CHAPTER

78

Engine Exhaust GE 115

(GE90-100 SERIES ENGINES)

CHAPTER 78
ENGINE EXHAUST GE 115

A = Added, R = Revised, D = Deleted, O = Overflow, C = Customer Originated Change

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ENGINE EXHAUST GE 115

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ENGINE EXHAUST SYSTEM - INTRODUCTION

Purpose

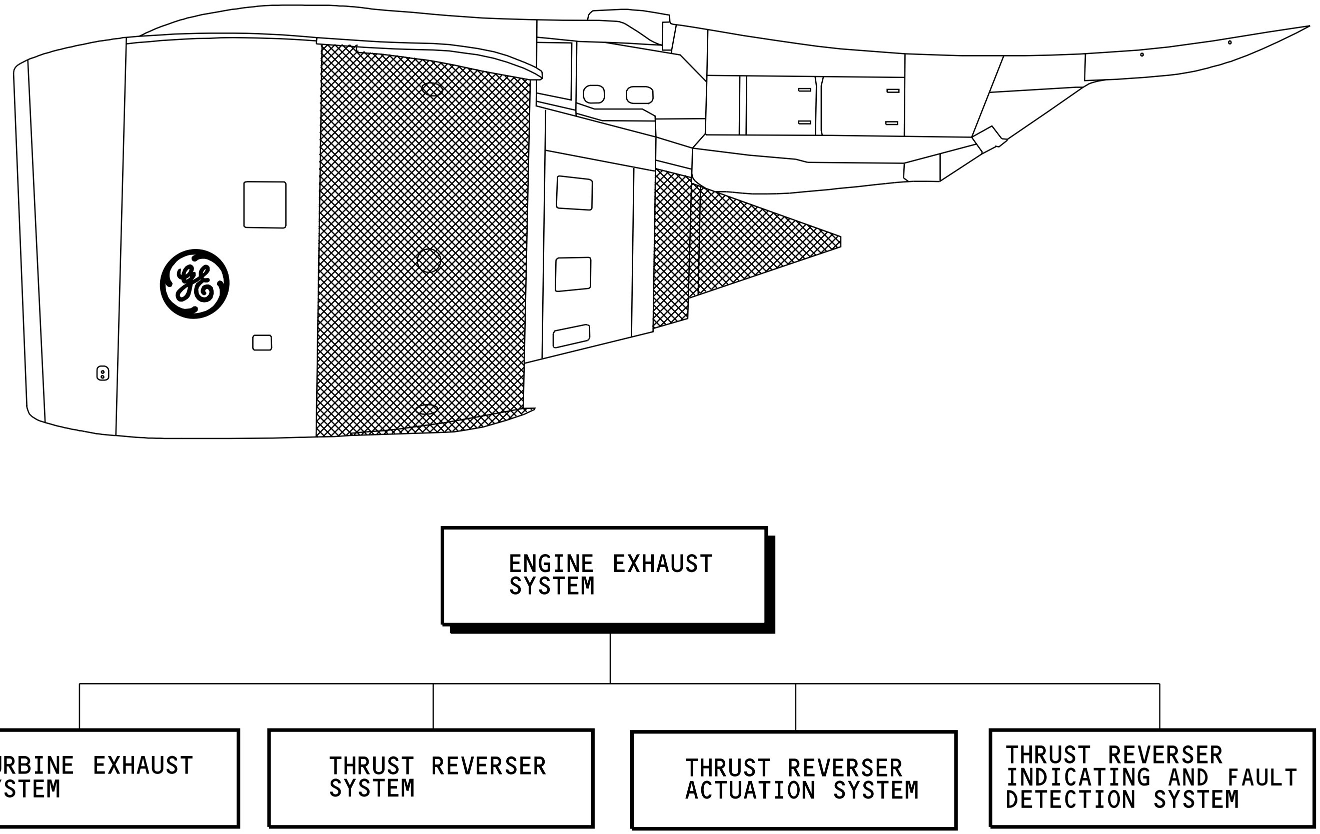
The engine exhaust system controls the direction of the engine exhaust gases.

The engine exhaust system has these subsystems:

- Turbine exhaust
- Thrust reverser (T/R)
- T/R actuation
- T/R indicating and fault detection.

Abbreviations and Acronyms

- AIMS - airplane information management system
- DCV - directional control valve
- EDIU - engine data interface unit
- EEC - electronic engine control
- EICAS - engine indication and crew alerting system
- ELMS - electrical load management system
- EPCS - electronic propulsion control system
- EPR - engine pressure ratio
- GSE - ground support equipment
- IV - isolation valve
- MAT - maintenance access terminal
- PDOS - powered door opening system
- PSEU - proximity sensor electronics unit
- PSS - proximity sensor system
- REV - reverse
- RTO - rejected takeoff
- RVDT - rotary variable differential transformer
- SL - sync lock
- SLV - sync lock valve
- sync - synchronizing
- TLA - thrust lever angle
- T/R - thrust reverser
- TRA - thrust resolver angle
- TRAS - thrust reverser actuation system



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ENGINE EXHAUST SYSTEM - INTRODUCTION

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ENGINE EXHAUST SYSTEM - GENERAL DESCRIPTION

General

The engine exhaust system controls the direction of the fan exhaust and turbine exhaust gases that make forward thrust and reverse thrust.

To make reverse thrust, you use the reverse thrust levers in the flight deck to control the direction of the fan exhaust gases. The pilot uses reverse thrust to help slow the airplane after landing or during a rejected takeoff (RTO).

Turbine Exhaust System

The turbine exhaust system uses the primary sleeve and forward and aft centerbodies to make an exit duct for the turbine exhaust gases. This system makes forward thrust only.

Thrust Reverser (T/R) System

The T/R system uses these components to control the direction of the fan exhaust:

- Sleeves
- Cascade segments
- Blocker doors
- Drag links.

This system makes forward and reverse thrust.

When the sleeves are forward (retracted), the fan exhaust makes forward thrust.

When the sleeves are aft (extended), the blocker doors and cascade segments turn the fan exhaust. This makes reverse thrust.

Thrust Reverser Actuation System (TRAS)

The TRAS moves the T/R sleeves. It uses hydraulic power for operation and electrical power for control.

The TRAS uses solenoids to control hydraulic power with these valves:

- Sync lock valve (SLV)
- Directional control valve (DCV)
- Isolation valve (IV)

Control stand switches energize the sync lock (SL) solenoid valve and the directional control solenoid valve. The sync lock valve supplies hydraulic power to release the sync lock. The DCV controls the direction of the hydraulic flow.

The EEC uses a thrust resolver angle (TRA) and other EEC inputs to control the isolation valve (IV). The IV supplies hydraulic pressure to the actuators.

The hydraulic actuators move the T/R sleeves to the extended or retracted position. The sync shafts keep the movement of the hydraulic actuators together. The sync lock/manual drive unit locks the sync shafts when the sleeves are in the retracted position.

The EEC monitors the T/R sleeve position with a rotary variable differential transformer (RVDT) to control the thrust lever interlock actuator and to schedule thrust. The thrust lever interlock actuator prevents the full movement of the reverse thrust lever until the T/R sleeves are in the correct position.

The test enable switch permits the operation of the TRAS for maintenance when the engine is not in operation.

The electrical load management system (ELMS) contains the TRAS relays.

Thrust Reverser Indicating and Fault Detection System

The T/R indicating and fault detection system uses the proximity sensor system and the EEC to monitor the TRAS.

The proximity sensor electronics unit (PSEU) receives position signals from proximity sensors for these components:

- Actuator locks
- Sync locks
- DCV.

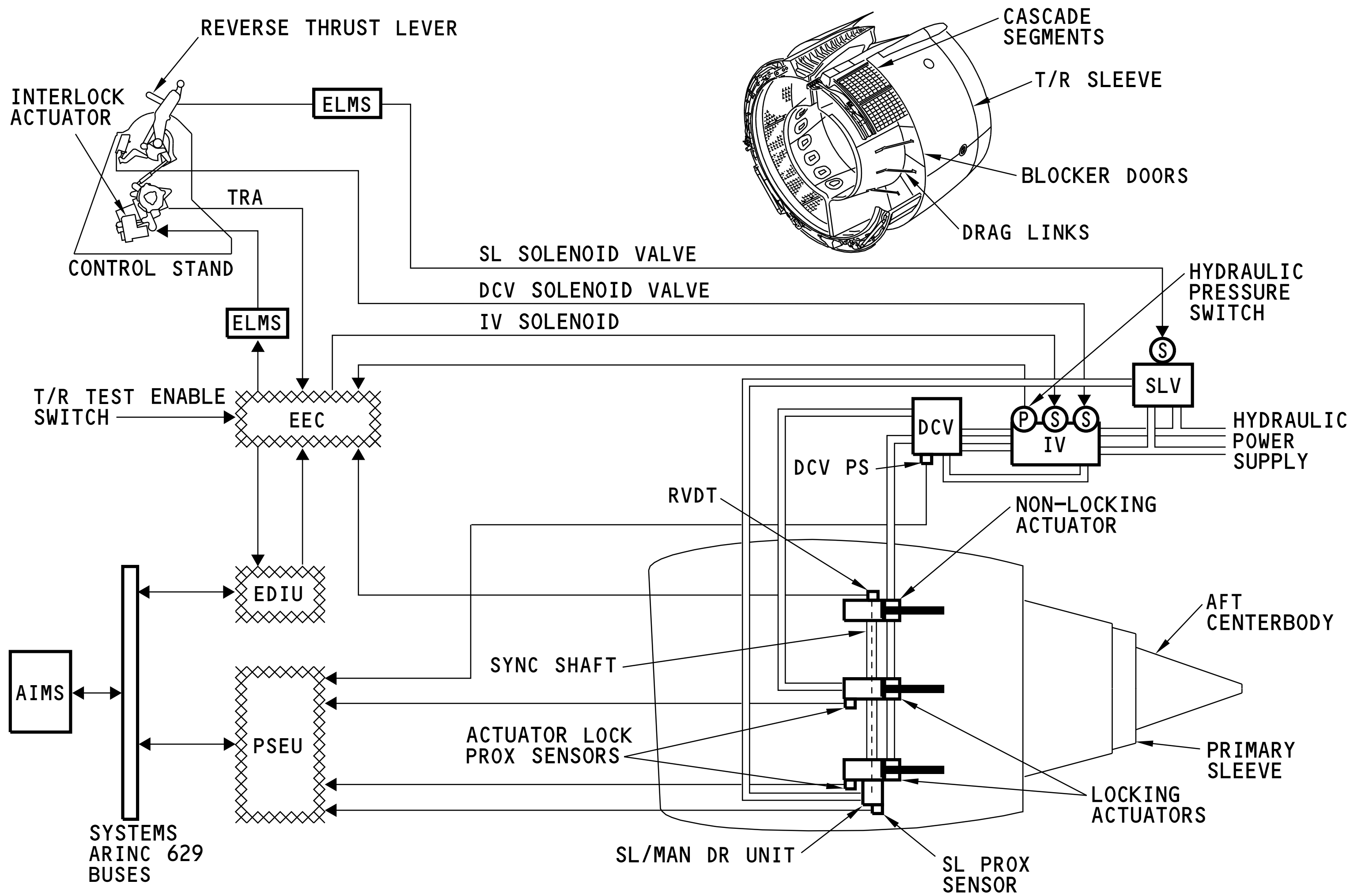
The EEC receives position signals from these components:

- RVDTs (T/R sleeve positions)

ENGINE EXHAUST SYSTEM - GENERAL DESCRIPTION

- Hydraulic pressure switch (on IV).

The EEC sends the positions of the components to the AIMS.



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ENGINE EXHAUST SYSTEM - GENERAL DESCRIPTION

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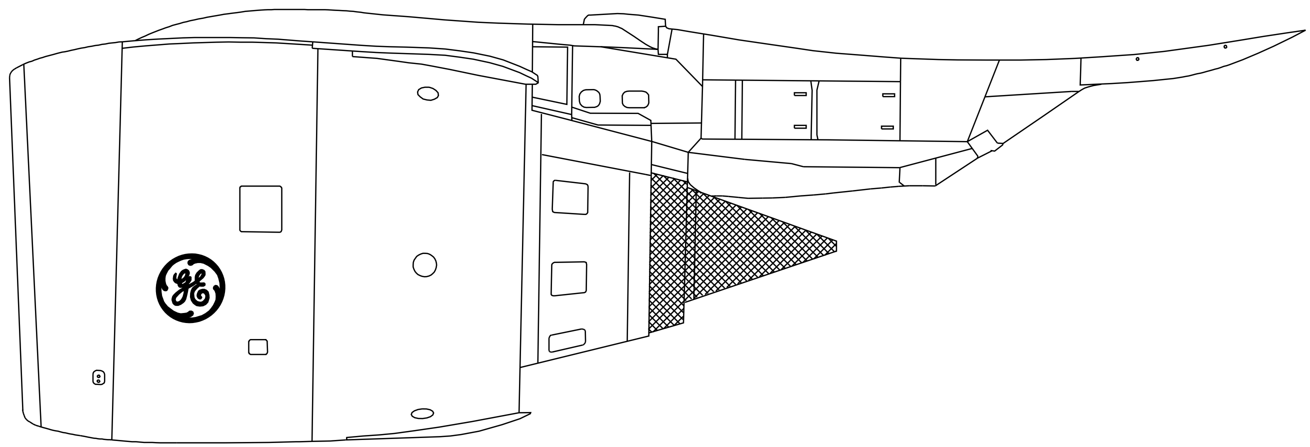
TURBINE EXHAUST SYSTEM - INTRODUCTION

Purpose

The turbine exhaust system makes an exit duct for the turbine exhaust.



ENGINE EXHAUST SYSTEM

- TURBINE EXHAUST SYSTEM
- THRUST REVERSER SYSTEM
- THRUST REVERSER ACTUATION SYSTEM
- THRUST REVERSER INDICATING AND FAULT DETECTION SYSTEM

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TURBINE EXHAUST SYSTEM - INTRODUCTION

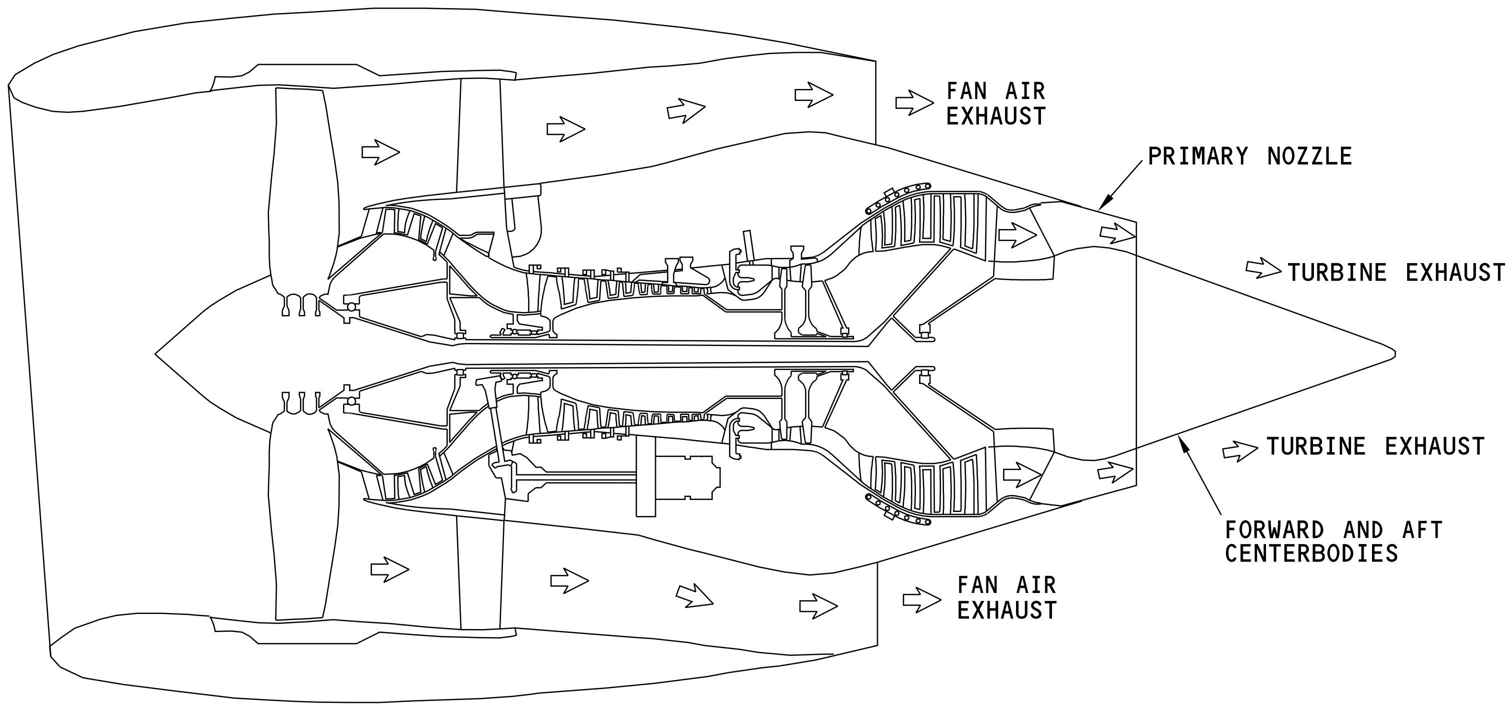
TURBINE EXHAUST SYSTEM - GENERAL DESCRIPTION

General

The turbine exhaust system controls the direction of the turbine exhaust and makes maximum thrust from the exhaust.

Physical Description

The primary nozzle makes the outer contour for the turbine exhaust. The centerbodies make the inner contour for the turbine exhaust.



TURBINE EXHAUST SYSTEM - GENERAL DESCRIPTION

TURBINE EXHAUST SYSTEM - COMPONENTS

General

These are the turbine exhaust system components:

- Primary nozzle
- Forward centerbody.
- Aft centerbody
- Vent tube extension (not shown).

Primary Nozzle

The primary nozzle makes the outer contour for the turbine exhaust.

The primary nozzle is aft of the aft cowl of the thrust reverser. It attaches to the turbine rear frame with 56 bolts. A fire seal is installed on the primary nozzle.

Forward and Aft Centerbodies

The forward and aft centerbodies make the inner contour of the turbine exhaust.

The forward center body is inside the primary nozzle. The forward center body attaches to the turbine rear frame with 28 nuts.

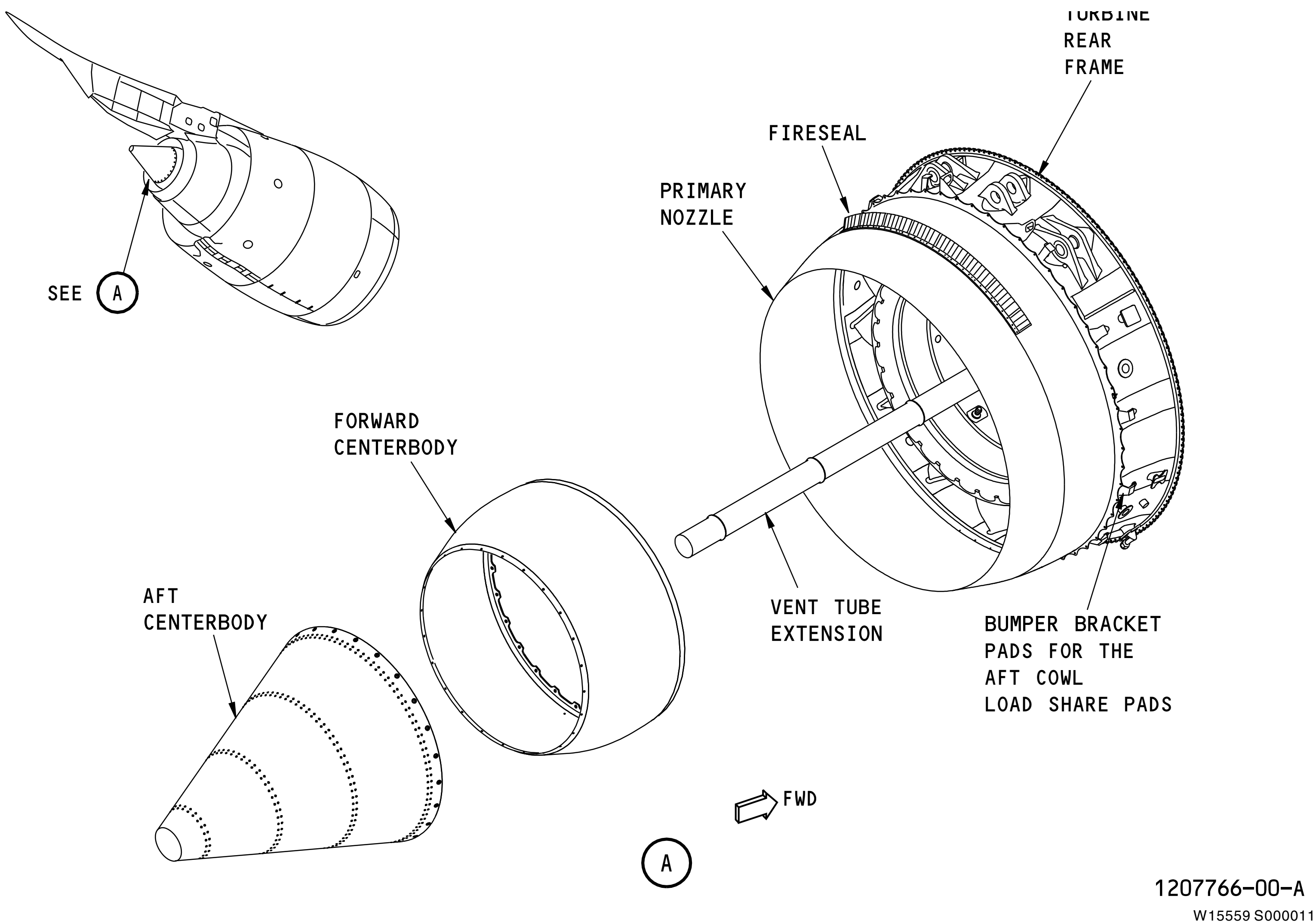
The aft center body is inside the primary nozzle. The aft center body attaches to the forward center body with 24 bolts.

Vent Tube Extension

The vent tube extension sends the oil sump vent air overboard.

The vent tube extension attaches to the number 5 bearing sump cover with 12 bolts.

The vent tube extension is inside the forward and aft centerbodies and vents air from the tip of the aft centerbody.



TURBINE EXHAUST SYSTEM - COMPONENTS

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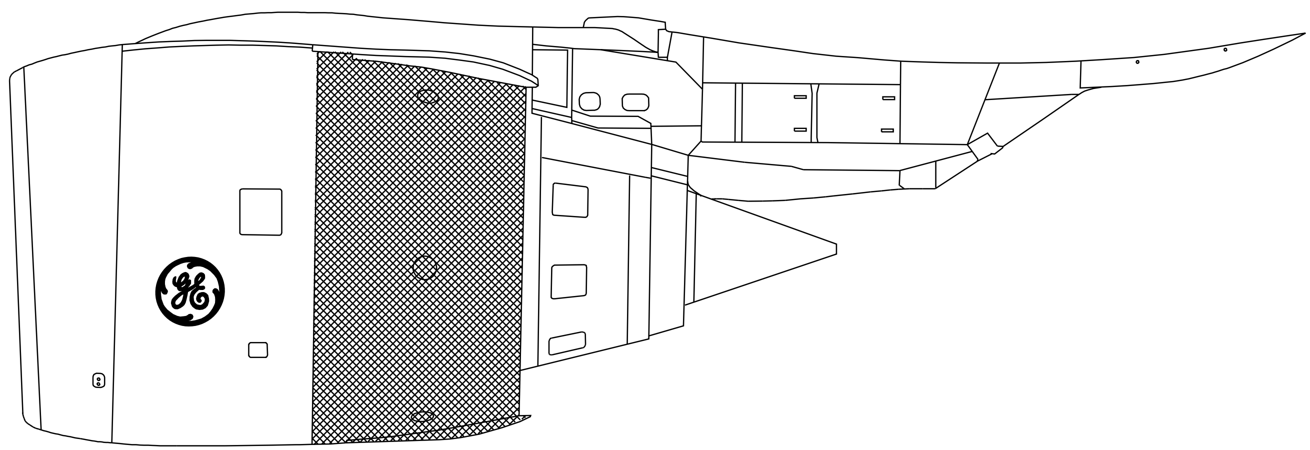
THRUST REVERSER SYSTEM - INTRODUCTION

Purpose

The thrust reverser (T/R) system controls the direction of the fan air exhaust to make forward or reverse thrust.



ENGINE EXHAUST SYSTEM

- TURBINE EXHAUST SYSTEM
- THRUST REVERSER SYSTEM
- THRUST REVERSER ACTUATION SYSTEM
- THRUST REVERSER INDICATING AND FAULT DETECTION SYSTEM

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THRUST REVERSER SYSTEM - INTRODUCTION

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THRUST REVERSER SYSTEM - GENERAL DESCRIPTION

General

The thrust reverser system controls the direction of the fan exhaust. It makes forward thrust or reverse thrust.

Physical Description

The thrust reverser (T/R) system has left and right T/R halves that attach to the engine strut. latch beam tension latches and aft cowl tension latches, deflection limiter latches, a V-band latch and V-groove latch band hold the T/R halves together.

Each T/R half has these parts:

- Torque box
- Fan duct cowl
- Aft cowl
- Upper bifurcation
- Lower bifurcation
- Hinge beam
- Latch beam
- Sliders and tracks
- Cascade segments
- T/R sleeve
- Blocker doors
- Blocker door drag links.

The thrust reverser system has fixed and translating structure, and components that provide actuation, control, indication and fault isolation/annunciation. The fixed and translating structure form the fan duct when in the forward position. When actuated for reverse thrust operation, the structure redirects the fan flow to produce reverse thrust. The actuation system has hydraulic actuators and valves. The control system controls the valves which provide hydraulic pressure to extend (deploy) and retract (stow) the translating structure or T/R sleeve. The indication system provides thrust reverser position and valve, sync-lock and actuator lock status to the airplane for flight crew and maintenance crew information.

The fixed structure is the inner wall for the fan duct cowl, cascades and torque box. The torque box forms the outer ring of the thrust reverser structure and also serves as a firewall. The torque box is attached to the hinge beam and latch beam at the front of the thrust reverser. The torque box provides the fixed structure to mount the thrust reverser actuation system. The v-blade of the torque box fits around the v-groove of the engine fan case when the thrust reverser is closed and latched. The torque box is an aluminum and steel structure.

The T/R sleeve is part of the fan duct. It uses sliders to move forward and aft in the tracks.

The fan duct cowl and aft cowl covers the inner engine core. The fan duct cowl, the upper and lower bifurcation, and the inner surface of the T/R sleeve forms the fan duct. The v-blade at the front of the fan duct cowl fits around the v-groove of the engine core when the thrust reverser is closed and latched. The fan duct cowl is a honeycomb composite structure.

The aft cowl gives a smooth surface for the fan air that comes from the fan duct. The aft cowl is mostly a titanium alloy structure and there are three pressure relief doors in each aft cowl.

The upper bifurcation connects the top of the fan duct cowl to the hinge beam. The lower bifurcation connects the bottom of the fan duct cowl to the latch beam. The upper and lower bifurcation is composite.

Sixteen cascade segments are attached between the torque box and the aft attach ring. The aft attach ring is connected between the hinge beam and the latch beam. The cascade segments are composite graphite/epoxy material.

Functional Description

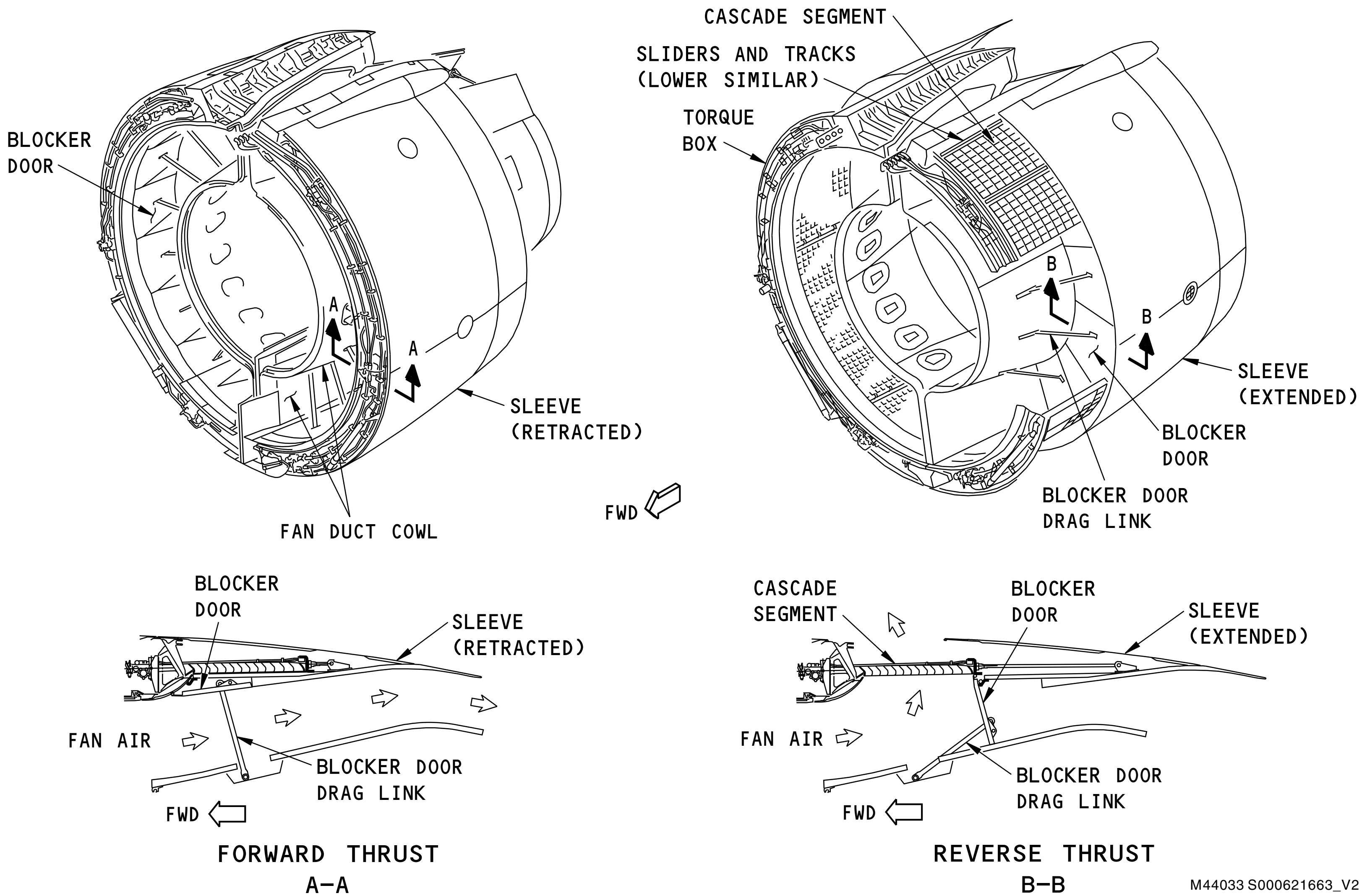
When the thrust reverser (T/R) sleeves are in the forward (retracted) position, the fan air goes through the fan duct and comes out at the rear of the fan duct. This makes forward thrust.

When the T/R sleeves move to the aft (extended) position, the blocker door drag links move the blocker doors into the fan duct. This makes the fan air flow through the cascade segments. The segments turn the fan air and cause it to come out the sides of the T/R in a forward direction. This makes reverse thrust.

THRUST REVERSER SYSTEM - GENERAL DESCRIPTION

Training Information Point

The left thrust reverser half weighs approximately 1703 lb (772 kg). The right thrust reverser half weighs approximately 1620 lb (735 kg). The thrust reverser for the GE90-100 series engine is lighter than the GE90-70/-80/-90 series engine. The thrust reverser halves require special ground support equipment (GSE) for removal, installation, and ground transportation.



THRUST REVERSER SYSTEM - GENERAL DESCRIPTION

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THRUST REVERSER SYSTEM - COMPONENTS

General

The thrust reverser has two thrust reverser halves on each engine. The thrust reverser has these main components:

- Translating sleeve
- Fan duct cowl
- Aft cowl

The thrust reverser actuation system (TRAS) which includes the locking and nonlocking hydraulic actuators, the sync lock/manual drive unit, the rotary variable differential transducer (RVDT), the isolation valve, sync lock valve, the directional control valve, and the electrical control and indication system are included in the SDS sections 78-34 and 78-36 that follow.

The thrust reverser sleeve has these components:

- Structure: outer wall, inner wall, acoustic panels, three actuator rod end attachment fittings and access panels
- Blocker doors
- Blocker door drag links
- Main and auxiliary track sliders
- Bullnose seal

The thrust reverser fan duct cowl has these components:

- Structure: Torque box, hinge and track beam, latch and track beam, inner wall, cascade aft attachment ring, hinge forward and track fairings
- V-band latch
- V-groove latch band
- Thrust reverser latch beam tension latches
- Cascade segments
- Bulb type fire seals
- Thermal insulation blankets
- Main and auxiliary track liners
- Latch access doors
- Precooler inlet duct kiss seal
- Pressure seals, miscellaneous seals, and bumpers
- Rubstrips

The thrust reverser aft cowl has these components:

- Pressure relief doors
- Bulb type fire seals and metal fire seals
- Deflection limiter latches and straps
- Aft cowl tension latches
- Thermal insulation blankets

Thrust Reverser

The thrust reverser is made of three major components; the translating sleeve, the fan duct cowl, and the aft cowl. The inner surface of the translating sleeve and the outer surface of the fan duct cowl forms the fan duct for the fan air exhaust. A cross-section view thru the thrust reverser, aft of the fan, shows a reduction in cross sectional area over the length of the fan duct; this feature is used to create thrust from the fan exhaust air.

Thrust Reverser Sleeve

The translating sleeve is part of the thrust reverser assembly. The translating sleeve engages tracks in the fan duct cowl assembly with sliders. The sleeve has a supporting structure attached to the main and auxiliary sliders, the blocker doors and drag links, the acoustic panel assemblies, the inner wall panel and the outer wall panel assemblies. When the thrust reverser is retracted, the cascade segments fit between the inner and outer wall panels of the sleeve.

The thrust reverser sleeve is stowed in a forward position during flight. When commanded during landing, the hydraulic actuators move the two thrust reverser sleeves aft. Because the drag links are connected to the inner wall of the fan duct, this moves the blockers doors down to block the flow of fan exhaust between the fan duct cowl and sleeve and exposes the cascade segments. The fan exhaust is directed forward through the vanes of the cascade segments to produce reverse thrust.

THRUST REVERSER SYSTEM - COMPONENTS

Bullnose seals are installed circumferentially along the full length of the inner wall panel of the thrust reverser sleeve. When the thrust reverser is retracted, the bullnose seal is compressed against the bullnose fairing on the torque box. The bullnose seal prevents aerodynamic pressurization of the inner and outer walls of the translating sleeve from the fan air exhaust. The loss of more than 65 percent of the bullnose seal may allow separation of the sleeve outer wall panel from the auxiliary track slider.

Thrust Reverser Fan Duct Cowl

The fan duct cowl is part of the thrust reverser assembly. There are a left and right fan duct cowl for each engine. The fan duct cowl assembly consists of the following: a one piece inner wall with upper and lower bifurcation and acoustic features, the precooler inlet duct, the forward torque box, the cascade aft attachment ring, the cascade segments, duct ventilation, the upper hinge and track beam, the lower latch and track beam, the V-band latch and the V -groove latch bands, the power door opening system (PDOS) opening actuator attachment fittings and the main and auxiliary tracks and track liners for the translating sleeve.

The cascade segments, precooler inlet duct, and inner wall are made of honeycomb composite materials. The torque box and upper hinge beam and lower latch beam are made of aluminum.

The inner wall forms part of the fan duct of the thrust reverser. The inner wall is a large one-piece composite structure that forms the upper bifurcation, the cowl that covers the engine core, and the lower bifurcation. On the airflow side, the inner wall has acoustic features. The hinge beam is attached to the upper bifurcation and the latch beam is attached to the lower bifurcation. The inner wall also has blocker door drag link mounts, the upper and lower bifurcation fire seals, vertical fire seals and engine core v-blade, the upper bifurcation compression cups and lower bifurcation compression pads, and the surge bleed duct. Most of the inner wall is made of honeycomb composite materials.

The torque box is a semi-circular structure that connects the upper hinge beam and the lower latch beam. The torque box also has a v-blade that engages the v-groove in the engine fan case. The hydraulic locking and non-locking actuators are installed through the torque box and the forward actuator gimbals are pinned to fittings on the torque box. The deploy and retract hydraulic tubing, and the sync shaft tube are located by tubing clamps mounted on the torque box. Wire bundles for the rotary variable differential transducer (RVDT) and the proximity sensors on the locking actuators and the sync lock/manual drive unit are attached to the torque box with wire bundle clamps. The v-groove latch bands and the v-band latch are attached to the torque box with clips. The forward attachment points for the cascade segments are on the aft side of the torque box.

The cascade aft attachment ring is a semi-circular structure connects the upper hinge beam with the lower latch beam and provides the aft attachment points for the cascade segments.

The upper hinge beam has machined flanges for the bushings for the No. 1, 2, 3 and 4 hinges. The upper hinge beam also has bracket structure for the forward fairing and track fairing that covers the hinges. The hinge beam fairings have small access doors that open to give clearance for the hinge fittings when the thrust reverser is opened. Small rubber bumpers were added to the door stops on the hinge beam access fairings to preload the access door hinge to prevent hinge pin vibration and subsequent loss of the access door in-flight.

The upper bifurcation compression cups engage the ends of four strut-mounted compression rods. There are four compression cups mounted on fittings on the left and right upper bifurcations. The compression rods are the primary load path to transfer the fan duct pressure load between the thrust reverser halves. Continued operation is not permitted with the compression rods damaged or missing. The compression rods are suspended from brackets under the strut. The compression rods are adjustable at the rod ends. The compression cups are not adjustable.

There are four compression wear plates mounted on fittings on the left and right lower bifurcation of the inner walls.

THRUST REVERSER SYSTEM - COMPONENTS

The right latch beam has five tension latches for the thrust reverser. The left latch beam has five latch hook bolts. The three latch access doors are attached to the left latch beam. The latch beam is covered with thermal insulation blankets.

The latch wearplates and shims are mounted to the side of the tension latches and are adjusted when the strut or the thrust reverser is replaced.

The tracks for the translating sleeve are machined into the hinge beam and the latch beam. Track liners are installed in the tracks. There is a main track and an auxiliary track on each beam. The main track engages the main track sliders on the inner wall of the translating sleeve and carries the weight of the translating sleeve. The auxiliary track engages the auxiliary track sliders on the outer wall of the translating sleeve.

On the lower latch beam, around the latch housings, there are five shear pins on the left thrust reverser and five shear pin bushings on the right thrust reverser. The shear pins fit into the bushings when the thrust reverser is closed and latched. The purpose of the shear pins and bushings is to align the bottom of the thrust reversers together. If a shear pin or bushing is missing, there would be an increase in loads and wear on the remaining shear pins and bushings. The forward shear pin and bushing and the aft shear pin and bushing cannot be missing. Any missing shear pin or bushings must be replaced.

Bulb-type fire seals are mounted in metal retainer tracks on the length of the upper bifurcation and aft cowl, the inner wall of the fan duct cowl to the vee-blade seal, and the lower bifurcation to the latch beam. When the thrust reverser is closed and latched, the bulb type fire seals are compressed against the metal seal depressors on the strut, the engine upper fancase, the structure around the lower engine drain mast and service module, and the engine core inner cowl support. The fire seal is aft of the inner wall v-blade. The inner wall v-blade fits into the v-groove in the inner cowl support. These seals help to contain an under cowl fire. Some of the fire seals act also act as aerodynamic seals which close off air gaps that can cause an operational economic penalty.

There are pressure seals on the lower bifurcation which are an aerodynamic seals which close off air gaps that can cause an operational economic penalty. There are miscellaneous seals and bumpers that provide a cushion for the thrust reverser halves when they come together when the thrust reverser is closed and latched.

The thermal insulation blankets are installed on brackets and click-bond studs that are installed on the inner surface of the inner wall. Thermal insulation blankets are mounted on the inside surface of the fan duct cowl and upper and lower bifurcation. These blankets are a thermal insulation and fire barrier which is necessary to keep the thrust reverser structurally serviceable and can decrease the damage and repair costs from a duct burst or fire. The thermal insulation prevents fire and engine operation heat damage to the composite inner wall of the fan duct cowl.

Rubstrips are mounted on the circumference of the torque box as a wear surface for the fan cowl panels and the translating sleeves.

The inner wall (or fan duct cowl) provides part of the duct for the fan air exhaust. The inner wall also covers engine core.

Aft Cowl

The aft cowl is located at the aft end of the fan duct cowl and there is a left and right aft cowl for each engine. The each aft cowl has three pressure relief doors, bulb fire seals and metal fire seals, two deflection limiter straps and latches, frame assemblies, load share pads and the skin panels. Three tension latches are mounted on the on the left aft cowl and three latch hook bolts on the right aft cowl. There are no hydraulic or electronic components in the aft cowl.

The primary purpose of the aft cowl assembly is to provide a load share structure for the engine and also to provide a smooth surface for the fan air which exits the fan duct.

The one piece bulb type fire seal on the thrust reverser upper bifurcation extends aft to the aft cowl. The two metal fire seals are mounted near the aft edge of the aft cowl. Both metal fire seals have two components, a fire seal that acts as a fire seal depressor and a fire seal that contacts the turbine exhaust sleeve. These fire seals help to contain an under cowl fire.

THRUST REVERSER SYSTEM - COMPONENTS

The aft cowl covers the turbine exhaust case of the engine and uses an iso-grid structure which reduces the number of fasteners and stringers.

