747-8
Airplane Characteristics for Airport Planning

Boeing Commercial Airplanes
## 747-8 AIRPLANE CHARACTERISTICS

### LIST OF ACTIVE PAGES

<table>
<thead>
<tr>
<th>Page</th>
<th>Date</th>
<th>Page</th>
<th>Date</th>
<th>Page</th>
<th>Date</th>
</tr>
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<tbody>
<tr>
<td>Original i to 112</td>
<td>Preliminary September 2008</td>
<td>3-4</td>
<td>December 2010</td>
<td>7-8</td>
<td>June 2010</td>
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<td>October 2010</td>
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<td>July 2010</td>
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<td>July 2010</td>
<td>91-120</td>
<td>July 2010</td>
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REV A

REV B

ALL

DECEMBER 2012
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE AND INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1</td>
<td>Scope</td>
<td>2</td>
</tr>
<tr>
<td>1.2</td>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>1.3</td>
<td>A Brief Description of the 747-8</td>
<td>4</td>
</tr>
<tr>
<td>2.0</td>
<td>AIRPLANE DESCRIPTION</td>
<td>5</td>
</tr>
<tr>
<td>2.1</td>
<td>General Characteristics</td>
<td>6</td>
</tr>
<tr>
<td>2.2</td>
<td>General Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>2.3</td>
<td>Ground Clearances</td>
<td>11</td>
</tr>
<tr>
<td>2.4</td>
<td>Interior Arrangement</td>
<td>13</td>
</tr>
<tr>
<td>2.5</td>
<td>Cabin Cross-Sections</td>
<td>15</td>
</tr>
<tr>
<td>2.6</td>
<td>Lower Cargo Compartments</td>
<td>18</td>
</tr>
<tr>
<td>2.7</td>
<td>Door Clearances</td>
<td>19</td>
</tr>
<tr>
<td>3.0</td>
<td>AIRPLANE PERFORMANCE</td>
<td>27</td>
</tr>
<tr>
<td>3.1</td>
<td>General Information</td>
<td>28</td>
</tr>
<tr>
<td>3.2</td>
<td>Payload/Range</td>
<td>29</td>
</tr>
<tr>
<td>3.3</td>
<td>FAA/EASA Takeoff Runway Length Requirements</td>
<td>31</td>
</tr>
<tr>
<td>3.4</td>
<td>FAA/EASA Landing Runway Length Requirements</td>
<td>39</td>
</tr>
<tr>
<td>4.0</td>
<td>GROUND MANEUVERING</td>
<td>41</td>
</tr>
<tr>
<td>4.1</td>
<td>General Information</td>
<td>42</td>
</tr>
<tr>
<td>4.2</td>
<td>Turning Radii</td>
<td>44</td>
</tr>
<tr>
<td>4.3</td>
<td>Clearance Radii</td>
<td>46</td>
</tr>
<tr>
<td>4.4</td>
<td>Visibility from Cockpit in Static Position</td>
<td>48</td>
</tr>
<tr>
<td>4.5</td>
<td>Runway and Taxiway Turn Paths</td>
<td>49</td>
</tr>
<tr>
<td>4.6</td>
<td>Runway Holding Bay</td>
<td>58</td>
</tr>
<tr>
<td>5.0</td>
<td>TERMINAL SERVICING</td>
<td>59</td>
</tr>
<tr>
<td>5.1</td>
<td>Airplane Servicing Arrangement - Typical Turnaround</td>
<td>61</td>
</tr>
<tr>
<td>5.2</td>
<td>Terminal Operations - Turnaround Station</td>
<td>63</td>
</tr>
<tr>
<td>5.3</td>
<td>Terminal Operations - En Route Station</td>
<td>67</td>
</tr>
<tr>
<td>5.4</td>
<td>Ground Servicing Connections</td>
<td>68</td>
</tr>
<tr>
<td>5.5</td>
<td>Engine Start Pneumatic Requirements</td>
<td>72</td>
</tr>
<tr>
<td>5.6</td>
<td>Ground Pneumatic Power Requirements - Heating/Cooling</td>
<td>75</td>
</tr>
<tr>
<td>5.7</td>
<td>Conditioned Air Flow Requirements</td>
<td>76</td>
</tr>
<tr>
<td>5.8</td>
<td>Ground Towing Requirements</td>
<td>77</td>
</tr>
<tr>
<td>6.0</td>
<td>JET ENGINE WAKE AND NOISE DATA</td>
<td>79</td>
</tr>
<tr>
<td>6.1</td>
<td>Jet Engine Exhaust Velocities and Temperatures</td>
<td>80</td>
</tr>
<tr>
<td>6.2</td>
<td>Airport and Community Noise</td>
<td>88</td>
</tr>
</tbody>
</table>
## TABLE OF CONTENTS (CONTINUED)

