4.0 GROUND MANEUVERING

4.1 General Information

4.2 Turning Radii

4.3 Clearance Radii

4.4 Visibility From Cockpit in Static Position

4.5 Runway and Taxiway Turn Paths

4.6 Runway Holding Bay
4.0 GROUND MANEUVERING

4.1 General Information

The 747 main landing gear consists of four main struts, each strut with four wheels. This geometric arrangement of the four main gears results in somewhat different ground maneuvering characteristics from those experienced with typical landing gear aircraft.

Basic factors that influence the geometry of the turn include:

1. Nose wheel steering angle
2. Engine power settings
3. Center of gravity location
4. Airplane weight
5. Pavement surface conditions
6. Amount of differential braking
7. Ground speed
8. Main landing gear steering

The steering system of the 747 incorporates steering of the main body landing gear in addition to the nose gear steering. This body gear steering system is hydraulically actuated and is programmed electrically to provide steering ratios proportionate to the nose gear steering angles. During takeoff and landing, the body gear steering system is centered, mechanically locked, and depressurized.

Steering of the main body gear has the following advantages over ground maneuvering without this steering feature; overall improved maneuverability, including improved nose gear tracking; elimination of the need for differential braking during ground turns, with subsequent reduced brake wear; reduced thrust requirements; lower main gear stress levels; and reduced tire scrubbing. The turning radii shown in Section 4.2 are derived from a previous test involving a 747-200. The 747-400 is expected to follow the same maneuvering characteristics.
4.1.1 GENERAL INFORMATION

MODEL 747

<table>
<thead>
<tr>
<th>NOSE GEAR</th>
<th>BODY GEAR</th>
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<tbody>
<tr>
<td>0° TO 20°</td>
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<tr>
<td>20° TO 70°</td>
<td>0° TO 13°</td>
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NOSEGEAR/BODY GEAR TURN RATIOS
4.2.1 TURNING RADII - WITH BODY GEAR STEERING - SYMMETRICAL THRUST

MODEL 747
D6-58326-1
96 DECEMBER 2002

NOTES:
- LOW SPEED 7–25 FT (2.1–7.6 M) PER SEC
- NO DIFFERENTIAL BREAKING
- DRY CONCRETE PAVEMENT
- DATA TAKEN FROM PREVIOUS 747–200 TESTS

OPERATING RANGE DEPENDENT ON:
- WEIGHT AND C.G. LOCATION
- PILOT TECHNIQUE

DISTANCE BETWEEN AIRPLANE CENTERLINE AND TURN CENTER (X)
4.2.2 TURNING RADIi - BODY GEAR STEERING INOPERATIVE - SYMMETRICAL THRUST

MODEL 747

D6-58326-1

DECEMBER 2002

97

NOTES:

- LOW SPEED 7-25 FT (2.1-7.6 m) PER SEC
- NO DIFFERENTIAL BREAKING
- DRY CONCRETE PAVEMENT
- DATA TAKEN FROM PREVIOUS 747-200 TESTS

REQUIRED THRUST VALUES OVERCAME NOSE GEAR EFFECTIVENESS

OPERATING RANGE DEPENDENT ON:

- WEIGHT AND C.G. LOCATION
- PILOT TECHNIQUE

DISTANCE BETWEEN AIRPLANE CENTERLINE AND TURN CENTER (X)
4.2.3 TURNING RADII - WITH BODY GEAR STEERING - UNSYMMETRICAL THRUST

MODEL 747

D6-58326-1

98 DECEMBER 2002

NOTES:
- LOW SPEED 7–25 FT (2.1–7.6 M) PER SEC
- NO DIFFERENTIAL BREAKING
- DRY CONCRETE PAVEMENT
- DATA TAKEN FROM PREVIOUS 747-200 TESTS

DISTANCE BETWEEN AIRPLANE CENTERLINE AND TURN CENTER (X)