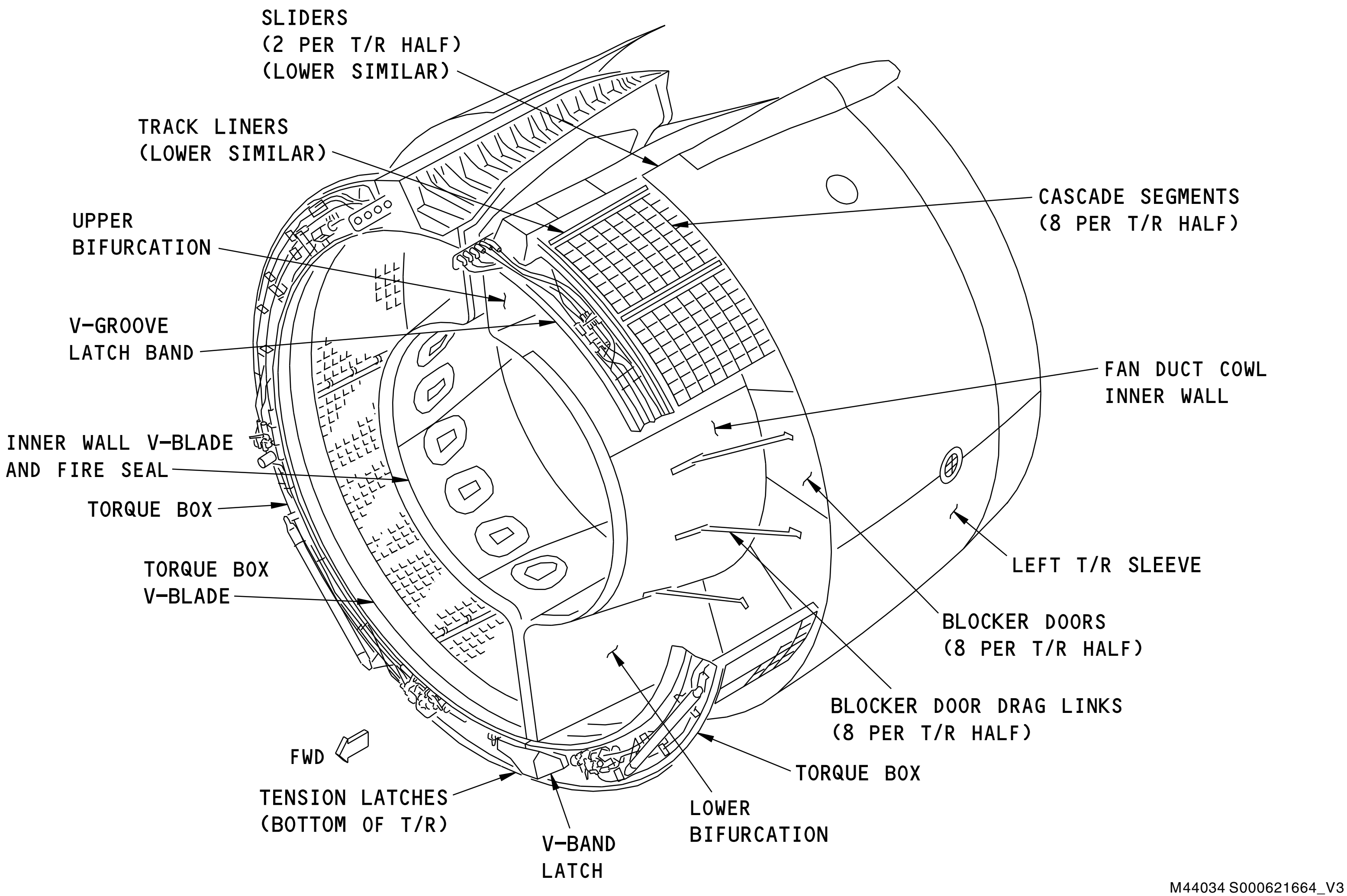
There are three pressure relief doors on each aft cowl. The pressure relief doors are hinged to open to release the under cowl air pressure from a duct burst when the pressure exceeds the door latch load.

There are thermal insulation blankets installed on studs that are installed on the inner surface of the aft cowl's iso-grid structure. These blankets are installed around the deflection limiter frames at the top of the aft cowl and around the latch housings at the bottom of the aft cowl.

The deflection limiter straps fit in the channel formed by the frames mounted on the aft cowl. The deflection limiter straps are connected to cross-tie rods. The forward straps are connected to a cross-tie rod that is suspended from brackets mounted on the bottom of the strut. The aft straps are connected to a cross-tie rod that retained between two engine brackets located aft of the aft engine mount. The cross-tie rods are adjusted to the correct length when they are installed or replaced and are not adjusted in-service. The forward deflection cross-tie rod has a turnbuckle feature. The deflection cross-tie rod has a center rod, two threaded side retainers and two threaded rod end/lug assemblies with end bearings.

There are compression pads on the tension latch housings on the left and right aft cowls. The compression pads on the right aft cowl are installed without shims and are not adjusted. The compression pads on the left aft cowl are adjusted with shims.

A total of ten load share pads are mounted circumferentially on the aft frame of the aft cowl. These load share pads come in contact with the engine mounted rubpads that are mounted on the engine turbine frame. When the thrust reverser is closed, the deflection limiter latches and straps clamp the aft cowl so that aft cowl acts as a load share structure for the engine. This limits the axial deflection of the engine during operation.



THRUST REVERSER SYSTEM - COMPONENTS

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THRUST REVERSER SYSTEM - TENSION LATCHES, T-HOOK LATCH, T-HOOK RECEIVER, INTERLOCK PIN AND SERRATED FITTING

General

The thrust reverser tension latches hold the thrust reverser halves together. There are five groups of latches:

- Deflection limiter latches
- Aft cowl tension latches
- Latch beam tension latches
- T-hook latch, gearbox, handle and T-hook receiver
- Interlock pin and serrated fitting

You open the T Bolt/ No. 2 centerline latches first, then open the remaining latches from aft to forward. You close the latches in the reverse sequence.

The thrust reverser for the GE90-100 engine has two additional latches than the thrust reverser on the GE90-70/-80/-90 engine. These additional latches were added to make sure the thrust reverser inner V-blade would not disengage from the engine core inner V-groove during a fan blade out event or a rejected takeoff event because of the higher thrust rating of this engine.

Deflection Limiter Tension Latches

There are four deflection limiter latches; two latches in each aft cowl approximately six inches from the centerline. The forward latches engage the eyebolts for two tension straps that go around the aft cowl to the deflection limiter cross-tie rod mounted on the strut. The aft latches engage the eyebolts for two tension straps that go around the aft cowl to the deflection limiter cross-tie rod mounted on the engine, aft of the aft engine mount.

The deflection limiter straps are connected to the cross-tie rods on the engine and the strut. The strap slides out of the channel of the aft cowl frames when the thrust reverser is opened. When the thrust reverser is closed, the strap slides down the channel to the latch hook.

These tension latches have adjustable hooks; use an allen wrench to adjust the hook adjustment nut. The force to close these deflection limiter latches is approximately 55 pounds (245 newtons). There is a secondary lock in the latch handle; push the lock to open the latch handle. There is a slot in the latch handle for a screwdriver blade to help open the latch handle if it binds in the closed position.

The latch handles are contoured to the shape of the outer surface of the aft cowl. The deflection limiter latches are not interchangeable between the left and right aft cowl halves.

Aft Cowl Tension Latches

There are three aft cowl tension latches in the left aft cowl, the No. 6, No. 7 and No. 8 tension latches. These latches hold the aft cowl halves together. These tension latches engage eyebolt keepers in the right aft cowl.

These tension latches have adjustable hooks; use an allen wrench to adjust the hook adjustment nut. The force to close these tension latches is approximately 55 pounds (245 newtons). There is a secondary lock in the latch handle; push the lock to open the latch handle. There is a slot in the latch handle for a screwdriver blade to help open the latch handle if it binds in the closed position.

The latch handles are contoured to the shape of the outer surface of the aft cowl. The aft cowl tension latches are not interchangeable between the forward, center and aft positions.

Latch Beam Tension Latches

There are five tension latches that hold the thrust reverser halves together.

The forward No.1 tension latch is behind to the V-band latch handle on the left torque box. This latch is a nonadjustable, lever actuated, T-hook that engages an adjustable hooked keeper on the right torque box. There is a trigger release lever on the forward latch handle. You move the trigger release lever down before you open the forward tension latch. The handle is orange color.

THRUST REVERSER SYSTEM - TENSION LATCHES, T-HOOK LATCH, T-HOOK RECEIVER, INTERLOCK PIN AND SERRATED FITTING

The No. 2, No. 3, No. 4 and No. 5 latch beam tension latches are on the bottom of the thrust reverser. You get access to the No. 2 through No. 4 latches through three latch beam access doors on the right side thrust reverser. The No. 5 tension latch is on the aft lower latch beam on the left side thrust reverser.

These tension latches engage latch bolts in the opposite latch beam. These tension latches have adjustable hooks; use an allen wrench to adjust the hook adjustment nut. The force to close these tension latches is approximately 55 pounds (245 newtons). There is a secondary lock in the latch handle; push the lock to open the latch handle. The latch handles have a small handle for your fingers to pull the latch handle open.

The No. 2 and No. 3 tension latches are interchangeable. The No. 4 tension latch is not interchangeable with No. 2, No. 3 or No. 5 tension latches. The No. 5 tension latch is not interchangeable with No. 2, No. 3 or No. 4 tension latches because the handle of the No.5 latch is made to follow the contour of the surface of the thrust reverser sleeve and latch beam fairings.

Upper Bifurcation T-Hook Latch

There is a handle and cable operated T-hook latch/gearbox on the upper bifurcation of the right side thrust reverser. The handle, push-pull cable, gearbox and T-hook are removed and installed as a one-piece unit.

The handle of the T-hook latch is forward of the No.2 tension latch on the lower latch beam. The T-hook engages a receiver on the upper bifurcation on the left thrust reverser that is forward of the precooler kiss seal and PDOS actuator. The T-hook handle moves a push-pull cable which operates a gearbox that turns the T-hook from the horizontal position to a vertical position. The T-hook is kept in the vertical position against spring force by an internal mechanism. When the T-hook is in the vertical position, the T-hook can pass between the ears of the T-hook receiver on the left side thrust reverser. When the T-hook handle is released, a spring on the gearbox returns the T-hook to the horizontal position. The T-hook engages slots in the ears of the receiver. The T-hook gearbox and the push-pull cable are installed on the inner wall of the thrust reverser. The gearbox and push-pull cable are covered by the thermal insulation blankets.

The T-hook can be adjusted in the vertical position with a turnbuckle and jam nuts on the T-hook handle.

If the gearbox, the push-pull cable or the handle were to become non-serviceable, the T-hook can be opened. You must climb into the right fan duct and get to the upper bifurcation, near the front of the thrust reverser. The T-hook can be accessed through a hole in the upper bifurcation inner wall. The T-hook shank has a 0.250 inch allen wrench feature so that you can turn the T-hook to the vertical position to disengage the T-hook from the T-hook receiver. Next, open the left side thrust reverser. Climb out of the fan duct. Finally, open the right side thrust reverser.

Lower Bifurcation Interlock Pin

There is an interlock pin on the lower bifurcation of the left side thrust reverser. The interlock pin engages a serrated fitting on a compression fitting on the lower bifurcation of the right side thrust reverser. The interlock pin engages the serrated fitting when the No.2 tension latch on the latch beam is closed and locked. The spring loaded interlock pin disengages from the serrated fitting when the No.2 tension latch is opened. The length of the interlock pin assembly can the changed by the adjustment of two turnbuckles to make sure the interlock pin engages the serrated fitting. The interlock pin is installed between a compression fitting and the No.2 latch bolt fitting on the lower bifurcation of the left thrust reverser.

Training Information Point

Chapter 78 tells you how to open and close the thrust reverser halves.

A stencil was added to the latch area on the thrust reverser and aft cowl which gives the location numbers of the latches.

The location number is different from the number used to identify a latch. As an example, the No.1 tension latch has location number 13.

A list of the latches, the latch location, and the location number is given.

Latch Location Numbers

Latch	Location	Location Number
[1] Right Aft Deflection Limiter Latch	Right Aft Cowl	1

(Continued)

Latch	Location	Location Number
[2] Left Aft Deflection Limiter Latch	Left Aft Cowl	2
[3] Left Forward Deflection Limiter Latch	Left Aft Cowl	3
[4] Right Forward Deflection Limiter Latch	Right Aft Cowl	4
[5] Aft Cowl Aft Tension Latch	Aft Cowl Centerline	5
[6] Aft Cowl MiddleTension Latch	Aft Cowl Centerline	6
[7] Aft Cowl Forward Tension Latch	Aft Cowl Centerline	7
[8] No.5 Tension Latch	Latch Beam Centerline	8
[9] No.4 Tension Latch	Latch Beam Centerline	9
[10] No.3 Tension Latch	Latch Beam Centerline	10
[11] No.2 Tension Latch and Interlock Pin	Latch Beam Centerline	11
[12] T-Hook Latch Handle	Latch Beam Centerline	12
[13] No.1 Tension Latch	Forward Torque Box	13
[14] V-band Latch	Forward Torque Box	14

CAUTION OPEN THE DEFLECTION LIMITER LATCHES ON THE AFT COWL BEFORE YOU OPEN THE THRUST REVERSER. IF THE LATCHES ARE NOT OPEN, DAMAGE TO THE STRUT, CROSS-TIE RODS, AND THE THRUST REVERSER WILL OCCUR.

When you open the thrust reverser, open the tension latches in this order:

NOTE: The latch location numbers are shown in brackets.

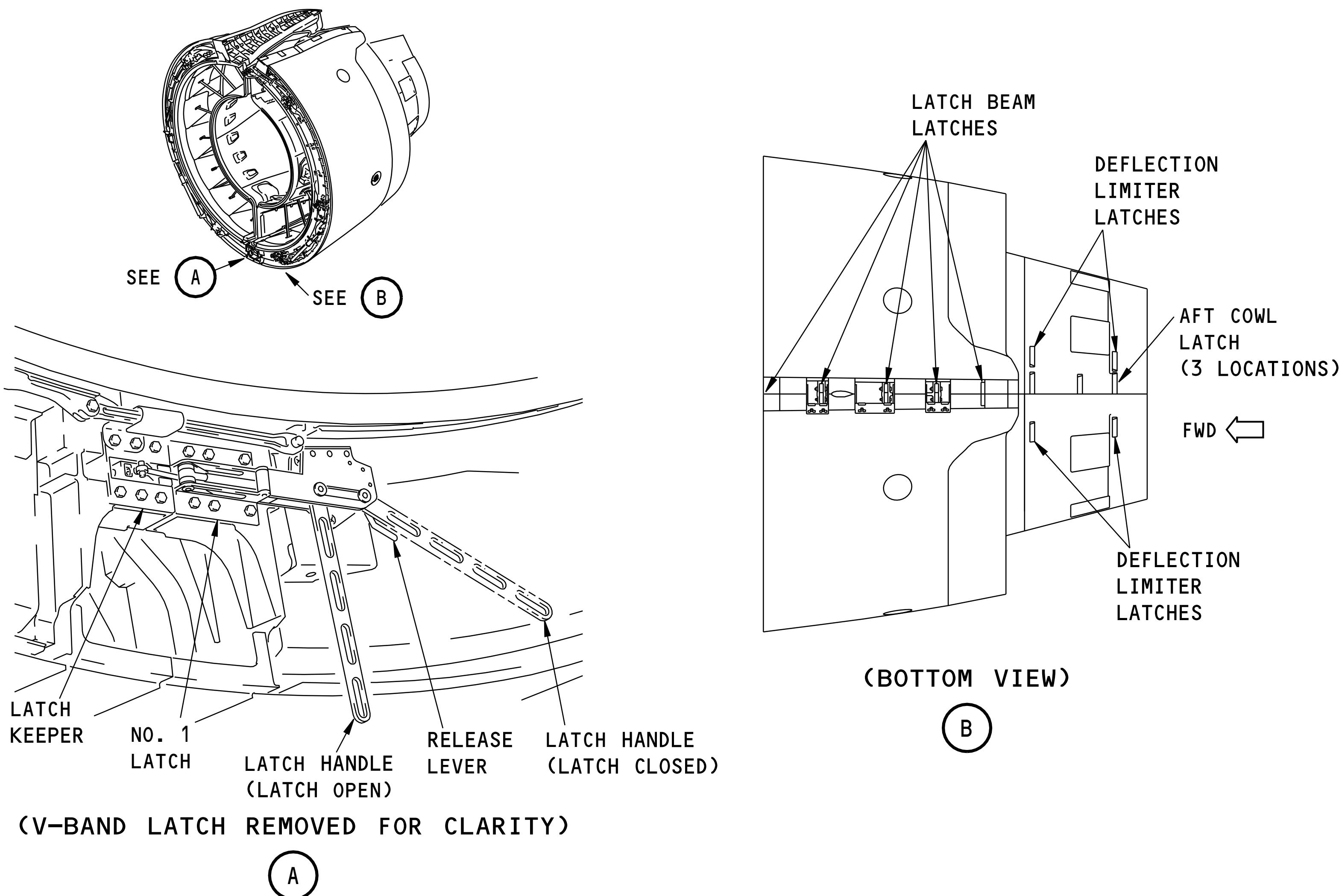
- Push the left and right PDOS down buttons to remove any hydraulic fluid from the actuators that could put a load on the latches.
- Open the T-hook [12]. Pull the T-hook handle down and at the same time push the T-handle toward the latch access door hinges to disengage the T-hook from the T-hook receiver. When you push the T-handle toward the latch access door hinges, you get through the release mechanism. Do not twist the T-handle; you can damage the T-handle or the push-pull cable.
- Open the No. 2 tension latch [11] and interlock pin. When the No.2 tension latch is opened, the interlock pin on the lower bifurcation will disengage from the serrated fitting.
- Open the deflection limiter latches; open the aft latches [1], [2] then the forward latches [3] and [4]. You must disengage the latch hook from the strap eyebolt. Failure to open the forward deflection limiter latches and disengage the latch hooks before you open the thrust reverser can cause damage to the forward deflection limiter rod and the two strut brackets that hold the rod. Failure to open the aft deflection limiter latches and disengage the latch hooks before you open the thrust reverser can cause damage to the aft deflection limiter rod and the two engine brackets that hold the rod.
- Open the aft cowl latches [5], [6] and [7] on the centerline after you open the deflection limiter latches. Open the aft latch first, then open the other latches in order from the aft latch to the forward latch.
- Open the three remaining aft latch beam latches [8], [9] and [10] after you open the aft cowl latches, but not the No.1 tension latch on the torque box. Open the aft latch first, then open the other latches in order from the aft latch to the forward latch.

THRUST REVERSER SYSTEM - TENSION LATCHES, T-HOOK LATCH, T-HOOK RECEIVER, INTERLOCK PIN AND SERRATED FITTING

- Open the No.1 tension latch [13] on the torque box.
- Open the v-band latch [14].

When you close the thrust reverser, close the tension latches in this order:

- Push the left and right PDOS down buttons to remove any hydraulic fluid from the actuators that could increase the force to close the latches.
- Close the v-band latch [14].
- Close the No.1 tension latch [13] on the torque box.
- Close the No.3 [10] , No.4 [9] and No.5 [8] tension latches. Close the latches from forward to aft.
- Close the aft cowl centerline latches [7], [6] and [5] before you close the deflection limiter latches and after you closed the latch beam latches. Close the forward aft cowl latch first, then close the other latches from the forward latch to the aft latch.
- Close the deflection limiter latches. Close the forward deflection limiter latches first [3], [4], then close the aft deflection limiter latches [2] and [1].
- Close the No.2 tension latch [11]. When the No.2 tension latch is closed, the interlock pin will engage the serrated fitting.
- Push the T-hook handle up [12] and at the same time push the T-handle toward the latch access door hinges to engage the T-hook in the T-hook receiver. When you push the T-handle toward the latch access door hinges, you get through the release mechanism. Do not twist the T-handle; you can damage the T-handle or the push-pull cable.



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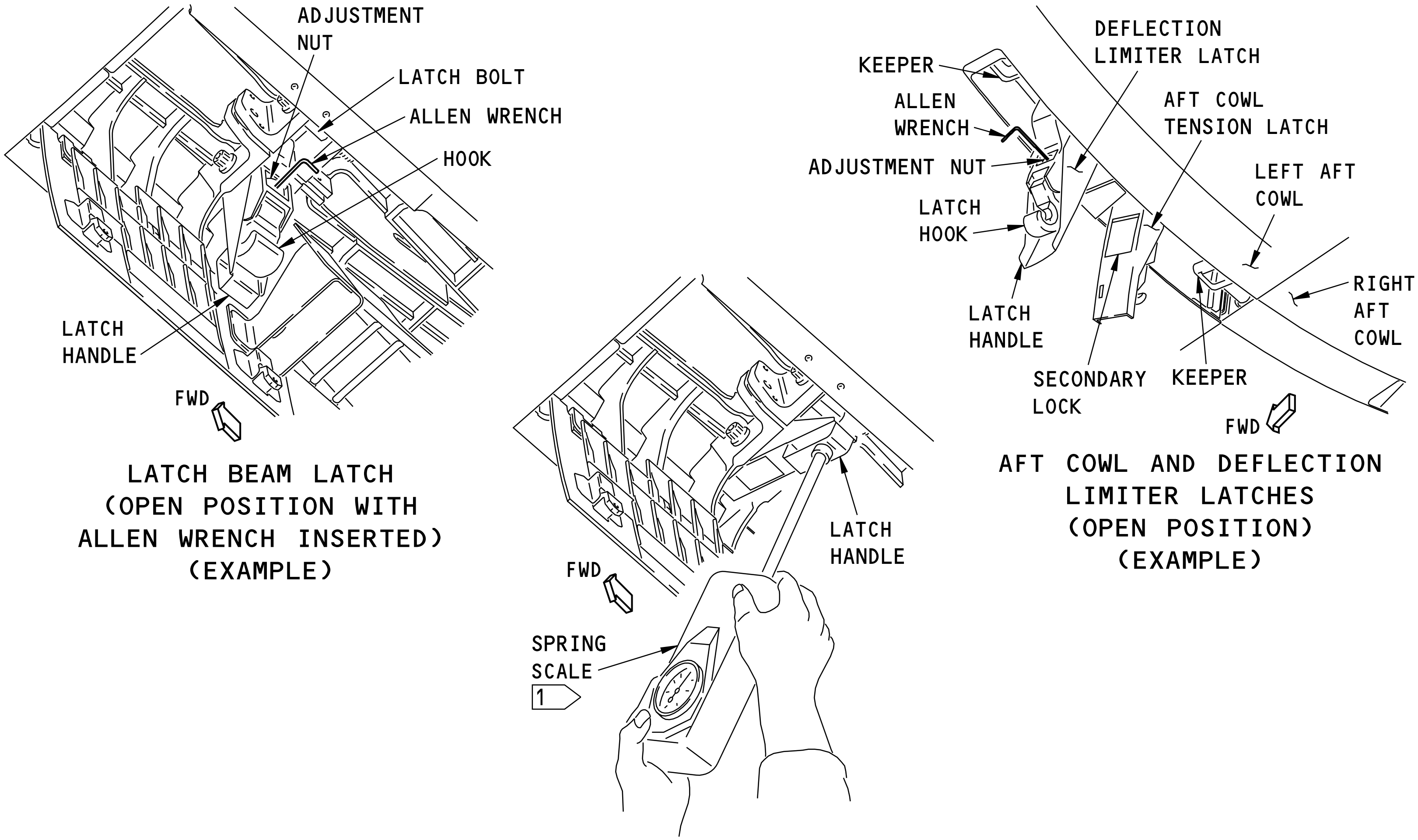
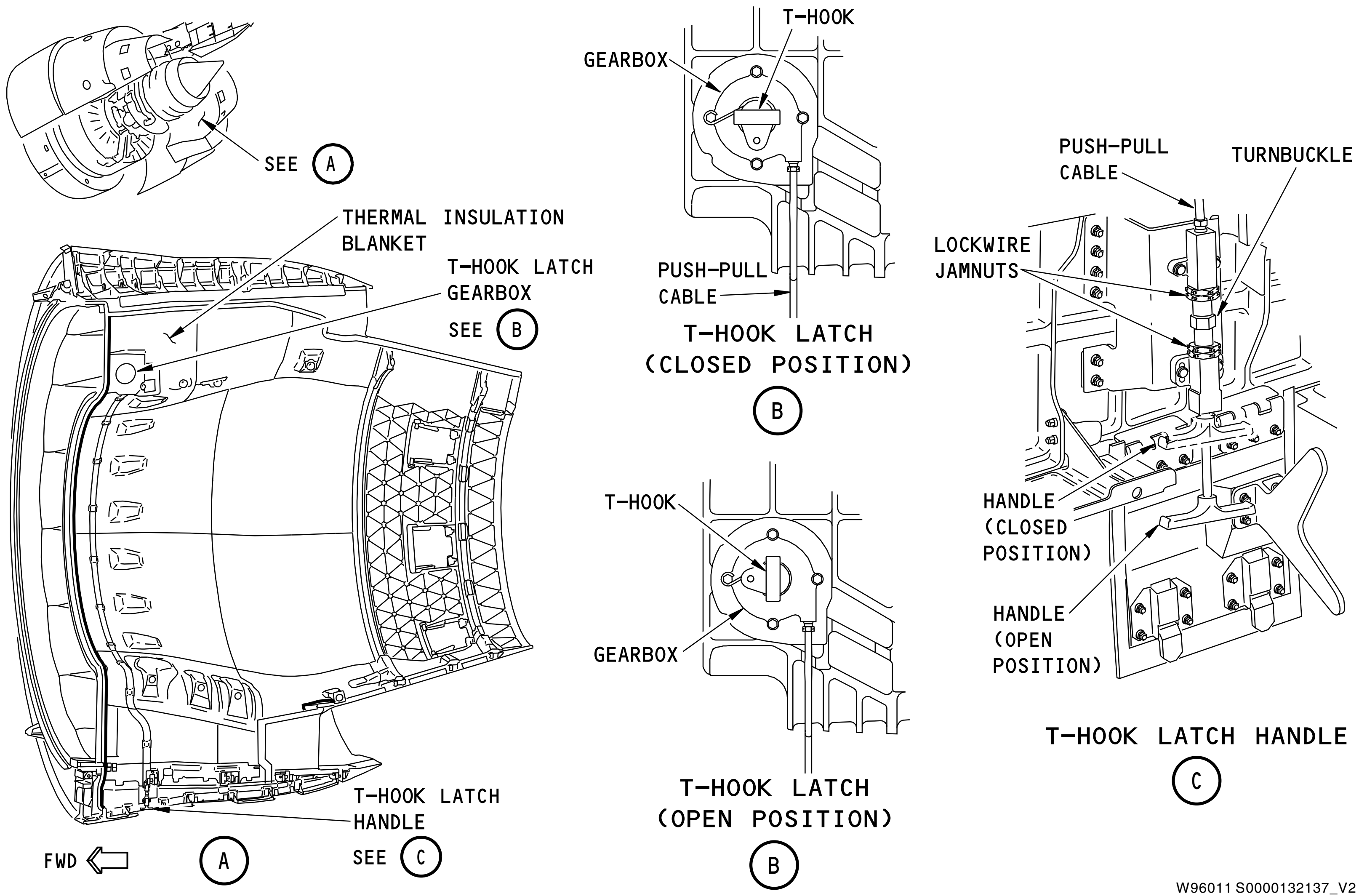
THRUST REVERSER SYSTEM - TENSION LATCHES



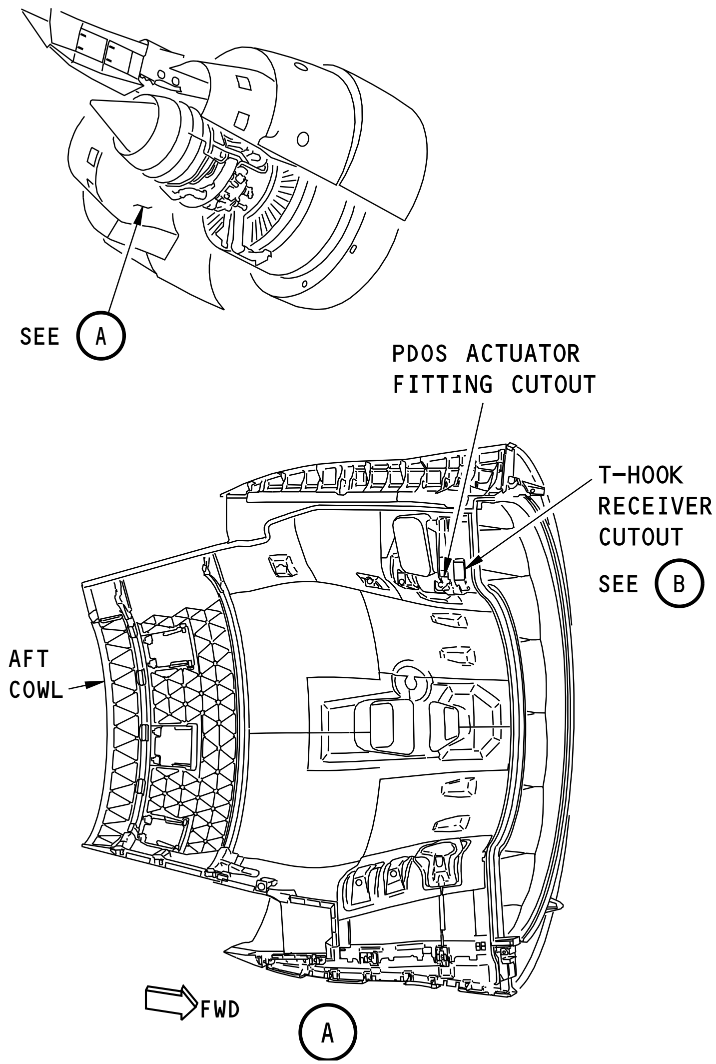
1 EXAMPLE OF THE SPRING SCALE USED TO MEASURE THE FORCE TO A LATCH. PLACE THE SCALE APPROXIMATELY 1.0 INCH (25.4 mm) FROM THE END OF THE HANDLE.

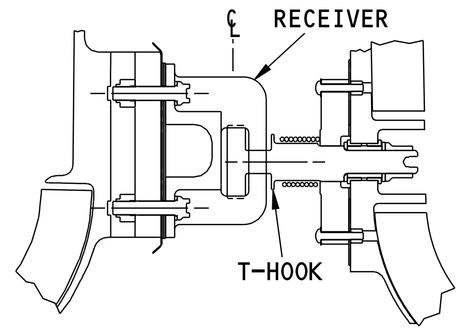
W13995 S0000116951_V1

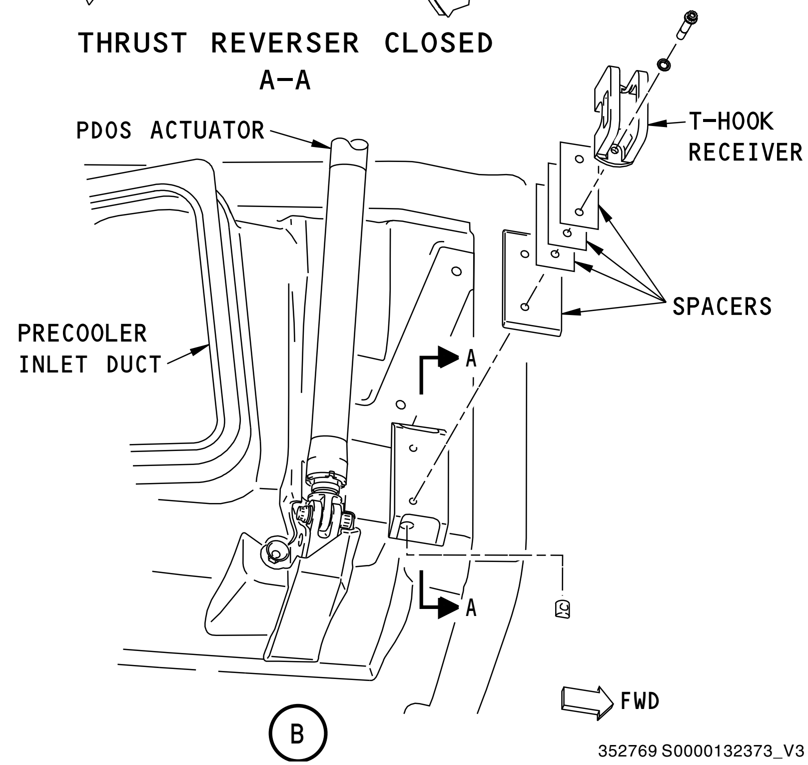
THRUST REVERSER SYSTEM - TENSION LATCHES



THRUST REVERSER SYSTEM - T-HOOK LATCH

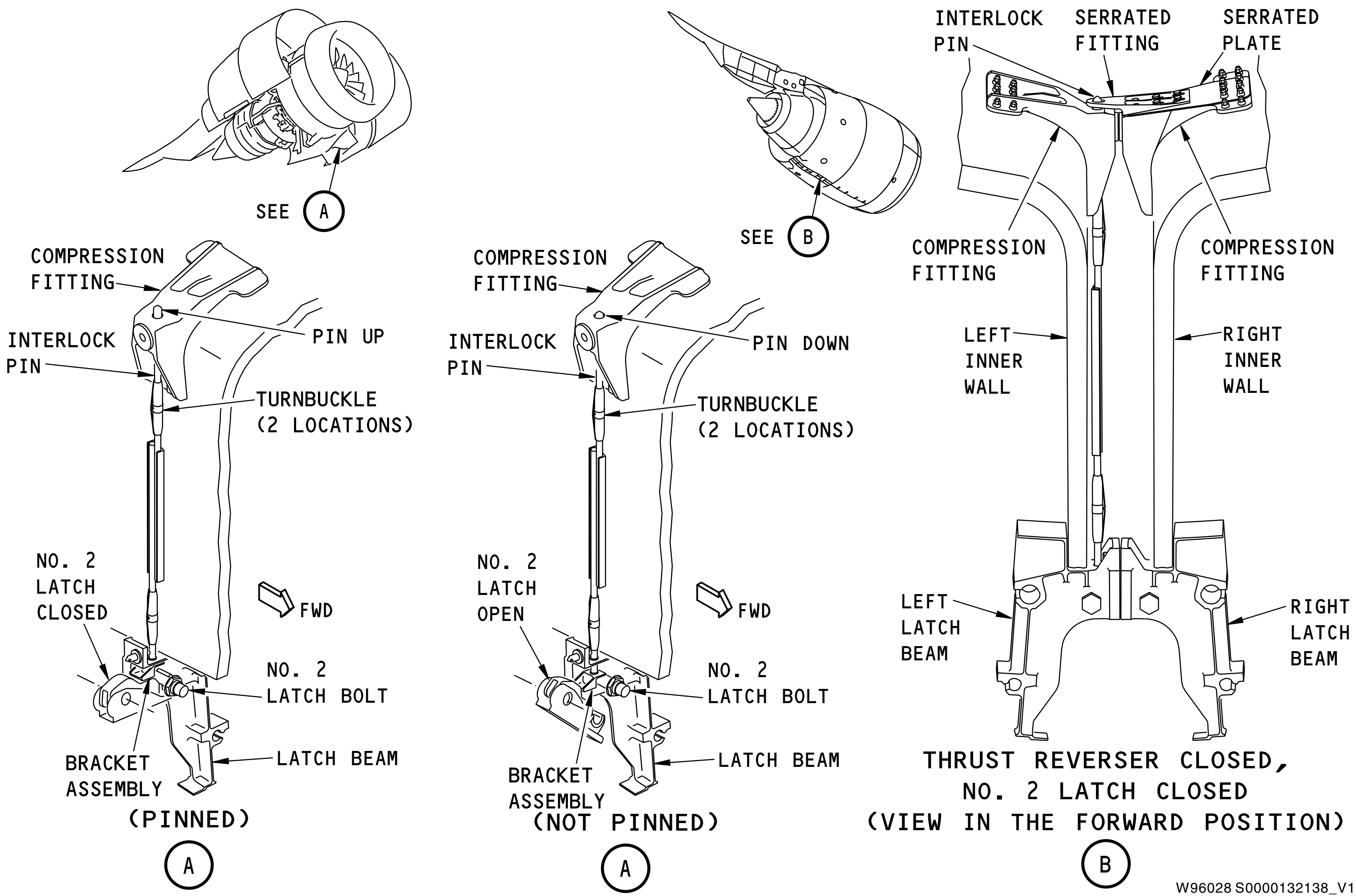




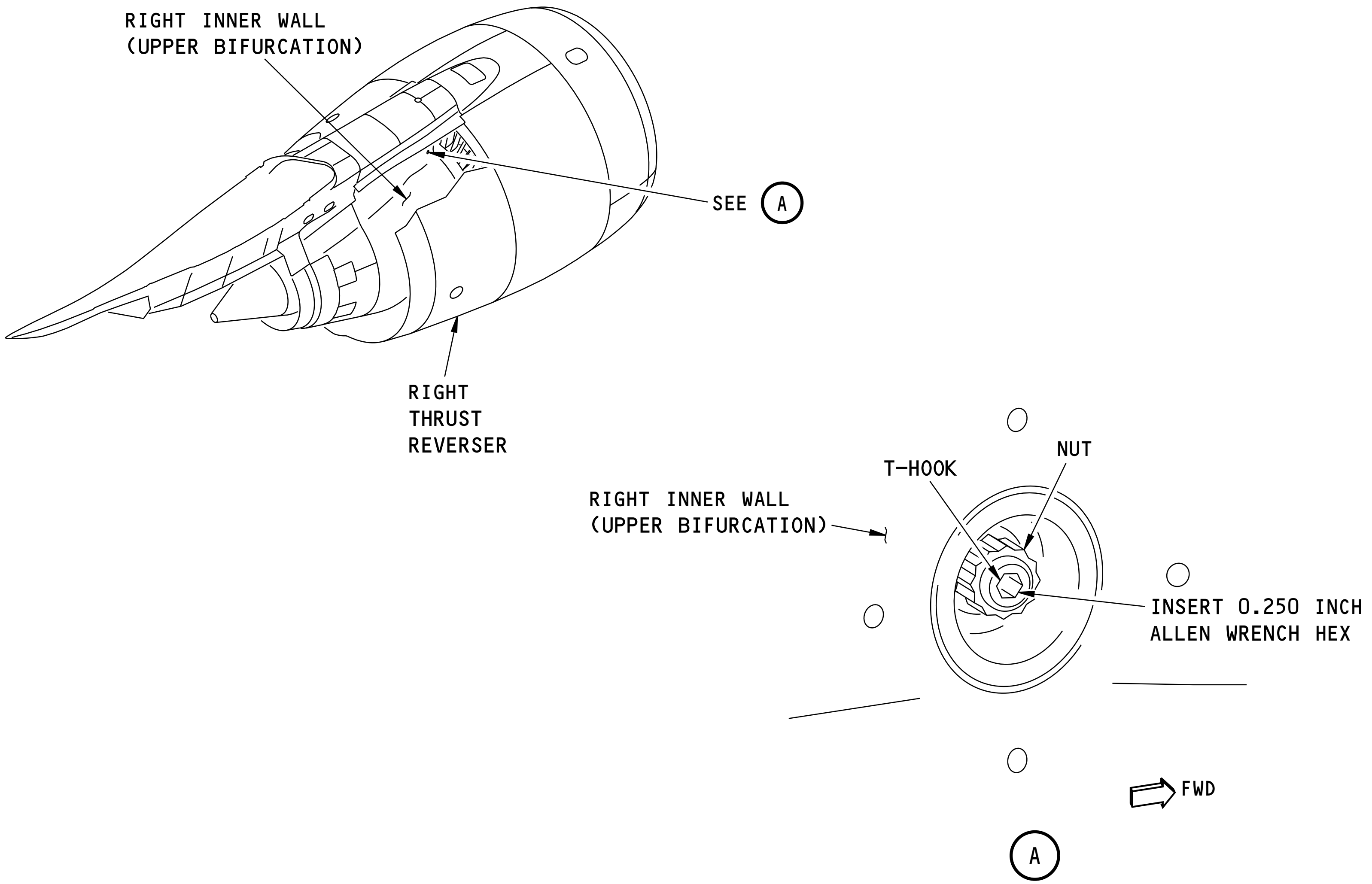


352769 S0000132373_V3

THRUST REVERSER SYSTEM - T-HOOK LATCH RECEIVER

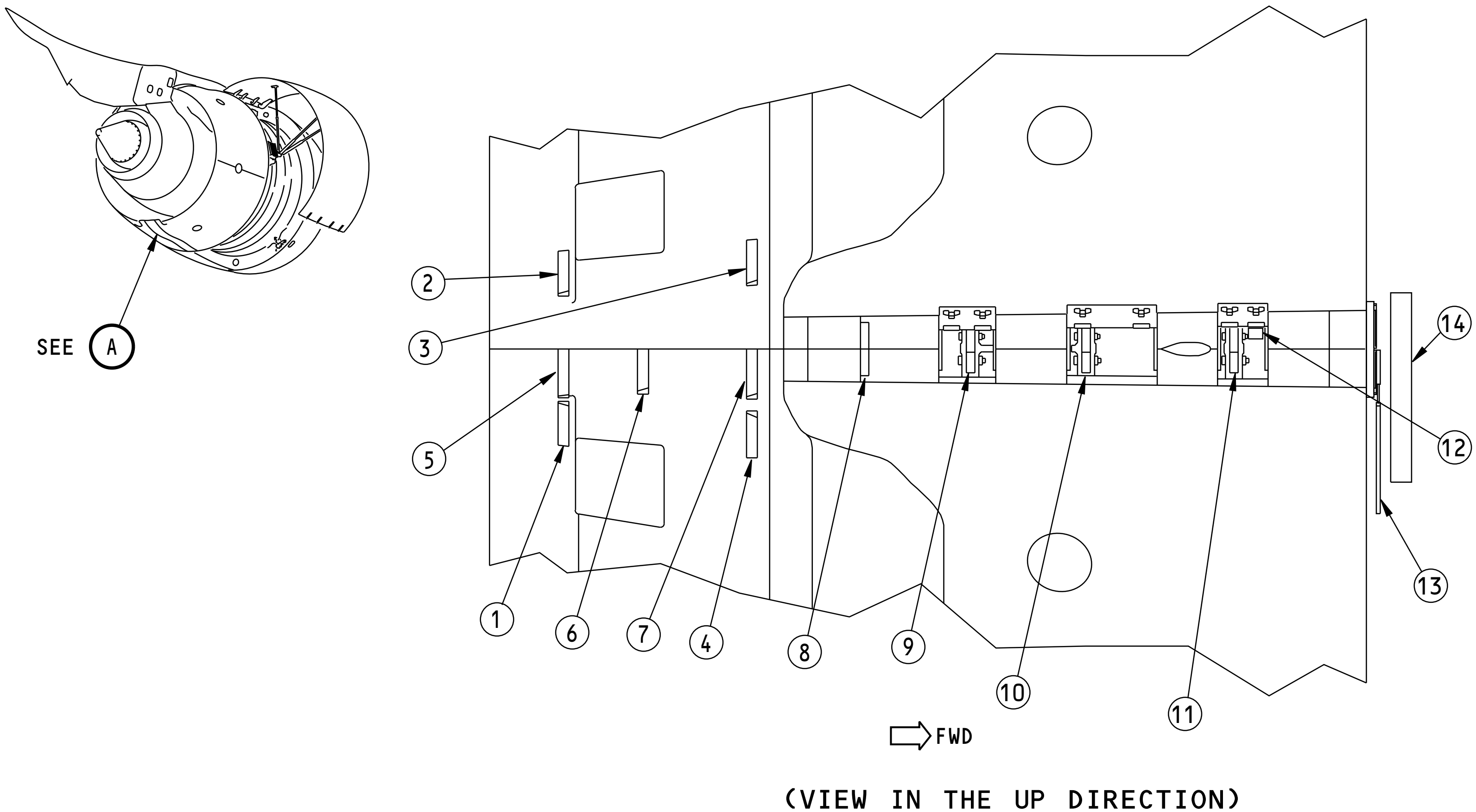


THRUST REVERSER SYSTEM - INTERLOCK PIN AND SERRATED FITTING



352423 S0000132369_V2

THRUST REVERSER SYSTEM - DAMAGED T-HOOK LATCH MANUAL OPERATION



LEGEND:

◯ = LATCH LOCATION NUMBERS

NOTE: THE STENCIL NUMBERS THAT INDENTIFY THE LATCHES ON THE THRUST REVERSER AND AFT COWL ARE NOT OPEN/CLOSE SEQUENCE NUMBERS.