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0</td>
<td>PAVEMENT DATA</td>
<td>91</td>
</tr>
<tr>
<td>7.1</td>
<td>General Information</td>
<td>92</td>
</tr>
<tr>
<td>7.2</td>
<td>Landing Gear Footprint</td>
<td>95</td>
</tr>
<tr>
<td>7.3</td>
<td>Maximum Pavement Loads</td>
<td>96</td>
</tr>
<tr>
<td>7.4</td>
<td>Landing Gear Loading on Pavement</td>
<td>97</td>
</tr>
<tr>
<td>7.5</td>
<td>Flexible Pavement Requirements - U.S. Army Corps of</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Engineers Method (S-77-1) and FAA Design Method</td>
<td></td>
</tr>
<tr>
<td>7.6</td>
<td>Flexible Pavement Requirements - LCN Conversion</td>
<td>103</td>
</tr>
<tr>
<td>7.7</td>
<td>Rigid Pavement Requirements - Portland Cement</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>Association Design Method</td>
<td></td>
</tr>
<tr>
<td>7.8</td>
<td>Rigid Pavement Requirements - LCN Conversion</td>
<td>109</td>
</tr>
<tr>
<td>7.9</td>
<td>Rigid Pavement Requirements - FAA Design Method</td>
<td>113</td>
</tr>
<tr>
<td>7.10</td>
<td>ACN/PCN Reporting System: Flexible and Rigid Pavements</td>
<td>114</td>
</tr>
<tr>
<td>7.11</td>
<td>Nose Gear Tethering (Optional)</td>
<td>119</td>
</tr>
<tr>
<td>8.0</td>
<td>FUTURE 747-8 DERIVATIVE AIRPLANES</td>
<td>121</td>
</tr>
<tr>
<td>9.0</td>
<td>SCALED DRAWINGS</td>
<td>123</td>
</tr>
<tr>
<td>9.1</td>
<td>Scaled Drawings - 747-8, 747-8F</td>
<td>125</td>
</tr>
</tbody>
</table>
1.0 SCOPE AND INTRODUCTION

1.1 Scope

1.2 Introduction

1.3 A Brief Description of the 747-8
1.0 SCOPE AND INTRODUCTION

1.1 Scope

This document provides, in a standardized format, airplane characteristics data for general airport planning. Since operational practices vary among airlines, specific data should be coordinated with the using airlines prior to facility design. Boeing Commercial Airplanes should be contacted for any additional information required.

Content of the document reflects the results of a coordinated effort by representatives from the following organizations:

- Aerospace Industries Association
- Airports Council International – North America
- International Industry Working Group
- International Air Transport Association

The airport planner may also want to consider the information presented in the "Commercial Aircraft Design Characteristics - Trends and Growth Projections," for long range planning needs and can be accessed via the following website:

http://www.boeing.com/airports

The document is updated periodically and represents the coordinated efforts of the following organizations regarding future aircraft growth trends.

- International Civil Aviation Organization
- International Coordinating Council of Aerospace Industries Associations
- Airports Council International – North America and World Organizations
- International Industry Working Group
- International Air Transport Association
1.2 Introduction

This document conforms to NAS 3601. It provides characteristics of the Boeing Model 747-8F (Freighter) and 747-8 (Intercontinental passenger) airplanes for airport planners, operators, airlines, architectural and engineering consultant organizations, and other interested industry agencies. Airplane changes and available options may alter model characteristics. The data presented herein reflects the certificated versions of the 747-8F and 747-8. The data will reflect typical airplanes in each model category. Data used is generic in scope and not customer-specific. The 747-8 series is an FAA Airplane Design Group VI and an ICAO Aerodrome Reference Code 4F category aircraft.