NOSE GEAR STEERING ANGLE, DEGREES

FEET

METERS

OPERATING RANGE DEPENDENT ON:
- WEIGHT AND C.G. LOCATION
- PILOT TECHNIQUE
4.2.4 TURNING RADII - BODY GEAR STEERING INOPERATIVE - SYMMETRICAL THRUST

**NOTES:**
- NO DIFFERENTIAL BREAKING
- DRY CONCRETE PAVEMENT
- DATA TAKEN FROM PREVIOUS 747-200 TESTS

**Operating Range Depends On:**
- WEIGHT AND C.G. LOCATION
- PILOT TECHNIQUE

**Distance Between Airplane Centerline and Turn Center (X):**

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<th>METERS</th>
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4.2.5 TURNING RADIUS - TOWED

MODEL 747

DISTANCE BETWEEN AIRPLANE CENTERLINE AND TURN CENTER, (X)

NOTES:
- ZERO ENGINE THRUST
- DRY CONCRETE PAVEMENT
- TORQUE LINKS CONNECTED
- DATA TAKEN FROM PREVIOUS 747-200 TESTS

1. WITH BODY GEAR STEERING - ROLLING DRAWBAR PULL APPROX. 13,300 LB (6,038 KG)
2. BODY GEAR STEERING INOPERATIVE - ROLLING DRAWBAR PULL APPROX. 20,400 LB (9,262 KG)
### 4.3.1 CLEARANCE RADIUS - ENGLISH UNITS

**MODEL 747-400, -400 COMBI, -400 FREIGHTER, -400ER, -400ER FREIGHTER**

<table>
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<tr>
<th>X * (FEET)</th>
<th>A (4) WING TIP (1)</th>
<th>A (4) WING TIP (2)</th>
<th>B (3) NOSE GEAR (1)</th>
<th>B (3) NOSE GEAR (2)</th>
<th>C (3) WING GEAR (1)</th>
<th>C (3) WING GEAR (2)</th>
<th>D TAIL TIP (1)</th>
<th>D TAIL TIP (2)</th>
<th>E NOSE (1)</th>
<th>E NOSE (2)</th>
<th>Z (3) MINIMUM WIDTH FOR 180° TURN (1)</th>
<th>Z (3) MINIMUM WIDTH FOR 180° TURN (2)</th>
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* X = DISTANCE BETWEEN AIRPLANE CENTERLINE AND TURN CENTER
  (1) BODY GEAR STEERING INOPERATIVE
  (2) WITH BODY GEAR STEERING
  (3) MEASURED TO OUTSIDE TIRE FACES
  (4) WINGSSPAN AT 213 FEET
### 4.3.2 CLEARANCE RADII - METRIC UNITS

*Model 747-400, -400 Combi, -400 Freighter, -400ER, -400ER Freighter*

#### D6-58326-1

102 DECEMBER 2002

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### NOTES:
1. CONSULT AIRLINE FOR OPERATING PROCEDURES
2. VALUES ARE ROUNDED TO THE NEAREST 0.1 METER

<table>
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<tr>
<th>X * (METERS)</th>
<th>A (4) WING TIP</th>
<th>B (3) NOSE GEAR</th>
<th>C (3) WING GEAR</th>
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</table>

* X = DISTANCE BETWEEN AIRPLANE CENTERLINE AND TURN CENTER

1. BODY GEAR STEERING INOPERATIVE
2. WITH BODY GEAR STEERING
3. MEASURED TO OUTSIDE TIRE FACES
4. WINGSPAN AT 64.9 METERS

---

![Airplane Diagram](attachment:image.png)
### 4.3.3 CLEARANCE RADII - ENGLISH UNITS