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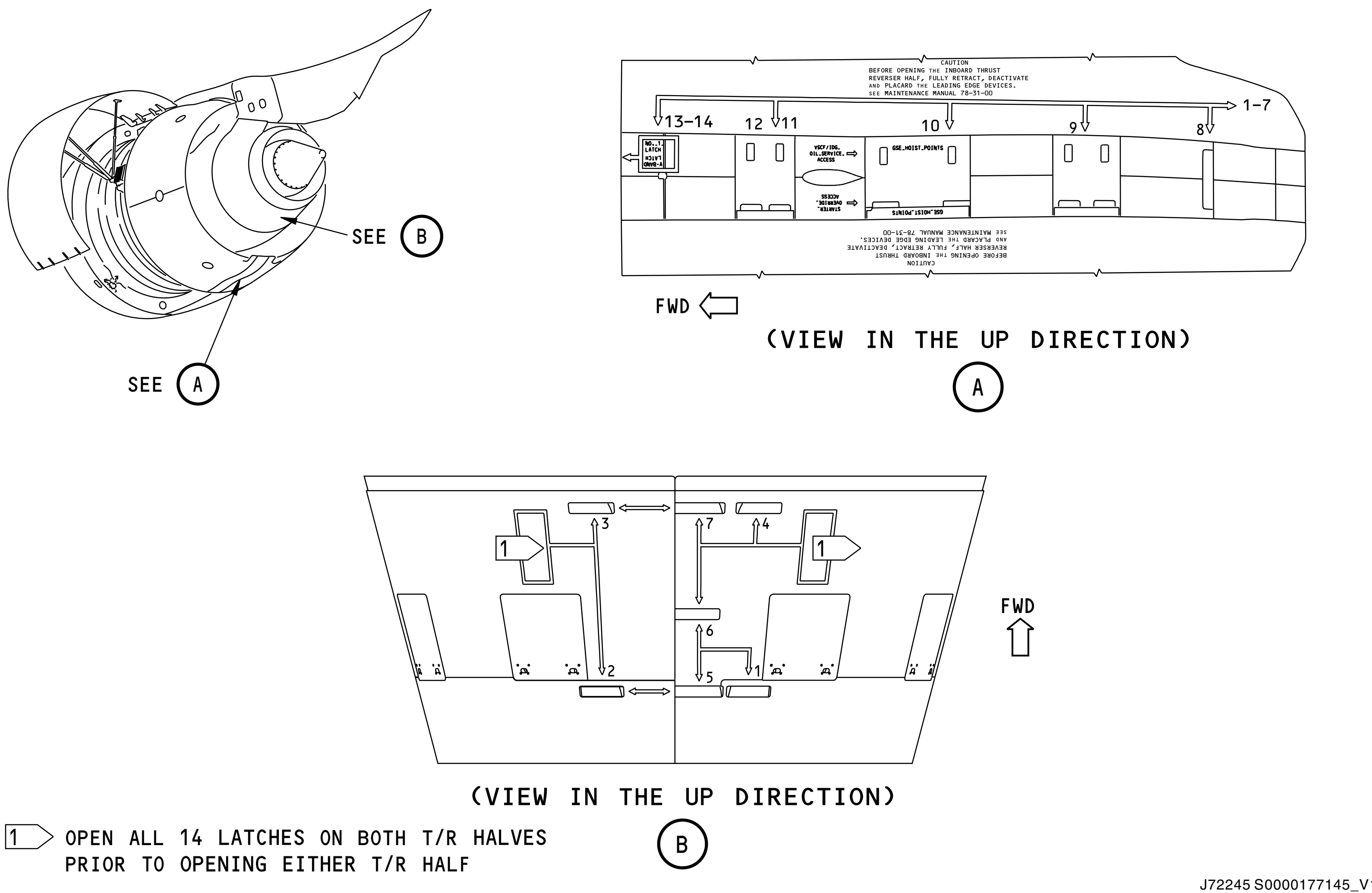
THRUST REVERSER SYSTEM - LATCH LOCATION NUMBERS



THRUST REVERSER LATCH STENCILS

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THRUST REVERSER SYSTEM - V-GROOVE LATCH BANDS AND V-BAND LATCH

Purpose

The v-groove latch bands and v-band latch gives a force to clamp the thrust reverser halves to the engine fan case. This transmits the reverse thrust loads to the engine fan case.

Location

The v-groove latch bands are mounted on the torque box for the thrust reverser halves. There is a left latch band and a right latch band. The top of the engine fan case has two brackets to attach the v-groove latch bands fittings.

Physical Description

The two v-groove latch bands are attached to the two engine fan case brackets. The latch bands come together at the bottom of the thrust reverser. The latch bands are attached to the torque box with retainer clips. The right latch band has a T-bolt receiver and the left latch band has the v-band latch.

The v-band latch has an adjustable hook to adjust the amount of force to close the latch. The v-band latch handle unfolds to open the latch or close and lock the latch. The v-band latch handle folds to stow the latch handle.

Functional Description

The hook on the v-band latch engages the latch band T-bolt retainer. The latch handle draws the hook back and puts the tension on the latch bands which clamps the thrust reverser halves together on the engine fan case. The force on the latch handle to close the latch is approximately 55 pounds (245 newtons).

You open the v-band latch last after the tension latches on the thrust reverser.

Training Information Point

Chapter 78 tells you how to operate the v-band latch.

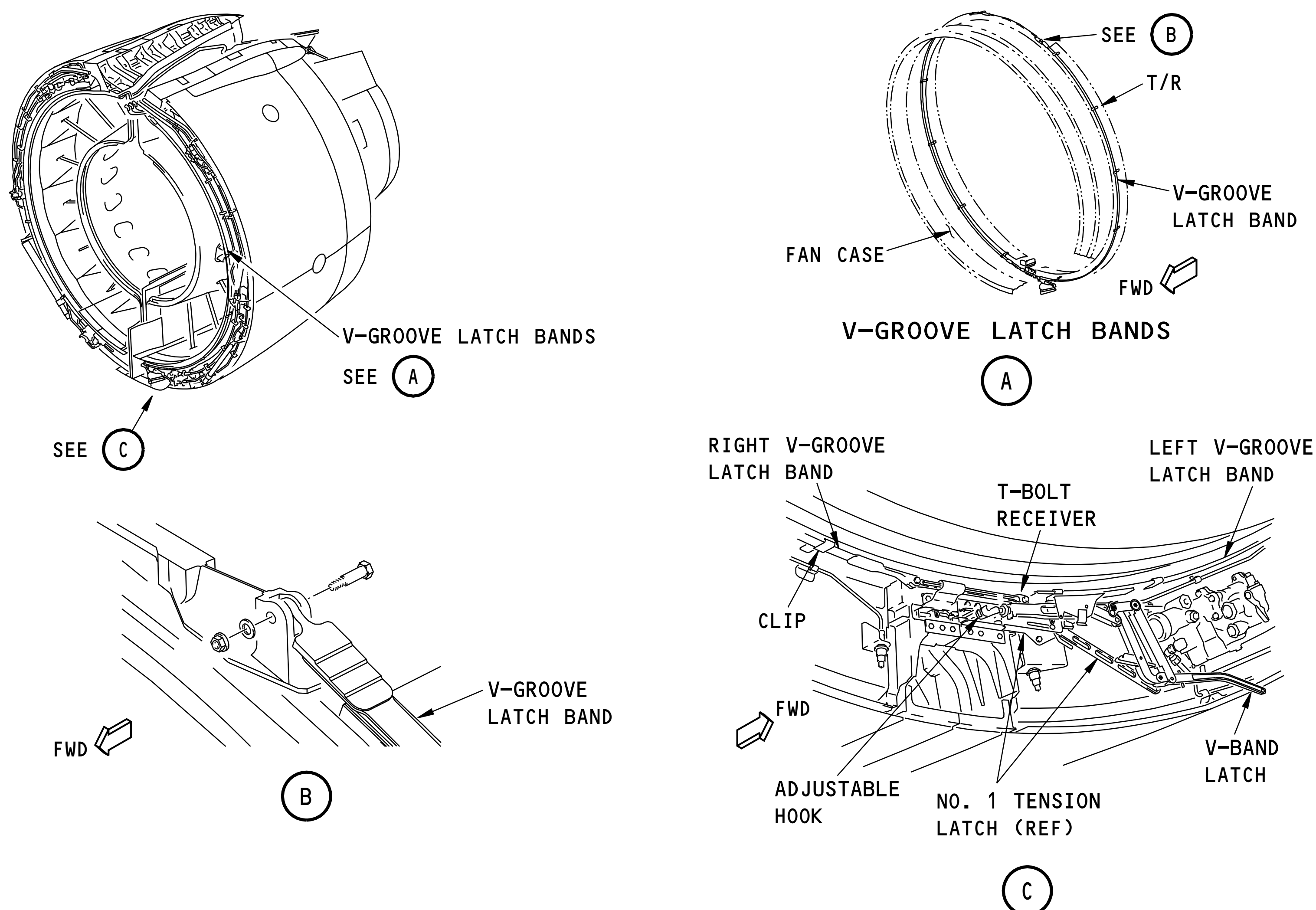
WARNING: MAKE SURE THAT YOU ARE FORWARD OF THE V-BAND LATCH WHEN YOU OPERATE THE LATCH HANDLE. INJURIES TO PERSONNEL CAN OCCUR IF THE LATCH OPENS SUDDENLY AND THE LATCH HANDLE HITS YOU.

You must be forward of the v-band latch when you operate the latch handle to open the v-band latch.

WARNING: MAKE SURE THE V-BAND LATCH IS FULLY ENGAGED BEFORE YOU RELEASE THE LATCH HANDLE. INJURIES TO PERSONNEL CAN OCCUR IF THE LATCH OPENS SUDDENLY AND THE LATCH HANDLE HITS YOU.

Do not push on the handle to close and engage the v-band latch. Always pull on the handle to close and engage the latch. If the latch does not engage and close correctly, or you accidentally release the latch handle, the latch handle will not be able to hit you if you pull on the handle. However, if you push on the latch handle and the latch does not engage and close correctly, or you accidentally release the latch handle, the latch handle can hit you with the same force that you used to close the latch.

WARNING: DO THE DEACTIVATION PROCEDURE TO PREVENT THE OPERATION OF THE THRUST REVERSER. THE ACCIDENTAL OPERATION OF THE THRUST REVERSER CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.



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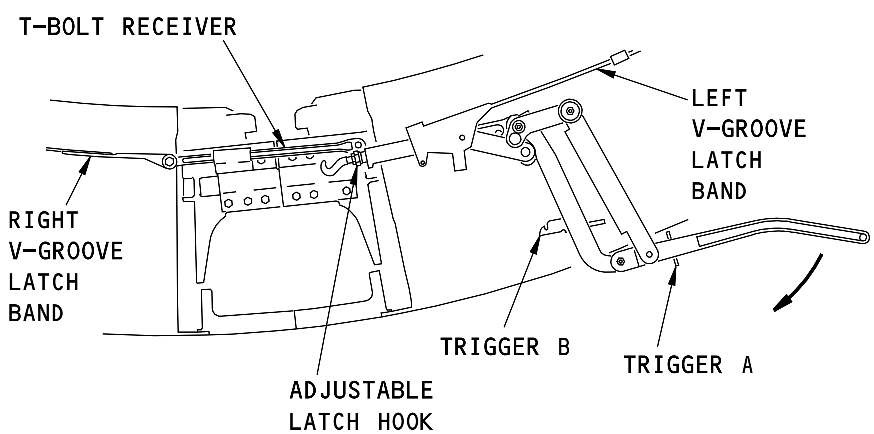
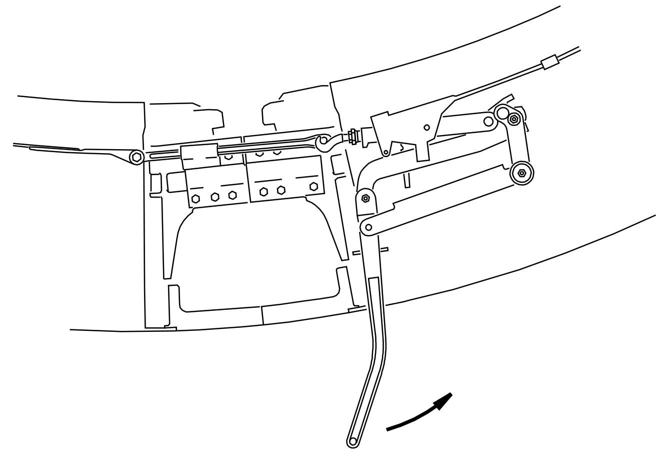
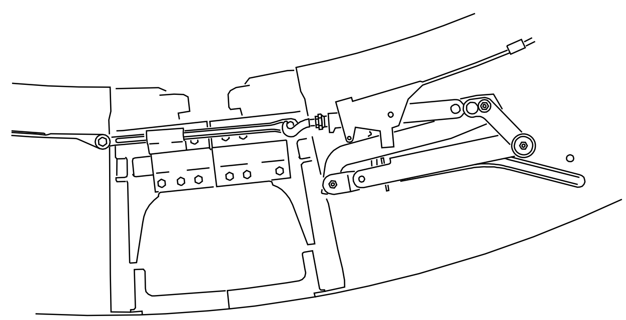
THRUST REVERSER SYSTEM - V-GROOVE LATCH BANDS



V-BAND LATCH
(POSITION TO ENGAGE)



V-BAND LATCH
(TAKE-UP POSITION)



V-BAND LATCH
(LOCKED AND STOWED POSITION)

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THRUST REVERSER SYSTEM - V-BAND LATCH

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THRUST REVERSER SYSTEM - T/R SLEEVE

Purpose

The thrust reverser (T/R) sleeve makes two different routings for the fan air:

- Forward
- Reverse.

Location

The thrust reverser sleeve is aft of the fan cowl panels. Track sliders attach the sleeve to the hinge beam and latch beam structure.

Physical Description

The thrust reverser sleeve is a composite assembly with a sleeve outer wall and a sleeve inner wall. The outer sleeve makes the exterior contour of the thrust reverser. The sleeve inner wall makes the outer wall of the fan duct. Also, the sleeve inner wall holds the blocker doors and acoustic panels and skins. The sleeve inner wall and sleeve outer wall are fastened together at the aft end of the sleeve.

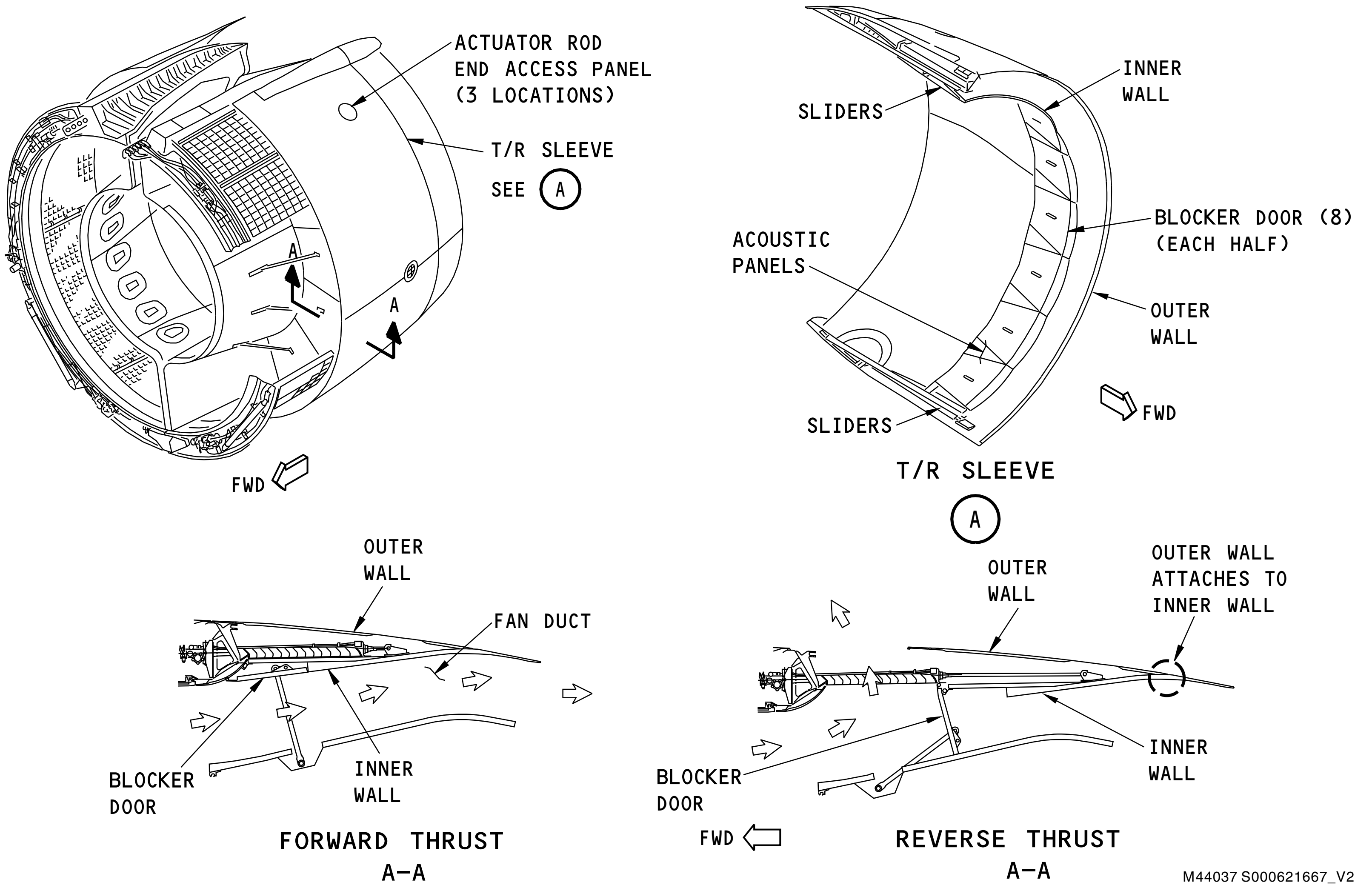
Two main track sliders attach the sleeve inner wall to the main tracks in the hinge beam and latch beam and carry most of the weight of the thrust reverser sleeve. Two auxiliary track sliders attach the sleeve outer wall to the auxiliary tracks in the hinge beam and latch beam.

The thrust reverser sleeve is moved aft to the extended (deploy) position and forward to the retracted (stow) position by the thrust reverser actuation system (TRAS). There are three access panels in the sleeve outer wall to get access to the rod end fittings for the thrust reverser hydraulic actuators.

Training Information Point

The thrust reverser sleeve weighs approximately 405 pounds (183 kilograms) and requires special ground support equipment (GSE) for removal and installation.

You must go into the fan duct to disconnect the drag links from the blocker doors when you remove and install the thrust reverser sleeve. Make sure the soles of your work boots are clean of unwanted material. Use boot socks over your work boots or use a protective mat to protect the composite surface of the sleeve.



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THRUST REVERSER SYSTEM - T/R SLEEVE

THRUST REVERSER SYSTEM - TRACK SLIDERS

Purpose

The track sliders permit the translating sleeves to move forward and aft in the tracks.

Location

The main and auxiliary sliders are on the top and the bottom of each thrust reverser sleeve.

Physical Description

Two main track sliders attach the sleeve inner wall to the tracks in the hinge beam and latch beam. The main track sliders carry most of the weight of the translating sleeve.

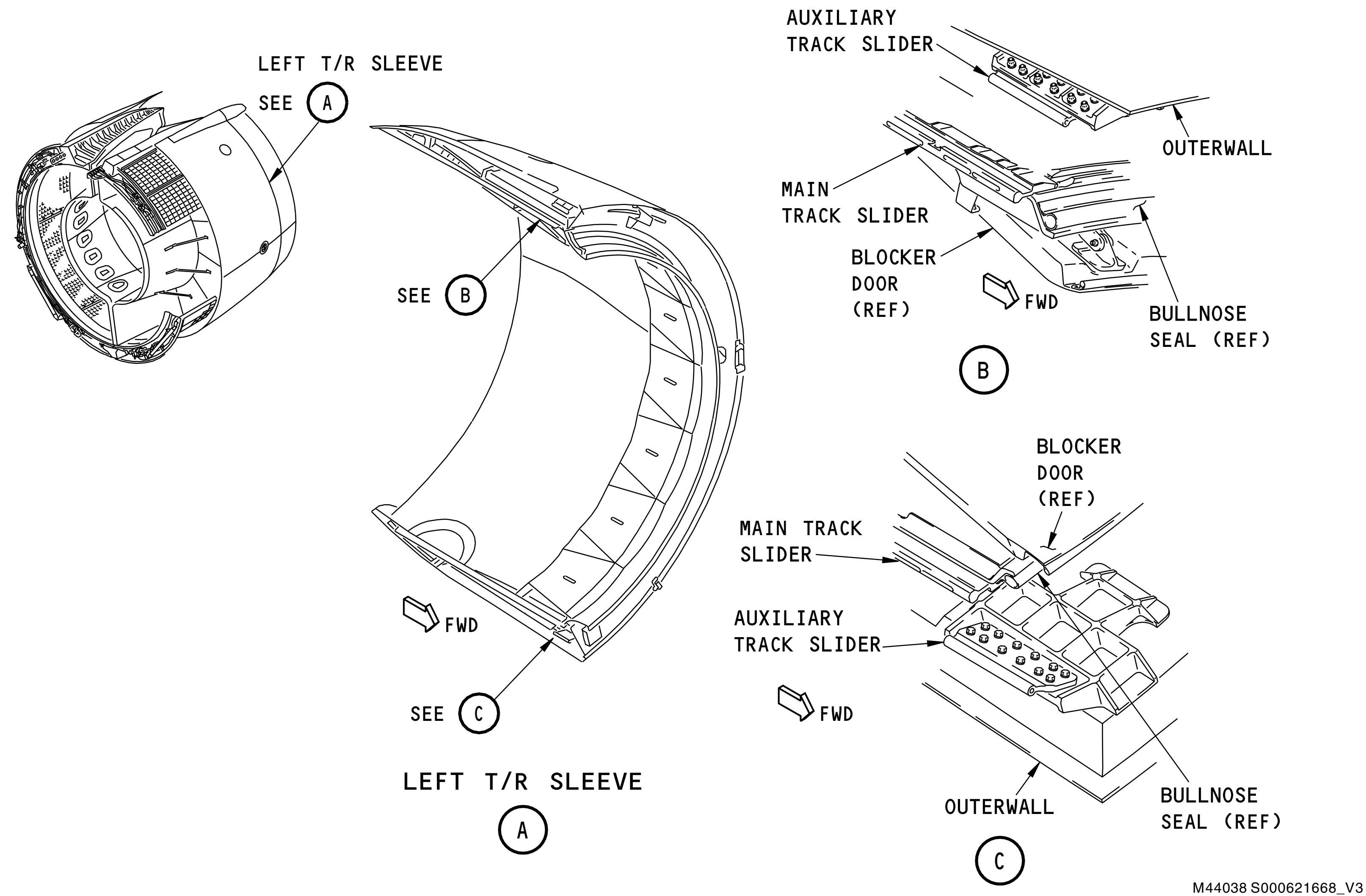
Two auxiliary track sliders attach the sleeve outer wall to the tracks in the hinge beam and latch beam. Because the sleeve outer wall is only attached to the sleeve inner wall at the aft end of the sleeve, the auxiliary track slider is the forward structural element that holds the outer sleeve in place. If the auxiliary track slider is missing, the sleeve outer wall is no longer held in position and could be damaged by the airflow.

The main track sliders and the auxiliary track sliders have a wear surface that reduces the friction between the sliders and the track liners.

Training Information Point

You must remove the sleeve to do a complete inspection of the main and auxiliary track sliders. You must also remove the sleeve to replace the auxiliary track sliders or the wear surfaces on the main track sliders.

WARNING DO THE DEACTIVATION PROCEDURE TO PREVENT THE OPERATION OF THE THRUST REVERSER. THE ACCIDENTAL OPERATION OF THE THRUST REVERSER CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.



THRUST REVERSER SYSTEM - TRACK SLIDERS

THRUST REVERSER SYSTEM - TRACKS AND TRACK LINERS

Purpose

The thrust reverser tracks and track liners hold the main and auxiliary track sliders and permit the translating sleeve to move forward and aft.

Location

The main and auxiliary tracks are machined into the upper hinge beam and lower latch beam of each thrust reverser half.

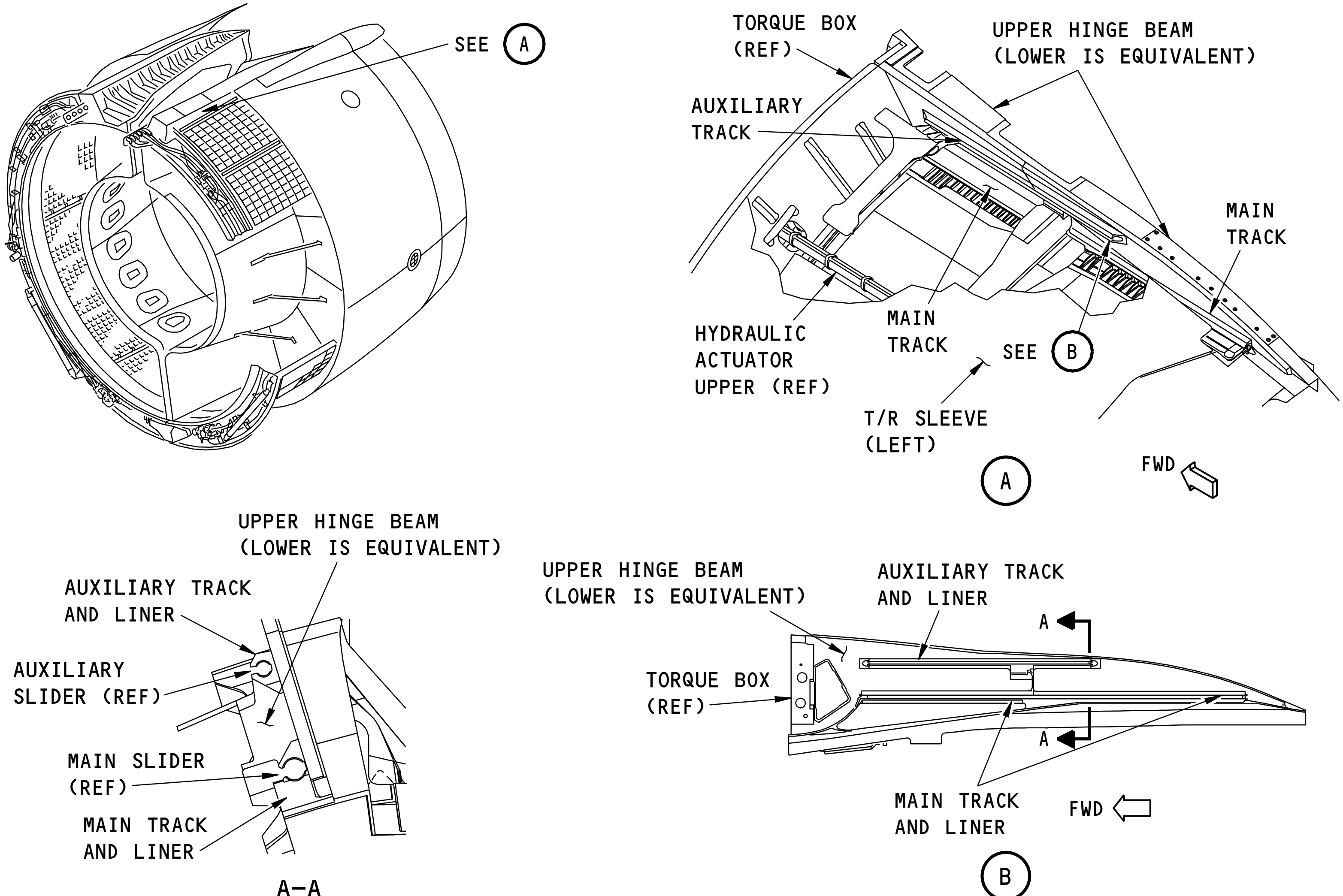
Physical Description

Each track has a track liner that holds the main or auxiliary track slider. The track liners are steel and protect the aluminum tracks.

Training Information Point

You must remove the sleeve to do a complete inspection of the track liners. You must also remove the sleeve to replace the track liners.

WARNING	DO THE DEACTIVATION PROCEDURE TO PREVENT THE OPERATION OF THE THRUST REVERSER. THE ACCIDENTAL OPERATION OF THE THRUST REVERSER CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.



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THRUST REVERSER SYSTEM - TRACKS AND TRACK LINERS

THRUST REVERSER SYSTEM - BLOCKER DOORS AND BLOCKER DOOR DRAG LINKS

Purpose

The thrust reverser blocker doors and the blocker door drag links make a blockage in the fan duct to change the direction of the fan air exhaust.

Location

The blocker doors connect to the forward end of the inner wall of the thrust reverser sleeve. The blocker door drag links connect the blocker doors to the fan duct inner wall.

Physical Description

Each thrust reverser sleeve has eight epoxy-graphite blocker doors. Each blocker door has a rubber bulb seal on the hinged end of the door.

The blocker door is a flat surface door with metal hinge fittings and drag link fittings attached to the door with fasteners. These fittings can be removed to replace damaged hinge bearings and drag link bushings.

The drag link fitting on the blocker door has a spring loaded link that gives the blocker door vibration dampening in the closed and faired position when the thrust reverser sleeve is stowed.

There are eight drag links. The drag links are attached to anchor fittings in the inner wall of the fan duct cowl and the spring loaded link on the blocker door.

Functional Description

When the thrust reverser sleeve is in the forward (retracted) position, the blocker doors make part of the fan duct outer wall.

When the thrust reverser sleeve is in the aft (extended) position, the blocker door drag links move the blocker doors into the fan duct.

Training Information Point

Ground support equipment (GSE) stackable platform blocks are used to get access to the blocker door hinges and drag link connection from inside the fan duct. Make sure the blocks are clean of contamination that could damage the composite surface of the sleeve.

You must extend the thrust reverser sleeve to inspect, remove, or install the blocker doors and connect the drag links to the blocker door.

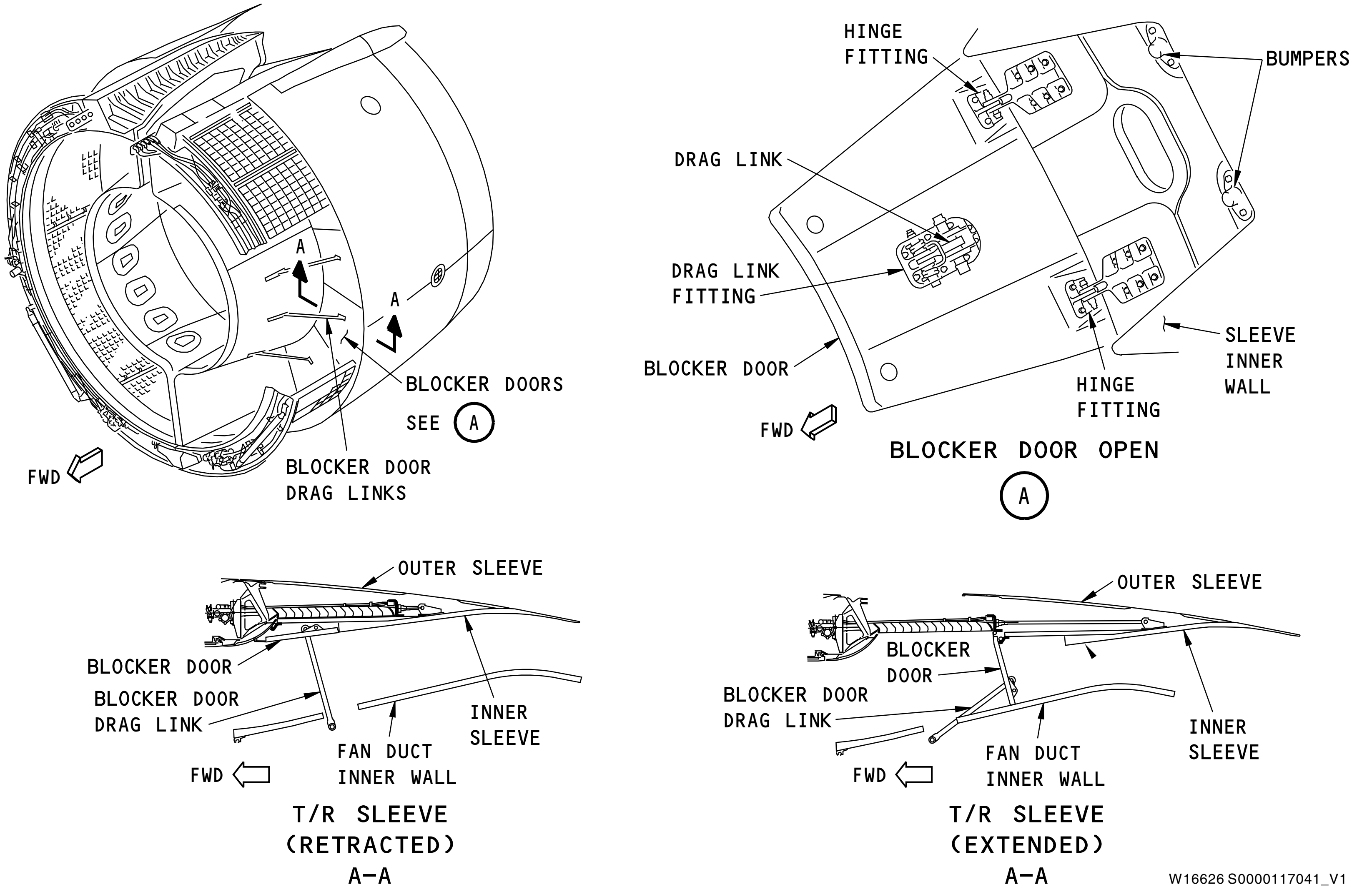
You must open the thrust reverser to inspect, remove, or install the blocker door drag link connection in the inner wall of the fan duct cowl.

Do not go into the thrust reverser fan duct when the thrust reverser is open. Your weight can cause the failure of the hold open rod.

Make sure the soles of your work boots are clean or unwanted material. Use boot socks over your work boots or use a protective mat to protect the composite surface of the sleeve.

Do not pull or stand on the drag links.

WARNING	DO THE DEACTIVATION PROCEDURE TO PREVENT THE OPERATION OF THE THRUST REVERSER. THE ACCIDENTAL OPERATION OF THE THRUST REVERSER CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.



THRUST REVERSER SYSTEM - BLOCKER DOORS AND BLOCKER DOOR DRAG LINKS

THRUST REVERSER SYSTEM - T/R CASCADE SEGMENTS

Purpose

The cascade segments control the direction of the fan air exhaust in reverse thrust when the thrust reverser sleeves are in the aft (extended) position and the blocker doors are opened in the fan duct. The cascade segments also give structural strength to the thrust reverser.

Location

The cascade segments attach to the torque box and the cascade segment attach ring. When the thrust reverser sleeve is retracted, the cascade segments fit in the space between the inner wall and outer wall of the sleeve. When the thrust reverser sleeve is extended, the cascade segments are exposed to the fan air exhaust flow turned by the blocker doors.

The thrust reverser on each engine has 16 cascade segments. The numbers 1 through 16 are used to identify the cascade segment locations on the engine.

Physical Description

The thrust reverser cascade segments are made of composite graphite-epoxy material. The cascade segments have attach flanges at the forward and aft edge of the segment. Webs that go between the forward flange to the aft flange are called strongbacks which transfer the reverse thrust loads from the vanes to the attach flanges. Between the strongbacks are rows of cascade vanes which turn the airflow to the correct direction for that cascade segment.

There are ten different types of cascade segments that can be installed. Nine of the cascades segment types are designed to turn the fan airflow to go out in a different angular direction and one segment type is designed to block the fan airflow.

There are actuator guide brackets that are mounted on the cascade segments. These guides are between the cascade segments 1 and 2, 4 and 5, 7 and 8, 9 and 10, 12 and 13, and 15 and 16.

Training Information Point

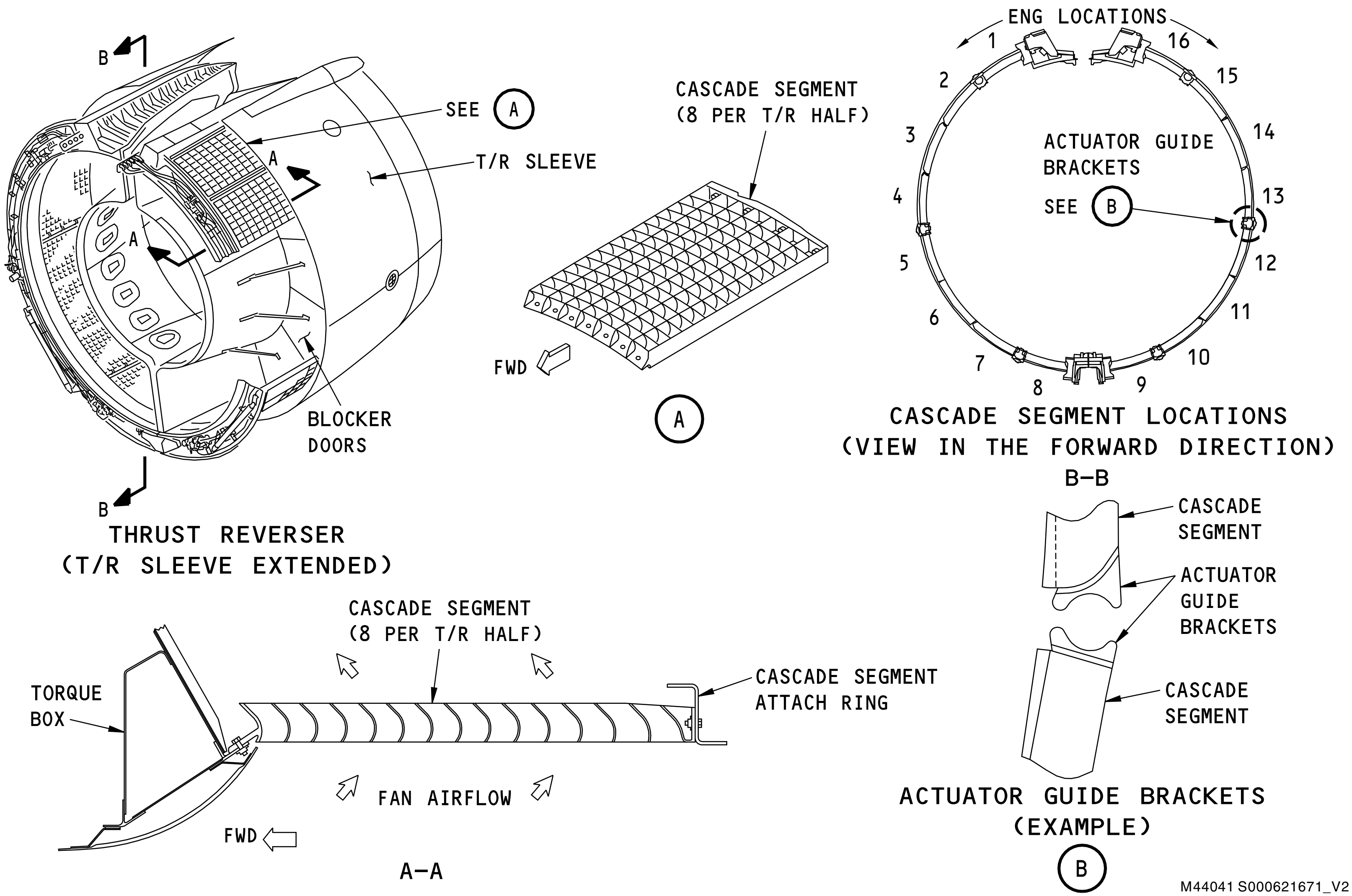
You must extend the thrust reverser sleeve to examine, remove, or install the cascade segments.

You must install the correct cascade segment in the correct location for the left or right engine installation. The cascade segment installation for the left engine is different from the cascade segment installation for the right engine. If the cascade segments are installed in the incorrect location, the reverse thrust airflow from the segment could cause engine ingestion of unwanted materials and cause damage to the engine and affect the control surfaces.

CAUTION DO NOT LIFT OR MOVE THE THRUST REVERSER HALF UNLESS THREE CASCADE SEGMENTS ARE INSTALLED. BETWEEN THE INSTALLED SEGMENTS, NO MORE THAN TWO CASCADE SEGMENTS CAN BE MISSING. DAMAGE TO THE THRUST REVERSER STRUCTURE CAN OCCUR.

CAUTION INSTALL THE CASCADE SEGMENTS IN THE CORRECT POSITION ON THE THRUST REVERSER. IF YOU INSTALL THE CASCADE SEGMENTS IN THE INCORRECT POSITION, DAMAGE TO EQUIPMENT CAN OCCUR.

WARNING DO THE DEACTIVATION PROCEDURE TO PREVENT THE OPERATION OF THE THRUST REVERSER. THE ACCIDENTAL OPERATION OF THE THRUST REVERSER CAN CAUSE INJURIES TO PERSONNEL AND DAMAGE TO EQUIPMENT.



THRUST REVERSER SYSTEM - T/R CASCADE SEGMENTS

THRUST REVERSER SYSTEM - T/R FIRE SEALS

General

There are two kinds of fire seals on the thrust reverser; a flexible rubber bulb-seal type and metal segmented or finger type.

Purpose

The fire seals help to contain an undercowl fuel-fed fire.

