SECTION 2-12

LANDING GEAR AND BRAKES

TABLE OF CONTENTS

THIS PAGE IS LEFT BLANK INTENTIONALLY

GENERAL

The EMB-145 landing gear incorporates braking and steering capabilities. The extension/retraction, steering and braking functions are hydraulically assisted, electronically controlled and electronically monitored. EICAS indications and messages alert crew to system status and failures. Each landing gear is equipped with alternate means of actuation in case of normal actuation system failure.

THIS PAGE IS LEFT BLANK INTENTIONALLY

AIR/GROUND INDICATION SYSTEM

Air/ground indication is determined by a system that detects landing gear shock absorber compression and relays information to the landing gear electronic unit for gear control. The system consists of five weight-on-wheel proximity switches. Two of them are installed on each main landing gear leg and one on the nose landing gear leg.

The Landing Gear Electronic Unit (LGEU) processes the main landing gear proximity switches' signals information in four independent channels and controls various equipment operations. Logic processing includes the position signal and its validity. If all proximity switch signals are valid, four signals are processed to assure that at least three signals indicate identical status for releasing the air/ground signal output.

Should one proximity switch signal be invalid, the logic will process the remaining three signals so that at least two indicate the same status. If a second proximity switch is invalid, the two remaining signals are processed only if both send the same signal. Disagreement between these two remaining proximity switches causes the Landing Gear Electronic Unit to de-energize the channels and provide a default output signal.

The nose landing gear proximity switch signal is sent only to the thrust reverser logic (if installed) and steering control.

LANDING GEAR OPERATION

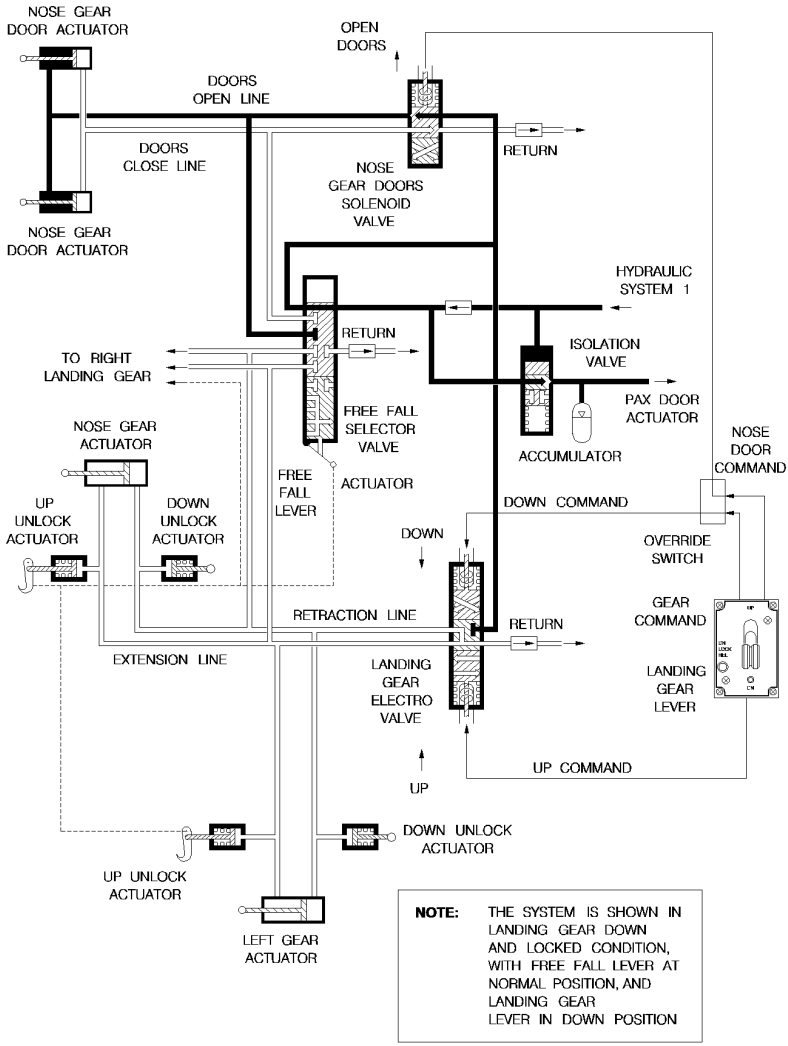
Landing gear retraction and extension are powered by the hydraulic system 1. An accumulator prevents pressure fluctuations and assists gear retraction after takeoff. The main landing gear legs retract inboard, while the nose landing gear retracts forward. Each main gear leg is mechanically linked to its respective door, which remains open when the gear is down. The doors close automatically when the main landing gear is retracted. The nose landing gear doors are hydraulically actuated and operate in sequence with the nose gear.

Gear retraction and extension are electrically commanded. If normal extension fails, the landing gear can be extended through an electrical override system. If the electrical override is not available, a free-fall system allows gear extension. Gear position is indicated on the EICAS display.

LANDING GEAR RETRACTION

Landing gear retraction is commanded through the Landing Gear Lever, installed on the main panel. Positioning the lever to the UP position signals the LGEU to command the Nose Gear Door Solenoid Valve and the Landing Gear Electrovalve. This allows pressure from the hydraulic system 1 to simultaneously reach landing gear and down unlock actuators. All gear legs are then retracted into their respective wheel wells.

The LGEU logic only allows the nose gear doors to close after the nose landing gear is locked in the UP position. When the uplock boxes are actuated, the proximity switches signal the LGEU that the gear is up and locked and that the Landing Gear Electrovalve may be deenergized. Nose landing gear door actuators are kept pressurized, but the gear actuator lines are connected to the return**.**



LANDING GEAR SCHEMATIC

To preclude an inadvertent retraction command while on the ground, the air/ground system provides a signal to a solenoid inside the Landing Gear Lever. This locks the lever and prevents movement towards the UP position. For emergency purposes only, a lock release button is provided beside the lever, allowing this protection to be overriden.

LANDING GEAR EXTENSION

NORMAL EXTENSION

Positioning the Landing Gear Lever to the DOWN position signals the LGEU to command the Landing Gear Electrovalve and the Nose Gear Doors Solenoid Valve. This allows pressure from the hydraulic system 1 to simultaneously reach the landing gear and door actuators, and also the up unlock actuators.

When the gear legs reach the down position, the down lock boxes are actuated. The proximity switches signal the LGEU that the gear is down and locked and that the Landing Gear Electrovalve may be de-energized.

ELECTRICAL OVERRIDE EXTENSION

The Electrical Override system is used to extend the landing should there occur a normal landing gear extension failure. This system bypasses the LGEU and actuates directly the Landing Gear Electrovalve and the Nose Gear Doors Solenoid Valve. The control switch is installed inside the free-fall lever compartment, on the floor, beside the copilot's seat. Extension through override is made in steps, first opening the doors and then extending the gear. When extension is completed, selecting the override switch to normal position deenergizes the Landing Gear Electrovalve and depressurizes all lines. The switch is safeguarded, being in the non-actuated position whenever the compartment door is closed.

FREE-FALL EXTENSION

Free-Fall extension is available in case of failure of both normal extension and electrical override extension. Actuation of free-fall landing gear extension is performed by pulling up the lever installed inside the free-fall lever compartment, on the floor, beside the copilot's seat.