For additional information contact:

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Seattle, Washington 98124-2207
U.S.A.

Attention: Manager, Airport Technology
Mail Code 20-93
Email: AirportTechnology@boeing.com
Fax: 206-662-0280
1.3 A Brief Description of the 747-8

The 747-8 is the latest derivative of the 747 family of airplanes and is offered in both Freighter and Passenger versions. The 747-8 is externally similar to the 747-400 with a higher gross weight, longer fuselage and increased wingspan. The 747-8 Freighter retains the 747-400F nose cargo door, continuing the capability to easily load outsized cargo. The 747-8 has new high bypass ratio engines, GEnx 2B, which are the quiet and efficient GEnx engines developed for the 787 aircraft. The 747-8 has a cruise speed of Mach 0.845 for the Freighter and Mach 0.855 for the Intercontinental, which are increased speeds from the 747-400 series, due to changes in the wing, the new raked wingtips, and the GEnx engines. The 747-8F entered revenue service in October 2011. The 747-8 entered revenue service in 2012.

Other characteristics unique to the 747-8 compared to the 747-400 include:

- Next generation advanced alloys
- New wing design, including new airfoils and raked wingtips replacing the winglets
- GEnx-2B67 engines, including light weight composite fan case and fan blades, modified to provide current 747-8 bleed requirements
- Improved flight deck while preserving 747-400 operational commonality
- New interior architecture to enhance passenger experience
- Improved aerodynamic efficiency and reduced seat-mile cost (Passenger variant) and reduced ton-mile cost (Freighter variant)
2.0  AIRPLANE DESCRIPTION

2.1  General Characteristics
2.2  General Dimensions
2.3  Ground Clearances
2.4  Interior Arrangements
2.5  Cabin Cross Sections
2.6  Lower Cargo Compartments
2.7  Door Clearances
2.0 AIRPLANE DESCRIPTION

2.1 General Characteristics

**Maximum Design Taxi Weight (MTW).** Maximum weight for ground maneuver as limited by aircraft strength and airworthiness requirements. (It includes weight of taxi and run-up fuel.)

**Maximum Design Takeoff Weight (MTOW).** Maximum weight for takeoff as limited by aircraft strength and airworthiness requirements. (This is the maximum weight at start of the takeoff run.)

**Maximum Design Landing Weight (MLW).** Maximum weight for landing as limited by aircraft strength and airworthiness requirements.

**Maximum Design Zero Fuel Weight (MZFW).** Maximum weight allowed before usable fuel and other specified usable agents must be loaded in defined sections of the aircraft as limited by strength and airworthiness requirements.

**Operating Empty Weight (OEW).** Weight of structure, powerplant, furnishing systems, unusable fuel and other unusable propulsion agents, and other items of equipment that are considered an integral part of a particular airplane configuration. Also included are certain standard items, personnel, equipment, and supplies necessary for full operations, excluding usable fuel and payload.

**Maximum Payload.** Maximum design zero fuel weight minus operational empty weight.

**Maximum Seating Capacity.** The maximum number of passengers specifically certificated or anticipated for certification.

**Maximum Cargo Volume.** The maximum space available for cargo.

**Usable Fuel.** Fuel available for aircraft propulsion.
<table>
<thead>
<tr>
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<td>CUBIC METERS</td>
<td>693</td>
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</tr>
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<td>CUBIC METERS</td>
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NOTES:

1. ESTIMATED WEIGHTS FOR ENGINE/AIRFRAME CONFIGURATION SHOWN. OPERATING EMPTY WEIGHT REFLECTS STANDARD ITEM ALLOWANCES. ACTUAL OEW AND PAYLOAD WILL VARY WITH AIRPLANE AND AIRLINE CONFIGURATION. CONSULT USING AIRLINE FOR VALUES.