The upper rubber fire seals closes the gap between the strut structure and the thrust reverser upper bifurcation walls. The lower rubber fire seal closes the gap between the lower bifurcation walls of the left and right thrust reverser halves.

The rubber fire seals also function as an aerodynamic seal and a fluid seal. The fire seals must be able to perform the sealing function ever when exposed to fuel, hydraulic fluid, engine oil, alkaline based cleaning solutions, isopropyl alcohol based deicing fluids and ethylene gycol based deicing fluids.

The metal segmented fire seals contain a fire under the aft cowl.

Location

The upper bulb-seal fire seals are mounted in retainer tracks on the inner surface of the upper bifurcation wall and aft cowl. These fire seals contact metal seal depressors mounted on the strut.

The lower bulb-seal are mounted in retainer tracks on the inner surface of the lower bifurcation wall. These fire seals contact seal depressors mounted on the engine support bracket assembly forward of the drain and service mast.

Two metal fire seals are mounted on the upper, aft edge of left and right aft cowls. The metal fire seals come in contact with seal depressors on the aft cowl fairing over the exhaust sleeve.

Physical Description

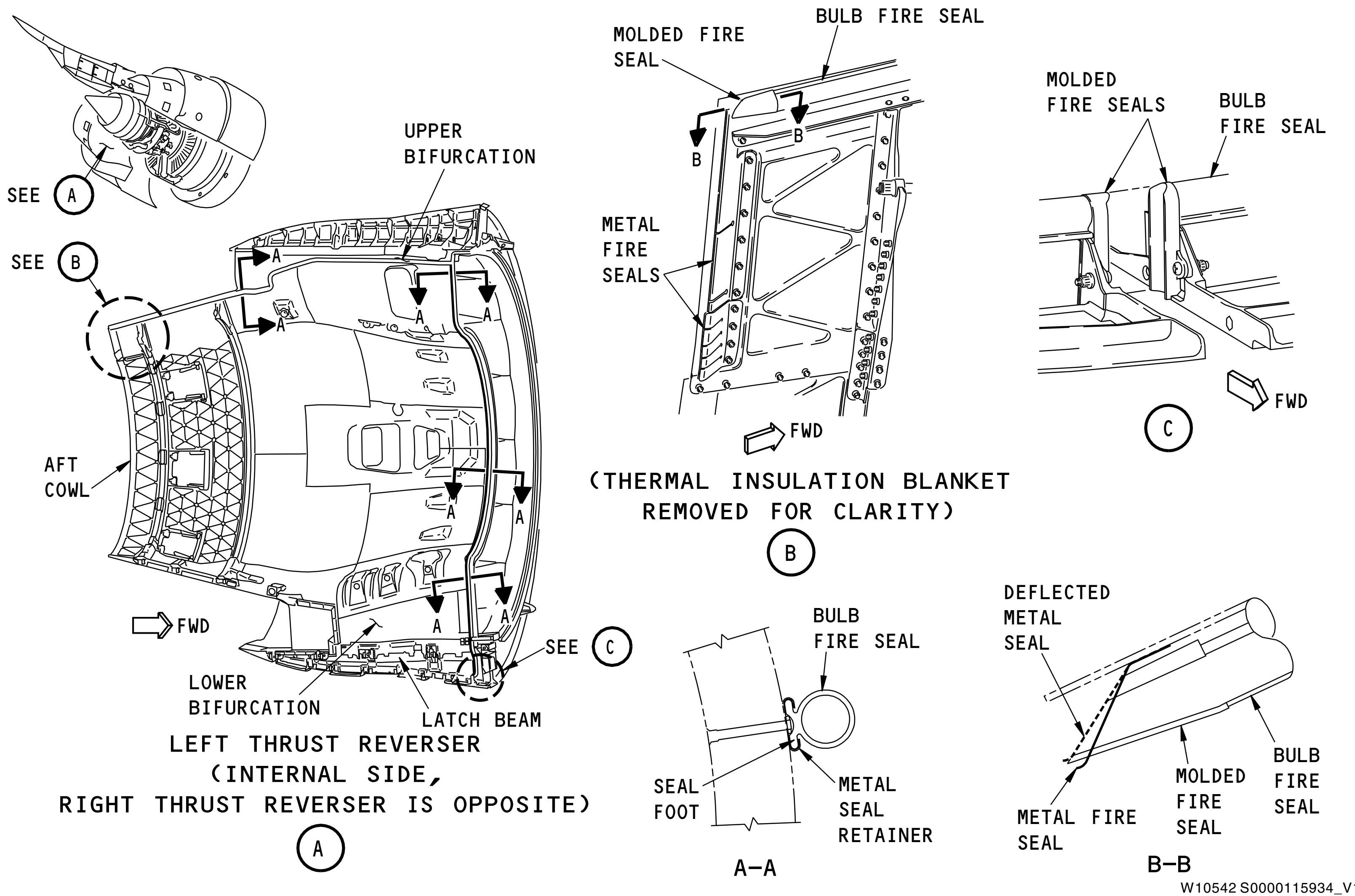
The rubber fire seals are constructed from a silicone rubber that is reinforced with fabric layers. The rubber fire seals are bulb-seals that have a circular cross-section and foot that fits in a metal seal retainer track. The bulb-seals can be hollow or can be filled in some segments with a sponge foam to prevent collapse of the seal where the seal fits in small radius curvature turns. The rubber fire seals are also molded into specific shapes for some areas.

Each metal fire seal assembly is made from two separate fire seals that overlap. These two seals have segments like fingers. The two seals are the same overall size but the segments on one seal blocks the slots between the segments on the second seal when the two seals are assembled together.

Training Information Point

You must open the thrust reverser to get access to the fire seals.

When the thrust reverser is closed and latched, the bulb-type fire seals are flattened when pressed against the seal depressors. There is a minimum seal contact width along the length of the fire seal for correct installation. Bulb-type fire seals that are damaged or missing are replaced.



THRUST REVERSER FIRE SEALS

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THRUST REVERSER SYSTEM - THERMAL INSULATION BLANKETS

General

The inside wall of the thrust reverser is covered with thermal insulation blankets.

Purpose

The blankets are a thermal insulation and fire barrier layer which is necessary to keep the thrust reverser structurally serviceable and can decrease the damage and repair costs from a duct burst or a fire. The thermal insulation in the blanket protects the composite inner wall of the fan duct cowl from radiant heat damage from fires and engine operation.

Location

The blankets are installed on the upper bifurcation of the thrust reverser next to the fire seal, on the inside surface of the thrust reverser inner wall, aft of the vertical fire seals, and on the lower bifurcation down to the thrust reverser latch beam. Blankets are also installed on the aft cowl next to the aft cowl tension latches and the aft cowl, forward and aft, deflection limiter tension straps.

Physical Description

The CRES metal-faced thermal insulation blanket is made of these components; a textured, hot-side, corrosion resistant steel (CRES) skin and a cold-side polyimide film over a glass cloth that is stitched around the thermal insulation of different densities and thicknesses. The metal face on the hot side of the blankets is the fire barrier and also the moisture barrier for the blanket. The polyimide sheet on the cold-side of the blanket is a moisture barrier. The moisture barrier prevents the contamination of the insulation from moisture or fluid which can make the insulation less effective. The color of the CRES metal faced blanket is bright silver with a textured surface.

The thermal insulation in the blanket protects the thrust reverser inner wall composite structure from the heat from the engine during normal operation and during a fire.

The blankets are removed and installed in a specific sequence or order. However, it is possible to remove and install some blankets without disturbing the other blankets.

The blankets are made to overlap along joints and seams. Some blankets are designed to fit under another blanket. There are different blanket thicknesses and blanket overlap at the fastener locations. When the blankets are installed, there can be a blanket that must be install first before the next blanket can be installed. A large quantity and different kinds of fasteners are required to attach the larger blankets.

The gaps at the edges of the blankets that are adjacent to the fire seals or some pressure seals are closed with filler and firewall sealant.

The blankets on the left thrust reverser have holes to let the bracket assembly and the interlock pin move through these blankets.

The blankets on the right thrust reverser have a channel molded into the blanket for the push-pull cable that operates the T-hook latch gearbox. The push-pull cable is protected by the blanket from the heat under the thrust reverser cowl during engine operation.

An upper bifurcation blanket on the left thrust reverser fits around the T-hook latch receiver. An upper bifurcation blanket on the right thrust reverser covers the T-hook latch gearbox. The PDOS actuator rodend must be disconnected to remove these blankets which requires the use of an overhead crane or hoist and the thrust reverser sling to keep the thrust reverser in the open position when the PDOS actuator is disconnected and the blanket is removed. These blankets have cutouts for the PDOS actuator fittings and cutouts for the T-hook latch gearbox and the T-hook latch receiver. The gaps at the cutouts closed with filler and firewall sealant.

THRUST REVERSER SYSTEM - THERMAL INSULATION BLANKETS

There is a small, circular, CRES thermal insulation blanket that is installed on the left thrust reverser half at approximately the center of the thrust reverser inner wall. This insulation blanket covers the plug in the inner wall for the exhaust duct for the start transient bleed valve. The exhaust duct for the start transient bleed valve is not installed in the inner wall for the GE90-100 series engines. The exhaust duct for the start transient bleed valve is only installed in the inner wall for the GE90-70/-80/-90 series engines. The inner wall is a common component for both the thrust reversers for the GE90-70/-80/-90 series engines and the GE90-100 series engines.

Training Point Information

You must open the thrust reverser to get access to the thermal insulation blankets.

The CRES metal-faced thermal insulation blankets are not interchangeable with the kapton-faced blankets from the thrust reversers for the GE90-70/-80/-90 series engine. The CRES metal-faced blankets are blankets of different weights, thicknesses, sizes and shapes which also changes the location, pattern, quantity and type of the blanket fasteners on the inner wall.

Do not step on the blankets. The CRES foil skin is 0.003 inch thick and it can be torn, scratched or punctured. Loose thermal insulation looks like a gray-white powder that escapes from tears in the CRES foil.

Hot, high speed air from a missing borescope inspection plug, or holes in pneumatic ducts, or pneumatic duct connections, or a partially missing precooler kiss seal can damage, tear and erode away the CRES foil skin, the glass cloth and the thermal insulation. Blankets with limited amounts of missing foil, cloth and thermal insulation material can be repaired or must be replaced. A temporary repair procedure is available for the CRES blanket. The temporary repair uses adhesive to bond a piece of CRES foil to the surface of the blanket. A CRES blanket with a temporary repair must be replaced within the time limits in the AMM with a serviceable replacement blanket or a blanket that has a permanent repair.

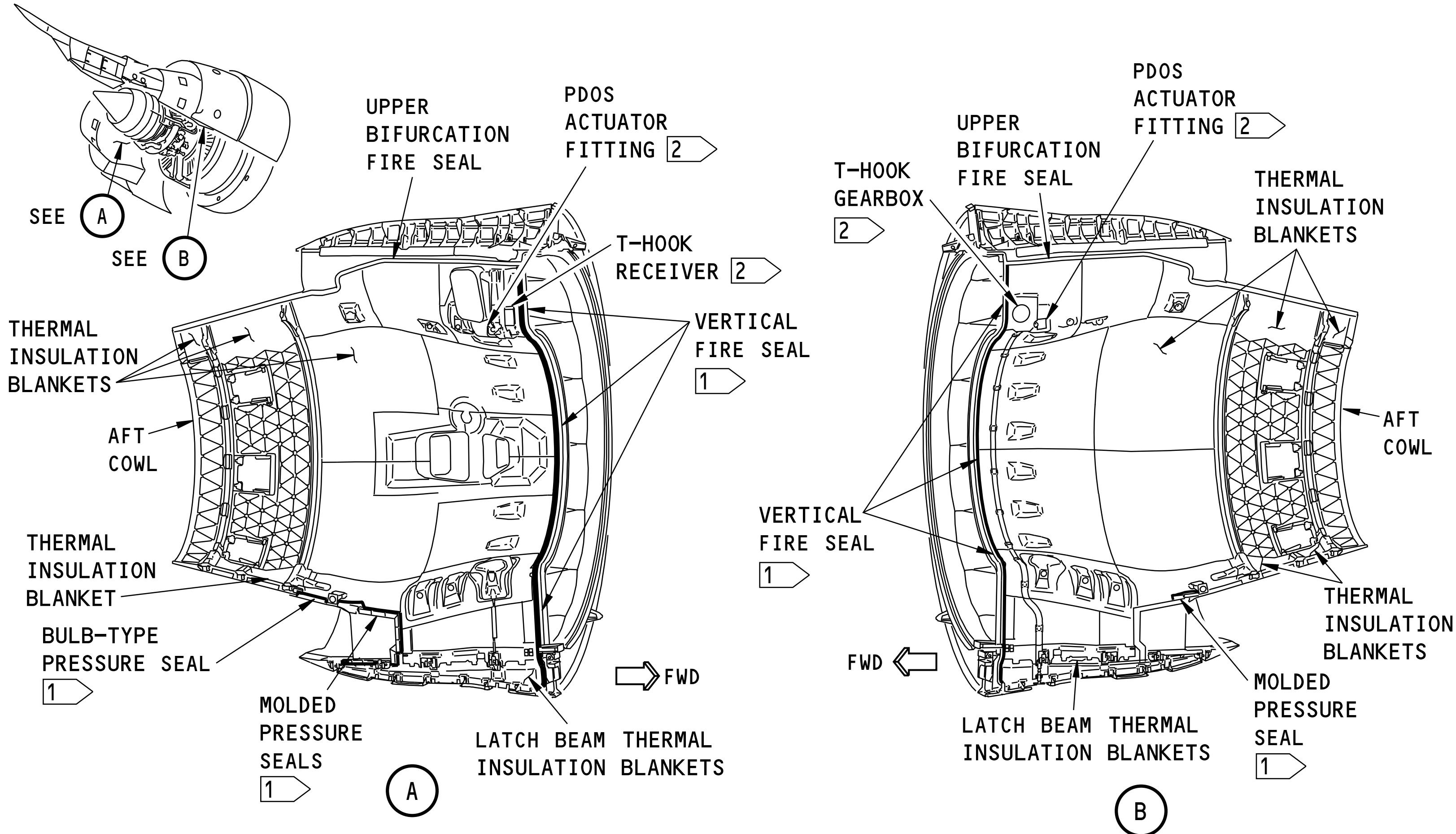
The permanent repair has insulation repair plugs that are used to replace missing insulation in the blanket. The permanent repair spot welds a piece of CRES foil to the surface of the blanket. The weld bead around the circumference of the CRES foil patch must be continuous to be moisture proof.

With a damaged thermal insulation blanket, the hot compressor air or radiated heat can cause heat damage to the thrust reverser inner wall composite structure. Heat damage to the composite material could cause delamination of the plys in the composite structure. Delamination of the composite structure may require replacement of the inner wall. A visual and tap test structural inspection is usually necessary for suspected delamination of the composite inner wall.

Large amounts of hot, compressor air from holes in bleed offtake pneumatic ducts, or gaps at pneumatic duct connections, or damaged kiss seals and kiss seal mating surfaces can cause a structural degradation of the T/R inner wall. The hot air can penetrate through the gaps between the overlapped blankets to cause convective heat damage to the T/R inner wall. Hot air can also cause thermal damage (anneal) to the compression fittings and drag link fittings. If the degradation is not found, part of the T/R inner wall could separate in flight or during a Refused Take Off (RTO). A degraded T/R inner wall could result in T/R parts separating from the airplane in flight, causing damage to other airplane areas and potential for personal injury on-ground. If a T/R fails during a RTO, the engine could produce forward thrust, and an unexpected thrust asymmetry which could result in runway excursion. It is important to find any holes in the bleed offtake pneumatic ducts, or gaps at pneumatic duct connections, or damaged kiss seals and kiss seal mating surfaces during engine visual inspections.

The insulation layer in the blanket must not be contaminated with oil, grease, hydraulic fluid, water, fuel, solvents to maintain its insulation ability. The insulation performance of the blankets will be reduced by 35 percent if the insulation is exposed to fluid such as water, engine oil, and hydraulic fluid. After the fluid has become dry, the insulation performance of the blankets will remain reduced by 35 percent.

Some of the blankets are very large and must be lifted and handled carefully. Support must be given at the edge of the blankets. The weight of the blanket can bend, twist or break the blanket.



1 GAPS BETWEEN THE FIRE SEALS AND PRESSURE SEALS AND THE THERMAL INSULATION BLANKETS ARE FILLED WITH SEALANT AND FILLER

2 GAPS AT BLANKET CUTOUT FOR T-HOOK GEARBOX AND T-HOOK RECEIVER AND PDOS ACTUATOR FITTING ARE FILLED WITH SEALANT AND FILLER

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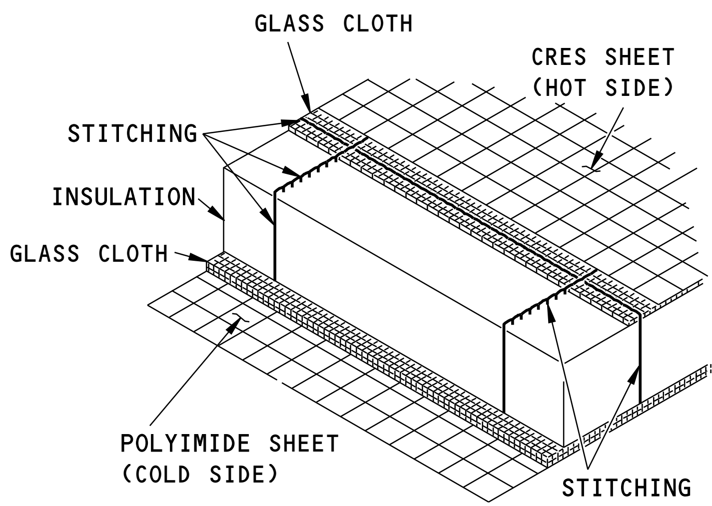
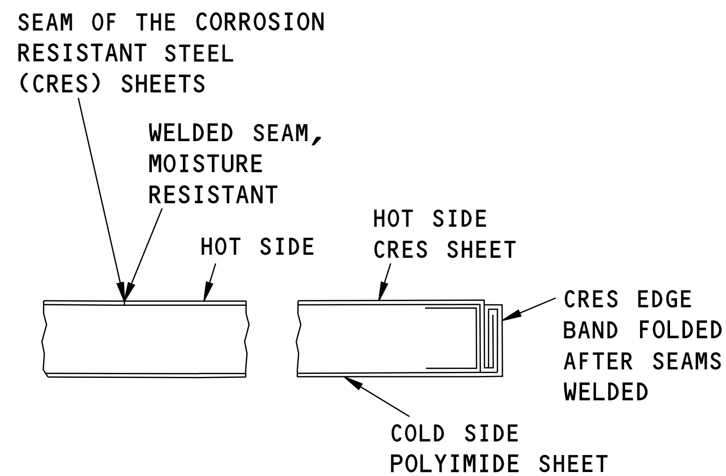
THRUST REVERSER - THERMAL INSULATION BLANKETS



METAL-FACED THERMAL BLANKET
CROSS SECTION
(EXAMPLE)



CROSS SECTION OF METAL-FACED
INSULATION BLANKET
AT SEAMS AND EDGEBAND

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THRUST REVERSER - THERMAL INSULATION BLANKETS

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THRUST REVERSER SYSTEM - BULLNOSE SEALS

Purpose

The bullnose seal prevents aerodynamic pressurization between the inner and outer walls of the translating sleeve from the fan exhaust.

Location

There is one bullnose seal for each translating sleeve, a total of four per airplane.

When the thrust reverser is retracted, the bullnose seal is compressed against the bullnose fairing on the torque box.

The bullnose seal is installed along the full circumference of the inner wall of the translating sleeve, radially out from the blocker door seals and radially in from the cascade segments.

Physical Description

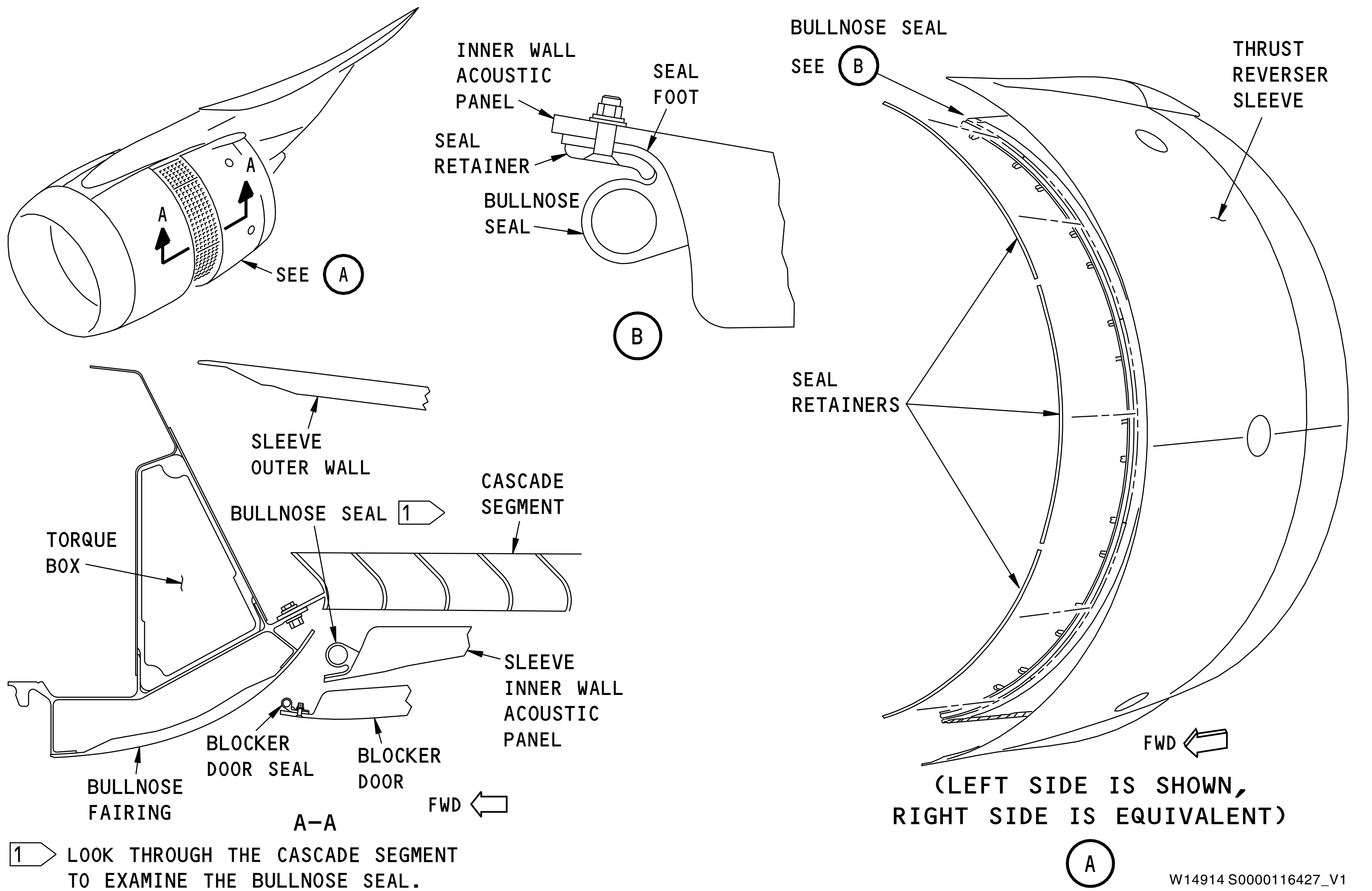
The bullnose seal is a one-piece, fabric reinforced, silicone rubber, bulb-type seal that is attached to the acoustic panel on the inner wall of the translating sleeve. The bullnose seal has a circular cross-section with a curved non-symmetrical base (or foot) that fits the curved contour of the acoustic panel of the sleeve inner wall. There are 124 bolts and three seal retainers that attach the seal to the acoustic panel.

A replacement bullnose seal does not have holes for the fasteners in the seal base. You must mark the hole locations from the acoustic panel on to the replacement seal, then drill or punch the holes into the seal base on the bench before you install the bullnose seal.

Training Point Information

The bullnose seal can be repaired in short segments instead of complete replacement. The repair replaces the damaged segment of the seal and the fabric/adhesive splices are made between the repair segment and the other ends of the seal. Clean seal surfaces for the adhesive are required to get the high strength bonds to hold the fabric splice to the bullnose seal. All unwanted materials such as oils, greases, waxes or dirt must be removed. The bullnose seal repair procedure cannot be used to repair the bulb-type fire seals found on the thrust reverser. The bulb-type fire seals must be replaced if damaged.

The loss of more than 65 percent of the bullnose seal may allow separation of the translating sleeve outer wall from the auxiliary slider track. In service, a maximum of 10 percent of the seal can be missing or damaged on each thrust reverser half. If repair or replacement cannot be done immediately, Boeing recommends inspection of the seal every 10 days to make sure the seal damage is not more than the maximum limit.



THRUST REVERSER BULLNOSE SEAL

THRUST REVERSER SYSTEM - PRESSURE RELIEF DOORS

Purpose

The pressure relief doors open to release the under cowl air pressure from a duct burst.

Location

The pressure relief doors are installed in the aft cowl. There are three doors in each aft cowl for a total of six doors per engine.

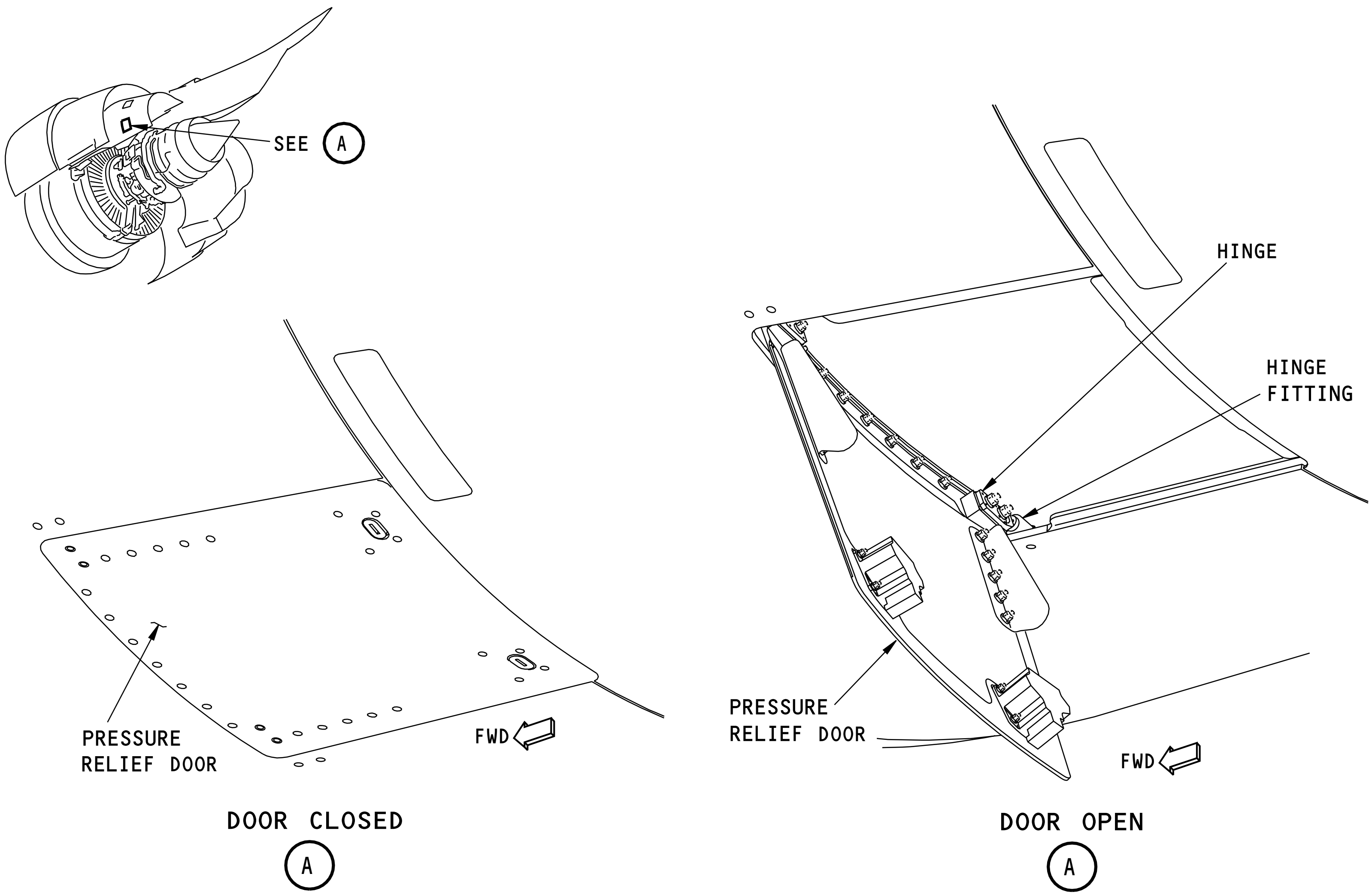
Physical Description

Each door is a machined aluminum plate that is hinged at the forward end. Each door has two replaceable pressure relief latches. All adjustment of the door is done during the installation. The hinge components are the same for the top and bottom hinge on each door.

Training Point Information

You must open the thrust reverser to get access to the hinge components and the pressure relief latches for the door.

Ground support equipment is used to determine if the pressure relief latches operate at the correct load.



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THRUST REVERSER SYSTEM - PRESSURE RELIEF DOORS

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THRUST REVERSER SYSTEM - REMOVAL, INSTALLATION AND ADJUSTMENT

Removal and Installation

To remove the thrust reverser, you must do these steps:

- Make sure there are a minimum of three cascade segments installed.
- Do the deactivation of the leading edge slats and the thrust reverser.
- Remove the fan cowl panels.
- Remove the forward fairing and track fairing.
- Disconnect the electrical and hydraulic connectors.
- Disconnect the structural grounding strap.
- Disconnect the forward and aft deflection limiter rods from the straps in the aft cowl.
- Disconnect the V-groove latch band to the engine fan case.
- Attach the thrust reverser sling/overhead crane.
- Support the thrust reverser weight with the sling/overhead crane.
- Disconnect the PDOS actuator.
- Disconnect the hold-open rod.
- Disconnect the No.1 and No.4 hinge cross-tie rods.
- Remove the No.2 and No.3 hinge bolts.
- Remove the thrust reverser from the strut.
- Place the thrust reverser on an approved transportation stand.

To install the thrust reverser, you must do these steps:

- Make sure there are a minimum of three cascade segments installed.
- Install the thrust reverser sling/overhead crane.
- Lift the thrust reverser from the transportation stand.
- Put the thrust reverser in position on the strut.
- Install the No.2 and No.3 hinge bolts.
- Adjust the gaps at the No.2 and No.3 hinges.
- Connect the No.1 and No.4 hinge cross-tie rods.
- Connect the structural grounding strap.
- Connect the PDOS actuator.
- Attach the hold-open rod.
- Open the thrust reverser with the sling.
- Install the forward and aft deflection limiter rods to the straps in the aft cowl.
- Attach the V-groove latch band to the engine fan case.
- Connect the electrical and hydraulic connectors.
- If necessary, do the thrust reverser adjustment procedure.
- Install the forward fairing and track fairing.
- Install the fan cowl panels.
- If necessary, change the cascade segment locations for the left or right engine.
- Activate the leading edge slats and the thrust reverser.
- Do the operational test for the thrust reverser system.

The left and right thrust reversers are interchangeable between the left and right engine, but the cascade segments must be installed in the correct position on the thrust reverser for the left or right engine.

The No.2 and No.3 hinge fittings carry the weight of the thrust reverser. The No.1 hinge cross-tie rod and No.4 hinge cross-tie rod positions the thrust reverser hinge line and are not a static load path.

Do not lift or move the thrust reverser with less than three cascade segments installed. A minimum of three cascade segments must be installed equally spaced around the thrust reverser half. No more than two cascade segments can be missing between the installed segments.

Adjustment

These are the steps to adjust the thrust reverser:

- Do a check for damaged or missing strut-mounted compression rods and deflection limiter cross-tie rods.
- Adjust the strut-mounted compression rods and the deflection limiter cross-tie rods if necessary.

THRUST REVERSER SYSTEM - REMOVAL, INSTALLATION AND ADJUSTMENT

- Adjust the latch beam splitline gap and latch wearplate gap (Left thrust reverser half No.1, 2, 3, 4 and 5 latch wearplates and left and right aft cowl No.1, 2, and 3 latch wearplates).
- Adjust the v-groove clearance.
- Adjust the v-band latch and centerline tension latches.
- Adjust the aft cowl deflection limiter latches.
- Adjust the aft cowl deflection limiter rods.
- Adjust the upper strut mounted compression rods, lower bifurcation compression pads and turbine case/aft cowl loadshare fittings.
- Adjust the upper bifurcation T-hook latch and the T-hook latch receiver.
- Adjust the lower bifurcation interlock pin and the serrated fitting for the interlock pin.
- Do a check of the fire seal compression.
- Do a final check of the thrust reverser adjustment.

Training Point Information

You must use the fall arrest lifeline procedure or other safety equipment to get access to the fairings and panels on the strut and the hinge bolts for the thrust reverser.

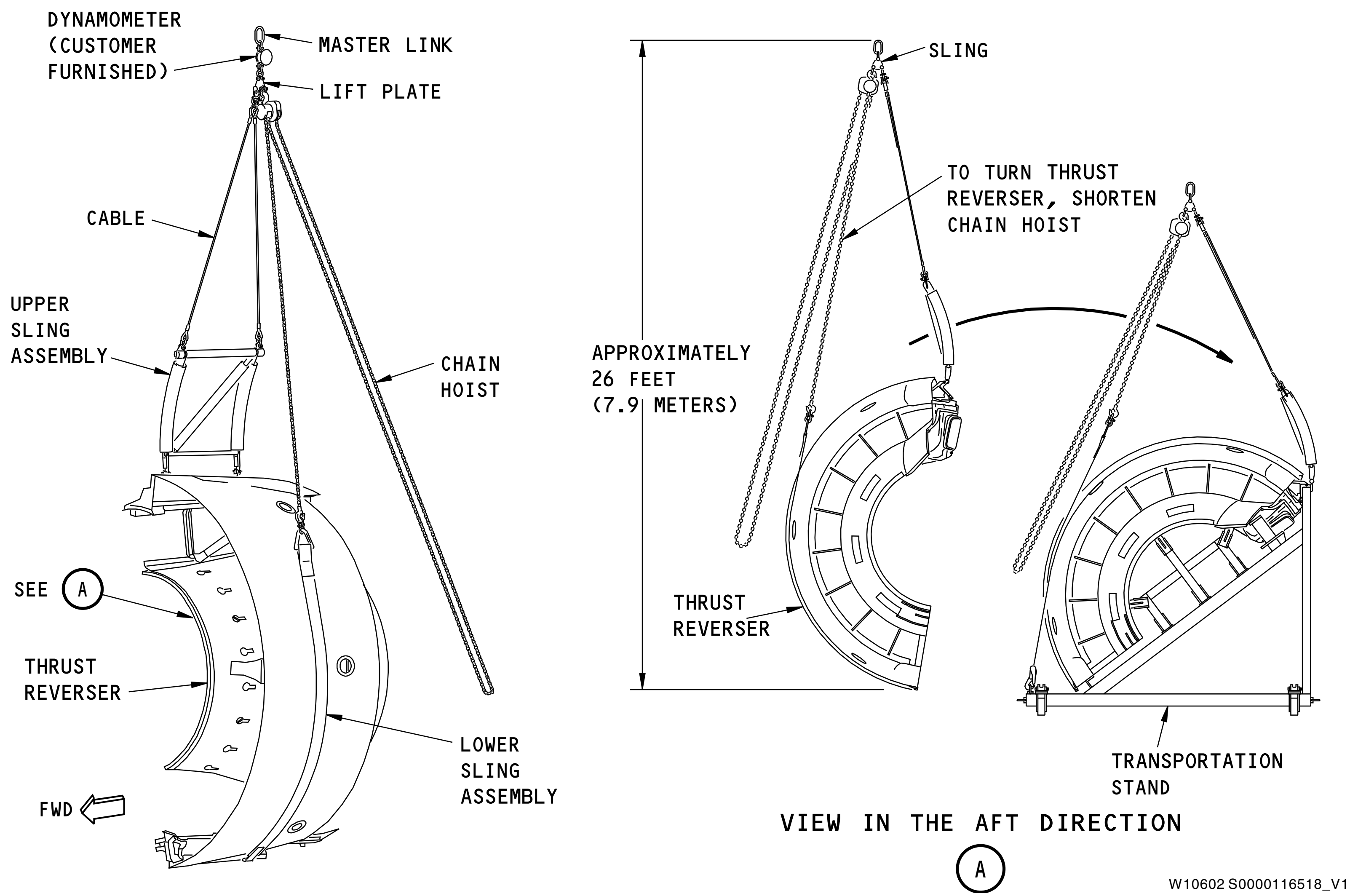
When the thrust reverser is moved with the sling,the thrust reverser must be in the near vertical position. If the thrust reverser is moved in the horizontal position, the center of mass can cause the thrust reverser to turn upside down suddenly. This can cause damage to the thrust reverser, the sling and crane and injury to personnel.

Install protection covers on electrical connectors and receptacles, hydraulic lines and fittings, and pneumatic ducts to keep them clean, prevent damage, and prevent unwanted materials in the ducts or lines.

The transportation stand is used to transport the thrust reverser half from the airplane to the maintenance shop. The transportation stand is also the work stand in the maintenance shop that allows access to the engine side and the airflow side of the thrust reverser half for component maintenance and repair. An approved repair fixture or an approved transportation stand is necessary to transport the thrust reverser, hold the thrust reverser during repair, and prevent damage to the thrust reverser and the thermal insulation blankets on the upper and lower bifurcation.

When you work under the thrust reverser, hold the thrust reverser in the open position with a minimum of two pieces of equipment at all times. There are three pieces of equipment that can hold open the thrust reverser: the hold open rods, a serviceable PDOS actuator and PDOS pump system, and the ground support equipment (GSE) sling with an overhead crane/hoist or equivalent equipment.

The strut mounted compression rods are the primary load path to transfer the fan duct pressure load between the thrust reverser halves. Continued operation is not permitted with the compression rods damaged or missing. The compression rods are adjustable at the rod ends. The compression cups are not adjustable. If the compression rods are found damaged, they must be replaced and adjusted again.



THRUST REVERSER SLING

THRUST REVERSER SYSTEM - LATCH ACCESS DOORS

Purpose

The latch access doors cover the tension latches on the bottom of the thrust reverser and spans the gap between the left and right thrust reverser halves when the thrust reverser is closed.

Location

There are three latch access doors installed on the right thrust reverser half.

Physical Description

The forward and aft doors are a composite structure. The center door is a machined aluminum door. These doors are hinged on the edge that is attached to the right thrust reverser half. There are two hinges on each door.

Each door has two latches. Each latch has an adjustment screw on the latch bolt to keep the door closed and flush with the fairings around the door opening.

Each latch that holds the latch access door in the closed position must be pushed two times to fully engage the latch. The latch can be partly engaged and a large gap can be seen between the two halves of the latch. The outer surface of the two halves will not align. When the outer surface of the latch is pushed two times, the gap will close to less than 0.039 inch (1 mm) between the two halves. The outer surface of the two halves will align when the latch is fully engaged.

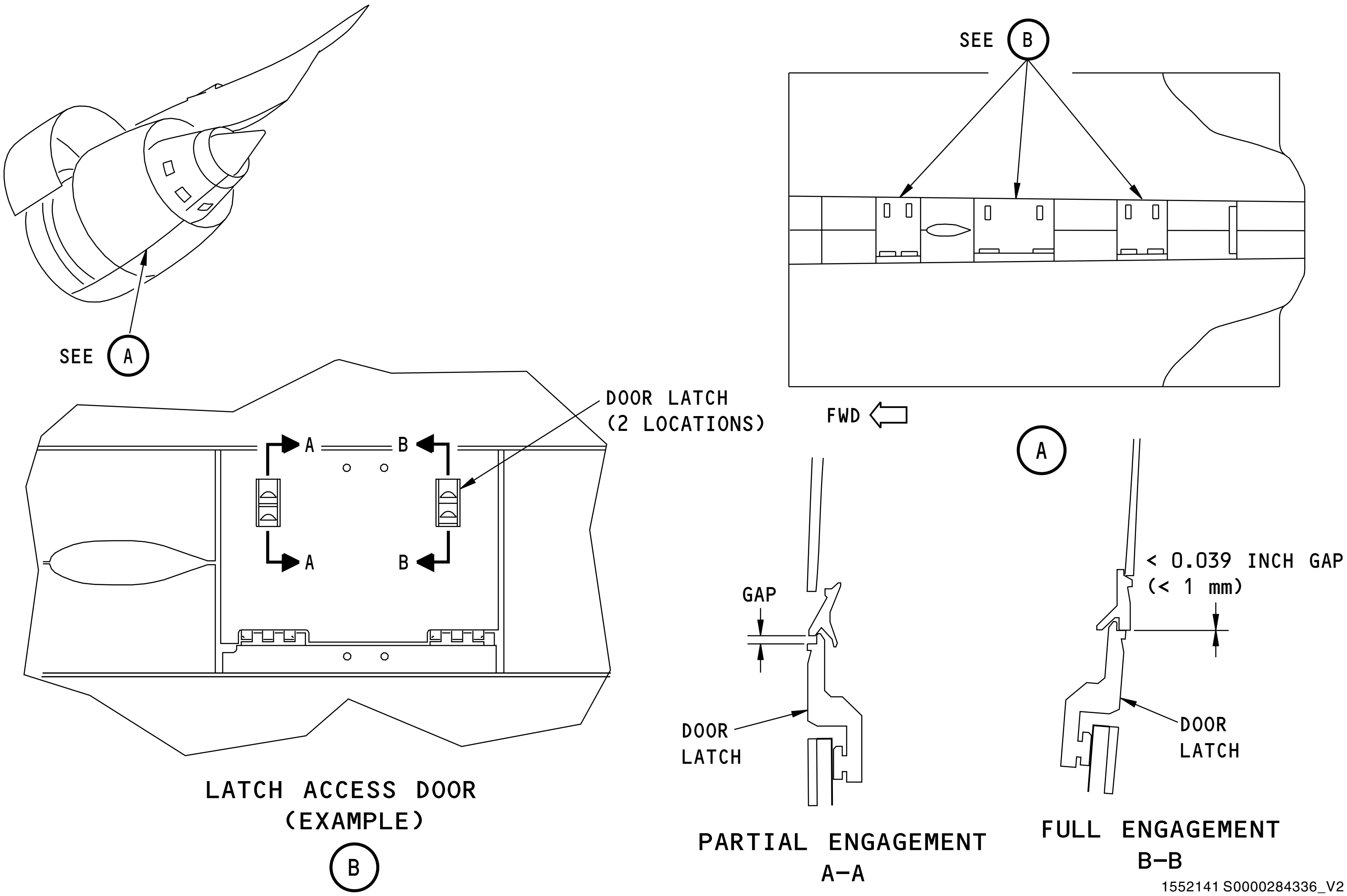
All the doors have fittings on the inside of the door which will prevent closure of the latch access door if the thrust reverser tension latch is not closed and latched.