This mechanically actuates the Free-Fall Selector Valve and unlocks the three landing gear legs uplocks. The Free-Fall Selector Valve isolates the hydraulic system pressure and connects the landing gear system hydraulic lines to the return. With the system unpressurized and the uplocks deactivated, all gear legs fall by gravity until they reach their downlock devices. If one main gear does not lock down, increase the aerodynamic drag by side slipping the aircraft to help lock the affected leg.

Once actuated, the free-fall lever remains locked in the vertical position until mechanically released.

LANDING GEAR WARNING

A LANDING GEAR voice message is provided to alert pilots any time the airplane is in a landing configuration and the gear legs are not locked down. The warning may be activated under one of three conditions:

1. Radio Altitude below 1200 ft, Flap Selector Lever set lower than 22°, one thrust lever set below 59° and the other thrust lever set below 45° (or the associated engine inoperative).

   NOTE: In case of Radio Altimeter loss, the message may be activated at any altitude, but may be canceled through the Landing Gear Warning Cutout Button.

2. Radio Altitude below 1200 ft, Flap Selector Lever between 22° and 45°, one thrust lever set below 59° and the other thrust lever set below 45° (or the associated engine inoperative).

   NOTE: - The Voice message cannot be canceled.
   - In case of Radio Altimeter loss, the message may be activated at any altitude.

3. Flap Selector Lever set at 45°.

   NOTE: The Voice message cannot be canceled.

EICAS MESSAGES

TYPE	MESSAGE	MEANING
WARNING	LG/LEVER DISAGREE	After 20 seconds of gear command, at least one landing gear is not in the selected position.
CAUTION	LG AIR/GND FAIL	LGEU failure or failure of two weight-on-wheel proximity switches.
	NLG UP/DOOR OPN (if applicable)	Nose LG is locked up and nose LG door is open.

CONTROLS AND INDICATORS

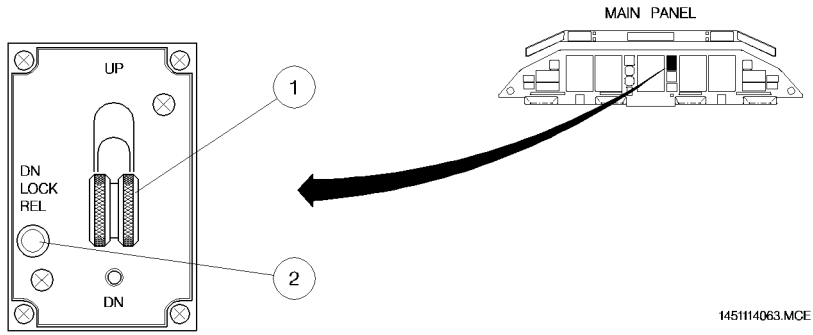
LANDING GEAR CONTROL BOX

1 - LANDING GEAR LEVER

UP - Selects landing gear retraction.
DOWN - Selects landing gear extension.

2 - DOWNLOCK RELEASE BUTTON

- Mechanically releases the lever lock, allowing the landing gear lever to be moved to the UP position when on the ground or in case it cannot be moved to the UP position after takeoff.



LANDING GEAR CONTROL BOX

FREE-FALL LEVER COMPARTMENT

1 - FREE-FALL LEVER

- When pulled up, depressurizes the landing gear hydraulic line and releases all gear uplocks.
- The lever is kept at the actuated position by a mechanical lock.

2 - FREE-FALL LEVER UNLOCK BUTTON

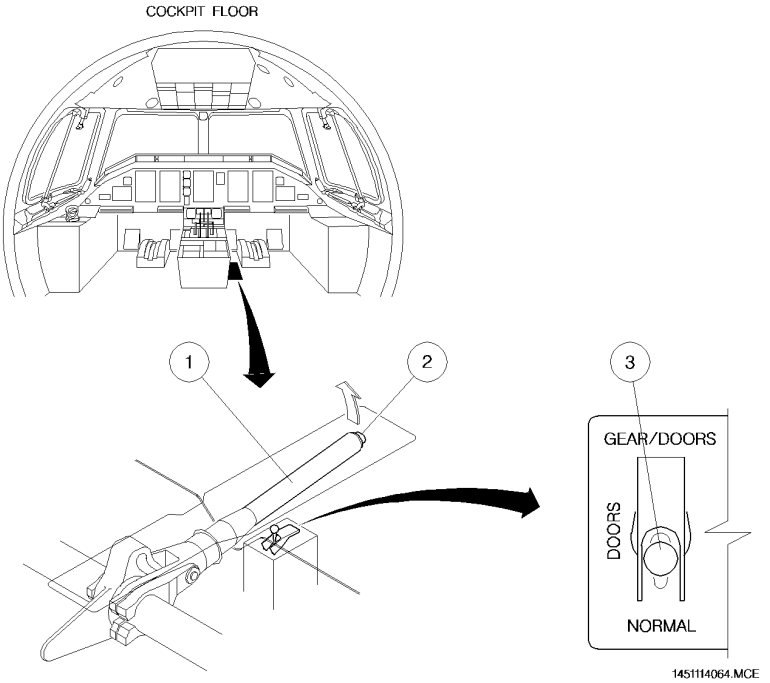
- When pressed, unlocks the free-fall lever, allowing it to be returned to the normal position, thus restoring the hydraulic operation of the landing gear.

3 - ELECTRICAL OVERRIDE SWITCH (guarded)

NORMAL - Landing gear retraction and extension are automatically performed and controlled by the Landing Gear Electronic Unit.

DOORS - Opens the nose landing gear doors.

GEAR/ DOORS - Extends the landing gear.

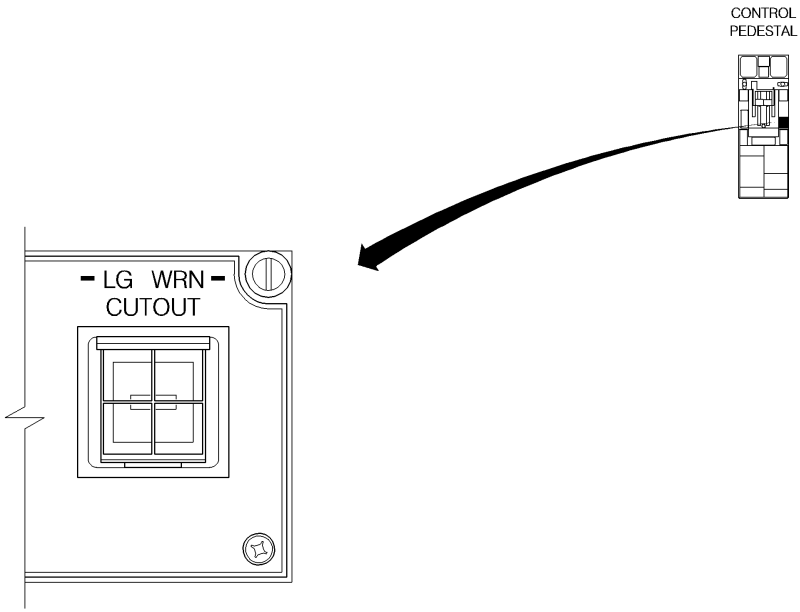


FREE-FALL LEVER COMPARTMENT

AOM-145/1114

LANDING GEAR WARNING CUTOUT BUTTON (guarded)

- When pressed, this button cancels the landing gear warning voice message if the Radio Altimeter is inoperative with Flap Selector Lever set lower than 22°, one thrust lever set below 59° and the other thrust lever set below 45° (or the associated engine inoperative).
- An amber indication bar illuminates inside the button and remains illuminated to indicate that a cancel action was performed.
- The amber indication bar extinguishes if the Thrust Levers are advanced or Flap Selector Lever is set at 22° or higher or landing gear is down and locked.



