4-22. REMOVING LOOSE EQUIPMENT AND THERMAL INSULATION FROM TRUCK/ TRAILER.

a. Remove tiedowns that secure loose equipment and thermal insulation containers to truck/trailer.

b. Using a forklift, remove containers from trailer or truck.

4-23. REMOVING NOZZLE EXTENSION FROM LOW-BED TRAILER.

a. Using a facility hoist capable of lifting 5,000 pounds, position Engine Handler Sling G4052 for attachment to Nozzle Extension Handling Adapter G4081 or to shipping container RK392-40013-11. Attach guidelines to sling.

b. Connect sling handling cables (long cables) to 4 lift rings on adapter frame or to 4 lift rings on shipping container.

c. Remove tiedowns that secure adapter or container to low-bed trailer.

d. Hoist adapter or container with nozzle extension clear of low-bed trailer and lower to ground.

e. Remove sling.

4-24. REMOVING ENGINE FROM LOW-BED TRAILER.

a. Attach Engine Handler Sling G4052 to a facility hoist capable of lifting 30,000 pounds.

b. Remove 2 forward lift/tiedown rings from Air Transport Engine Handler G4044 and install 2 forward lift adapters (stored on forward platform). Store lift/tiedown rings on forward platform.

c. Using hoist, position sling above handler. Lower sling, guiding sling cables down over engine to avoid any possible damage to engine.

CAUTION

Cables must not be connected to the extreme aft lift/tiedown rings, since cables can damage the engine thrust chamber exit when the handler is lifted.

- Lift ring eyebolts and lift adapter bolts must have full thread engagement and must be positioned so that lift rings and adapters are in the line of lift before the sling is connected.

d. Connect sling cables to handler at 2 forward lift adapters and 2 aft lift rings (located forward of rear stacking adapters).

e. Remove all tiedown chains that secure handler to low-bed trailer.

f. Make sure that handler wheel brakes are unlocked.

g. Using hoist, lift engine and handler clear of low-bed trailer and carefully lower to ground.

h. Lock handler brakes, and disconnect sling from handler and store in appropriate equipment storage area.

4-25 and 4-26. (Deleted)

All data on pages 4-16 through 4-18 deleted.

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-3896-9. Supplements which have been incorporated into this manual shall be removed from the Appendix and destroyed.

Supplement Number	Dated	Description	Supplement Status
R-3896-9-1	22 May 1967	Changes turbopump shaft preload fixture and installation procedure.	Incorporated
R-3896-9-2	30 June 1967	Provides requirement and installation procedures for thrust chamber throat security closure.	Incorporated
R-3896-9-3	7 July 1967	Corrects part number and pressurizing agent used in thrust chamber throat closure.	Incorporated
R-3896-9-4	11 July 1967	Adds removal procedure for turbopump shaft preload fixture.	Incorporated
R-3896-9-5	9 August 1967	Adds storage information for attaching parts and installation instructions for turbopump shaft preload fixture.	Incorporated
R-3896-9-6	11 August 1967	Changes security closure shaft installation procedure and adds padding for engine cover.	Incorporated
R-3896-9-7	16 August 1967	Added seals for impact recorder cover.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3896-9-8	12 December 1967	Includes additional handling instructions and expands driver operating procedures.	Incorporated
R-3896-9-9	20 May 1968	Clarifies operation of impact recorder unit during water shipment.	Incorporated
R-3896-9-10	15 August 1968	Clarifies indication of humidity indicator on Thrust Chamber Throat Security Closure G4089.	Incorporated
R-3896-9-11	2 December 1968	Specifies attaching hardware for closure of Turbopump Shaft Preload Fixture G4088 and installation of cup ST3950173RKL001 when fixture is removed.	Incorporated
R-3896-6-12	8 January 1969	Removes requirements of Impact Recorder Unit G4090 for F-1 engine shipment by water transport.	Incorporated
R-3896-9-13	15 January 1969	Removes requirements of Turbopump Shaft Preload Fixture G4088 for F-1 engine shipment by water transport.	Incorporated
R-3896-9-14	16 July 1969	Adds purge requirements for oxidizer pump seal when rotating engine from vertical to horizontal (maintenance) position and from horizontal to lowered (shipping) position.	Incorporated
R-3896-9-15	30 July 1969	Adds requirement for installing turbopump shaft preload fixture on turbopump for an individual turbopump shipment.	Incorporated

Supplement Number	Dated	Description	Supplement Status
R-3896-9-16	5 December 1969	Removes the requirement for a Supplemental Engine Log Book and the recording of the thrust chamber throat security closure lock combination.	Incorporated
R-3896-9-17	28 January 1970	Specifies the part number of the turbopump oxidizer inlet closure to be used in conjunction with the turbopump shaft preload fixture.	Incorporated
R-3896-9-18	24 August 1970	Adds a requirement for protecting the nozzle extension attach flange and the igniter boss threads during shipping.	Incorporated