Training Point Information

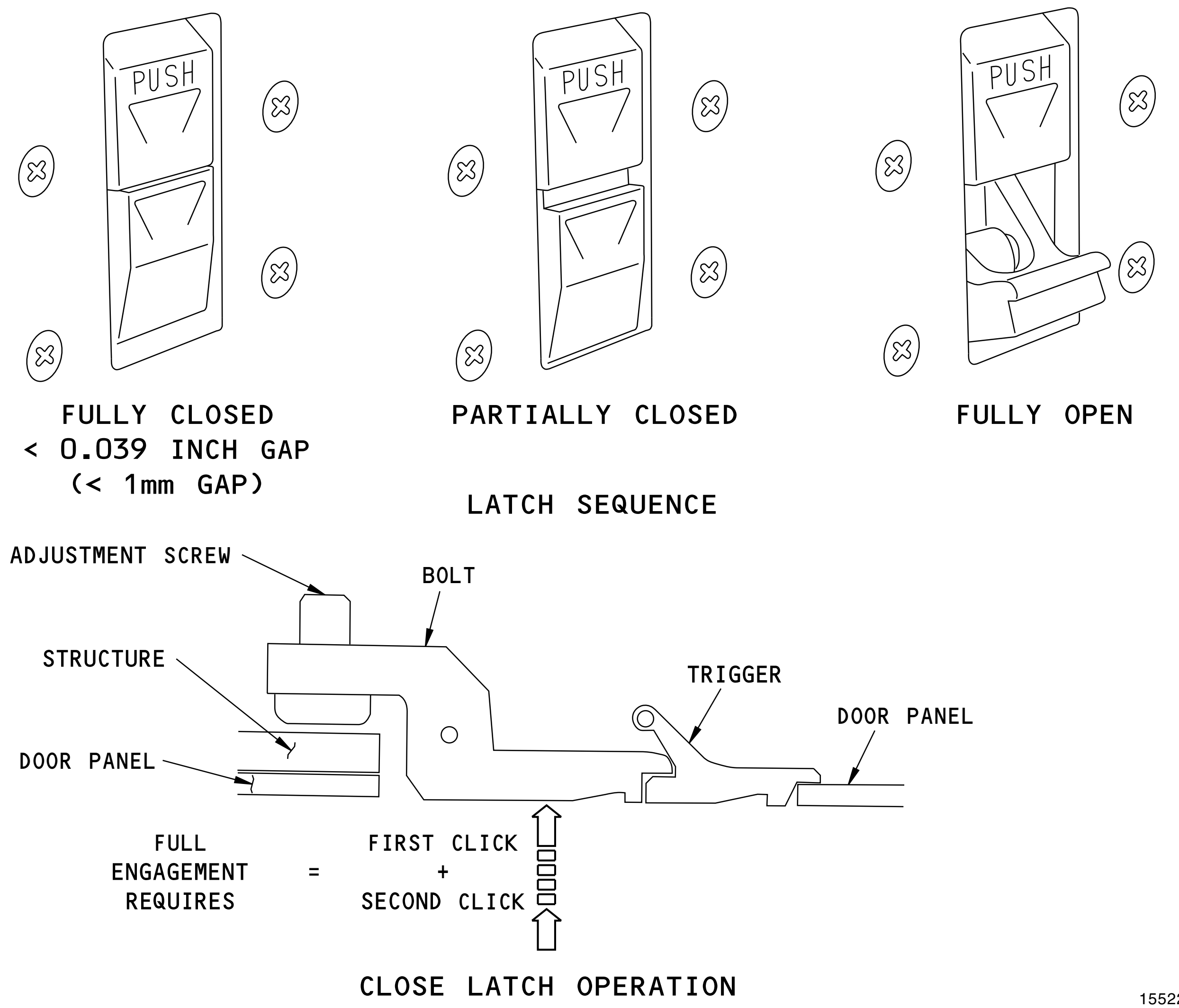
CAUTION DO A CHECK OF THE FIT AND FLUSHNESS OF THE CLOSED LATCH ACCESS DOORS TO THE FAIRINGS AROUND THE DOOR OPENINGS. IF THE FIT AND FLUSHNESS ARE NOT CORRECT, DAMAGE TO THE DOORS CAN OCCUR.

The latch access door must not be loose when the door is closed and latched. The closed latch access door must flush with the fairings around the door opening to prevent the door opening during flight.

Chapter 78 tells you how to open and close the thrust reverser.



THRUST REVERSER LATCH ACCESS DOORS



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LATCH CLOSURE

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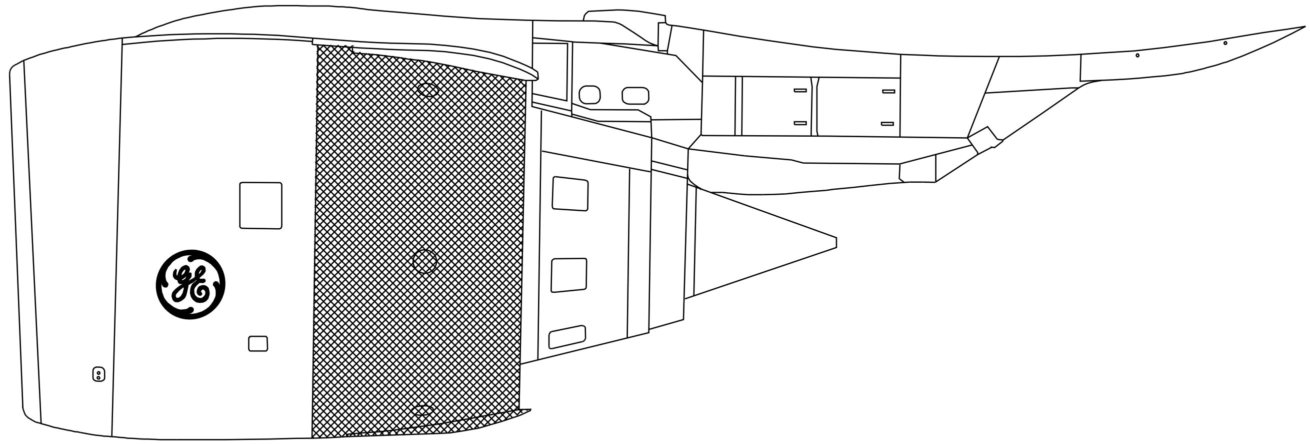
THRUST REVERSER ACTUATION SYSTEM (TRAS) - INTRODUCTION

General

The thrust reverser actuation system (TRAS) supplies hydraulic power to extend or retract the T/R sleeves.



ENGINE EXHAUST SYSTEM

- TURBINE EXHAUST SYSTEM
- THRUST REVERSER SYSTEM
- THRUST REVERSER ACTUATION SYSTEM
- THRUST REVERSER INDICATING AND FAULT DETECTION SYSTEM

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THRUST REVERSER ACTUATION SYSTEM (TRAS) - INTRODUCTION

TRAS - GENERAL DESCRIPTION

General

The thrust reverser actuation system (TRAS) moves the thrust reverser (T/R) sleeves. It operates on the ground only. The TRAS uses hydraulic pressure for operation and electrical power for control.

The TRAS uses these valves to control hydraulic pressure to the hydraulic actuators:

- Sync lock valve (SLV)
- Directional control valve (DCV)
- Isolation valve.

The hydraulic actuators move the thrust reverser sleeves.

The sync shafts keep the movement of the actuators together. They also permit manual operation of the thrust reverser sleeves for maintenance.

The sync lock/manual drive units lock the sync shafts in the retracted position.

The reverse thrust lever interlock actuator prevents the maximum reverse thrust command until the thrust reverser sleeves get near the extended position. The electronic engine control (EEC) uses thrust reverser sleeve position data from the rotary variable differential transducers (RVDTs) to control the interlock actuator.

The thrust reverser test enable switch permits the operation of the TRAS when the engine is not in operation. You use this switch for thrust reverser maintenance.

Extend

To extend the thrust reverser sleeves you put the reverse thrust lever in the reverse thrust interlock position. This causes three control signals to go to the TRAS. These are the effects of the control signals:

- The sync lock valve (SLV) opens and supplies hydraulic control pressure to release the sync lock/manual drive units.
- The isolation valve opens and supplies hydraulic pressure through the DCV to the actuators.
- The directional control solenoid valve opens and supplies hydraulic control pressure to the directional control valve (DCV). This moves the DCV to permit hydraulic power to go to the extend and retract sides of the hydraulic actuators.

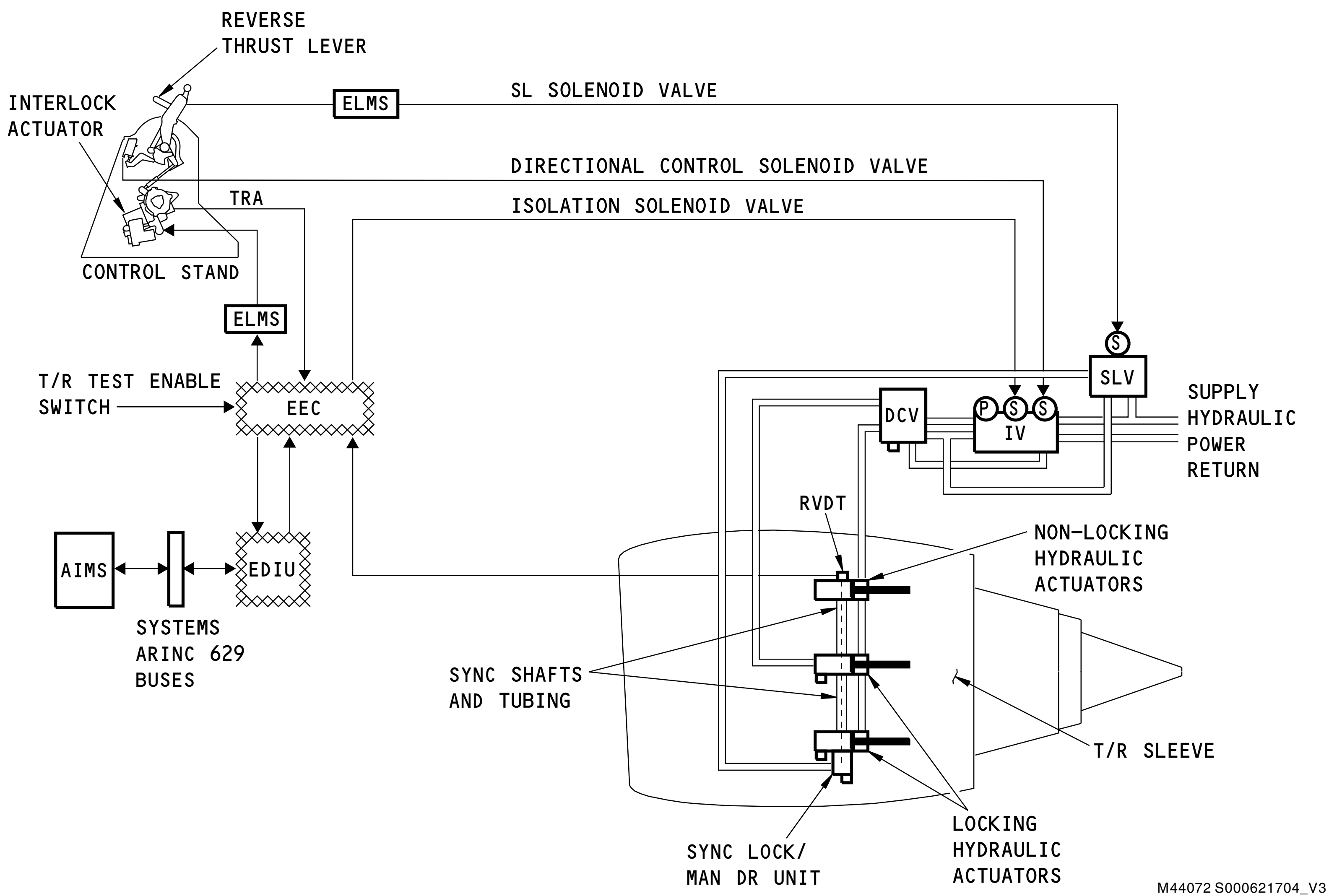
Hydraulic pressure to the actuators releases the locking actuators and moves the sleeves to the aft (extended) position.

Retract

To retract the thrust reverser sleeves you put the reverse thrust levers in the forward thrust position. This causes two control signals to go to the TRAS. These are the effects of the control signals:

- The signal to open the sync lock valve (SLV) is removed. A time delay circuit in the electrical load management system (ELMS) keeps the sync lock solenoid valve energized. This keeps the SLV open and the sync lock unlocked. The sync locks stay unlocked until the time delay is complete.
- The directional control solenoid valve closes and removes the hydraulic control pressure to the directional control valve (DCV). This moves the DCV to permit hydraulic power to go to the retract side of the actuators.
- The electronic engine control (EEC) begins a time delay before closing the isolation valve. The isolation valve stays open and supplies hydraulic power through the DCV to the actuators. The isolation valve closes when the time delay is complete.

Hydraulic pressure to the retract side of the actuators moves the thrust reverser sleeves to the forward (retracted) position.



TRAS - GENERAL DESCRIPTION

TRAS - COMPONENTS

General

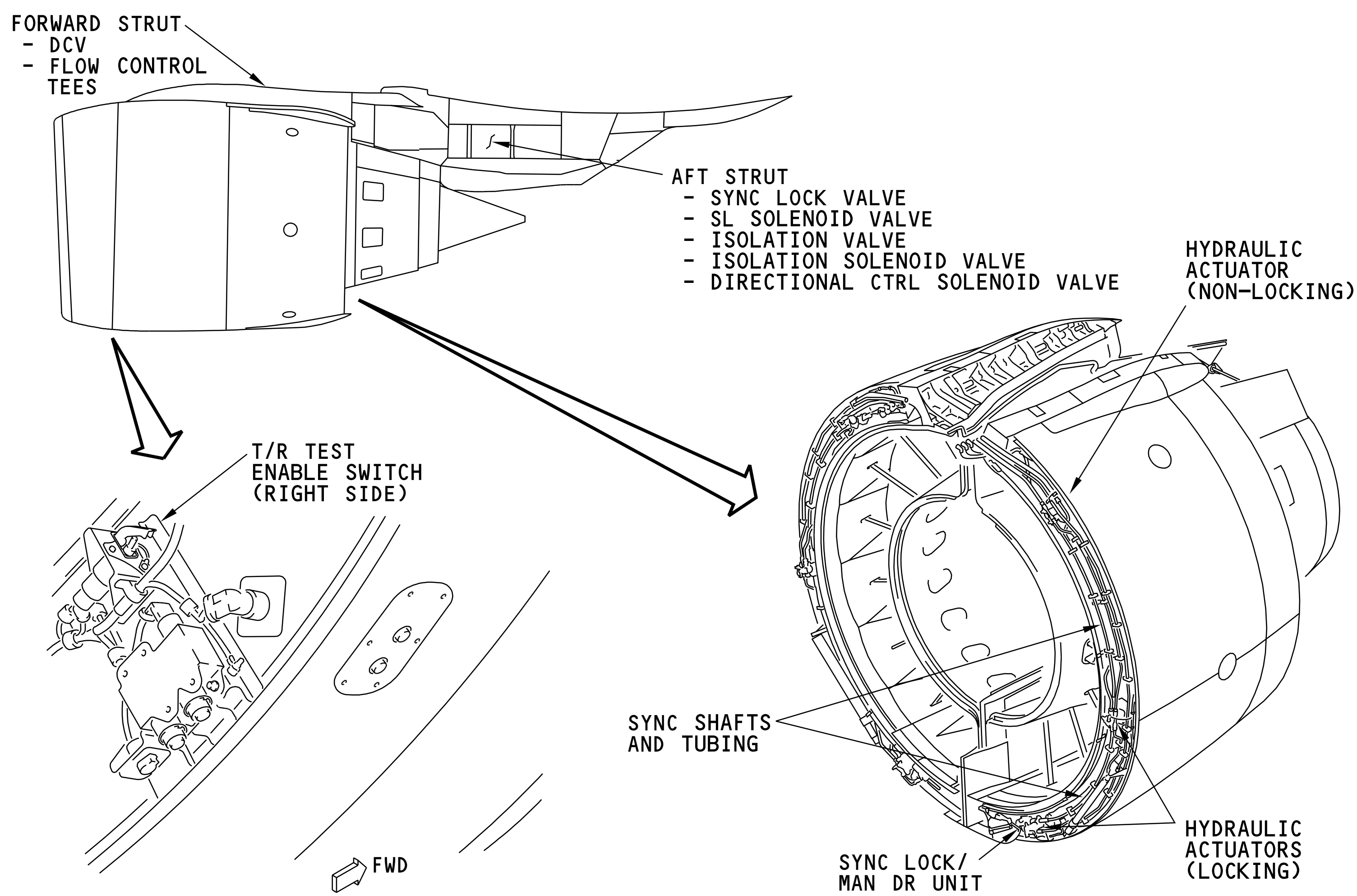
These are the thrust reverser actuation system (TRAS) components on the strut:

- Directional Control Valve (DCV)
- Flow control tees
- Sync lock valve (SLV)
- Sync lock solenoid valve
- Isolation valve (IV)
- Isolation solenoid valve
- Directional control solenoid valve.

These are the TRAS components on the thrust reverser (T/R):

- Hydraulic actuator (non-locking)
- Hydraulic actuator (locking)
- Sync lock/manual drive unit
- Sync shafts and tubing.

The thrust reverser test enable switch is on the inlet cowl aft bulkhead, right side.



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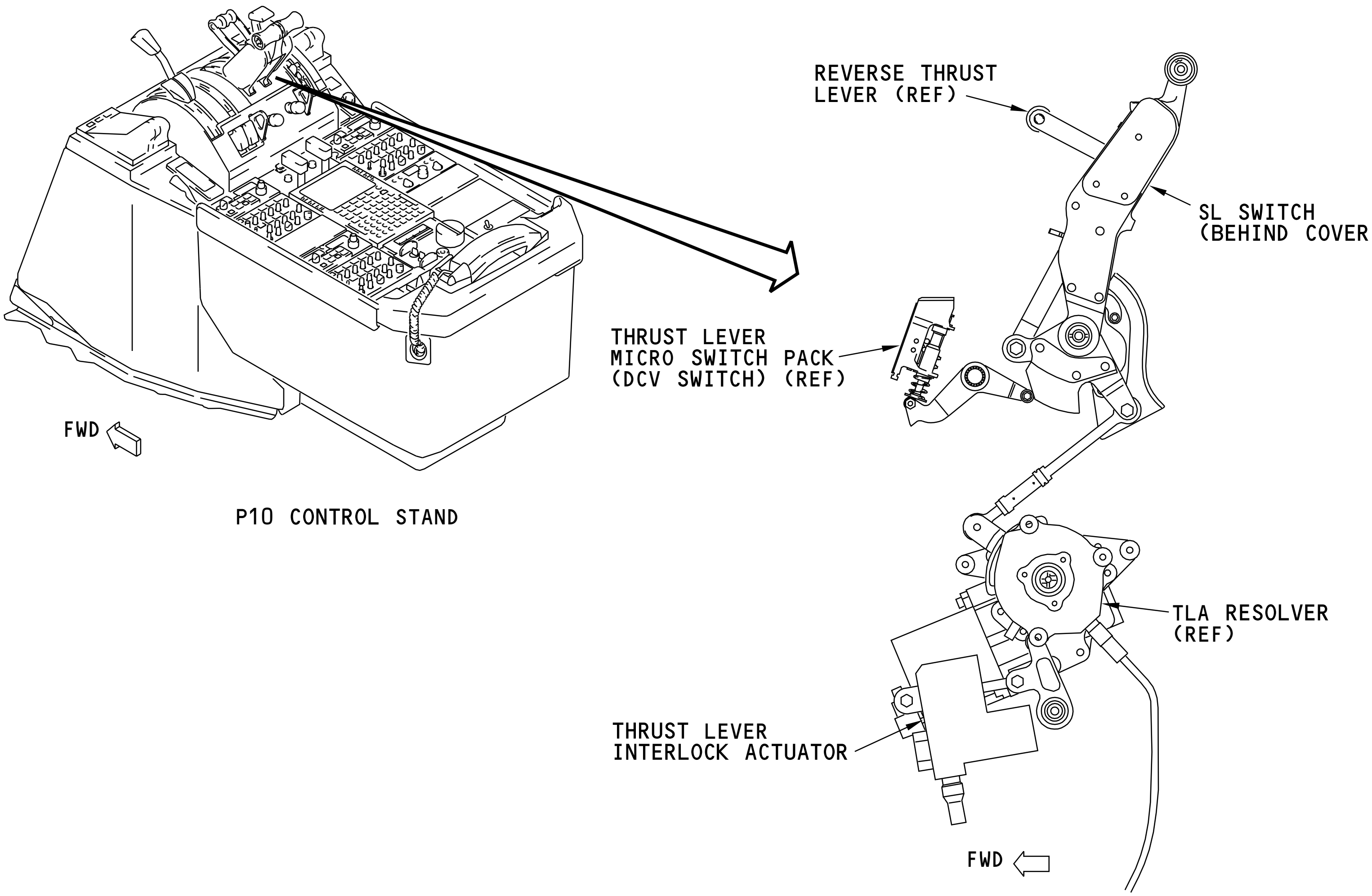
TRAS - COMPONENTS

TRAS - FLIGHT DECK COMPONENTS

General

These are the thrust reverser actuation system (TRAS) components in the P10 control stand:

- Thrust reverser sync lock switches in the thrust levers.
- Reverse thrust lever interlock actuators.
- Directional control valve switches in the thrust lever micro switch pack.



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TRAS - FLIGHT DECK COMPONENTS

TRAS - SYNC LOCK SWITCH

Purpose

The sync lock switch closes the circuit that causes the sync lock (SL) solenoid valve to energize.

Location

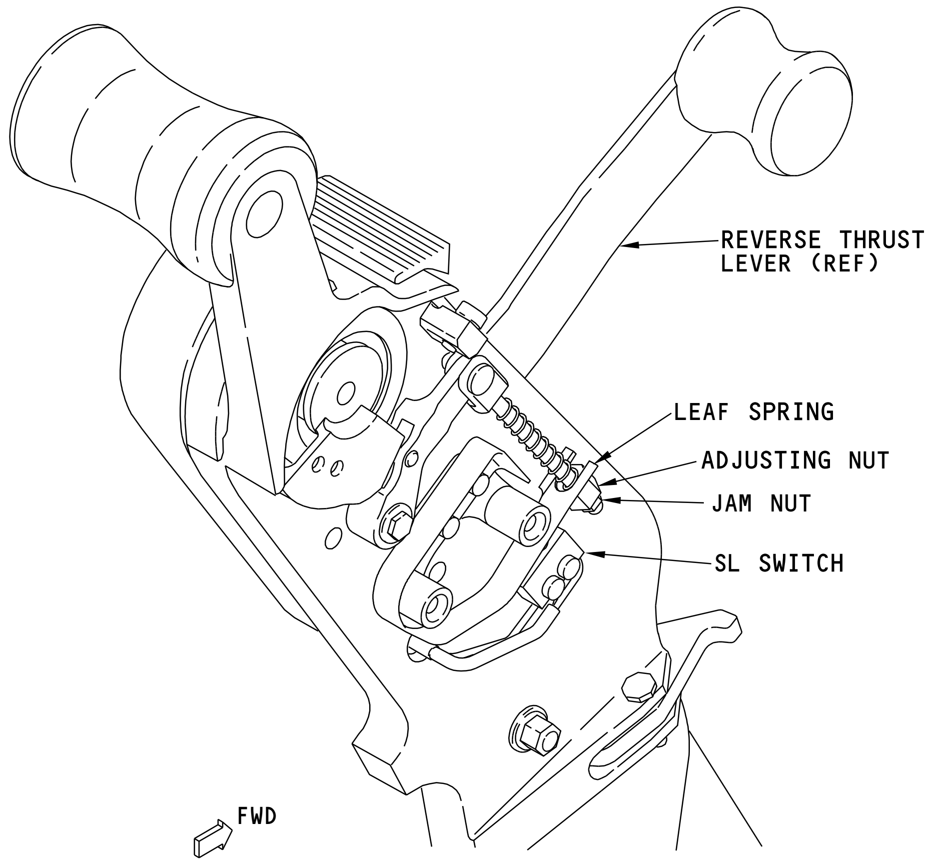
The sync lock switches are in the thrust levers. There are two sync lock switches; one in the left thrust lever and one in the right thrust lever. You remove the cover on the side of the thrust lever to get access to the switch. The switch installation in the thrust levers are on the inboard side of each lever.

Training Information Point

When you move the reverse thrust lever up and aft, a thrust lever cam turns. The cam moves a lever and support shaft mechanism to move a leaf spring to operate the sync lock switch. A cam detent tells you when the reverse thrust lever is at reverse idle.

You use a protractor on the reverse thrust lever to adjust the sync lock switch. The sync lock switch is set at a specified reverse thrust lever angle. You turn the adjusting nut to make the leaf spring touch the sync lock switch at the specified angle.

The sync lock switch will close the circuit to open the sync lock valve between 9.5 and 12.5 degrees of reverse thrust lever travel (nominal 11 degrees).



LEFT THRUST LEVER
(SIDE COVER REMOVED - RIGHT SIMILAR)

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TRAS - SYNC LOCK SWITCH

TRAS - SYNC LOCK VALVE

Purpose

The sync lock valve (SLV) supplies hydraulic control pressure to release the sync lock/manual drive units.

Location

The sync lock valve is in the aft strut hydraulics bay. You must open the left access panel on the aft strut fairing to get access to the sync lock valve.

Physical Description

The sync lock valve has these electrical parts:

- Sync lock valve solenoid valve
- Electrical connector.

The sync lock valve has these hydraulic connections:

- System return port
- System pressure port
- Control pressure port.

The hydraulic ports are identified on the valve housing; union fittings and packing are installed in all ports.

The sync lock valve weighs 2.2 pounds (1.0 kilogram).

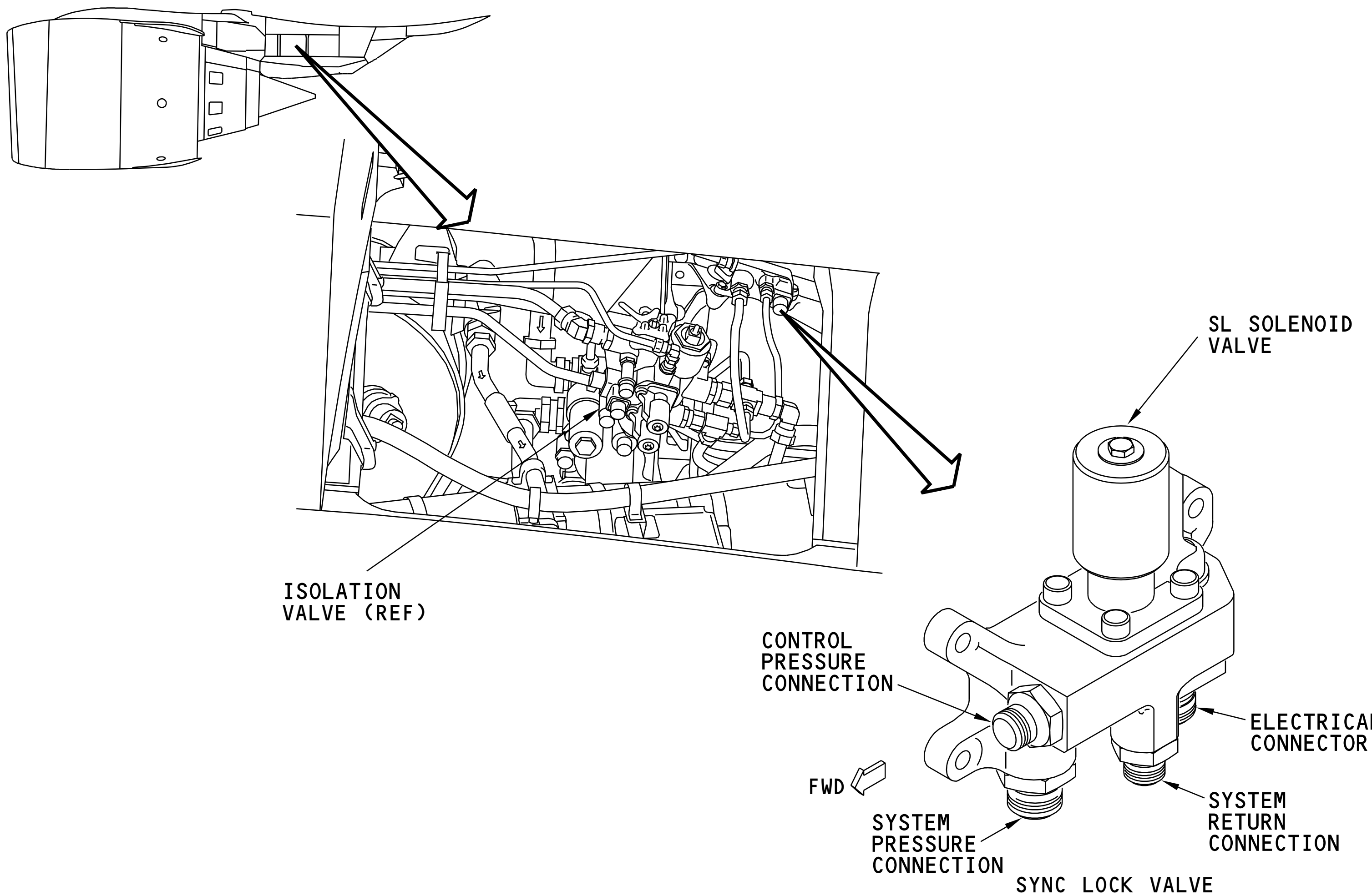
The sync lock valve and the sync lock solenoid valve are line replaceable units (LRUs).

Sync Lock Solenoid Valve

The sync lock valve solenoid valve is installed on the sync lock valve. It is energizes when there is a reverse thrust command. This permits hydraulic system pressure to go to the control pressure port.

Control pressure from the sync lock valve goes to the sync lock/manual drive units and releases the locks. When there is no reverse thrust command, control pressure goes to the system return port.

If the sync lock solenoid valve is replaced on the valve, there is packing that is replaced on the electrical plug on the solenoid valve. In addition, a solenoid gasket which seals the base of the solenoid valve to the valve body is replaced.



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TRAS - SYNC LOCK VALVE

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TRAS - SYNC LOCK/MANUAL DRIVE UNIT

Purpose

The sync lock/manual drive unit is an hydraulically operated unit. It does these mechanical functions:

- Provides a third lock for the thrust reverser actuation system on each thrust reverser half.
- Turns the sync shafts and the hydraulic actuators during manual operation to extend and retract the thrust reverser sleeve.

The sync lock/manual manual drive units prevent the movement of the sync shafts when there is no reverse thrust command. This keeps the actuators and sleeves in the forward (retracted) position.

Location

A sync lock/manual drive unit is installed to the lower hydraulic actuator on each thrust reverser half. Open the fan cowl panels to get access to the sync lock/manual drive units.

Physical Description

These are the parts on the sync lock/manual drive unit:

- Lock pin
- Lock release lever and target
- Hydraulic control port
- Manual drive unit
- Proximity sensor

The sync lock manual drive unit is a manual drive and lock mechanism with a lockout piston. The unit weighs approximately 7.5 pounds (3.4 kilograms). A union fitting and packing are installed in the control pressure port.

The manual drive and lock mechanism are in a sealed housing that is installed on the lower hydraulic actuator. The sync lock/manual drive unit in operation is filled with hydraulic fluid. When the sync lock/manual drive unit is replaced on the hydraulic actuator, the packing between the backup rings must be replaced.

The sync lock/manual drive unit is installed on the lower hydraulic actuator with five bolts and filler washers. The bolts are lockwired.

The manual drive is a right-angle drive with a spring loaded pinion gear which engages the bevel gear on the rotating jaw. A clutch is splined on the pinion gear. The lock mechanism is a rotating jaw and a sliding jaw; both have two locking teeth. The sliding jaw is spring loaded to engage with the rotating jaw for locking, and is moved hydraulically to disengage for unlock. When unlock hydraulic pressure is applied to the differential area of a lockout piston that is perpendicular to the sliding jaw. This piston is normally disengaged by a spring, but when hydraulic pressure is applied, the piston is forced to engage a groove in the unlocked sliding jaw and keeps the jaw in the unlocked position.

The output shaft on the rotating jaw in the sync lock manual drive unit has a square cross-section drive that fits into the hydraulic actuator worm gear that also connects the square drive of the sync shaft.

The sync lock/manual drive unit is the same identical unit on the left and right thrust reverser half. When the sync lock/manual drive unit is installed on the left thrust reverser half, the unlock lever, proximity sensor and the hydraulic and electrical connections are between the unit and the forward torque box. When the unit is installed on the right thrust reverser half, the unlock lever, proximity sensor and the hydraulic and electrical connections are away from the forward torque box.

Lock Release Lever and Lock Pin

You use the lock release lever to manually release the sync lock. The lock pin holds the lever in the not locked position. The lever is spring loaded to return to the locked position.

The target for the sync lock proximity sensor is mounted on the lever.

Control Pressure Connection

The control pressure port gets hydraulic control pressure from the sync lock valve (SLV). Hydraulic pressure from the sync lock valve releases the sync lock when there is a reverse thrust command.

TRAS - SYNC LOCK/MANUAL DRIVE UNIT

Manual Drive Unit

A manual 3/8 inch square drive permits you to manually extend and retract the thrust reverser sleeve for maintenance. The manual drive has an internal clutch which limits the input torque to a maximum of 110 pound-inches (12.4 Newton-meters).

Proximity Sensor and Target

The proximity sensor is mounted in a flange on the body of the manual drive unit. The proximity sensor uses a target mounted on the lock release lever to send sync lock position data to the thrust reverser indicating and fault detection system. The signal from the sensor will indicate target NEAR for the lock position and target FAR for the unlock position.

See section 78-36 for more information.

Operation

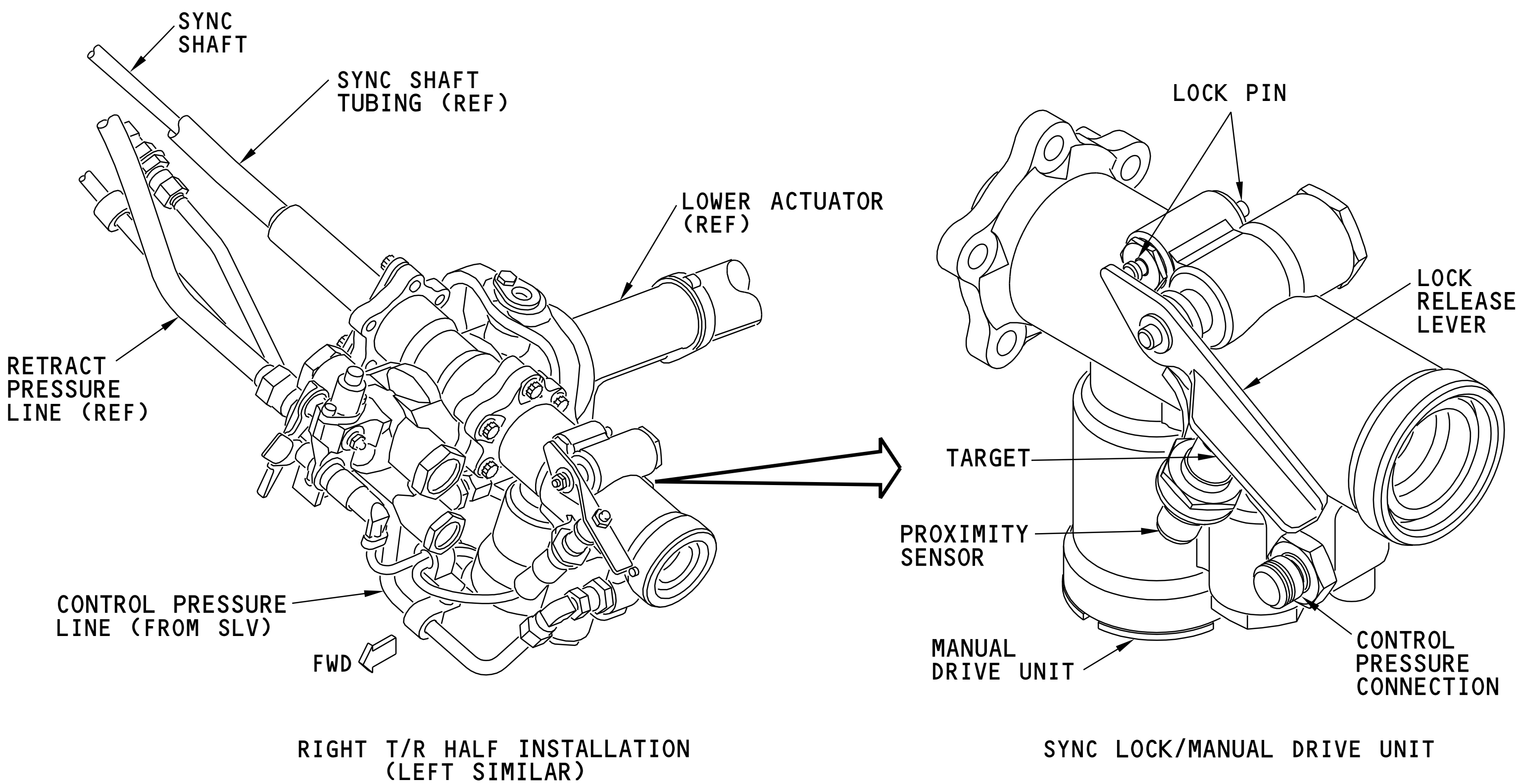
When hydraulic presssure is applied at the control port, the internal sliding jaw in the unit moves to the unlock position against spring force and disengages from the rotating jaw which unlocks the sync shafts. The sliding jaw also turns the external lock release lever and target away from the proximity sensor to indicate the unlock position. With hydraulic pressure, a lockout piston moves to hold the sliding jaw in the unlocked position during the extension of the thrust reverser sleeves.

When hydraulic pressure is removed at the control port, the lockout piston is spring-loaded to return to it's usual position which releases the sliding jaw. Without hydraulic pressure, the sliding jaw is spring-loaded to return to the locked position and to engage the rotating jaw which locks the sync shafts. This causes the lock release lever and target to turn toward the proximity sensor to indicate the lock position. When the jaws are engaged, the sync shafts will not turn. This is the reason there is a time delay in the control circuit for the sync lock valve to allow the thrust reverser sleeves to retract to the stow and lock position before the sync lock jaws engage.

For ground maintenance, move the lock release lever away from the proximity sensor and use the lock pin to hold the lever in the unlock position. Insert a 3/8 inch square drive in the manual drive unit and push into the unit to engage the internal pinion gear with the bevel gear on the rotating jaw. You must maintain the inward force against a spring force to keep the pinion gear engaged as you turn the square drive to extend or retract the thrust reverser sleeves. The clutch in the manual drive will release to prevent damage to the actuation system if you exceed 110 pound-inches (12.4 Newton meters) of torque. When you remove the manual square drive, the pinion gear is spring-loaded to disengage the bevel gear.

Training Information Point

The retract side of the thrust reverser hydraulic actuation system must be pressurized when the sync lock/manual drive unit is installed. The hydraulic pressure will make sure all the hydraulic actuators are completely retracted and the bullnose seal is compressed to correctly rig the thrust reverser actuation system. Do not decrease the hydraulic pressure while you install the unit.



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TRAS - SYNC LOCK/MANUAL DRIVE UNIT

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TRAS - ISOLATION VALVE

Purpose

The isolation valve isolates the airplane hydraulic system from the thrust reverser actuation system (TRAS). It also permits hydraulic power to go to the TRAS to move the thrust reverser sleeves.

Physical Description

The isolation valve has these components:

- Hydraulic pressure switch
- Bypass valve
- Isolation shutoff valve
- Directional control valve solenoid valve
- Isolation valve solenoid valve
- Check valve.

The isolation valve has these hydraulic connections:

- Hydraulic system return port (SYS RTN)
- Hydraulic system pressure port (SYS PRESS)
- Control pressure port (CRTL)
- TRAS pressure port (TRAS PRESS)
- TRAS return port (TRAS RTN).

The valve body contains an isolation shutoff valve and a bypass valve. The valve is a sealed housing which in operation is filled with hydraulic fluid from the hydraulic system. The isolation valve is used to deactivate the thrust reverser actuation system (TRAS) for flight dispatch. Both valves are used to deactivate the TRAS for ground maintenance. The bypass valve and the isolation shutoff valve are an internal close tolerance slide with internal seals which moves in the valve body.

The isolation valve weighs 11.65 pounds (5.28 kilograms). The names of all ports, SYS RTN, SYS PRESS, CRTL, TRAS PRESS, TRAS RTN, are etched on the valve body. Union fittings and packing are installed in all hydraulic ports. On the valve body there are two electrical connectors and in the valve body there is internal wiring for the isolation valve solenoid valve and the directional control valve solenoid valve.

The isolation valve is mounted in the aft strut hydraulic bay. Open the strut side access doors to get access to the isolation valve.

Hydraulic Pressure Switch

The hydraulic pressure switch is installed in a hydraulic port at the TRAS pressure port (TRAS PRESS) on the isolation valve body. The pressure switch has an electrical connector. If the hydraulic pressure switch is replaced, a packing must be replace on the hydraulic fitting on the switch. The hydraulic pressure switch sends the position of the isolation shutoff valve, opened or closed, to the thrust reverser indicating and fault detection system. See section 78-36 for more information.

Bypass Valve

The isolation valve uses an internal check valve in the hydraulic system return line to prevent a pressure surge that can unlock the TRAS. The valve bypasses that check valve and connects the TRAS pressure port (TRAS PRESS) to the hydraulic system return port (SYS RTN).

Manually turn the crank to depress the plunger to move the valve to the bypass position. The crank is then pinned to keep the valve in the bypass position. When the pin is removed, the bypass valve is spring-loaded to return to the closed position which pushes the plunger out. The bypass valve prevents a hydraulic lock in the TRAS when you manually extend the thrust reverser sleeve.