NOTE: THE LANDING GEAR WARNING CUTOUT BUTTON MAY ALSO BE LOCATED ON THE MAIN PANEL.

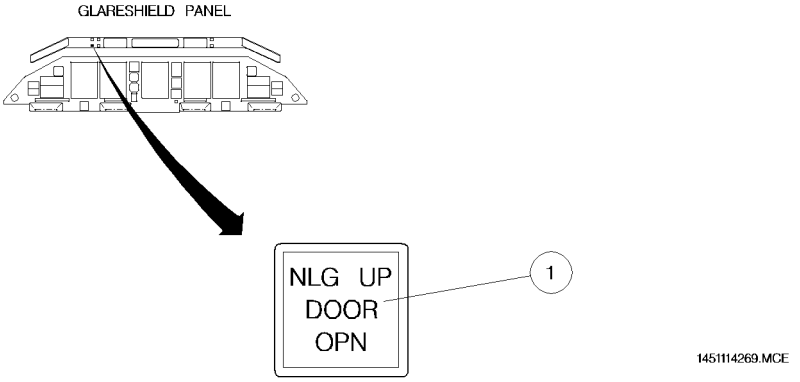
145AOM2120004.MCE

LANDING GEAR WARNING CUTOUT BUTTON

GLARESHIELD PANEL

1 - NOSE LANDING GEAR DOORS INDICATION LIGHT (if installed)

– Illuminates to indicate that the nose landing gear is locked in the retracted position and at least one door is not closed.



GLARESHIELD PANEL

EICAS INDICATIONS

1 - LANDING GEAR POSITION

– Position is indicated by three boxes, one for each gear.

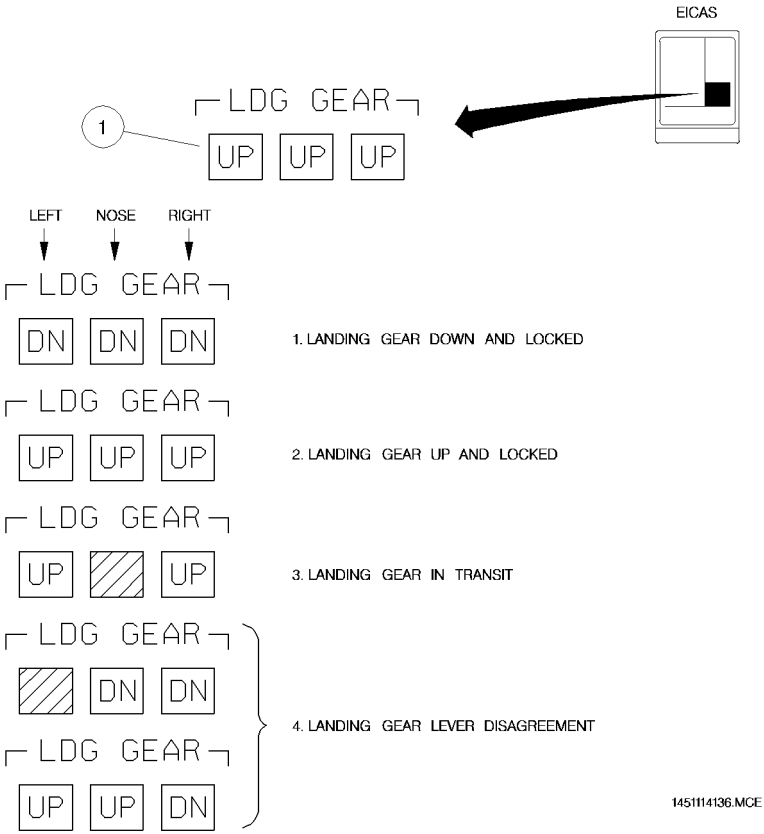
– Landing gear down and locked is indicated by a green DN label inside a green box.

– Landing gear in transit is indicated when the box is cross-hatched in amber and black.

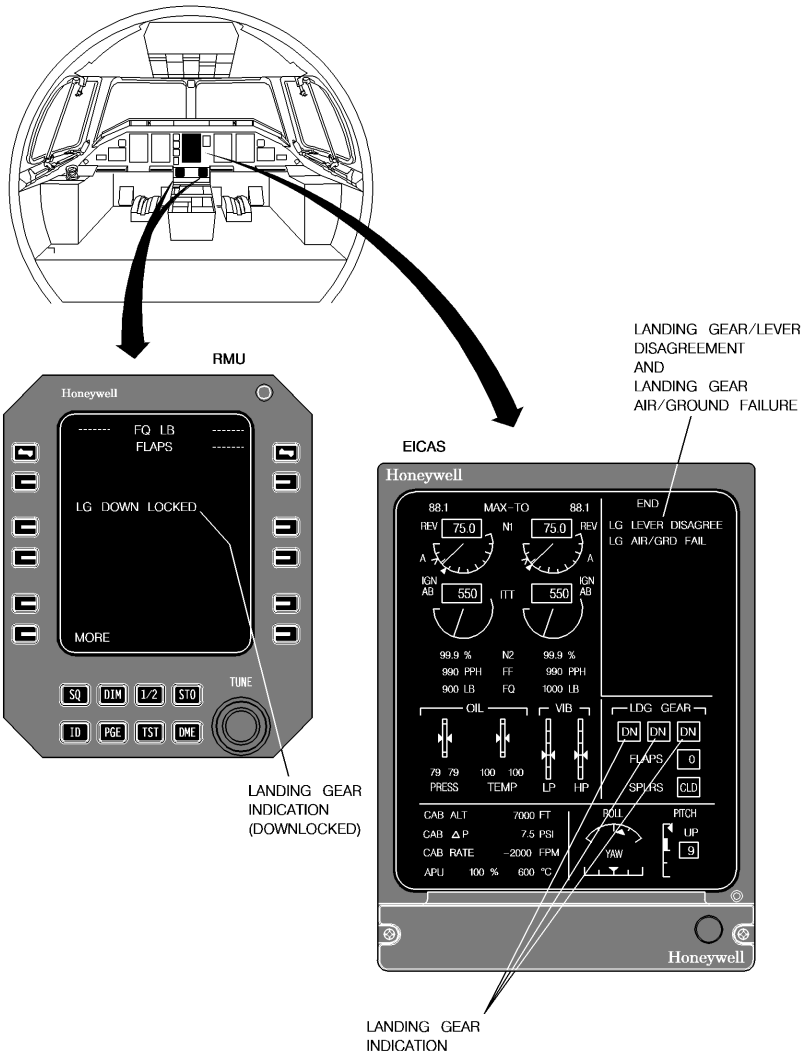
– Landing gear up and locked is indicated by a white UP label inside a white box.

– Landing gear lever disagreement (landing gear is not in the selected position after 20 seconds) is indicated by a box cross-hatched in red and black or by a red label (UP or DN) inside a red box.

– Indication of landing gear downlocked is also presented on the RMU through the green LG DOWN LOCKED legend.



LANDING GEAR POSITION INDICATION ON EICAS



LANDING GEAR INDICATIONS

BRAKE SYSTEM

The braking system consists of the normal brake system, emergency/parking brake system, and gear-retracting-in-flight braking. The normal brake system is supplied by hydraulic systems 1 and 2. It is electronically commanded and monitored. The emergency/parking brake system is supplied only by hydraulic system 2 and is mechanically actuated. Normal braking is controlled by the pedals. Emergency braking is controlled by the emergency/parking brake handle. Gear-retracting-in-flight braking is controlled by both hydraulic systems and by a mechanical stop within the nose gear wheel well. This braking is electronically commanded and monitored.