**MODEL 747-400 DOMESTIC**

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<th>A WING TIP (1)</th>
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* X = DISTANCE BETWEEN AIRPLANE CENTERLINE AND TURN CENTER
  (1) BODY GEAR STEERING INOPERATIVE
  (2) WITH BODY GEAR STEERING
  (3) MEASURED TO OUTSIDE TIRE FACES
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* X = DISTANCE BETWEEN AIRPLANE CENTERLINE AND TURN CENTER
(1) BODY GEAR STEERING INOPERATIVE
(2) WITH BODY GEAR STEERING
(3) MEASURED TO OUTSIDE TIRE FACES

4.3.4 CLEARANCE RADII - METRIC UNITS
MODEL 747-400 DOMESTIC

D6-58326-1
NOT TO BE USED FOR LANDING APPROACH VISIBILITY

VISUAL ANGLES IN VERTICAL PLANE THROUGH PILOT'S EYE POSITION

VISUAL ANGLES IN PLANE PERPENDICULAR TO LONGITUDINAL AXIS THROUGH PILOT'S EYE POSITION

NOTES:
(1) VISUAL ANGLES THROUGH WINDSHIELD
(2) VISUAL ANGLES THROUGH SIDE WINDOW
(3) VISUAL ANGLES FROM NORMAL POSITION
(4) VISUAL ANGLES FROM ALERT POSITION, HEAD MOVED OUTBOARD 5 IN (0.13 M)
(5) VISUAL ANGLES WITH HEAD MOVED 7 IN (0.18 M) OUTBOARD
* HEAD IS ROTATED ABOUT A POINT 3 IN (0.08 M) AFT OF PILOT'S EYE POSITION

4.4 VISIBILITY FROM COCKPIT IN STATIC POSITION
MODEL 747-400
D6-58326-1
**NOSE GEAR TRACKING BEYOND INTERSECTING TAXIWAY CENTERLINE (JUDGEMENTAL OVERSTEERING)**

**RUNWAY AND TAXIWAY TURN PATHS - RUNWAY-TO-TAXIWAY, 90 DEGREES**

**NOTES:**
- SYMMETRICAL THRUST
- MID CG
- BODY GEAR STEERING INOPERATIVE
- NO DIFFERENTIAL BRAKING
- BEFORE DETERMINING THE SIZE OF INTERSECTION FILLETS, CONSULT USING AIRLINES OR AIRPORT AUTHORITY REGARDING OPERATING PROCEDURES AND AIRCRAFT TYPES EXPECTED TO SERVE THE AIRPORT.

**APPROX PATH OF OUTSIDE EDGE OF WING GEAR TIRES**

**APPROX PATH OF NOSE GEAR**

**APPROX 16 FT (5 M) (BOTH SIDES)**

**R=100 FT (30 M)**

**APPROX 7 FT (2 M)**

**R=100 FT (30 M)**

**150 FT (45 M)**

**75 FT (23 M)**

**NOSE GEAR TRACKING CENTERLINE TO CENTERLINE**
4.5.2 RUNWAY AND TAXIWAY TURN PATHS - RUNWAY-TO-TAXIWAY, MORE THAN 90 DEGREES, NOSE GEAR TRACKS CENTERLINE

**NOTES:**
* SYMMETRICAL THRUST
* MID CG
* BODY GEAR STEERING INOPERATIVE
* NO DIFFERENTIAL BRAKING
* BEFORE DETERMINING THE SIZE OF INTERSECTION FILLETS, CONSULT USING AIRLINES OR AIRPORT AUTHORITY REGARDING OPERATING PROCEDURES AND AIRCRAFT TYPES EXPECTED TO SERVE THE AIRPORT.