Isolation Shutoff Valve

The isolation shutoff valve isolates the TRAS from hydraulic pressure from the airplane hydraulic system.

TRAS - ISOLATION VALVE

The isolation shutoff valve is operated by hydraulic pressure from the isolation valve solenoid valve. When the isolation solenoid valve is energized, hydraulic pressure is ported through the solenoid valve to move the slide in the isolation shutoff valve to the open position against spring force. This connects the hydraulic system pressure port (SYS PRESS) to the TRAS pressure port (TRAS PRESS). When the isolation solenoid valve is de-energized, spring force and hydraulic system pressure moves the slide of the isolation shutoff valve back to the closed position. The TRAS pressure port (TRAS PRESS) is isolated from the hydraulic pressure (SYS PRESS) port.

The isolation shutoff valve can be manually locked-out to deactivate the TRAS system. Push-in the plunger to keep the shutoff valve slide in the closed position and install a pin to keep the plunger pushed-in. When the pin is removed, the plunger is spring-loaded to push the plunger out; the shutoff valve slide will remain in the closed position.

Directional Control Valve Solenoid Valve

The directional control valve solenoid valve supplies hydraulic control pressure to open the directional control valve (DCV). When the directional control valve solenoid valve is energized, hydraulic pressure (SYS PRESS) goes through the solenoid valve and goes out the control port (CRTL). When the directional control valve solenoid valve is de-energized, the solenoid valve closes and the control port (CRTL) is isolated from the hydraulic pressure (SYS PRESS).

The directional control valve solenoid valve is installed on the isolation valve body with four screws and washers. The screws are lockwired. If the directional control valve solenoid valve is replaced on the valve, there is packing that is replaced on the electrical plug on the solenoid valve. In addition, a solenoid gasket which seals the base of the solenoid valve to the valve body is replaced.

Isolation Valve Solenoid Valve

The isolation valve solenoid valve supplies hydraulic pressure to move the isolation shutoff valve to the open position.

The isolation valve solenoid valve is installed on the isolation valve body with four screws and washers. The screws are lockwired. If the isolation valve solenoid valve is replaced on the isolation valve, there is packing that is replaced on the electrical plug on the solenoid valve. In addition, a solenoid gasket which seals the base of the solenoid valve to the valve body is replaced.

Check Valve

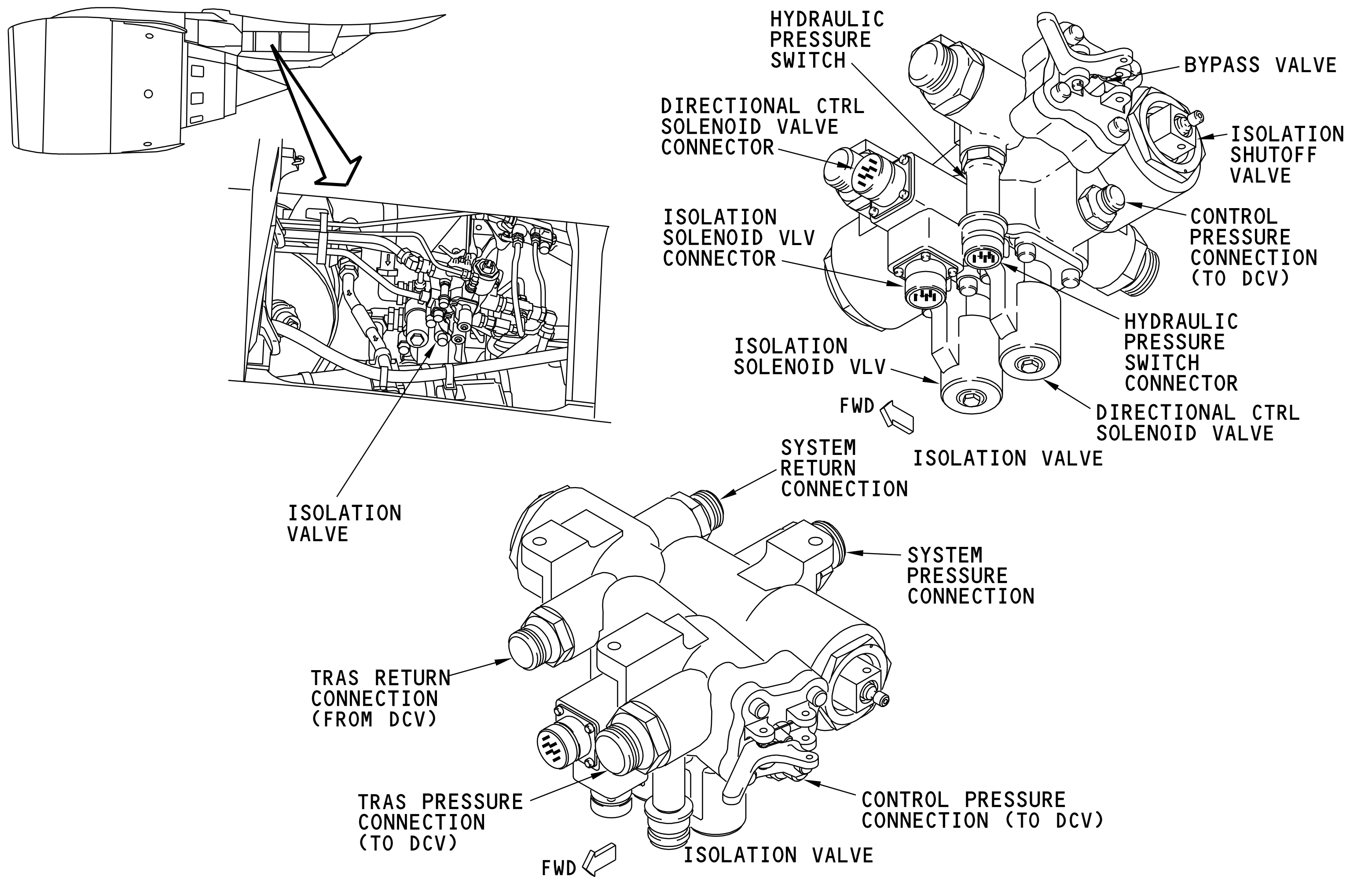
The isolation valve uses an internal check valve in the hydraulic system return line to prevent a pressure surge that can unlock the TRAS. The check valve is ported to vent hydraulic pressure to hydraulic return port (SYS RTN).

Training Information Point

Use the bypass valve for ground maintenance when you manually extend and retract the thrust reverser sleeve. When you open the bypass valve, the hydraulic fluid in the TRAS hydraulic tubing can return to the hydraulic system return line which prevents hydraulic lock. However, if TRAS hydraulic components must be removed, remove the pin from the crank to close the bypass valve to prevent drainage from the hydraulic system return lines.

The isolation valve is an line replaceable unit (LRU). These isolation valve components are also LRUs:

- Directional control valve solenoid valve
- Isolation valve solenoid valve
- Hydraulic pressure switch.



TRAS - ISOLATION VALVE

TRAS - DIRECTIONAL CONTROL VALVE

Purpose

The directional control valve (DCV) supplies hydraulic pressure to extend or retract the thrust reverser actuators.

Physical Description

The directional control valve (DCV) has these hydraulic connections:

- TRAS return port (TRAS RTN)
- TRAS pressure port (TRAS PRESS)
- Control pressure port (CONTROL)
- Retract pressure port (RETRACT)
- Extend pressure port (EXTEND).

The dry weight of the directional control valve (DCV) is 6.45 pounds (2.92 kilograms). The names of the ports (TRAS RTN, TRAS PRESS, CONTROL, RETRACT, EXTEND) are etched on the valve housing. Union fittings and packing are installed in all hydraulic ports.

The DCV is controlled with hydraulic pressure from the directional control valve solenoid valve on the isolation valve (IV). The DCV has an internal spring, main slide and auxiliary slide. A proximity sensor is mounted on the DCV to give the valve position indication.

You must remove the strut access panels to get access to the DCV.

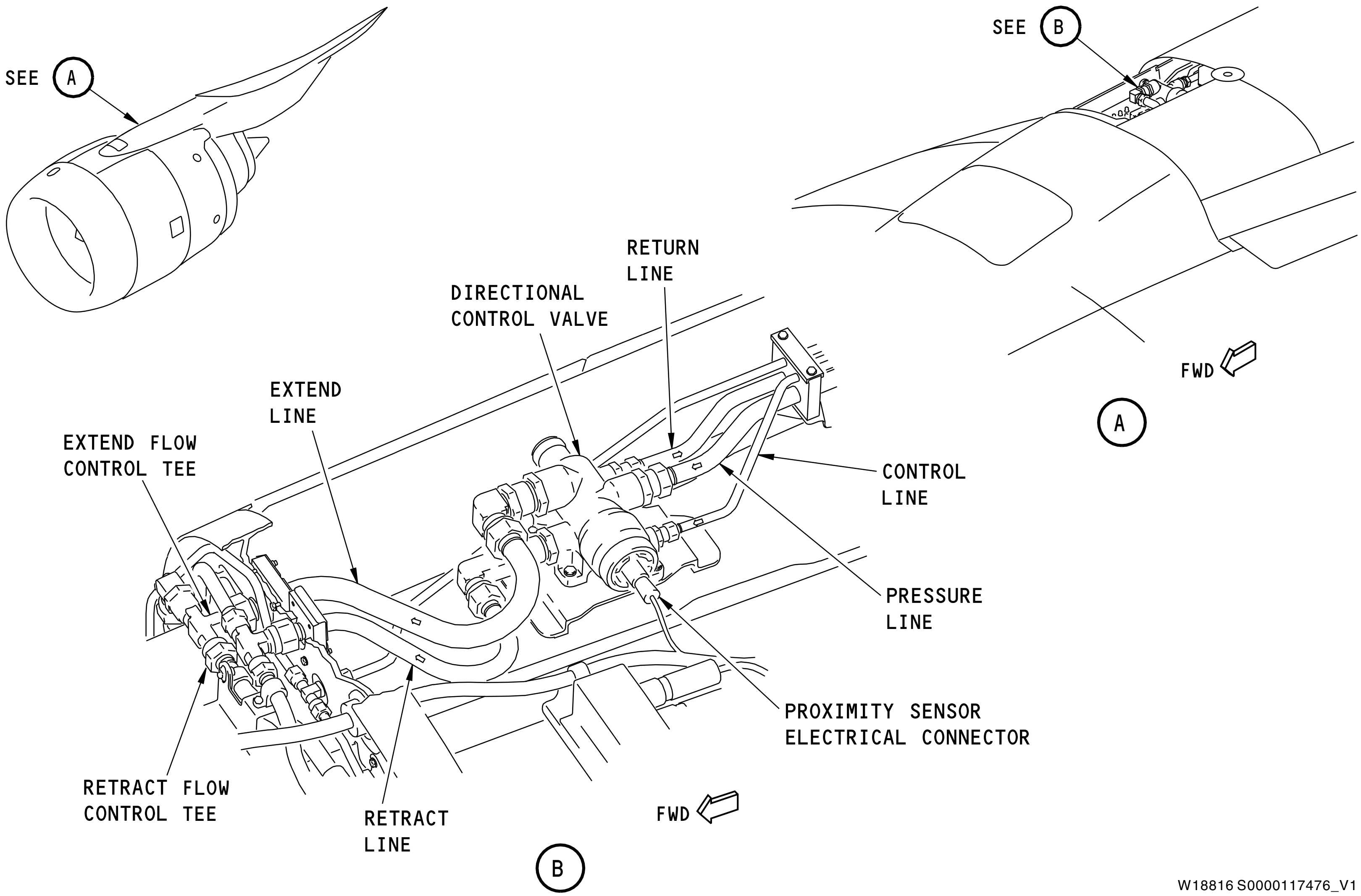
DCV Proximity Sensor

The directional control valve (DCV) proximity sensor sends DCV position data to the T/R indicating and fault detection system. The proximity sensor has an electrical connector. The DCV proximity sensor senses the position of the auxiliary slide. When the DCV is in the retract position, the signal from the sensor is target NEAR. When the DCV is in the extend position, the signal from the sensor is target FAR. See section 78-36 for more information.

Functional Description

Control hydraulic pressure from the isolation valve (IV) enters the directional control valve (DCV) through the control pressure port (CONTROL). The control pressure moves the auxiliary slide and main slide against spring force to a mid-mode position in the DCV. This opens internal passages which allows hydraulic pressure from the TRAS pressure port (TRAS PRESS) to move the main slide to the extend position. The main slide connects the TRAS pressure port (TRAS PRESS) to the extend pressure port (EXTEND) and retract (RETRACT) pressure port which go to the hydraulic actuators. The TRAS return port (TRAS RTN) is blocked by the main slide.

When control pressure from the isolation valve is removed, the auxiliary slide and main slide are pushed back the the retract position by spring force and hydraulic pressure from the TRAS pressure port (TRAS PRESS). The main slide connects the TRAS return port (TRAS RTN) to the extend pressure port (EXTEND) and the TRAS pressure port (TRAS PRESS) to the retract pressure port (RETRACT) that goes to the hydraulic actuators. Hydraulic fluid in the extend line goes to TRAS return port (TRAS RTN).



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TRAS - DIRECTIONAL CONTROL VALVE

TRAS - HYDRAULIC ACTUATORS, SYNC SHAFTS AND TUBING - INTRODUCTION

General

The TRAS uses six hydraulic actuators to extend and retract the T/R sleeves.

The sync shafts make sure the actuators on each sleeve move together.

Hydraulic Actuators

The actuators are linear movement actuators and attach to the torque box and the T/R sleeves. They get hydraulic power from the IV and the DCV.

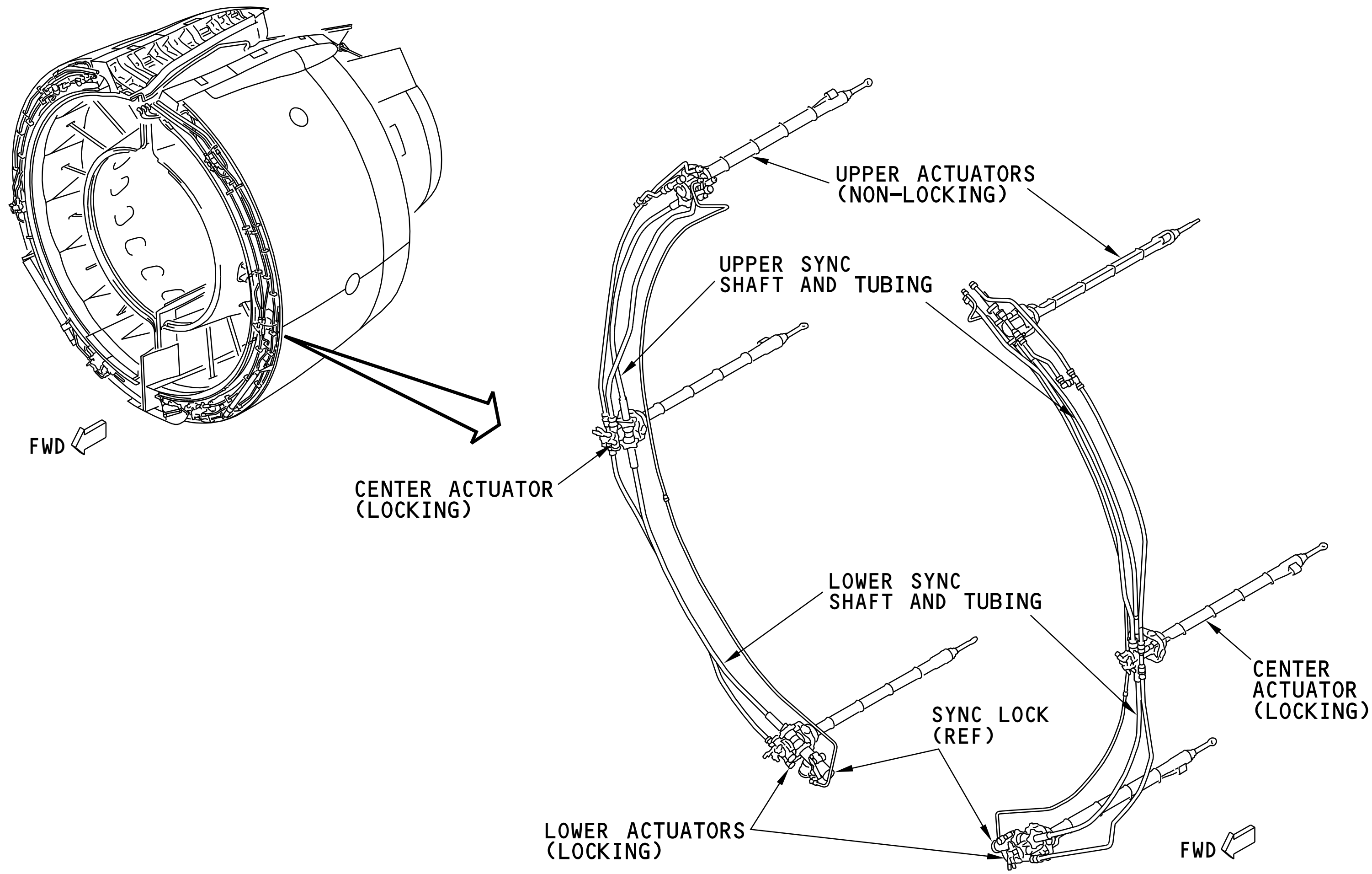
Each T/R half has two locking actuators and one non-locking actuator.

Sync Shafts and Tubing

There is an upper and lower sync shaft and tubing on each T/R half.

The sync shaft tubing contains the sync shafts. The tubing also makes a routing for the TRAS extend pressure to go from the center actuator to the upper and lower actuators.

The sync shafts connect the drive mechanisms of the actuators together. The sync shafts on the left T/R half operate independently of sync shafts on the right T/R half.



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TRAS - HYDRAULIC ACTUATORS, SYNC SHAFTS AND TUBING - INTRODUCTION

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TRAS - LOCKING HYDRAULIC ACTUATORS

General

The thrust reverser actuation system (TRAS) uses six hydraulic actuators to extend and retract the thrust reverser sleeves (T/R). There are four locking actuators for each engine.

The sync shafts make sure the actuators on each sleeve move together.

Purpose

The locking hydraulic actuators have these functions:

- Extend the T/R sleeves
- Retract the T/R sleeves
- Lock the T/R sleeves in the retracted position.

Location

Each thrust reverser half has a center and lower locking actuator. The actuator is attached to the thrust reverser torque box at the gimbal assembly and the thrust reverser sleeve with the actuator rod end.

You get access to the electrical connector for the actuator lock proximity sensor, the actuator lock lever and lock pin, the hydraulic connections, the sync shaft tubing, and the gimbal assembly through the fan cowl panels.

You get access to the actuator rod end that attaches to the thrust reverser sleeve through the small, circular access panels on the side of the thrust reverser sleeve.

Physical Description

The locking actuators have these parts and connections:

- Extend pressure connections
- Retract pressure connections
- Sync shaft and tubing connections
- Gimbal assembly
- Lock release lever and lever lock pin
- Actuator lock proximity sensor
- Rod end.

The locking actuator weighs approximately 33.2 pounds (15.1 kilograms). Fully retracted, the actuator length is 51.7 inches (1313 millimeters). Full extended, the actuator length is 85.8 inches (2179 millimeters). The extension stroke for the actuator is approximately 34 inches (864 millimeters).

The locking actuator contains an internal lock mechanism that prevents piston movement. When the actuator is stowed and locked, an internal lock spring positions a lock sleeve that holds the lock keys radially in slots in the piston. When deploy hydraulic pressure is applied, the lock sleeve moves in the opposite direction from the piston, against the spring force, which releases the keys. As the piston extends, the piston forces the lock keys radially outward and a lock spring follower on the lead screw prevents the keys from engaging during the piston extension and retraction.

The actuators have an internal lead screw and worm wheel which are concentric with the piston. The lead screw turns through a nut that is fastened to the head end of the piston. The piston moves axially and independently from the lead screw. As the piston extends or retracts, the nut on the piston causes the lead screw and worm wheel to turn which turns the worm shaft. The worm shaft is connected to the sync shafts which are connected to the other actuators. The sync shafts synchonize the operation of the other actuators.

Extend Pressure Connections

The extend pressure connection on the center actuator gets extend pressure from the directional control valve (DCV).

The extend pressure connection on the lower actuator has a cap. The lower actuator does not use the extend pressure connection. It gets extend hydraulic pressure from the center actuator through the sync shaft tube.

Retract Pressure Connections

The upper retract pressure connection on the center actuator gets retract hydraulic pressure from the DCV through the upper actuator. The lower actuator gets retract hydraulic pressure from the center actuator.

TRAS - LOCKING HYDRAULIC ACTUATORS

Sync Shaft and Tubing Connections

The sync shaft connects the worm shafts of the actuators together. There are connections on both the top and bottom of each actuator. The sync lock/manual drive unit connects to the sync shaft connection on the bottom of the lower actuator. The sync shaft tubing makes a routing for the extend hydraulic pressure.

Gimbal Assembly

A gimbal assembly attaches the head end of the actuator to the forward side of the thrust reverser torque box. You must open the fan cowl to get access to the gimbal assembly.

Lock Release Lever and Lever Lock Pin

The lock release handle turns the internal lever which pulls the lock sleeve against spring force to release the lock keys in the actuator. The lever lock pin holds the lever and the handle in the not locked position. This permits the manual movement of the thrust reverser sleeve.

Actuator Lock Proximity Sensor

The actuator lock proximity sensor uses a target mounted on the lock release handle to sends lock position data to the T/R indicating and fault detection system. The signal from the sensor will indicate target NEAR for the lock position and target FAR for the unlock position. See section 78-36 for more information.

Rod End

The rod end of the actuator attaches to the thrust reverser sleeve. You get access to the rod end through the access panels on the side of the thrust reverser sleeve.

Functional Description

When there is no reverse thrust command, an internal lock mechanism locks the actuators in the retracted position.

When there is a reverse thrust command, hydraulic pressure from the directional control valve (DCV) is directed to the extend and retract sides of the actuator piston. The extend pressure releases the actuator lock mechanism which unlocks the actuator piston. The piston extends because the surface area of the piston on the extend side is larger than the retract side of the piston. This permits the actuators to move the thrust reverser sleeve to the extended position in 2-3 seconds.

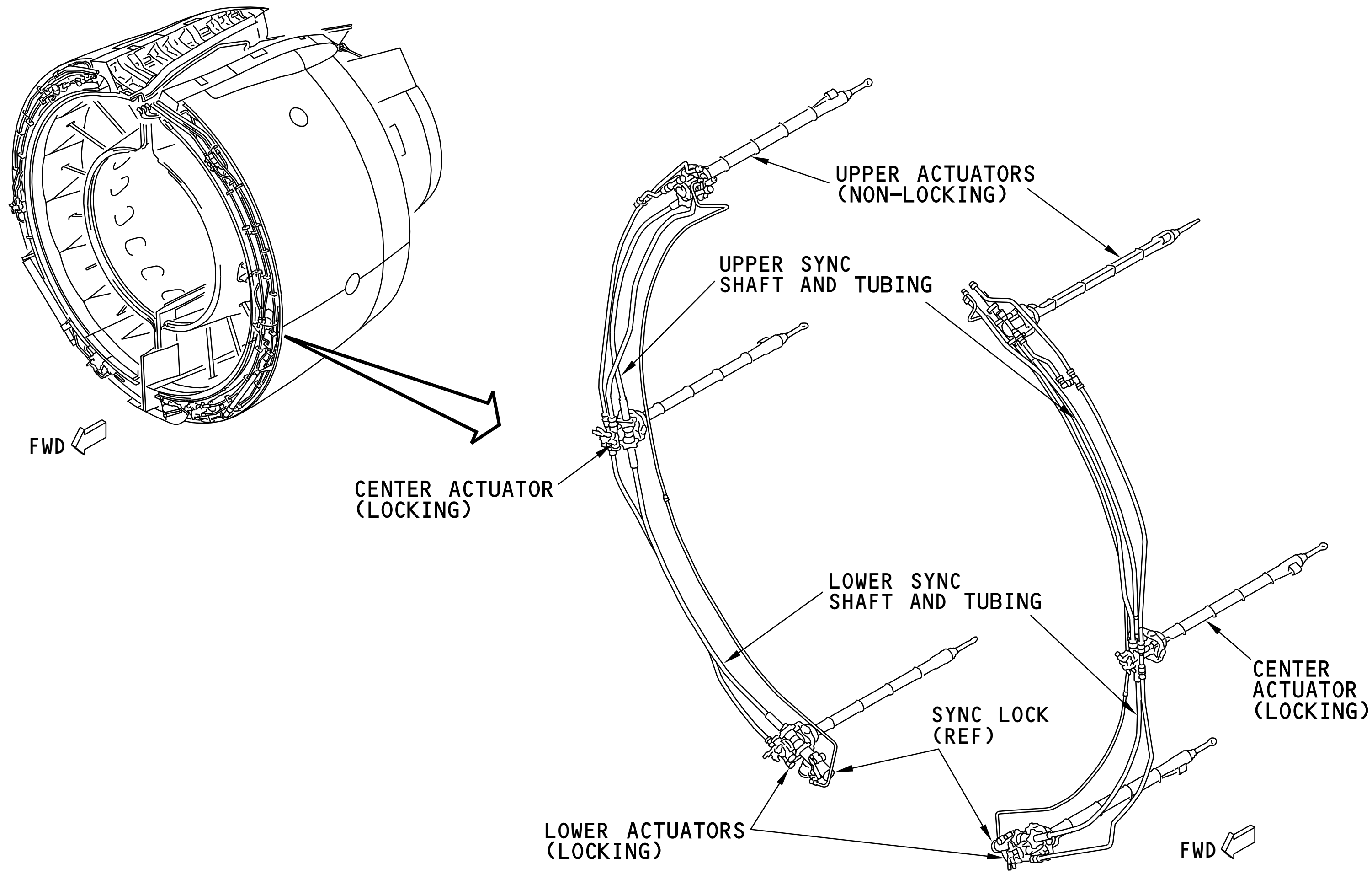
When the thrust reversers are commanded to retract, hydraulic pressure from the DCV is directed to the retract side of the piston. Hydraulic fluid in the deploy side tubing is directed to the hydraulic return line through the DCV. The actuators will retract and stow the thrust reverser sleeve in 3-5 seconds.

Training Information Point

The locking actuators are interchangeable but the correct plugs and unions must be installed in the actuator hydraulic ports for the installation at the center or lower position, left or right thrust reverser half.

Correct rigging of the thrust reverser actuators is done with the correct installation of the locking actuator. There are no adjustments that can be made after the actuators are installed. All adjustments to the actuators are made when the actuators are assembled at the fully retracted position per the component maintenance manual. Any adjustments to the actuators that are made during the installation, such as turning the actuator rod end, can affect the operation of the thrust reverser actuation system. This can cause the thrust reverser sleeve to bind or jam, operate slowly, cause damage to the actuator or damage to the thrust reverser structure.

The retract side of the thrust reverser hydraulic actuation system must be pressurized when a locking actuator is installed. The hydraulic pressure will make sure all the hydraulic actuators are completely retracted and the bullnose seal is compressed to correctly rig the thrust reverser actuation system. Do not remove the hydraulic pressure while you install the actuator.



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TRAS - HYDRAULIC ACTUATORS, SYNC SHAFTS AND TUBING - INTRODUCTION

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TRAS - NON-LOCKING HYDRAULIC ACTUATORS

General

The thrust reverser actuation system (TRAS) uses six hydraulic actuators to extend and retract the thrust reverser sleeves. There are two non-locking actuators for each engine.

The sync shafts make sure the actuators on each sleeve move together.

Purpose

The non-locking hydraulic actuators have these functions:

- Extend the T/R sleeves
- Retract the T/R sleeves

Location

Each thrust reverser (T/R) half has an upper non-locking actuator. The actuator is attached to the T/R torque box at the gimbal assembly and the thrust reverser sleeve with the actuator rod end.

You get access to the hydraulic connections, the sync shaft tubing, and the gimbal assembly when you open the fan cowl panels.

You get access to the actuator rod end that attaches to the T/R sleeve through the small, circular access panels on the side of the T/R sleeve.

Physical Description

The non-locking actuators have these parts and connections:

- Retract pressure connections
- Sync shaft and tubing connections
- Gimbal assembly
- Rod end.
- Rotary variable differential transducer (RVDT)

The non-locking actuator weighs approximately 29.1 pounds (13.2 kilograms). Fully retracted, the actuator length is 48.7 inches (1237 millimeters). Full extension stroke for the actuator is approximately 34 inches (864 millimeters).

The actuators have an internal lead screw and worm wheel which are concentric with the piston. The lead screw turns through a nut that is fastened to the head end of the piston. The piston moves axially and independently from the lead screw. As the piston extends or retracts, the nut on the piston causes the lead screw and worm wheel to turn which turns the worm shaft. The worm shaft is connected to the sync shafts which are connected to the other actuators. The sync shafts synchonize the operation of the other actuators.

Retract Pressure Connections

The upper retract pressure connection on the upper actuator gets retract pressure from the directional control valve (DCV). The lower retract pressure connection sends retract pressure to the center actuator.

Sync Shaft and Tubing Connections

The sync shaft connects the worm shafts of the actuators together. There are connections on both the top and bottom of each actuator. The sync shaft tubing makes a routing for the extend hydraulic pressure. The center actuator sends extend pressure to the upper actuator through the sync shaft tubing.

Gimbal Assembly

A gimbal assembly attaches the head end of the actuator to the forward side of the T/R torque box. You must open the fan cowl to get access to the gimbal assembly. These gimbals are forged and non-symmmetrical and are not the same as the actuators on the GE90-70/-80/-90 thrust reversers.

Rod End

The rod end of the actuator attaches to clevis fitting in the T/R sleeve. You get access to the rod end through the access panels on the side of the T/R sleeve. Because the clevis fitting is the same fitting used in the left sleeve and the right sleeve, the bolt that attaches the rod end to the clevis fitting is installed with the plain bushing on the bottom on the left sleeve and the plain bushing from the top on the right T/R sleeve.

TRAS - NON-LOCKING HYDRAULIC ACTUATORS

RVDT

The rotary variable differential transducer (RVDT) attaches to the upper sync shaft and tubing connection. The drive mechanism in the upper actuator turns the RVDT. The RVDT sends T/R sleeve position data to the EEC for control and indication functions. See section 78-36 for more information.

Functional Description

When there is a reverse thrust command, hydraulic pressure from the directional control valve (DCV) is directed to the extend and retract sides of the actuator piston. The piston extends because the surface area of the piston on the extend side is larger than the retract side of the piston. This permits the actuators to move the T/R sleeve to the extended position in 2-3 seconds.

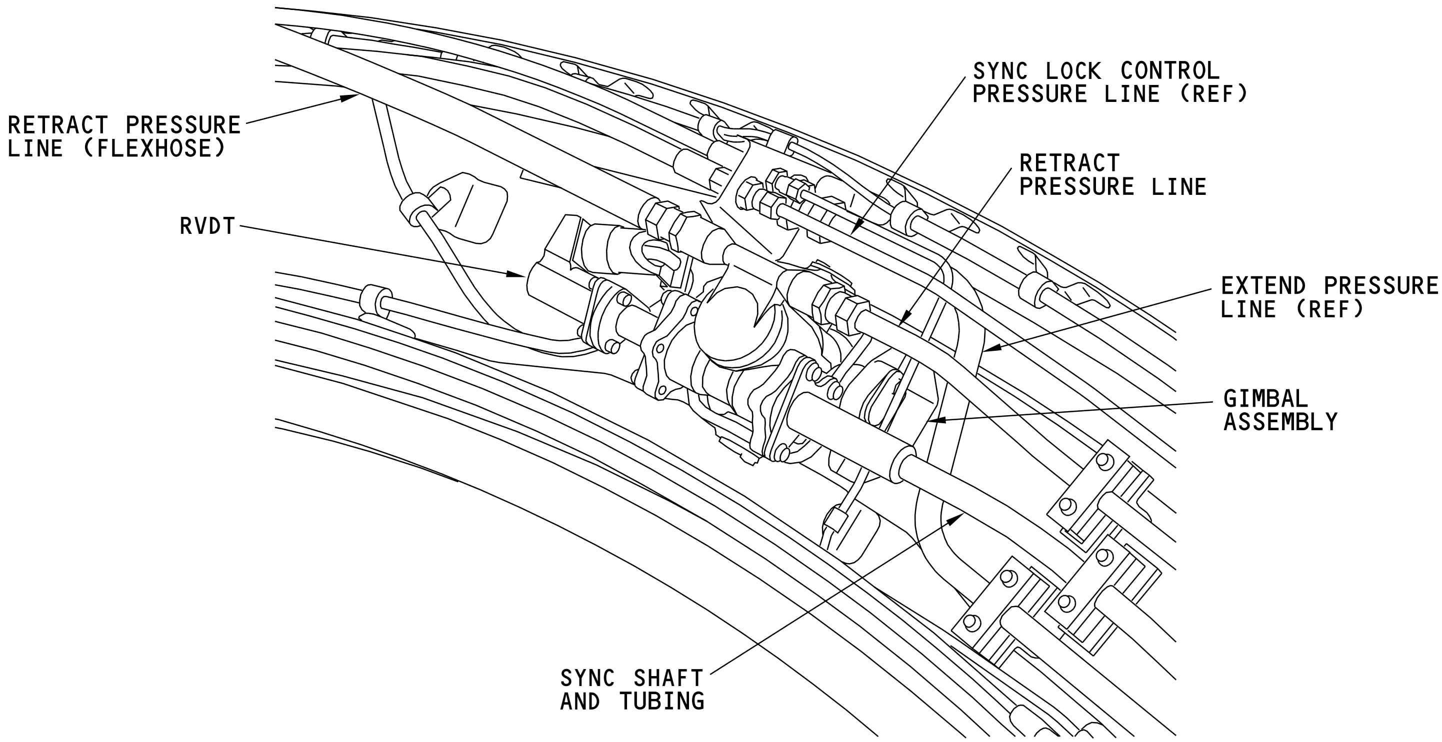
When the thrust reversers are commanded to retract, hydraulic pressure from the DCV is directed to the retract side of the piston. Hydraulic fluid in the deploy side tubing is directed to the hydraulic return line through the DCV. The actuators will retract and stow the T/R sleeve in 3-5 seconds.

Training Information Point

The non-locking actuators are interchangeable between the left and right thrust reverser halves, but the correct plugs and unions must be installed in the actuator hydraulic ports for the installation at the upper position of the thrust reverser half.

Correct rigging of the thrust reverser actuators is done with the correct installation of the non-locking actuator. There are no adjustments that can be made after the actuators are installed. All adjustments to the actuators are made when the actuators are assembled at the fully retracted position per the component maintenance manual. Any adjustments to the actuators that are made during the installation, such as turning the actuator rod end, can affect the operation of the thrust reverser actuation system. This can cause the T/R sleeve to bind or jam, operate slowly, cause damage to the actuator or damage to the thrust reverser structure.

The retract side of the thrust reverser hydraulic actuation system must be pressurized when a non-locking actuator is installed. The hydraulic pressure will make sure all the hydraulic actuators are completely retracted and the bullnose seal is compressed to correctly rig the thrust reverser actuation system. Do not remove the hydraulic pressure while you install the actuator.



LEFT UPPER ACTUATOR

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TRAS - NON-LOCKING HYDRAULIC ACTUATORS

TRAS - REVERSE THRUST LEVER INTERLOCK ACTUATOR

Purpose

The reverse thrust lever interlock actuator releases the reverse interlock which keeps the engine thrust command at idle until the thrust reverser (T/R) sleeves get near the extended position.

Physical Description

A control rod connects the crank on the thrust lever to the autothrottle brake housing which turns the thrust lever resolver. The resolver angle (TRA) is the primary input to the electronic engine control (EEC) for setting engine thrust.

There is one interlock actuator for each thrust lever. The interlock actuators are mounted at the bottom of the control stand. Each actuator has a clevis mounting that attaches the actuator to the control stand structure and a rod end that attaches to the interlock crank assembly. The interlock crank assembly has a roller that contacts an interlock stop on the autothrottle brake housing. The interlock stop physically prevents the reverse thrust lever movement to the full reverse thrust position until the two thrust reverser sleeves have deployed approximately 60 percent.

The interlock actuator is a linear actuator with a 28v dc motor. Internally, the actuator has a brake, spur reduction gear drive train, ball screw and nut assembly, load limit clutch and stroke limit switches. Positive mechanical stops in the unit prevent overtravel of the actuator if a limit switch malfunctions.

The actuator weighs approximately 2.5 pounds (1.13 kilograms).

There is a separator bar clamped to the wire bundles from the two interlock actuators. This bar is to prevent the interchange of the left side interlock actuator connector connected to the control stand electrical panel connector for the right side interlock actuator connector.

Functional Description

When you move the reverse thrust lever to command reverse thrust, the thrust lever movement causes the autothrottle brake assembly to turn until the interlock stop engages the roller on the interlock crank assembly. The roller on the crank assembly prevents any further movement of the autothrottle brake assembly in the reverse thrust direction. It stops the assembly at the reverse thrust interlock position.

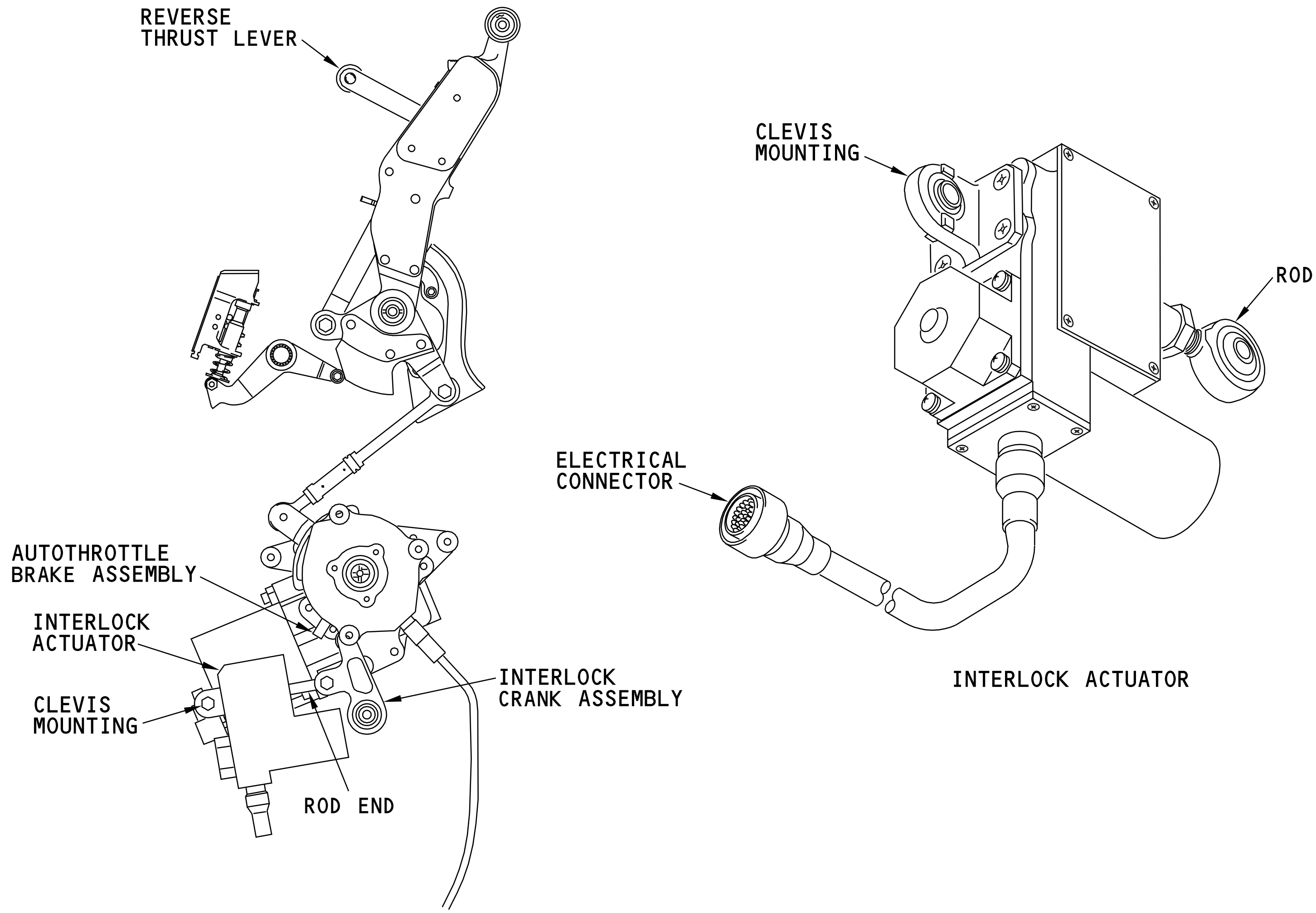
When the thrust reverser sleeves get near the extended position (approximately 60 percent deployment), the EEC provides electrical power to electromagnetically release the internal brake and the motor starts. Actuator operation will continue until the extend limit switch is actuated which interrupts the electrical power to the motor. Spring force causes the brake to engage which prevents overrun of the actuator.

The interlock actuator extends the rod end which turns the interlock crank assembly roller away from the interlock stop. The roller no longer blocks the movement of the autothrottle brake assembly. The pilot can now move the reverse thrust lever to increase the reverse thrust from idle to the maximum reverse thrust position.

There is no interlock actuator limit when you command forward thrust. When the polarity of the electrical power input is reversed, the actuator operates in the retract direction which continues until the retract limit switch is reached. If the limit switches malfunction, the load limit clutch slips to prevent damage to the actuator when it engages the mechanical stops.

Training Information Point

The interlock actuators can extend or retract in less than 1 second; make sure you are clear of the interlock actuators and the moving mechanism.



TRAS - REVERSE THRUST LEVER INTERLOCK ACTUATOR

TRAS - FUNCTIONAL DESCRIPTION - CONTROL

General

When the engine fire switch is in the NORM position, the TRAS uses electrical dc power from the appropriate ELMS panel to control the extension and retraction of the T/R sleeves.

These components must get control signals before the thrust reversers can move:

- SL solenoid valve
- Directional control solenoid valve
- Isolation solenoid valve.

These components send the control signals:

- SL switch through the SL relay
- DCV switch
- EEC.

Extend

When you move the reverse thrust lever to the reverse idle position, the SL and DCV switches move to the extend position. The SL switch sends a control signal to the SL relay. When the SL relay energizes, power goes to the SL solenoid valve. The SL solenoid valve energizes so that hydraulic control pressure can release the sync lock.

The DCV switch energizes the directional control solenoid valve. This permits hydraulic control pressure to operate the DCV. The DCV moves to the extend position.