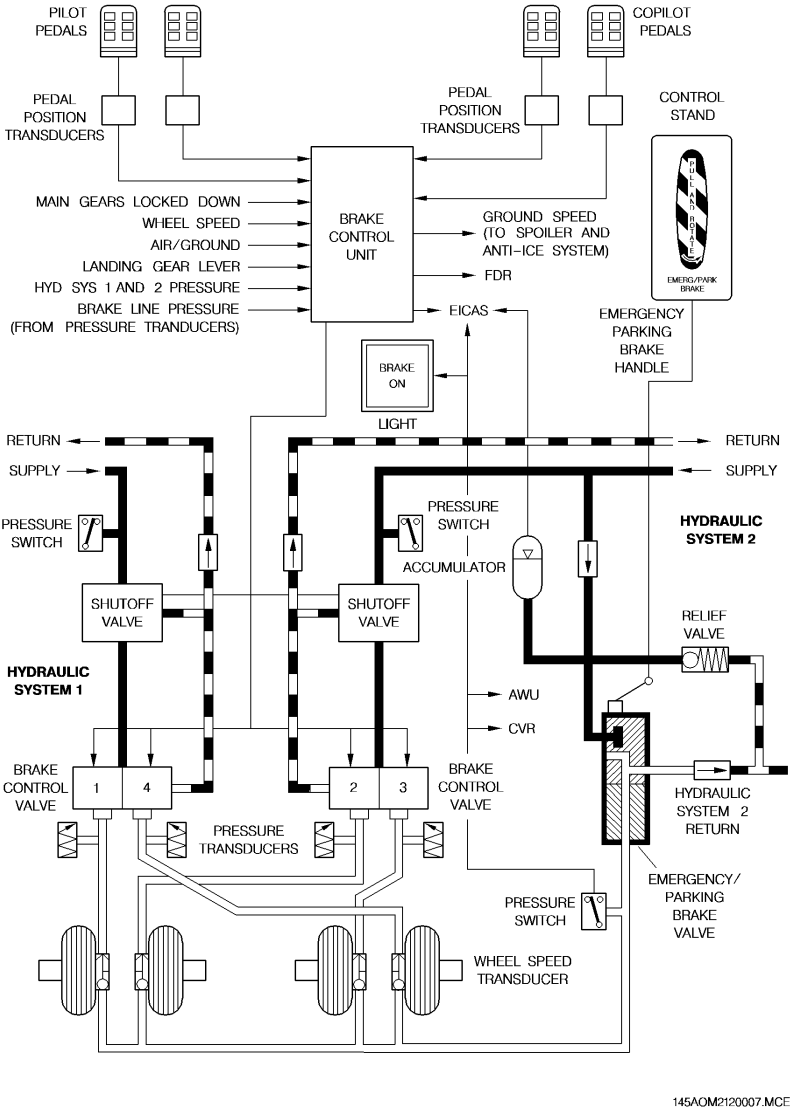
Braking through the pedals incorporates some protections not available when using the emergency brake handle. Brake temperature is shown on the MFD Hydraulic Page.

NORMAL BRAKE SYSTEM

Normal brake system is operated by rudder pedal inputs. The brakes are powered by two independent hydraulic systems. It is controlled and monitored by the Brake Control Unit (BCU). The BCU receives signals from the pedal position transducers and commands the four Brake Control Valves (BCV) to modulate required pressure to the wheel brakes. BCVs 1 and 4 control the hydraulic pressure from system 1 to the outboard wheels. BCVs 2 and 3 control the hydraulic pressure from system 2 to the inboard wheels.
The hydraulic system 1 and the ESS DC BUS 1 supply the main brake system for the control of the outboard wheels. The hydraulic system 2 and the ESS DC BUS 2 supply the main brake system for the control of the inboard wheels.

Pressure and wheel speed transducers send signals to the BCU so that it can monitor brake performance and send the appropriate signals to the crew alerting system and other systems. The BCU also receives signals from the landing gear position and condition, air/ground situation, and hydraulic system status. The system displays messages on the EICAS to indicate a failure in one pair of brakes or a failure in a single wheel brake (brake degraded performance). In the event of brake system failure, the BCU will shut down the affected hydraulic system through the shutoff valves. The shutoff valves are energized whenever the landing gear is extended and de-energized after landing gear retraction.

Protective functions controlled by the normal braking system include anti-skid protection, locked wheel protection, and touch-down protection.



145AOM2120007.MCE

BRAKE SYSTEM SCHEMATIC

ANTI-SKID PROTECTION

The anti-skid protection controls the amount of hydraulic pressure applied by the pilots on the brakes. The anti-skid provides the maximum allowable braking effort for the runaway surface in use. It minimizes tire wear, optimizes braking distance, and prevents skidding.

To perform this function, the BCU computes the wheel speed signals from the four speed transducers. If one signals falls below the wheel speed average, a skid is probably occurring, and braking pressure is relieved on that side. After that wheel speed has returned to the average speed, normal braking operation is restored.

The anti-skid does not apply pressure on the brakes, but only relieves it. So, to perform a differential braking technique, the pilot should reduce pressure on the side opposite to the turn, instead of applying pressure to the desired side.

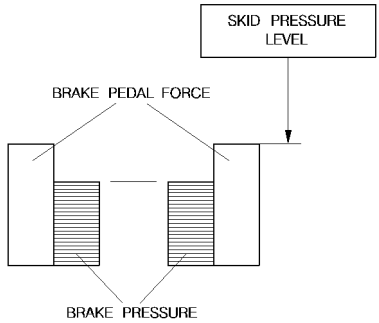
The anti-skid system incorporates the locked wheel protection and touchdown protection features.

LOCKED WHEEL PROTECTION

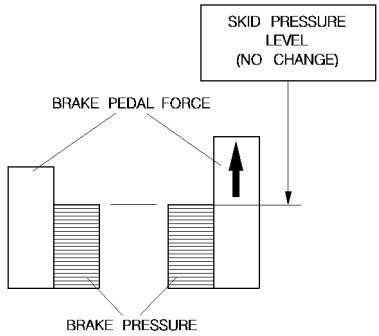
Locked wheel protection is activated for wheel speeds above 30 kt. It compares wheel speeds signals. If one wheel speed is 30% lower than that of another, a full brake pressure relief is commanded to the associated wheel, allowing wheel speed recovery. The 30% tolerance between the wheel speeds is provided to permit an amount of differential braking, for steering purposes.

For wheel speeds below 30 kt, the locked wheel protection is deactivated and the brake system actuates without the wheel speed comparator. For wheel speeds below 10 kt, the anti-skid protection is deactivated, allowing the pilot to lock and pivot on a wheel.

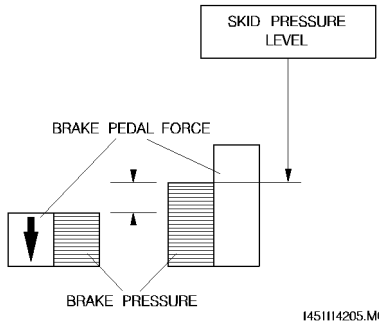
THE ANTI-SKID FUNCTION MODULATES THE BRAKE PRESSURE TO A LEVEL WHICH PREVENTS THE WHEELS FROM SKIDDING. IF ONE OF THE WHEELS LOCKS, THE ANTI-SKID FUNCTION REDUCES THE BRAKE PRESSURE OF THE ASSOCIATED PAIR, THUS ELIMINATING THE SKIDING.