2. 747-8F IS NOT DESIGNED WITH TAIL FUEL TANKS

2.1.1 GENERAL CHARACTERISTICS

MODEL 747-8F
<table>
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<th>747-8</th>
</tr>
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NOTES:

1. ESTIMATED WEIGHTS FOR ENGINE/AIRFRAME CONFIGURATION SHOWN. OPERATING EMPTY WEIGHT REFLECTS STANDARD ITEM ALLOWANCES. ACTUAL OEW AND PAYLOAD WILL VARY WITH AIRPLANE AND AIRLINE CONFIGURATION. CONSULT USING AIRLINE FOR VALUES.

2. VALUE INCLUDES TAIL FUEL TANK VOLUME.

2.1.2 GENERAL CHARACTERISTICS
MODEL 747-8
2.2.1 GENERAL DIMENSIONS

MODEL 747-8F
2.2.2 GENERAL DIMENSIONS

MODEL 747-8
### MINIMUM | MAXIMUM
---|---
A | 38 - 8 | 11.79 | 40 - 3 | 12.24
B | 15 - 7 | 4.75 | 17 - 2 | 5.24
C | 15 - 8 | 4.78 | 17 - 1 | 5.19
D | 9 - 0 | 2.75 | 10 - 4 | 3.14
E | 5 - 9 | 1.75 | 6 - 8 | 2.04
F | 9 - 6 | 2.90 | 10 - 7 | 3.21
G | 10 - 1 | 3.07 | 11 - 3 | 3.42
K | 62 - 3 | 18.97 | 64 - 2 | 19.56
L | 28 - 2 | 8.58 | 30 - 1 | 9.16
M | 21 - 5 | 6.52 | 22 - 5 | 6.48
N | 6 - 3 | 1.90 | 6 - 11 | 2.10
P | 2 - 5 | 0.73 | 3 - 3 | 0.99
U | 16 - 3 | 4.95 | 17 - 3 | 5.25

NOTES: VERTICAL CLEARANCES SHOWN OCCUR DURING MAXIMUM VARIATIONS OF AIRPLANE ATTITUDE. COMBINATIONS OF AIRPLANE LOADING/UNLOADING ACTIVITIES THAT PRODUCE THE GREATEST POSSIBLE VARIATIONS OF ATTITUDE WERE USED TO ESTABLISH THE VARIATIONS SHOWN. DURING ROUTINE SERVICING, THE AIRPLANE REMAINS RELATIVELY STABLE; PITCH AND ELEVATION CHANGES OCCUR SLOWLY.

A GSE TETHERING DEVICE MAY BE USED TO MAINTAIN STABILITY BETWEEN THE MAIN DECK DOOR SILL AND THE LOADING DOCK. CARGO BRIDGE ATTACHMENT FITTINGS LOCATED ON THE NOSE DOOR SILL AT THE FORWARD EDGE OF THE MAIN CARGO DOOR DECK MAY BE USED FOR NOSE DOOR SILL STABILIZATION.

### 2.3.1 GROUND CLEARANCES

*MODEL 747-8F*
### Minimum and Maximum Clearances

<table>
<thead>
<tr>
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<td>M</td>
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<td>22-4</td>
</tr>
<tr>
<td>N</td>
<td>6-3</td>
<td>6-10</td>
</tr>
<tr>
<td>P</td>
<td>2-5</td>
<td>3-2</td>
</tr>
<tr>
<td>S</td>
<td>16-0</td>
<td>16-10</td>
</tr>
<tr>
<td>T</td>
<td>16-3</td>
<td>17-1</td>
</tr>
<tr>
<td>V</td>
<td>16-2</td>
<td>16-9</td>
</tr>
</tbody>
</table>

### Notes

Vertical clearances shown occur during maximum variations of airplane attitude. Combinations of airplane loading/unloading activities that produce the greatest possible variations of attitude were used to establish the variations shown. During routine servicing, the airplane remains relatively stable; pitch and elevation changes occur slowly.