The EEC must have these inputs to energize the isolation solenoid valve:

- TRA less than 30 degrees
- Airplane on ground
- Engine operating.

If the EEC finds the inputs to be in the proper configuration to extend the thrust reverser, the EEC energizes the isolation solenoid valve. This pressurizes the T/R system and extends the sleeves. The EEC uses data from the hydraulic pressure switch to make sure the isolation valve is in the correct position.

Retract

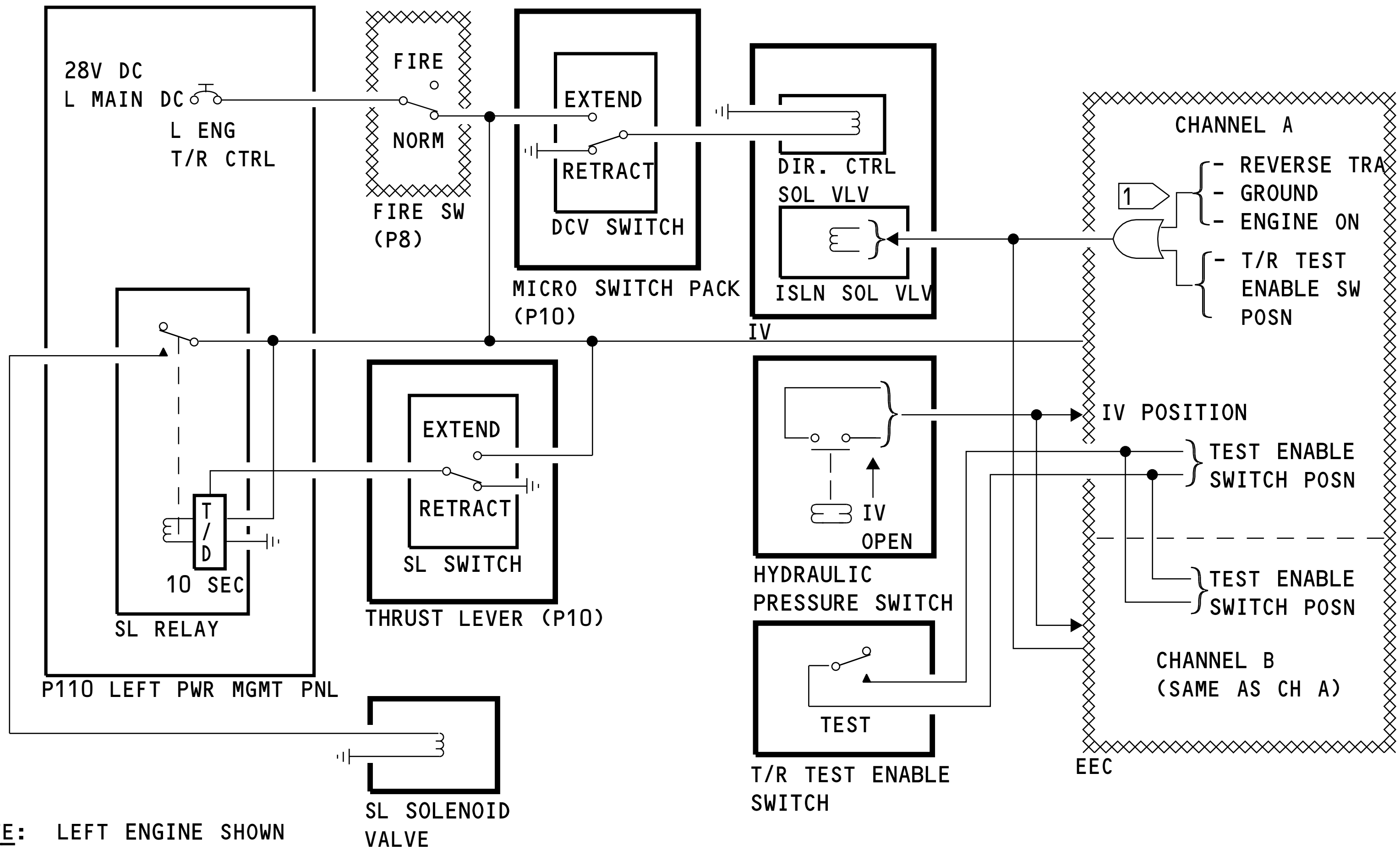
When you move the reverse thrust lever to the forward idle position, the isolation valve stays open. The EEC starts a 20 second time delay. The time delay keeps the isolation valve open to make sure retraction is complete. After the time delay, the EEC de-energizes the isolation valve solenoid.

The DCV switch moves to the retract position and de-energizes the directional control solenoid valve. The DCV moves to the retract position. This permits hydraulic power to retract the hydraulic actuators.

The SL switch moves to the retract position and de-energizes the SL relay. A 10 second time delay keeps the SL relay energized to make sure retraction is complete. When SL relay de-energizes, the SL solenoid valve closes. This locks the sync lock/manual drive units.

Manual Operation

You use the T/R test enable switch to extend the T/R sleeves to do maintenance. You push and hold the switch with the reverse thrust levers up. This permits the EEC to energize the isolation solenoid valve when the engine is not running.



NOTE: LEFT ENGINE SHOWN
RIGHT SIMILAR.

1 20 SECOND TIME DELAY
DURING RETRACTION

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TRAS - FUNCTIONAL DESCRIPTION - CONTROL

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TRAS - FUNCTIONAL DESCRIPTION - ACTUATION

General

To extend or retract the thrust reverser (T/R) sleeves, hydraulic pressure must release the sync locks and move the hydraulic actuators.

To release the sync locks, hydraulic pressure goes through the sync lock valve (SLV) to the sync locks.

To move the thrust reverser (T/R) sleeves, hydraulic pressure goes to the actuators in this sequence:

- Isolation valve (IV)
- Directional control valve (DCV)
- Hydraulic actuators.

Flow tees hydraulically connect the components of the two thrust reverser halves to the control components in the strut. The flow tees in the lines from the directional control valve (DCV) also contain orifices to hydraulically synchronize the thrust reverser halves.

Extend

This sequence occurs when there is a command to extend the thrust reverser sleeves:

- The sync lock switch in the thrust lever sends a signal through a relay in the electrical load management system (ELMS) to energize the sync lock solenoid valve. The sync lock solenoid valve opens and supplies hydraulic control pressure through the sync lock valve to the sync lock/manual drive units. The hydraulic control pressure moves the lock mechanisms in the sync locks to release the sync shafts.
- The directional control valve (DCV) switch in the thrust lever microswitch pack sends a signal to energize the directional control solenoid valve. The directional control solenoid valve opens and supplies hydraulic control pressure to the DCV. This moves an internal spool valve to the extend position.
- The electronic engine control (EEC) energizes the isolation solenoid valve. This supplies internal hydraulic pressure to move the isolation shutoff valve to the open position. The open shutoff valve supplies hydraulic system pressure to the TRAS pressure port of the isolation valve to the directional control valve.

The TRAS hydraulic pressure from the isolation valve goes through directional control valve (DCV) to the extend (head) and retract (rod) sides of the hydraulic actuator piston. The extend pressure releases the actuator lock mechanism which unlocks the actuator piston. The piston extends because the surface area of the piston on the extend side is larger than the retract side of the piston. This permits the actuators to move the thrust reverser sleeve to the extended position in 2-3 seconds.

The EEC gets thrust reverser sleeve position data from the rotary variable differential transducers (RVDTs). When both thrust reverser sleeves are more than 60 percent extended, the EEC provides electrical power to the interlock actuator to electromagnetically release the internal brake and the actuator motor starts. Actuator operation will continue until the extend limit switch is actuated which interrupts the electrical power to the motor. Spring force causes the brake to engage which prevents overrun of the actuator.

The interlock actuator extends the rod end which turns the roller on the interlock crank assembly away from the interlock stop on the autothrottle brake housing. The roller no longer blocks the rotation of the autothrottle brake assembly. The pilot can now move the reverse thrust lever to increase the reverse thrust from idle to the maximum reverse thrust position.

Retract

This sequence occurs when there is a command to retract the thrust reverser sleeves:

- The directional control solenoid valve closes. This removes hydraulic control pressure to the directional control valve (DCV). Spring force in the DCV moves the internal spool valve to the retract position. This permits TRAS pressure to go only to the retract port of the DCV.

TRAS - FUNCTIONAL DESCRIPTION - ACTUATION

- The sync lock solenoid valve stays open and supplies hydraulic control pressure through the sync lock valve to the sync lock/manual drive units. The hydraulic control pressure keeps the sync lock/manual drive units and sync shafts released.
- The isolation solenoid valve stays energized. The internal hydraulic control pressure keeps the isolation shutoff valve open. It supplies hydraulic system pressure through the isolation shutoff valve to the TRAS pressure port of the isolation valve and to the directional control valve.

When the thrust reversers are commanded to retract, the directional control solenoid valve closes which causes the directional control valve to move to the retract position. The TRAS hydraulic pressure from the isolation valve goes through directional control valve (DCV) to the retract (rod) side of the hydraulic actuator piston. Hydraulic fluid in the deploy side tubing is directed to the hydraulic return line through the DCV. The actuators will retract and stow the thrust reverser sleeve in 3-5 seconds. The hydraulic actuator locks engage when the sleeve is in the stowed position.

Time delays in the control circuits in the EEC and the ELMS cause the sync lock valve (10 seconds) and isolation valve (20 seconds) to stay open. When the time delays are complete, the valves close. The sync lock valve closes first and causes the sync lock/manual drive units to lock the sync shafts. The isolation valve closes last to remove hydraulic pressure from the TRAS.

When both sleeves are less than 40 percent extended, the EEC energizes the thrust lever interlock actuator. When the polarity of the electrical power input is reversed, the actuator operates in the retract direction which continues until the retract limit switch is reached. If the limit switches malfunction, the load limit clutch slips to prevent damage to the actuator when it engages the mechanical stops.The interlock actuator retracts the rod end which turns the interlock crank assembly roller toward from the interlock stop on the autothrottle brake housing. The roller blocks the movement of the autothrottle brake assembly to command reverse thrust. There is no interlock actuator limitation when you command forward thrust.

Deactivation for Ground Maintenance

To deactivate the thrust reverser for maintenance, you open the thrust reverser control circuit breakers to keep electrical power from the three solenoid valves. On the isolation valve, you must also push the isolation shutoff valve plunger and install a pin to hold it in place. This keeps the shutoff valve closed which prevents hydraulic system pressure from going into the TRAS.

Manual Operation

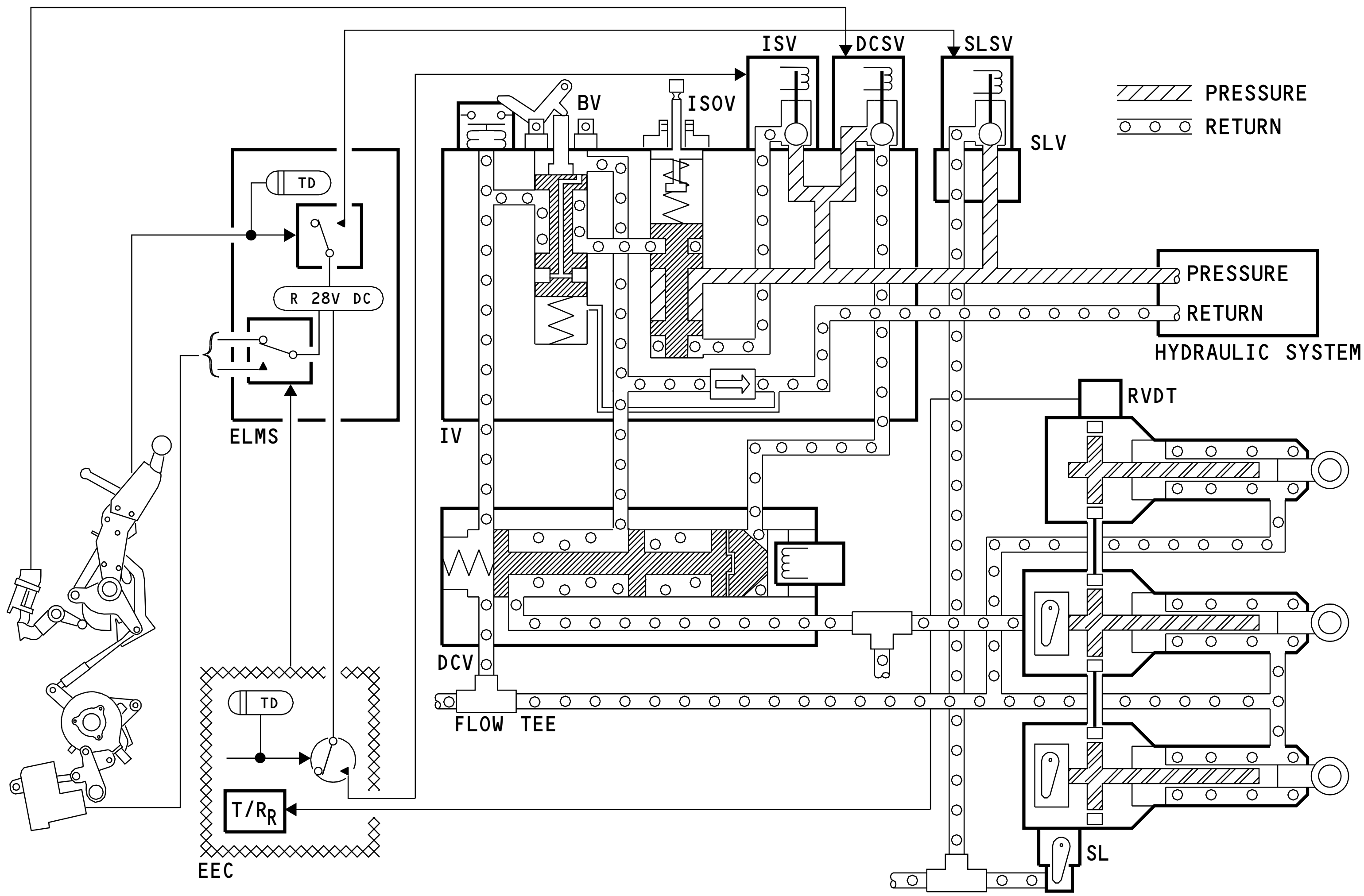
To manually operate the thrust reverser sleeves you must deactivate the thrust reverser isolation valve for maintenance.

Open the thrust reverser control circuit breakers.

On the isolation valve, manually turn the crank to depress the plunger to move the bypass valve to the bypass position. The crank is then pinned to keep the valve in the bypass position. The bypass valve now connects the extend and retract pressure lines of the TRAS together. When the pin is removed, the bypass valve is spring-loaded to return to the closed position which pushes the plunger out. The bypass valve prevents a hydraulic lock in the TRAS when you manually extend the thrust reverser sleeve. The hydraulic fluid on the deploy side goes to the system return line.

On the isolation valve, push-in the plunger to keep the shutoff valve slide in the closed position and install a pin to keep the plunger pushed-in. When the pin is removed, the plunger is spring-loaded to push the plunger out; the shutoff valve slide will remain in the closed position.

Use the sync lock/manual drive unit to extend and retract the thrust reverser sleeve.



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TRAS - FUNCTIONAL DESCRIPTION - ACTUATION

TRAS - FUNCTIONAL DESCRIPTION - REVERSE THRUST LEVER INTERLOCK

General

Each reverse thrust lever interlock actuator has two positions:

- No interlock
- Interlock.

When the interlock actuator is in the interlock position, you cannot move the reverse thrust lever beyond idle. When the interlock actuator is in the no interlock position, you can move the reverse thrust lever beyond idle to maximum reverse.

The ELMS panel provides the electrical dc power to move the interlock actuator for the left or right engine.

No Interlock

The electronic engine control (EEC) controls the interlock actuator through the T/R interlock relay in the left power management panel. When the EEC supplies a ground to energize the relay, power goes to the actuator motor. This extends the interlock actuator to rotate the actuator crank away from the interlock stop on the thrust lever angle (TLA) resolver.

These conditions must be met for the EEC to energize the relay:

- Both T/R sleeves are more than 60 percent extended
- The thrust resolver angle (TRA) is less than 30 degrees.

After the actuator moves to the no interlock position, internal limit switches in the actuator open to remove power to the motor.

If either of the above conditions does not occur, the EEC does not change the position of the interlock actuator.

Interlock

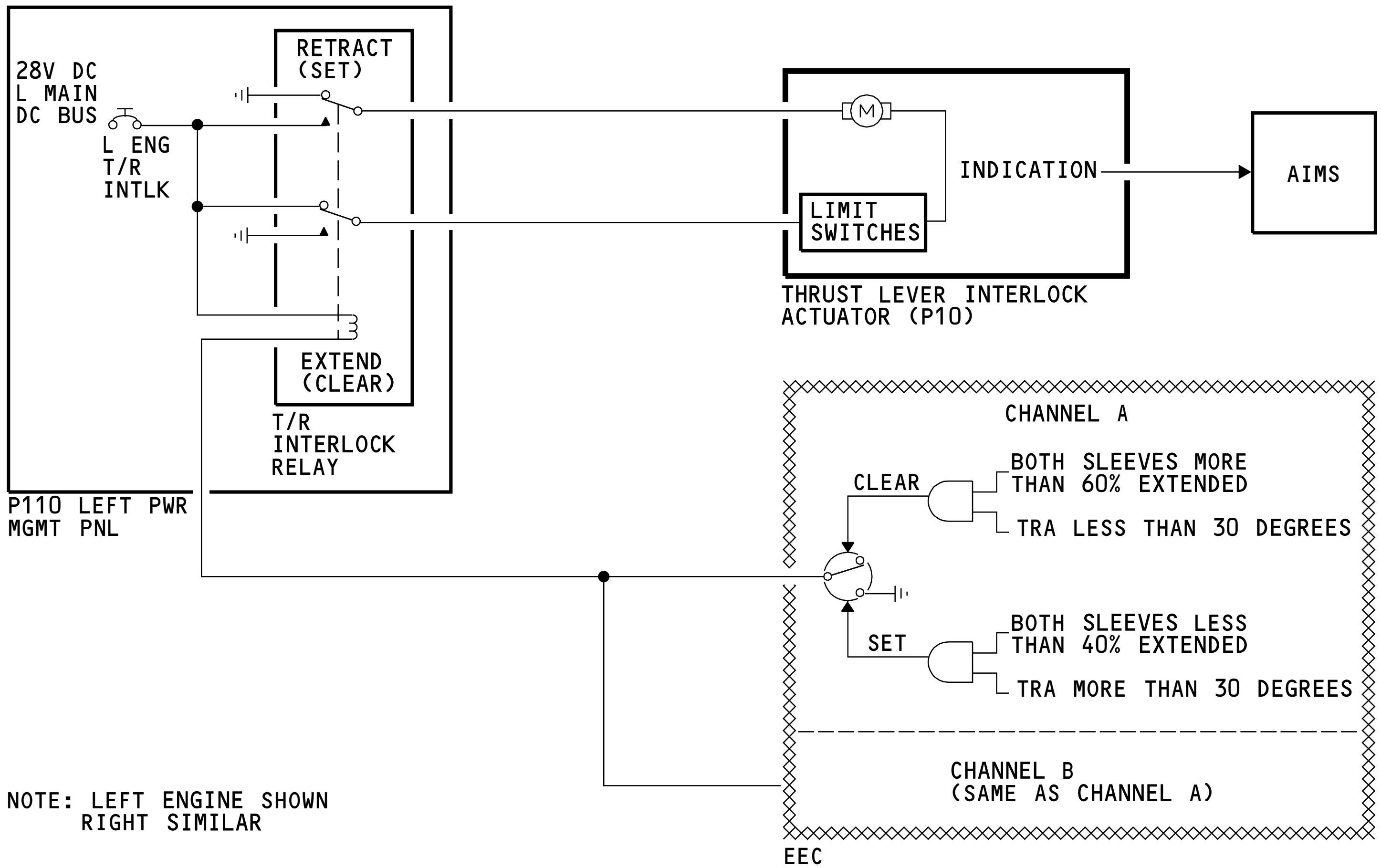
When the EEC removes the ground to the T/R interlock relay, power goes to the actuator motor. This retracts the interlock actuator which rotates the actuator crank to the interlock position.

These conditions must be met for the EEC to remove the ground:

- Both T/R sleeves are less than 40 percent extended
- The thrust resolver angle (TRA) is more than 30 degrees.

After the actuator moves to the interlock position, internal limit switches open to remove power to the motor.

If either of the above conditions does not occur, the EEC does not change the position of the interlock actuator.



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TRAS - FUNCTIONAL DESCRIPTION - REVERSE THRUST LEVER INTERLOCK

TRAS - POWER EXTENSION/RETRACTION - TRAINING INFORMATION POINTS

General

To do maintenance on the T/R, you can extend or retract the T/R sleeves without operating the engines. To do this, you supply electrical and hydraulic power. Then you use the EEC maintenance switch and the T/R test enable switch.

Extension

This is an overview of the procedure to extend the T/R sleeves:

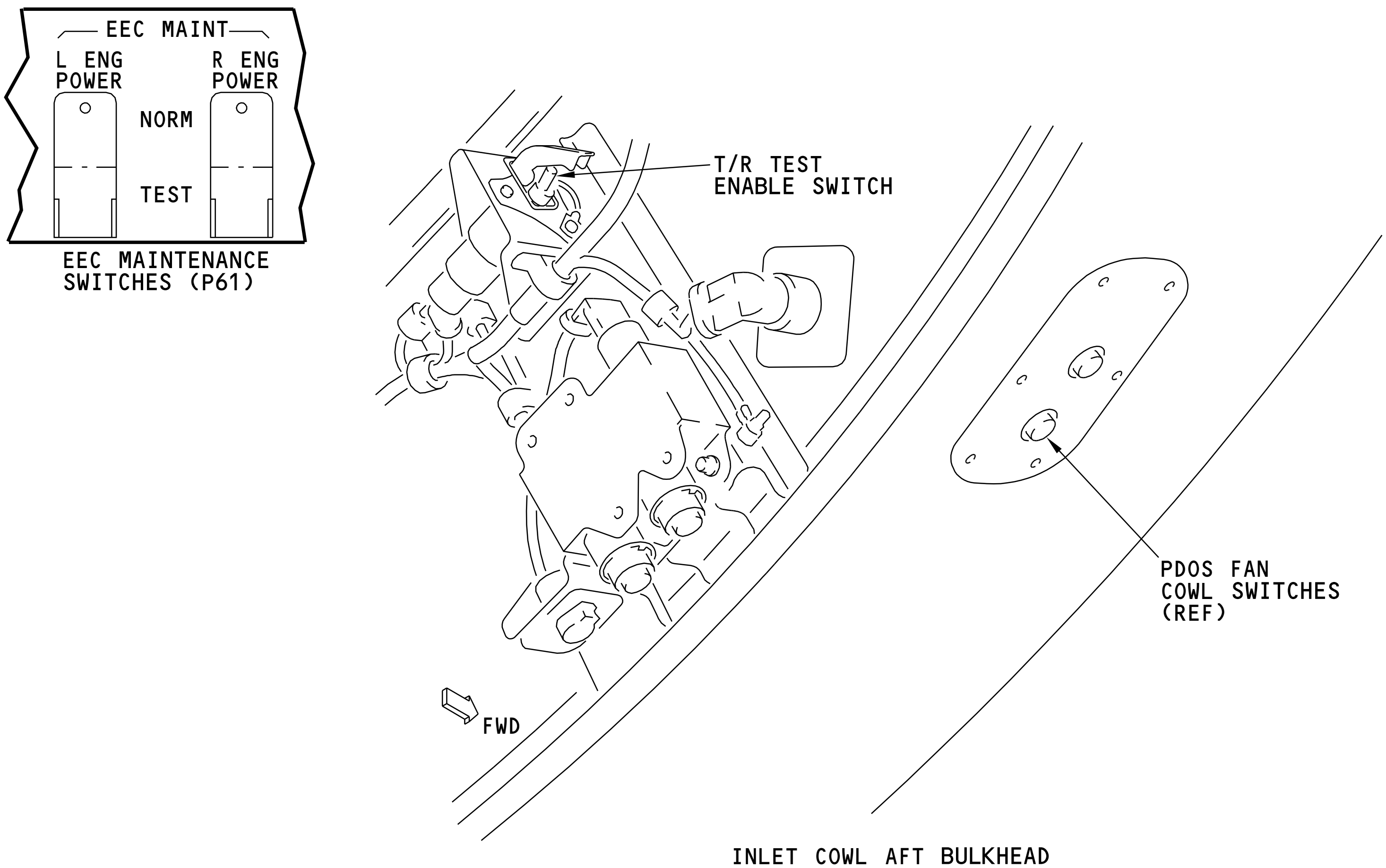
- After you supply electrical and hydraulic power, make sure the fuel control switch is in CUTOFF.
- Move the applicable EEC maintenance switch to the TEST position. This switch lets power go to the EEC.
- Move the reverse thrust levers to the interlock (reverse idle) position.
- To extend the sleeve, push and hold the T/R test enable switch. This switch lets the EEC open the isolation valve when the engine is not running (N2 is zero).

When the sleeve is in the fully extended position, you must deactivate the isolation valve before you do maintenance.

Retraction

You must use two people to retract the T/R sleeves. This is an overview of the procedure:

- Activate the isolation valve.
- The first person will push and hold the T/R test enable switch.
- The second person in the flight deck will move the reverse thrust levers to the forward idle position.
- The first person will push and hold the test enable switch until the sleeves are fully retracted and the sync locks engage correctly. Hold the test enable switch for 15 to 19 seconds after the sleeves have fully retracted to prevent EICAS and CMC messages.



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TRAS - POWER EXTENSION/RETRACTION - TRAINING INFORMATION POINTS

TRAS - DEACTIVATION - TRAINING INFORMATION POINTS

General

To deactivate the thrust reverser (T/R), you must do these two tasks:

- Make sure that hydraulic power does not go to the T/R system
- Mechanically prevent the movement of each T/R sleeve.

Hydraulic Deactivation

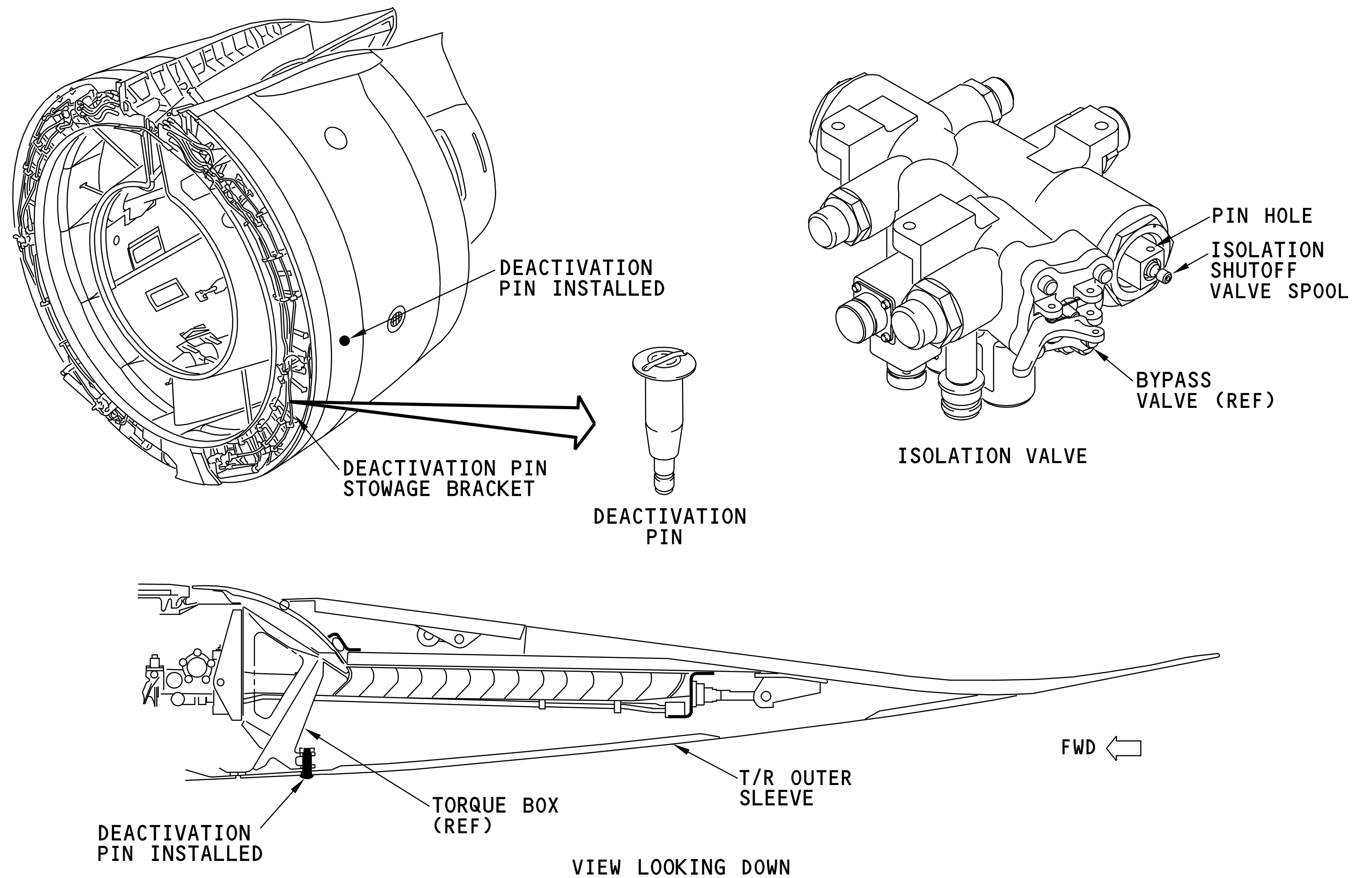
To make sure that hydraulic power does not go to the T/R system, you must put a pin in the isolation shutoff valve spool on the IV. Because the spool is spring-loaded to the out position, you push the spool in and lock it with a pin. This keeps hydraulic power away from the DCV and the hydraulic actuators.

Mechanical Deactivation

To mechanically prevent the movement of each T/R sleeve, the sleeves must be in the fully retracted position. Then, you remove the plug that is in each outer sleeve and replace it with a deactivation pin. The pins are in a bracket on the T/R torque box between the center and lower actuators of each sleeve. The pin screws in.

Activation

To activate the T/R system, do the deactivation procedure in the reverse order.



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TRAS - DEACTIVATION - TRAINING INFORMATION POINTS

TRAS - MANUAL EXTENSION/RETRACTION - TRAINING INFORMATION POINTS

General

Manual operation permits you to move one sleeve at a time. To move each sleeve manually, you must unlock the related two locking actuators and the related sync lock. You also operate the bypass valve in the isolation valve.

Extend/Retract

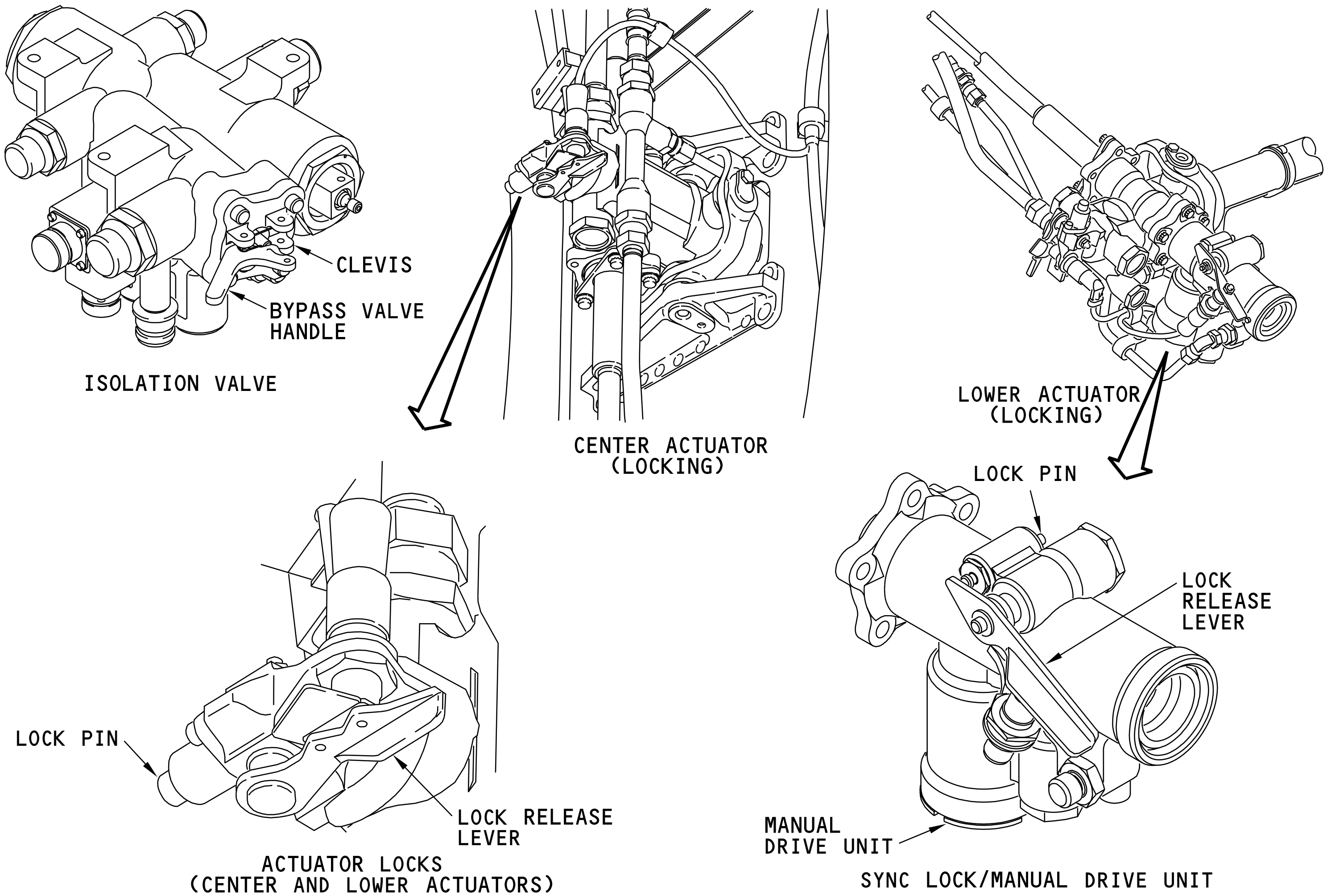
This is an overview of the procedure to manually extend the T/R sleeves:

- Deactivate the IV. (See the section on T/R deactivation for more information.)
- Move the bypass valve handle on the IV so it aligns with the clevis. Install a pin. This keeps the bypass valve open.
- Release the locks on the center actuator, lower actuator, and SL. Push the lock pins in to keep the locks released.
- Use a 3/8 inch square drive on the manual drive unit to extend the sleeve.

NOTE: The bypass valve must be open before you manually extend or retract the T/R sleeve. This will prevent a hydraulic lock, which can prevent movement of the T/R sleeve. But, you must close the bypass valve if you remove T/R components or hydraulic tubing. If you do not close the bypass valve, leakage of the hydraulic fluid from the reservoir will occur when you remove the components or tubing.

NOTE: You must push and hold the 3/8 inch drive in while you turn the manual drive unit. A clutch in the manual drive unit prevents damage to the sync shaft system.

To manually retract the sleeve, do the procedure in the reverse order.



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TRAS - MANUAL EXTENSION/RETRACTION - TRAINING INFORMATION POINTS

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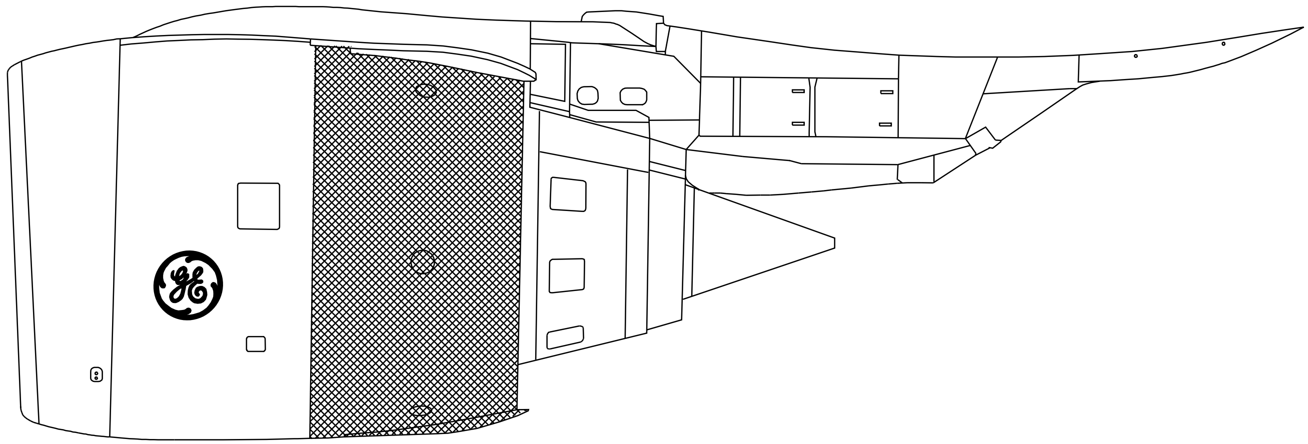
THRUST REVERSER (T/R) INDICATING AND FAULT DETECTION - INTRODUCTION

Purpose

The T/R indicating and fault detection system supplies data for these functions:

- Extend and retract control
- Flight deck indication
- Fault detection.



- ENGINE EXHAUST SYSTEM
  - TURBINE EXHAUST SYSTEM
  - THRUST REVERSER SYSTEM
  - THRUST REVERSER ACTUATION SYSTEM
  - THRUST REVERSER INDICATING AND FAULT DETECTION SYSTEM

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THRUST REVERSER (T/R) INDICATING AND FAULT DETECTION - INTRODUCTION

T/R INDICATING AND FAULT DETECTION - GENERAL DESCRIPTION

General

The thrust reverser indicating and fault detection system monitors the thrust reverser actuation system (TRAS). It sends the linear position data for the thrust reverser sleeves and the position data for the isolation valve (IV) to the electronic engine control (EEC), and the position of the locks in the locking actuators and the system lock/manual drive units and the position of the directional control valve (DCV) to the proximity sensor electronics unit (PSEU).

EEC Data

The thrust reverser indicating and fault detection system sends this data to the electronic engine control (EEC):

- Thrust reverser isolation valve (IV) position with the hydraulic pressure switch
- Thrust reverser sleeve position with the rotary variable differential transducer (RVDT).

The electronic engine control (EEC) uses the isolation valve hydraulic pressure switch data to monitor the position (open or closed) of the IV. The electronic engine control (EEC) uses the RVDT data to make sure the thrust reverser sleeves are in the correct position before you can increase thrust from idle.

The electronic engine control (EEC) sends data to the AIMS for these indications:

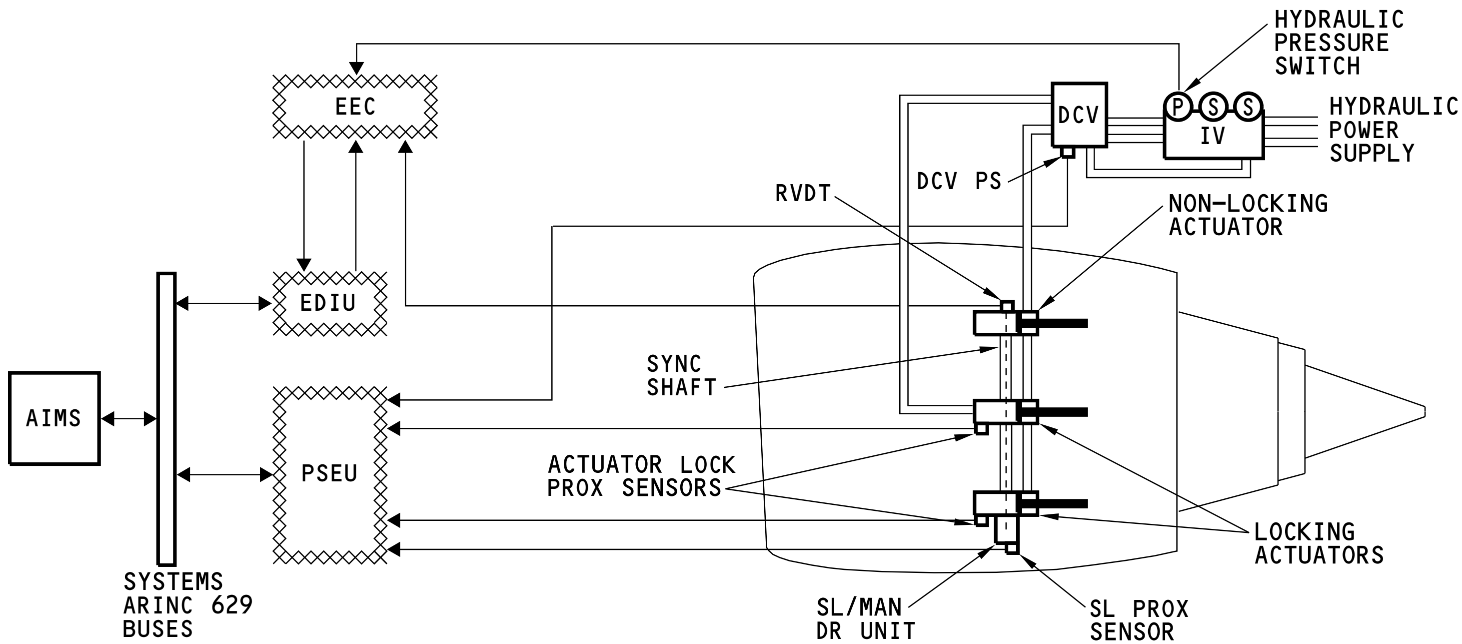
- Normal extend and retract indication
- Alert, status, and maintenance messages if the position of the isolation valve or the thrust reverser sleeve is not correct.

PSEU Data

The thrust reverser on each engine has seven proximity sensors. They send this data to the proximity sensor electronics unit (PSEU):

- Directional control valve (DCV) position (extend or retract)
- Locking hydraulic actuator positions (locked or not locked)
- Sync lock positions (locked or not locked).

The proximity sensor electronics unit (PSEU) sends the data to the AIMS to make alert, status, and maintenance messages for non-normal conditions.



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T/R INDICATING AND FAULT DETECTION - GENERAL DESCRIPTION

T/R INDICATING AND FAULT DETECTION - COMPONENTS

General

There are two thrust reverser indication and fault detection components are located on the DCV and the IV. All others thrust reverser indication and fault detection components are on the forward torque box of the thrust reverser. You open the fan cowl panels to get access to these components.