IF THE PILOT APPLIES DIFFERENTIAL PEDAL FORCE TO STEER THE AIRPLANE THROUGH DIFFERENTIAL BRAKING, THE ANTI-SKID FUNCTION MAINTAINS THE SKID PRESSURE LEVEL, THUS PRECLUDIND THE AIRPLANE FROM TURNING.



THE CORRECT ACTION CONSISTS IN A REDUCTION OF THE OPPOSITE PEDAL FORCE TO A POINT BELOW THE SKID LEVEL, WHICH PERMITS THE REDUCTION OF THE CORRESPONDING BRAKE PRESSURE.



I451I14205.MCE

DIFFERENTIAL BRAKING TECHNIQUE

TOUCHDOWN PROTECTION

The touchdown protection system inhibits brake actuation before the main wheels spin up during landing. Brake actuation will be allowed only after 3 seconds from the latest touchdown or after the wheels have spun-up to 50 kt. In bouncing landings, the countdown is reset after each runway contact.

Touchdown protection is provided by the brake system receiving signals from main landing gear weight-on-wheel proximity switches. If one landing gear proximity switch fails at the air position, the brake system will operate normally. However, if both proximity switches fail at the air position, braking capacity will be available only for wheel speeds above 10 kt.
Below 10 kt, a loss of the main brake capacity will occur, but emergency braking is still available.

GEAR-RETRACTING-IN-FLIGHT BRAKING

Gear-retracting-in-flight braking prevents the landing gear from being retracted when the wheels are turning. This system computes signals from the air/ground indicating system and from the landing gear lever position. As soon as the airplane is airborne and the gears are commanded to retract, it applies braking pressure to the main wheels. The nose wheels are braked by a stop within the nose landing gear wheel well.

THIS PAGE IS LEFT BLANK INTENTIONALLY

EMERGENCY/PARKING BRAKE SYSTEM

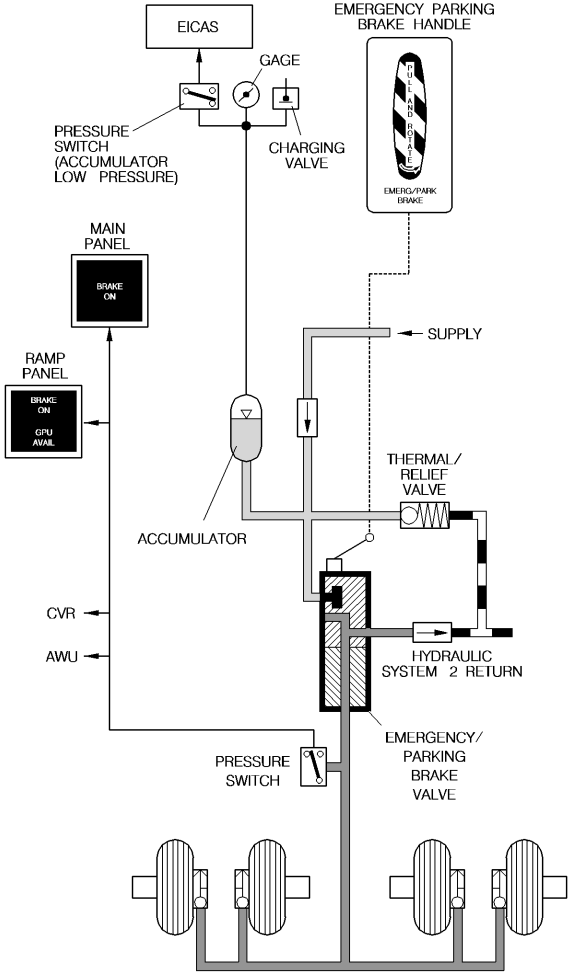
The emergency/parking brake system is used when parking the airplane or when the normal braking system has failed. The emergency/parking brake system is mechanically commanded and hydraulically actuated. It is totally independent of the BCU, so it has none of the normal braking system protections.

The emergency/parking brake is controlled through a handle located on the left side of the control pedestal. This modulates the Emergency/Parking Brake Valve. When the Emergency/Parking Brake Valve is actuated, hydraulic pressure coming from a dedicated accumulator is equally applied to the four main landing gear brakes. Braking capacity is proportional to the handle displacement. A BRAKE ON indicating light illuminates to indicate that pressure is being applied to the wheel brakes. A locking device allows the handle to be held in the actuated position, for parking purposes.

The accumulator is supplied by hydraulic system 2. A caution message is displayed on the EICAS in case of accumulator hydraulic low pressure. After the message is displayed, if no leakage exists, at least one full emergency/parking brake application is available. If overpressure occurs due to overheating, a thermal relief valve allows hydraulic system communication with the return. A refilling connection is provided to allow pressurization of the accumulator.

The accumulator allows 6 complete emergency actuation or at least 24 hours of parking brake actuation.

NOTE: To prevent transfer of hydraulic fluid from one system to the other, normal braking should be applied and held while the parking brake is fully applied or released.



145AOM2120019.MCE

EMERGENCY/PARKING BRAKE SYSTEM SCHEMATIC

EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	EMRG BRK LO PRES	Emergency/parking brake accumulator presents a low pressure condition.
	BRK OUTBD (INBD) INOP	Outboard and/or inboard pair of brakes is inoperative.
	BRAKE OVERHEAT	Any brake temperature has exceeded 420°C.(*)
	BRAKE DEGRADED	Total or partial loss of braking capability of one outboard wheel (1 or 4) and/or one inboard wheel (2 or 3), or internal BCU failure.

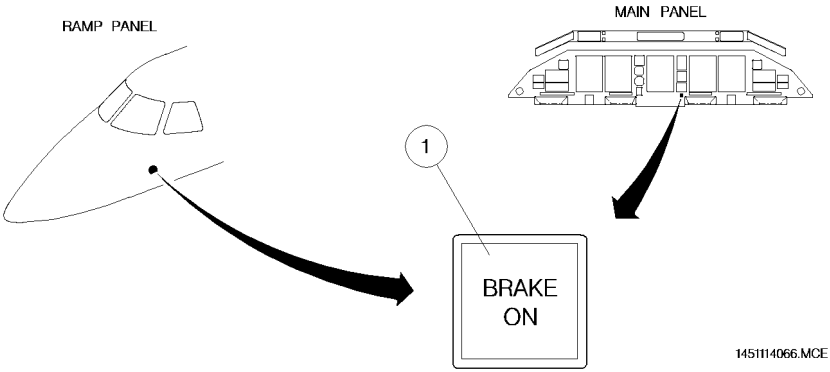
NOTE: (*) For EMB-145 airplanes equipped with LR brakes, the brake overheat set point is 450°C.

CONTROLS AND INDICATORS

MAIN PANEL/RAMP PANEL

1 - BRAKE ON LIGHT

– Illuminates when emergency/parking brake is applied.