---

### 2.3.2 Ground Clearances

**Model 747-8**
2.4.1 TYPICAL INTERIOR ARRANGEMENTS, THREE CLASS, 467 PASSENGERS

MODEL 747-8
2.4.3 TYPICAL INTERIOR ARRANGEMENTS – MAIN DECK CARGO

MODEL 747-8F

Main deck

Forward lower hold

Aft lower hold

- (27) 96-in x 125-in x 10-ft contoured pallets
- (5) 96-in x 125-in x 8-ft contoured pallets
- (2) 96-in x 125-in x 8-ft contoured pallets
- (12) 96-in x 125-in contoured pallets
- (2) LD-1 containers
2.5.1 CABIN CROSS-SECTIONS

MODEL 747-8

21 FT 4 IN (6.50 M)
(CONSTANT CABIN CROSS-SECTION)
BUSINESS CLASS UPPER DECK - 4-ABREAST
MAIN DECK FIRST CLASS - 6-ABREAST
2.5.2 CABIN CROSS-SECTIONS
MODEL 747-8
2.5.3 CABIN CROSS-SECTIONS

MODEL 747-8
2.6 LOWER CARGO COMPARTMENTS - CONTAINERS AND BULK CARGO

MODEL 747-8, 747-8F

<table>
<thead>
<tr>
<th>CONTAINER DATA</th>
<th>HALF-WIDTH</th>
<th>FULL-WIDTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERNAL VOLUME PER CONTAINER</td>
<td>173 CU FT</td>
<td>350 CU FT</td>
</tr>
<tr>
<td>4.9 CU M</td>
<td>9.9 CU M</td>
<td></td>
</tr>
<tr>
<td>TARE WEIGHT</td>
<td>270 LB</td>
<td>470 LB</td>
</tr>
<tr>
<td>123 KG</td>
<td>213 KG</td>
<td></td>
</tr>
<tr>
<td>MAXIMUM CARGO WEIGHT PER CONTAINER</td>
<td>3,230 LB</td>
<td>6,530 LB</td>
</tr>
<tr>
<td>1,465 KG</td>
<td>2,962 KG</td>
<td></td>
</tr>
<tr>
<td>MAXIMUM GROSS WEIGHT PER CONTAINER</td>
<td>3,500 LB</td>
<td>7,000 LB</td>
</tr>
<tr>
<td>1,588 KG</td>
<td>3,175 KG</td>
<td></td>
</tr>
<tr>
<td>TOTAL VOLUME OF 12 FULL-WIDTH PLUS 2 HALF-WIDTH CONTAINERS IS 4,546 CU FT (129 CU M)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GROSS WEIGHT FOR 12 FULL-WIDTH PLUS 2 HALF-WIDTH CONTAINERS IS 91,000 LB (41,277 KG)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. CONTAINER WEIGHT AND DATA ARE TYPICAL. CONSULT USING AIRLINE FOR SPECIFIC DATA.
2. OPTIONS ARE OFFERED FOR CARRIAGE OF CERTAIN STANDARD MILITARY AND COMMERCIAL PALLETS IN CONTAINER COMPARTMENTS.
2.7.1 DOOR CLEARANCES - MAIN ENTRY DOOR LOCATIONS

**NOTES:**

1. PASSENGER DOOR – LEFT SIDE ONLY FOR THE 747-8 FREIGHTER
2. 10 PASSENGER DOORS – 5 EACH SIDE FOR THE 747-8 INTERCONTINENTAL
3. DOOR OPENING SIZE = 42 BY 76 IN (1.07 BY 1.93 M)
4. OVERALL DOOR SIZE = 47 BY 76 IN (1.19 BY 1.93 M)
5. SEE SECTION 2.3 FOR DOOR SILL HEIGHTS