Component Locations

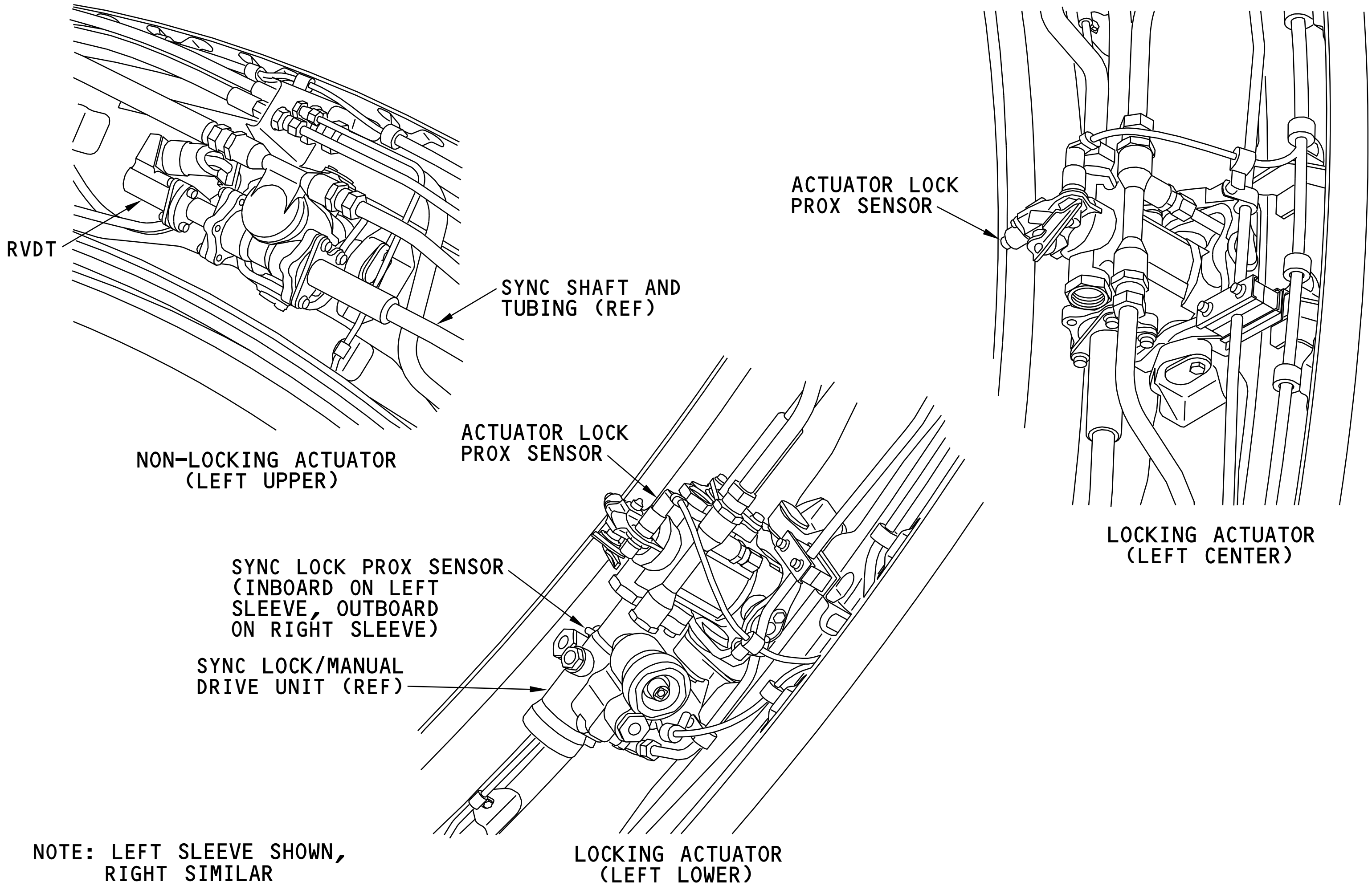
There is one thrust reverser position transducer or rotary variable differential transducer (RVDT) on the upper, non-locking hydraulic actuator of each thrust reverser half. The RVDT is installed opposite the sync shaft connection to the actuator.

The actuator lock proximity sensor is on the forward part of center and lower locking hydraulic actuator of each thrust reverser half. The proximity sensor uses a target on the lock release lever.

The sync lock proximity sensor is on the thrust reverser sync lock/manual drive unit. The sync lock/manual drive unit is installed opposite the sync shaft connection to the lower, locking hydraulic actuator on each thrust reverser half. The proximity sensor uses a target on the lock release lever.

The directional control valve proximity sensor is mounted in the directional control valve (DCV). The proximity sensor senses the position of the auxiliary slide in the valve.

The thrust reverser hydraulic pressure switch is mounted on the TRAS PRESS port on the isolation valve.



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T/R INDICATING AND FAULT DETECTION - COMPONENTS

T/R INDICATING AND FAULT DETECTION - HYDRAULIC PRESSURE SWITCH AND DCV PROXIMITY SENSOR

Hydraulic Pressure Switch

The hydraulic pressure switch monitors the pressure out of the isolation shutoff valve. It sends a signal to the EEC when the isolation valve is open. If the isolation valve is open when there is no command to extend or retract the reverser, the EEC sends a signal to the AIMS to show an alert or status message.

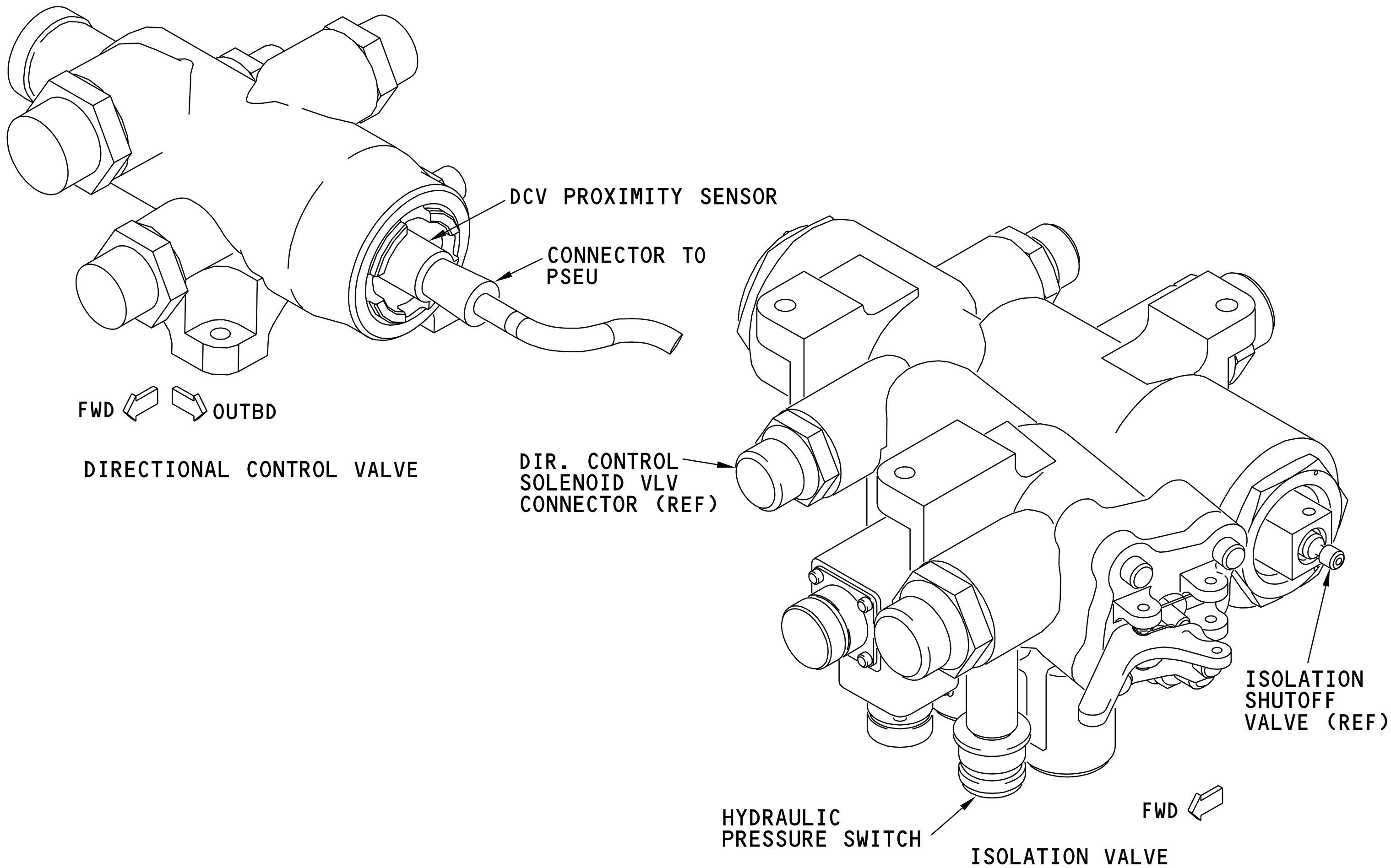
The hydraulic pressure switch is on the forward, left side of the isolation valve. It is near the hydraulic tube that connects to the DCV.

DCV Proximity Sensor

The DCV proximity sensor monitors the position of the directional control valve (DCV). The position data goes to the PSEU. If the DCV is in the extend position when there is a retract command, the PSEU sends a signal to the AIMS for fault indication on the flight deck.

The DCV proximity sensor is on the left side of the directional control valve.

The proximity sensor monitors the position of the auxiliary slider in the DCV (not shown). When the DCV is in the extend position, the auxiliary slider is away from the proximity sensor. When the DCV is in the retract position, the auxiliary slider is near the proximity sensor.



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T/R INDICATING AND FAULT DETECTION - HYDRAULIC PRESSURE SWITCH AND DCV PROXIMITY SENSOR

T/R INDICATING AND FAULT DETECTION - ACTUATOR LOCK PROXIMITY SENSOR

General

The actuator lock proximity sensor monitors the position of the locking jaw in each locking hydraulic actuator. It sends the position data to the proximity sensor electronic unit (PSEU).

Each thrust reverser sleeve has two actuator lock proximity sensors. Thus, there are four actuator lock proximity sensors on each engine.

Location

The actuator lock proximity sensors are on the forward end of each locking hydraulic actuator. You open the fan cowl panels to get access to the sensors.

Physical Description

There two parts: a proximity sensor and a target. The proximity sensor is mounted in a flange on the body of the actuator. The target is part of the lock release lever for the locking actuator. An electrical connector is connected to the end of the sensor.

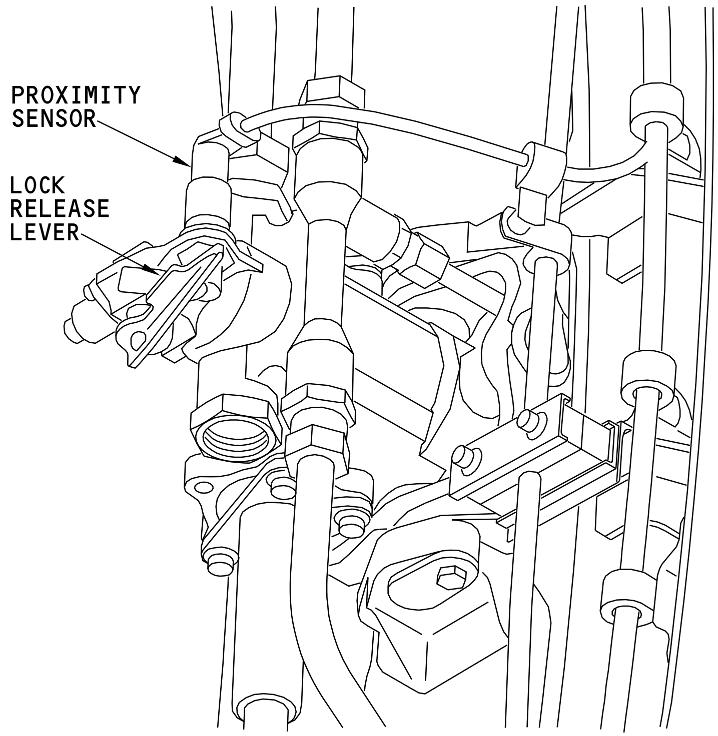
Functional Description

When the locking actuators get deploy hydraulic pressure, the locking sleeve in the actuator moves to the unlock position which also moves the lock release lever to the unlock position. The target on the lever moves away from the proximity sensor. This sends a signal to the proximity sensor electronic unit (PSEU). The signal from the sensor will indicate target NEAR for the lock position and target FAR for the unlock position.

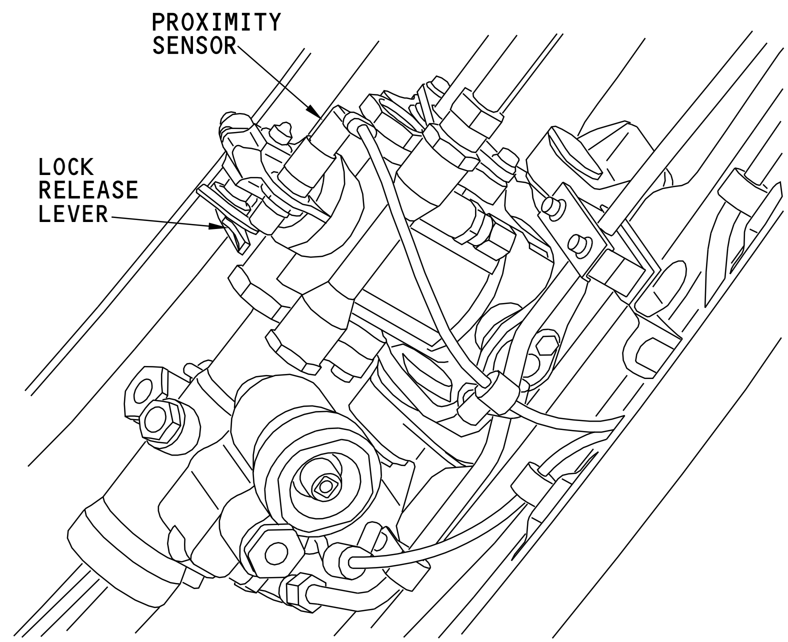
If the locking sleeve is not locked when the thrust reverser is in the retracted position, fault indication shows on the flight deck and a maintenance message is latched.

Training Information Point

The gap between the proximity sensor and the target is 0.030 – 0.035 inch (0.0076 – 0.0089 mm) for new actuators. The in-service limit for the gap between the proximity sensor and the target can be 0.022 - 0.043 inch (0.0056 - 0.0109 mm) after replacement of the proximity sensor on actuators in-service.



LOCKING ACTUATOR
(LEFT CENTER)



LOCKING ACTUATOR
(LEFT LOWER)

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T/R INDICATING AND FAULT DETECTION - ACTUATOR LOCK PROXIMITY SENSOR

T/R INDICATING AND FAULT DETECTION - SYNC LOCK PROXIMITY SENSOR

General

The sync lock proximity sensor monitors the position of the sync lock which attaches to each lower locking hydraulic actuator. It sends the position data to the proximity sensor electronic unit (PSEU).

Each thrust reverser sleeve has one sync lock proximity sensor.

Location

The sync lock/manual drive unit is the same identical unit on the left and right thrust reverser half. When the sync lock/manual drive unit is installed on the left thrust reverser half, the lock release lever, proximity sensor and the electrical connections are between the unit and the forward torque box. When the unit is installed on the right thrust reverser half, the lock release lever, proximity sensor and the electrical connections are away from the forward torque box. You open the fan cowl panels to get access to the sensors.

Physical Description

There are two parts: the sync lock proximity sensor and a target. The target is mounted on the lock release lever on the sync lock/manual drive unit.

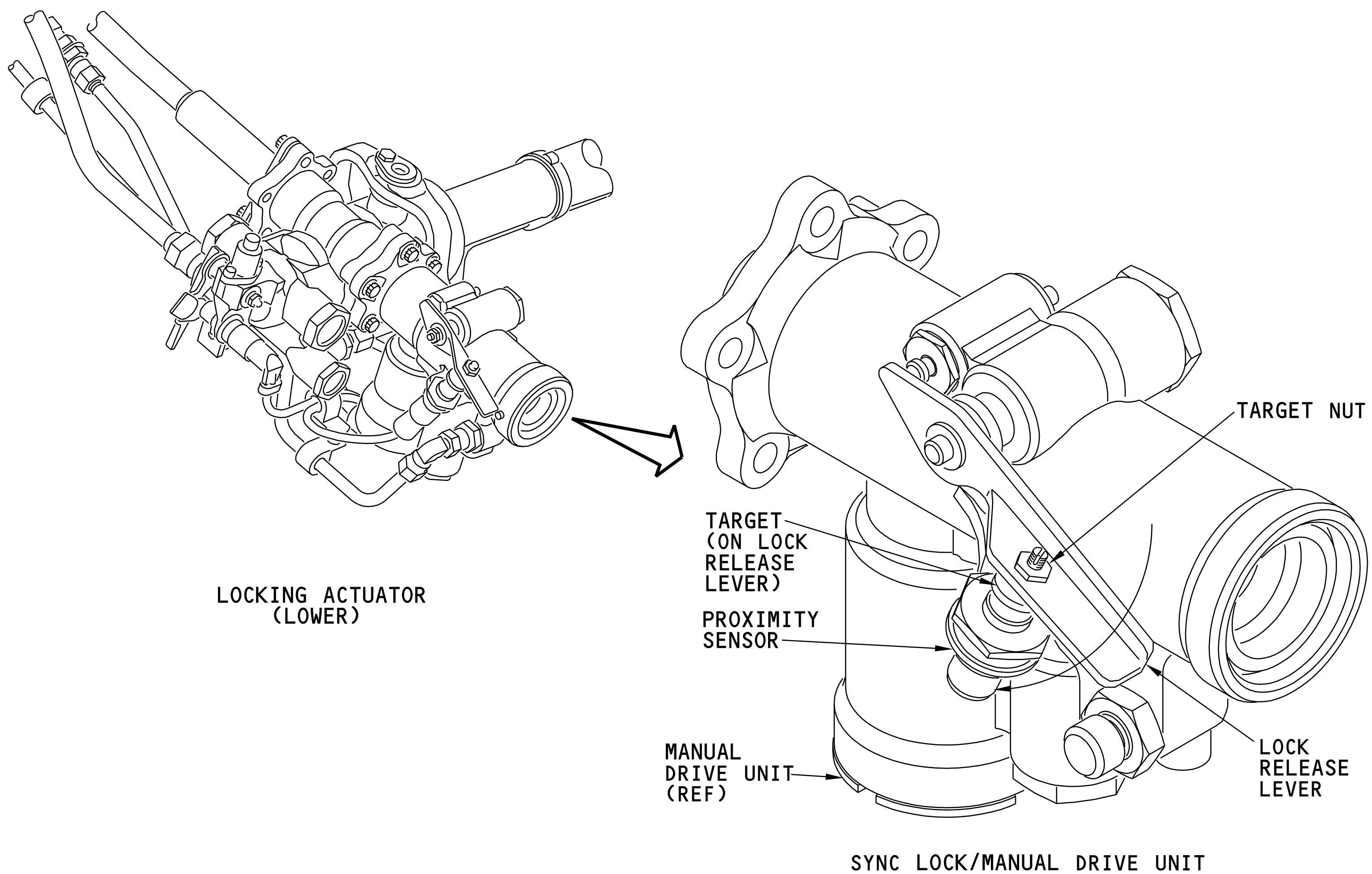
Functional Description

When the sync lock gets hydraulic pressure from the sync lock valve, the sliding jaw disengages the locking jaw and moves the lock release lever to the unlock position. The target moves away from the proximity sensor. This sends a signal to the proximity sensor electronic unit (PSEU) that the actuator is not locked.

If the sync lock is not locked when the thrust reverser is in the retracted position, fault indication shows on the flight deck and a maintenance message is latched.

Training Information Point

When you install a new proximity sensor, you must do a check of the gap between the proximity sensor and the target. There is a nut on the lock release lever so you can adjust the gap.



M44125 S000621756_V1

T/R INDICATING AND FAULT DETECTION - SYNC LOCK PROXIMITY SENSOR

T/R INDICATING AND FAULT DETECTION - T/R POSITION TRANSDUCER (RVDT)

General

The thrust reverser position transducer is the rotary variable differential transducer (RVDT). The RVDT sends the thrust reverser sleeve position data to the electronic engine control (EEC). The EEC will not permit more than idle thrust if the sleeves are less than 60 percent of full extension. The EEC also uses the position data to supply flight deck indication of when the sleeve is not in the fully retracted position, when the sleeve is fully extended, for fault detection and to determine the interlock relay command for the reverse thrust lever interlock actuator.

There is one RVDT on the upper, non-locking hydraulic actuator of each sleeve. Thus, each engine has two RVDTs.

Location

The RVDT is installed on the upper sync shaft flange on each non-locking actuator. You open the fan cowl panels to get access to the RVDTs.

Physical Description

The RVDT has two parts; the transducer and the gearbox. The RVDT is replaced as one unit. The RVDT weighs approximately 2.4 pounds (1.08 kg). The RVDT gearbox is a sealed housing that is installed on the upper hydraulic actuator. The RVDT gearbox in operation is filled with hydraulic fluid. When the RVDT is replaced, the packing between the backup rings on the gearbox must be replaced. The gearbox has a square drive shaft that engages the worm shaft in the non-locking actuator. Internal seals on the gearbox shaft prevents hydraulic fluid contamination of the transducer. The transducer has an electrical connector.

Functional Description

Each RVDT has two sets of coils for channel A and B. The EEC gives an excitation voltage to each channel and receives an output analog signal from the RVDT for that channel.

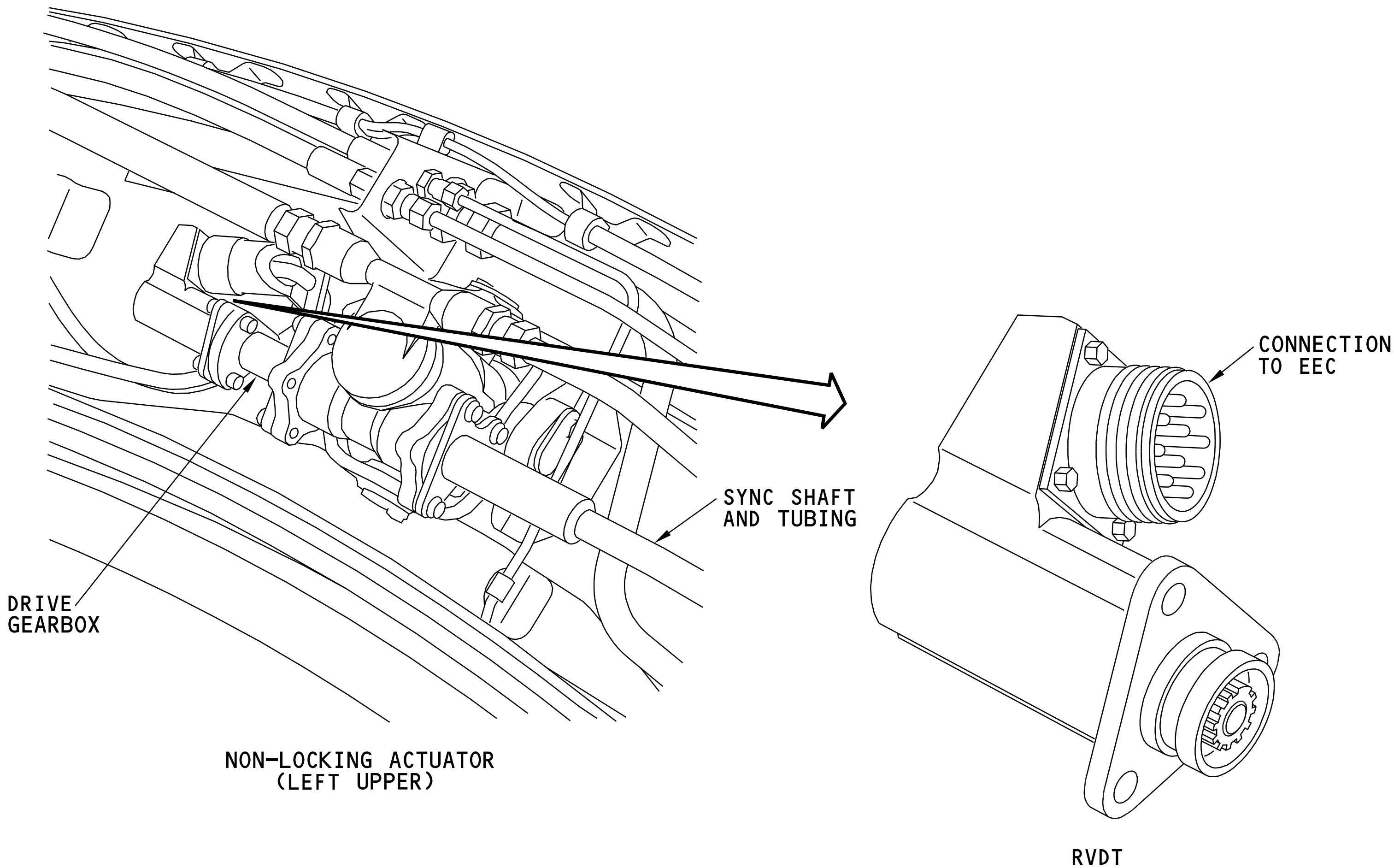
The RVDT gearbox has a square drive shaft that engages the worm shaft in the non-locking actuator. The worm shaft turns as the actuator extends or retracts. When the shaft turns, the RVDT makes a voltage that changes linearly in proportion to the worm shaft position.

Training Information Point

When you replace the RVDT, do not turn the gearbox square shaft. The new RVDT is shipped from the supplier with protective caps with the square shaft in the null position. If the gearbox shaft is turned, you have lost the null position and you must re-rig the RVDT to find the null output voltage.

The steps for rigging the RVDT are in the suppliers component repair instructions as part of an accuracy test. To rig the RVDT back to the null position requires a bench test setup which would include a power supply capable of providing 7.07 ± 0.16 VRMS at a frequency of 3000 ± 50 Hz, a rotary revolution counter, a switch box for excitation and output signals from channel A and B, and a digital multimeter with 0.1% accuracy. The shaft position is critical because you cannot overshoot or reverse the rotation direction as you position the shaft. The shaft rotation must be smooth to each data point you take in the counter-clockwise and clockwise directions as you try to find the null position.

The RVDT on the 777 GE90/GE115 thrust reverser has different electrical characteristics than the RVDTs on other thrust reverser/engine models (Pratt Whitney and Rolls Royce) because of the EEC. These RVDTs are not interchangeable. The physical characteristics (weight and size) of all the RVDTs are similar.



M44126 S000621757_V1

T/R INDICATING AND FAULT DETECTION - T/R POSITION TRANSDUCER (RVDT)

T/R INDICATING AND FAULT DETECTION - INDICATIONS

General

Flight deck indication of the thrust reverser (T/R) position shows on the EICAS display, status display, and EPCS maintenance page 1. Any system failure that reduces the level of safety of the system is shown on both the EICAS display and the status display. There are no alert messages that are shown in flight. Thus, no crew action is necessary for thrust reverser system faults.

For system faults, the CMCS has maintenance messages to aid in fault isolation.

EICAS Display

The thrust reverser position indication is shown above the N1 data on the EICAS display.

When one thrust reverser sleeve extension is 10 percent or more, the amber REV indication is shown on the EICAS display. This tells the flight crew that the thrust reverser is released and in transit.

When both sleeves are 90 percent extended, the amber REV indication changes to a green REV indication. This tells the flight crew that the thrust reverser is fully extended.

If the airspeed is less than 80 kts, a system failure that reduces the level of safety causes the ENG REVERSER L(R) advisory message to be shown.

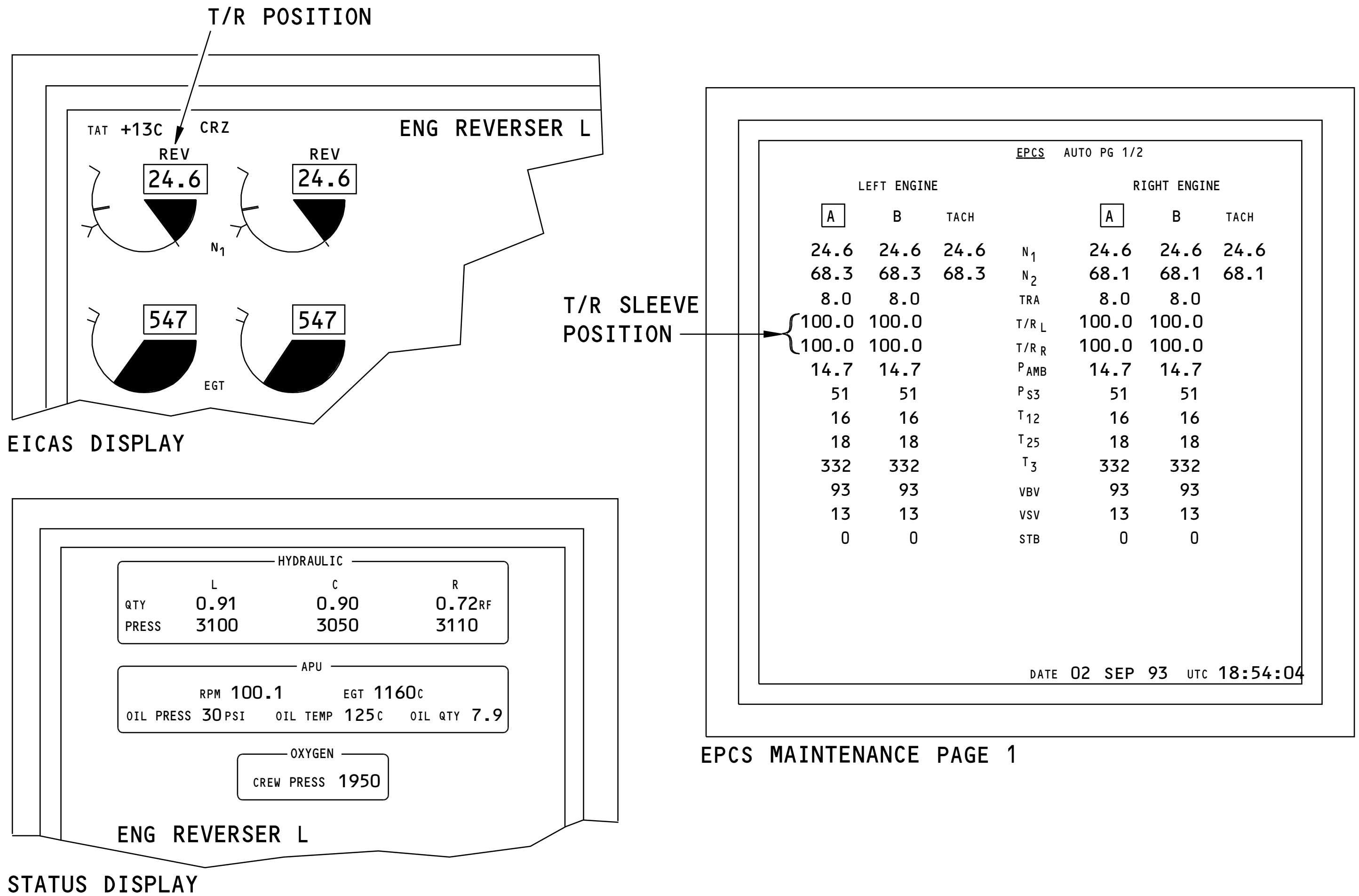
Status Display

The ENG REVERSER L(R) status message is shown for any failures that may reduce the system level of safety.

The ENG REVERSER SNSR L(R) status message is shown for sensor or sensor circuit faults. This message is not shown if there are sensor or sensor circuit faults, then the ENG REVERSER L(R) message will appear.

EPCS Maintenance Page

The thrust reverser sleeve position is shown on the EPCS maintenance page 1. For each EEC channel, the data is shown for both the left and right sleeves. The range is from zero percent (fully retracted) to 100 percent (fully extended).



NOTE: THE DATA SHOWN ON THE DISPLAYS IS ONLY AN EXAMPLE.

M44153 S000621758_V2

T/R INDICATING AND FAULT DETECTION - INDICATIONS

T/R INDICATING AND FAULT DETECTION - FUNCTIONAL DESCRIPTION - EEC INPUTS

General

The electronic engine control (EEC) gets data from thrust reverser (T/R) sensors to make sure these conditions occur:

- The isolation valve sends pressure to the hydraulic actuators only during thrust reverser extend and retract operation
- The engine operates above idle thrust only when the thrust reverser is in the fully extended position
- The flight deck gets proper indication of normal and non-normal thrust reverser operation.

This data comes from the hydraulic pressure switch on the isolation valve and the rotary variable differential transducers (RVDT).

Hydraulic Pressure Switch

The hydraulic pressure switch signal goes to both channels of the EEC. The switch closes when the isolation valve is open. If the switch shows that the valve is open without an open command from the EEC, the EEC sends a signal to the AIMS to show advisory and status messages.

If the isolation valve does not open when it gets an EEC command to open, the EEC sends a signal to the AIMS for the central maintenance computing system (CMCS) maintenance messages.

Thrust Reverser Position Transducer (RVDT)

Each EEC channel gets data from the rotary variable differential transducer (RVDT) on each non-locking (upper) hydraulic actuator. The EEC uses this data to:

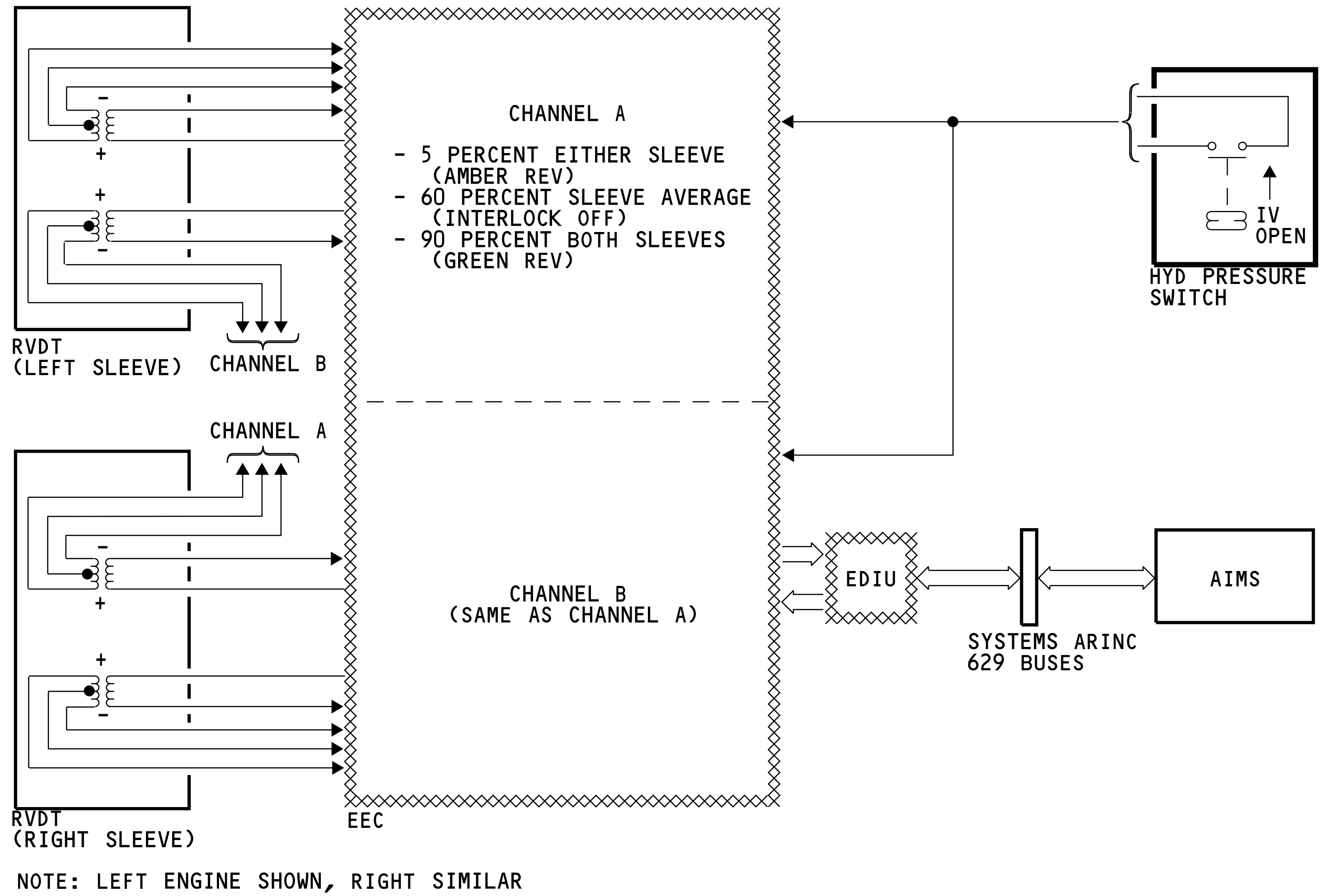
- Operate the thrust lever interlock actuator
- Send indication data to the AIMS
- Schedule reverse thrust.

When either T/R sleeve extension is 10 percent, the EEC sends a signal to the AIMS to show the amber REV indication on the EICAS display. This tells the flight crew that the T/R is released and in transit.

When the average of the sleeve extensions is 60 percent, the EEC sends a signal to the ELMS to operate the thrust lever interlock actuator. This removes the block that prevents the flight crew from commanding more than reverse idle thrust.

When both T/R sleeves are 90 percent extended, the EEC sends a signal to the AIMS to change the amber REV indication to a green REV indication. This tells the flight crew that the T/R is fully extended. The EEC will permit maximum thrust based on the command from the flight crew.

The EEC does a rate check, range check, crosscheck and signal noise on the position data to make sure the RVDT data is valid.



M44127 S000621759_V1

T/R INDICATING AND FAULT DETECTION - FUNCTIONAL DESCRIPTION - EEC INPUTS

T/R INDICATING AND FAULT DETECTION - FUNCTIONAL DESCRIPTION - PSEU INPUTS

General

The proximity sensor electronics unit (PSEU) gets data from these sensors to make sure the actuators and valves are in the correct positions:

- Directional control valve (DCV) proximity sensor
- Actuator lock proximity sensors
- Sync lock proximity sensors.

The PSEU sends signals to the airplane information management system (AIMS) through the systems ARINC 629 data buses.

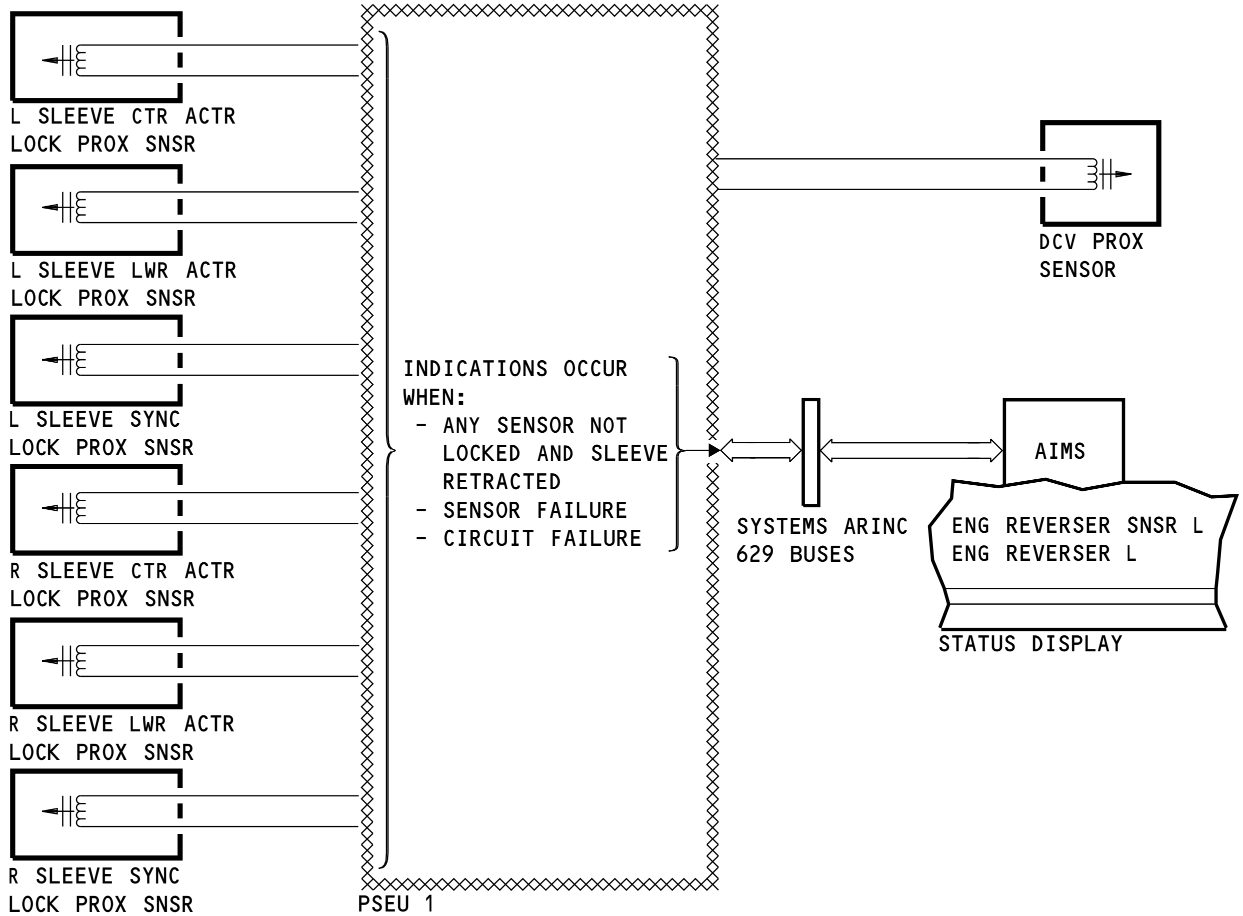
Sensors Show Not Locked

If any of the locks are not locked and the sleeve is in the retracted position, the AIMS shows advisory and status messages such as ENG REVERSER L(R).

If the directional control valve (DCV) is in the extended position without an extend command, the AIMS shows advisory and status messages such as ENG REVERSER L(R).

Sensor Failure

If there is a single failure in a sensor, or in a sensor circuit, the AIMS shows the ENG REVERSER SNSR L(R) status message. The AIMS also makes a central maintenance computer system (CMCS) maintenance message.



NOTE: LEFT ENGINE SHOWN, RIGHT SIMILAR.

M44128 S000621760_V2

T/R INDICATING AND FAULT DETECTION - FUNCTIONAL DESCRIPTION - PSEU INPUTS