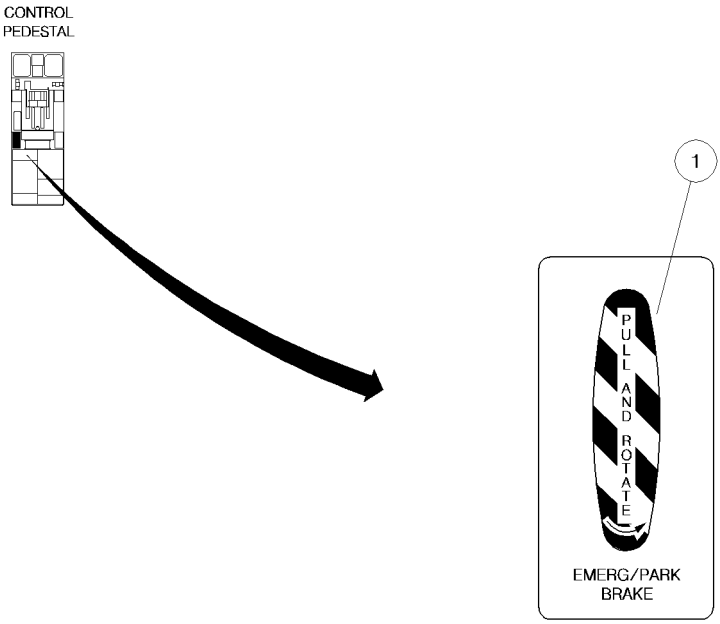


BRAKE ON LIGHT

CONTROL PEDESTAL

1 - EMERGENCY/PARKING BRAKE HANDLE

- Actuates the emergency/parking brake valve.
- Pull the handle and rotate to lock in the fully-actuated position.



1451114065.MCE

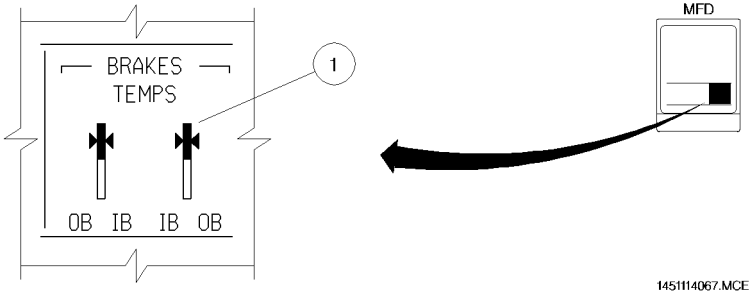
EMERGENCY/PARKING BRAKE HANDLE

MFD INDICATIONS

1 - BRAKE TEMPERATURE INDICATION

- Temperature is indicated by two vertical bars (one for each main landing gear) and four pointers (one for each brake).
- The scale ranges from 0 to 500°C.
- The scale and pointer are green when temperature is below 200°C, and amber when equal or greater than 200°C.
- The temperature indication pointer is removed from the display in case of loss of temperature sensor signal.

NOTE: For EMB-145 airplanes equipped with LR brakes, the scale and pointer are green when temperature is below 250°C, and amber when equal or greater than 250°C.



BRAKE TEMPERATURE INDICATION

NOSE WHEEL STEERING SYSTEM

The nose wheel steering system is electronically controlled and hydraulically operated. It is powered by the hydraulic system 1. The Electronic Control Module is energized when the landing gear is down and locked, with the airplane on ground. In this condition, steering can be controlled by either the pedals or the steering handle. In either case, the commanded displacement is measured by a potentiometer box, which transmits the signal to the Electronic Control Module. The Electronic Control Module signals the hydraulic manifold to pressurize the steering actuator in the commanded direction. For monitoring purpose, a feedback potentiometer in the nose landing gear leg transmits nose wheel displacement information to the Electronic Control Module.

Maximum nose wheel displacement values due to actuation of the steering handle and pedals are presented in the table below in degrees:

CERTIFICATION	APPLICABILITY	PEDALS ONLY	STEERING HANDLE ONLY	HANDLE AND PEDALS
CTA/JAA	All Airplanes	5°	71°	76°
FAA	Pre-Mod. SB 145-32-0002	5°	50°	55°
	Post-Mod. SB 145-32-0002 or S/N 145.029 and on	5°	71°	76°

NOTE: Steering handle actuation with nose wheels beyond their operational limits may cause damage to the nose wheel steering system.
Check if the nose wheel position indication mark is within the nose wheel position indication scale limits.

A position sensor set to 7° disengages the system if the nose wheel is rotated above this limit by using the rudder pedals. To reengage the system, resume command through the handle.

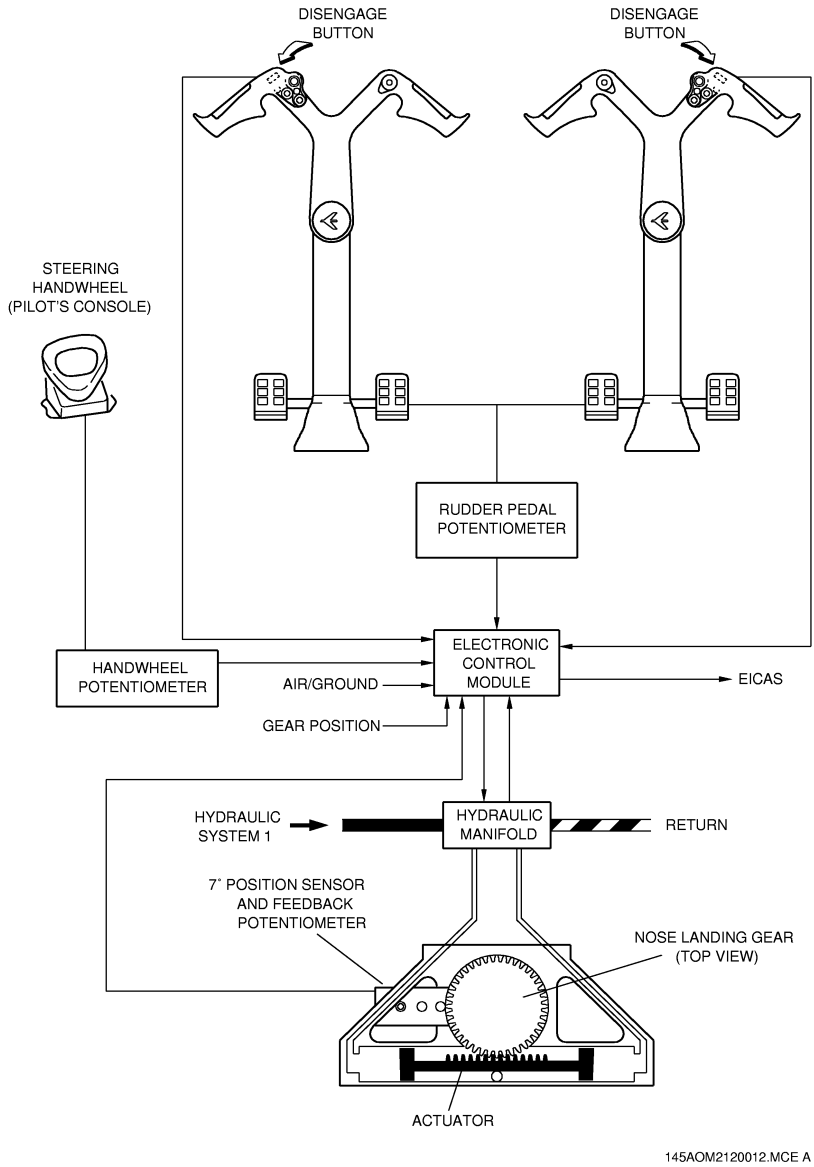
The steering system may be manually disengaged through switches located on the pilots' control wheels. Automatic system disablement occurs as soon as the airplane is airborne. Nose wheel centering with the nose gear shock absorber extension is provided by a cam. The nose wheel is also centered by caster effect whenever the system is disengaged.