- **R=100 FT (30 M)**
- **MODIFIED FILLET**
- **APPROX PATH OF OUTSIDE EDGE OF WING GEAR TIRES**
- **RUNWAY-TO-TAXIWAY CENTERLINE OF TURN**
- **NOSE GEAR TRACKING CENTERLINE-TO-CENTERLINE**

**DECEMBER 2002**
4.5.3  RUNWAY AND TAXIWAY TURN PATHS - RUNWAY-TO-TAXIWAY, MORE THAN 90 DEGREES, JUDGMENTAL OVERSTEERING

- Model 747-400

NOTES:
* SYMMETRICAL THRUST
* M/D CO
* BODY GEAR STEERING INOPERATIVE
* NO DIFFERENTIAL BRAKING
* BEFORE DETERMINING THE SIZE OF INTERSECTION FILLETS, CONSULT USING AIRLINES OR AIRPORT AUTHORITY REGARDING OPERATING PROCEDURES AND AIRCRAFT TYPES EXPECTED TO SERVE THE AIRPORT.

APPROX PATH OF OUTSIDE EDGE OF WING GEAR TIRES

APPROX PATH OF NOSE GEAR

RUNWAY-TO-TAXIWAY CENTERLINE OF TURN

NOSE GEAR TRACKING BEYOND CENTERLINE OF TURNS (JUDGMENTAL OVERSTEERING)

R=100 FT (30 M)

APPROX 12 FT (3.6 M)

50 FT (45 M)

75 FT (23 M)
4.5.4 RUNWAY AND TAXIWAY TURN PATHS - TAXIWAY-TO-TAXIWAY, 90 DEGREES

MODEL 747-400

NOTES:
* SYMMETRICAL THRUST
* M/D CG
* BODY GEAR STEERING INOPERATIVE
* NO DIFFERENTIAL BRAKING
* BEFORE DETERMINING THE SIZE OF INTERSECTION FILLETS, CONSULT USING AIRLINES OR AIRPORT AUTHORITY REGARDING OPERATING PROCEDURES AND AIRCRAFT TYPES EXPECTED TO SERVE THE AIRPORT.

APPROX PATH OF OUTSIDE EDGE OF WING GEAR TIRES
APPROX 16 FT (5 M) (BOTH SIDES)
R=100 FT (30 M)
MODIFIED FILLET

APPROX PATH OF OUTSIDE EDGE OF WING GEAR TIRES

APPROX PATH OF NOSE GEAR

NOSE GEAR TRACKING BEYOND INTERSECTING TAXIWAY CENTERLINE (JUDGEMENTAL OVERSTEERING)

APPROX PATH OF NOSE GEAR
NOSE GEAR TRACKING CENTERLINE TO CENTERLINE
4.5.5  RUNWAY AND TAXIWAY TURN PATHS - TAXIWAY-TO-TAXIWAY, 90 DEGREES, ICAO RECOMMENDATION

Model 747-400

NOTES:
* SYMMETRICAL THRUST
* MID CG
* BODY GEAR STEERING INOPERATIVE
* NO DIFFERENTIAL BRAKING
* BEFORE DETERMINING THE SIZE OF INTERSECTION FILLETS, CONSULT USING AIRLINES OR AIRPORT AUTHORITY REGARDING OPERATING PROCEDURES AND AIRCRAFT TYPES EXPECTED TO SERVE THE AIRPORT.

R = 100 FT (30 M)

MODIFIED FILLET

APPROX PATH OF OUTSIDE EDGE OF WING GEAR TIRES

PATH OF COCKPIT FOLLOWING CENTERLINE OF TURNS

APPROX PATH OF NOSE GEAR

COCKPIT FOLLOWING CENTERLINE OF TURNS (ICAO RECOMMENDATION)
4.6 RUNWAY HOLDING BAY
MODEL 747-400

NOTES:
* SYMMETRICAL THRUST
* MID CG
* BODY GEAR STEERING INOPERATIVE
* NO DIFFERENTIAL BRAKING
* BEFORE DETERMINING THE SIZE OF INTERSECTION FILLETS, CONSULT USING AIRLINES OR AIRPORT AUTHORITY REGARDING OPERATING PROCEDURES AND AIRCRAFT TYPES EXPECTED TO SERVE THE AIRPORT.