If the Electronic Control Module detects a failure, the EICAS is signaled to present a caution message. In these cases, for airplanes Post-Mod. SB 145-32-0104 or with an equivalent modification factory incorporated, the tiller commands will be inhibited if ground speed is above 25 kt.

Optionally, some airplanes are equipped with an external Steering Disengagement Switch which allows ground personnel to disengage steering prior to towing operations. The switch actuates directly on the steering system, shutting its power down. The disengagement switch inhibits the steering actuation commanded by the steering handle and the rudder pedals. A caution message is displayed on the EICAS whenever the steering system is disengaged by the external switch. Steering Disengagement Switch is installed in a compartment on the left front fuselage.

EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	STEER INOP	Steering system is inoperative. Message is presented only on ground.

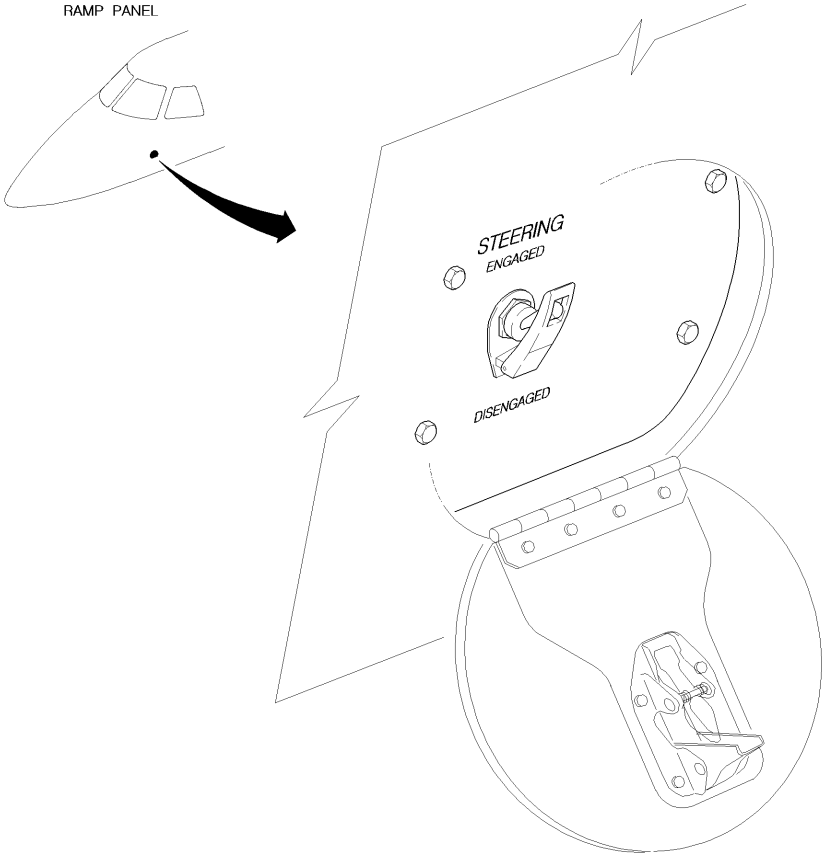


NOSE WHEEL STEERING SCHEMATIC

CONTROLS AND INDICATORS

STEERING DISENGAGEMENT SWITH (guarded)

ENGAGED - Allows normal steering system operation
DISENGAGED - Disables steering system operation.



145AOM2120017.MCE

STEERING DISENGAGEMENT SWITCH COMPARTMENT

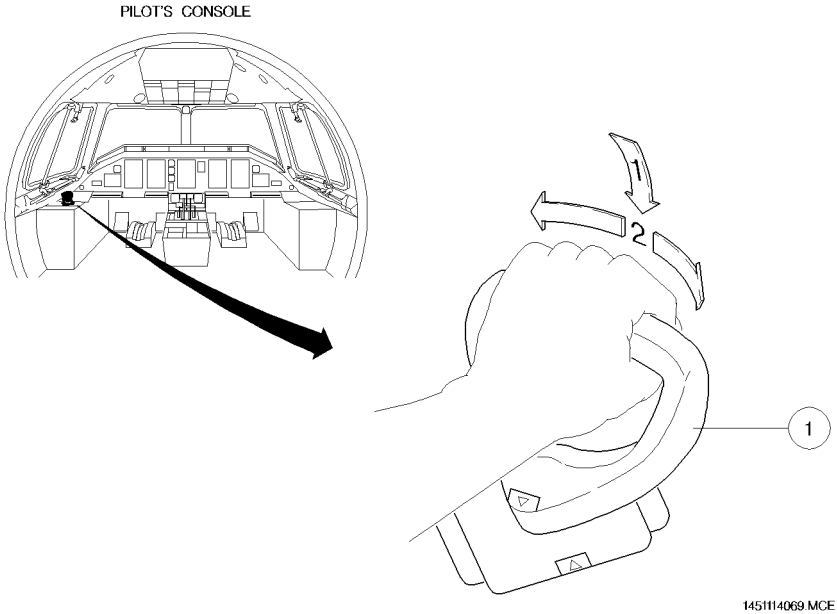
PILOT'S CONSOLE

1 - STEERING HANDLE

- Commands nose wheel steering, allowing 71° deflection to either side.
- Push the handle down (step 1) to enable the command or to reset the steering system after disconnection. Then rotate left or right (step 2) to command steering.

NOTE: - For airplanes operanting under FAA certification and Pre-Mod SB 145-32-0002 the nose wheel steering deflection is limited to 50 to either side.

- The Steering Handle has priority over the Steering Disengage button when both are pressed (in case of emergency, jammed rudder for example, the Steering Handle is used to control the airplane and the pilot must keep the Steering Disengage Button pressed to avoid nose wheel deflection once on ground).

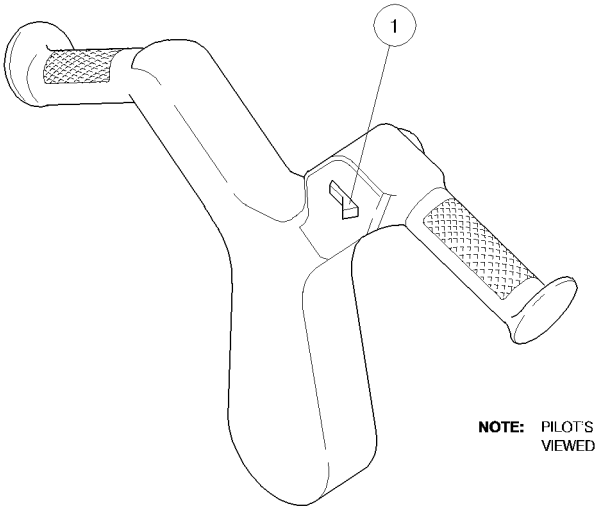


STEERING HANDLE

CONTROL WHEEL

1 - STEERING DISENGAGE BUTTON

– When pressed disengages the nose wheel steering system.

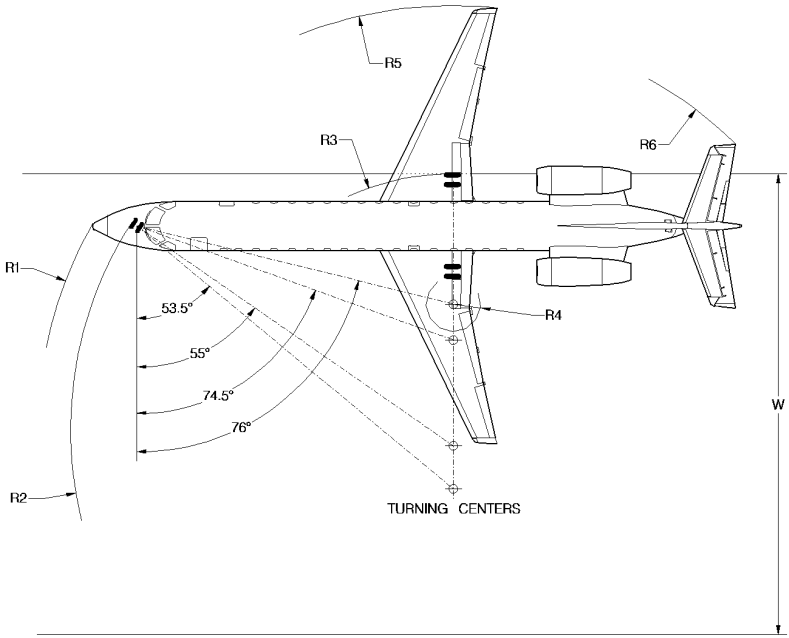


NOTE: PILOT'S CONTROL WHEEL SHOWN, VIEWED FROM BEHIND.

1451114070.MCE

STEERING DISENGAGE BUTTON

EMB-145 MINIMUM TURNING RADII

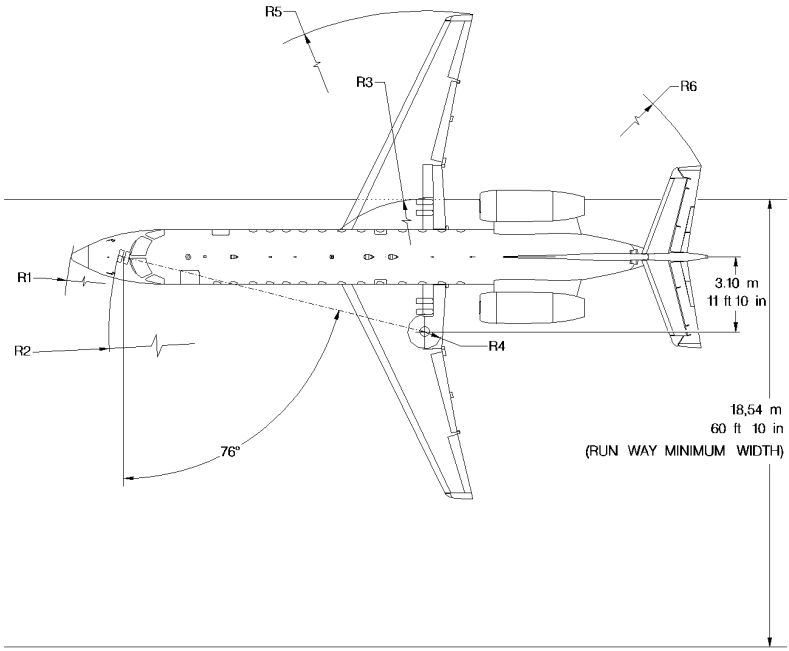


STEERING ANGLE	NOSE R1	NOSE GEAR R2	OUTBOARD GEAR R3	INBOARD GEAR R4	RIGHT WINGTIP R5	RIGHT TAILTIP R6	WIDTH W
53.5°	19.79 m	18.19 m	13.08 m	8.31 m	20.81 m	19.43 m	31.27 m
	64 ft 11 in	59 ft 8 in	42 ft 3 in	27 ft 3 in	68 ft 3 in	63 ft 9 in	102 ft 6 in
55°	19.48 m	17.86 m	12.50 m	7.74 m	20.24 m	19.00 m	30.36 m
	63 ft 11 in	58 ft 7 in	41 ft 0 in	25 ft 5 in	66 ft 5 in	62 ft 4 in	99 ft 6 in
74.5°	17.10 m	15.21 m	6.39 m	1.62 m	14.17 m	15.12 m	21.94 m
	56 ft 1 in	49 ft 11 in	21 ft 0 in	5 ft 4 in	46 ft 6 in	49 ft 7 in	72 ft 0 in
76°	17.01 m	15.11 m	5.99 m	1.25 m	13.77 m	14.92 m	21.21 m
	55 ft 9 in	49 ft 7 in	19 ft 8 in	4 ft 1 in	45 ft 2 in	48 ft 11 in	69 ft 7 in

1451114332.MCE

THIS PAGE IS LEFT BLANK INTENTIONALLY

EMB-135 MINIMUM TURNING RADII

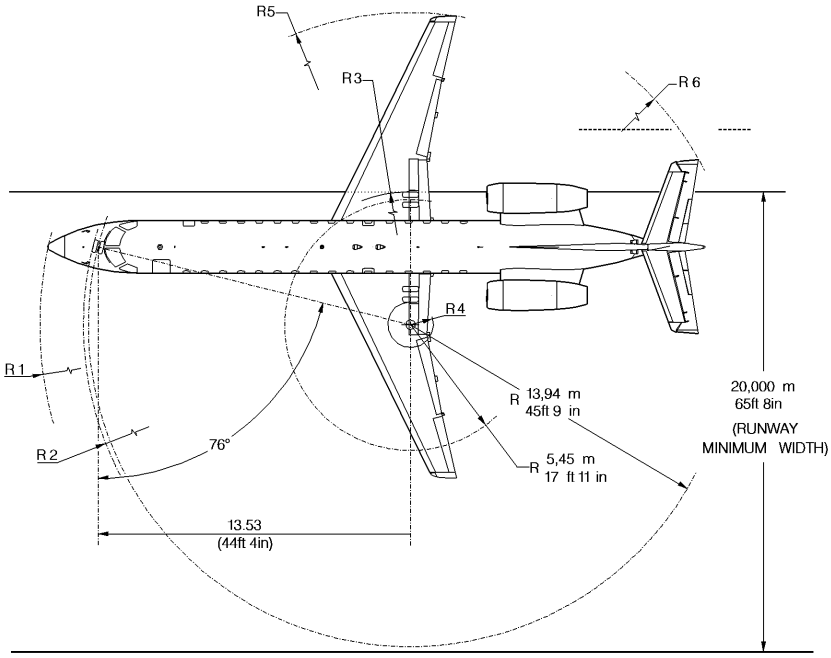


STEERING STEEL	NOSE R1	NOSE GEAR R2	OUTBOARD GEAR R3	INBOARD GEAR R4	RIGHT WINGTIP R5	RIGHT TAILTIP R6
76°	14.94 m	13.05 m	5.49 m	0.72 m	13.27 m	13.34 m
	49 ft 0 in	42 ft 10 in	18 ft 0 in	2 ft 4 in	43 ft 7 in	43 ft 9 in

1451114336.MCE

THIS PAGE IS LEFT BLANK INTENTIONALLY

EMB-140 MINIMUM TURNING RADII



STEERING STEEL	NOSE R1	NOSE GEAR R2	OUTBOARD GEAR R3	INBOARD GEAR R4	RIGHT WINGTIP R5	RIGHT TAILTIP R6
76°	16.05 m	14.16 m	5.74 m	0.98 m	13.53 m	14.40 m
	52 ft 8 in	46 ft 6 in	18 ft 10 in	3 ft 3 in	44 ft 5 in	47 ft 3 in

145AOM2120021.MCE

THIS PAGE IS LEFT BLANK INTENTIONALLY