**MODEL 747-8, 747-8F**
2.7.2 DOOR CLEARANCES - MAIN ENTRY DOORS 1-4

MODEL 747-8, 747-8F

<table>
<thead>
<tr>
<th>DOOR NUMBER</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7 FT 6 IN</td>
<td>7 FT 6 IN</td>
<td>7 FT 6 IN</td>
<td>7 FT 6 IN</td>
</tr>
<tr>
<td></td>
<td>2.29 M</td>
<td>2.29 M</td>
<td>2.29 M</td>
<td>2.29 M</td>
</tr>
<tr>
<td>B</td>
<td>3 FT 9 IN</td>
<td>4 FT 0 IN</td>
<td>3 FT 8 IN</td>
<td>3 FT 6 IN</td>
</tr>
<tr>
<td></td>
<td>1.14 M</td>
<td>1.22 M</td>
<td>1.12 M</td>
<td>1.12 M</td>
</tr>
<tr>
<td>C</td>
<td>0.71 M</td>
<td>0.13 M</td>
<td>0.10 M</td>
<td>0.10 M</td>
</tr>
<tr>
<td>D</td>
<td>1 IN</td>
<td>1 IN</td>
<td>1 IN</td>
<td>1 IN</td>
</tr>
<tr>
<td>E</td>
<td>0.03 M</td>
<td>0.03 M</td>
<td>0.03 M</td>
<td>0.03 M</td>
</tr>
<tr>
<td>F</td>
<td>2 IN</td>
<td>2 IN</td>
<td>1 IN</td>
<td>1 IN</td>
</tr>
<tr>
<td>G</td>
<td>1 FT 7 IN</td>
<td>1 FT 7 IN</td>
<td>1 FT 10 IN</td>
<td>1 FT 10 IN</td>
</tr>
<tr>
<td></td>
<td>0.48 M</td>
<td>0.48 M</td>
<td>0.55 M</td>
<td>0.55 M</td>
</tr>
<tr>
<td>H</td>
<td>1 FT 11 IN</td>
<td>1 FT 11 IN</td>
<td>2 FT 0 IN</td>
<td>2 FT 1 IN</td>
</tr>
<tr>
<td></td>
<td>0.58 M</td>
<td>0.58 M</td>
<td>0.61 M</td>
<td>0.61 M</td>
</tr>
<tr>
<td>I</td>
<td>1 IN</td>
<td>3 IN</td>
<td>0</td>
<td>3 IN</td>
</tr>
<tr>
<td></td>
<td>0.03 M</td>
<td>0.08 M</td>
<td>0</td>
<td>0.08 M</td>
</tr>
<tr>
<td>J</td>
<td>9 FT 6 IN</td>
<td>10 FT 5 IN</td>
<td>10 FT 8 IN</td>
<td>10 FT 5 IN</td>
</tr>
<tr>
<td></td>
<td>2.80 M</td>
<td>3.18 M</td>
<td>3.25 M</td>
<td>3.18 M</td>
</tr>
</tbody>
</table>

1. MEASURED AT DOOR OPENING CENTERLINE AT DOOR SILL LEVEL.
2. LH SIDE ONLY ON 747-8F.
3. SEE SEC. 2.3 FOR DOOR SILL HEIGHTS.
2.7.3 DOOR CLEARANCES - MAIN ENTRY DOOR 5

MODEL 747-8

1. MEASURED AT DOOR OPENING CENTERLINE AT DOOR SILL LEVEL AT 90° FROM AIRPLANE CENTERLINE
2. DOOR HINGE IS INCLINED 3 DEGREES FROM VERTICAL
3. SEE SEC. 2.3 FOR DOOR SILL HEIGHTS
2.7.4 DOOR CLEARANCES – LOWER FORWARD CARGO COMPARTMENT

MODEL 747-8, 747-8F

SEE SECTION 2.3 FOR DOOR SILL HEIGHTS
2.7.5 DOOR CLEARANCES – LOWER AFT CARGO COMPARTMENT

MODEL 747-8, 747-8F
2.7.6 DOOR CLEARANCES - BULK CARGO COMPARTMENT

MODEL 747-8

SEE SECTION 2.3 FOR DOOR SILL HEIGHTS
2.7.7 DOOR CLEARANCES – MAIN DECK CARGO DOOR

MODEL 747-8F

① SEE SECTION 2.3 FOR DOOR SILL HEIGHTS
2.7.8 DOOR CLEARANCES - NOSE CARGO DOOR

MODEL 747-8F
3.0  AIRPLANE PERFORMANCE

3.1  General Information

3.2  Payload/Range

3.3  FAA/EASA Takeoff Runway Length Requirements

3.4  FAA/EASA Landing Runway Length Requirements
3.0 AIRPLANE PERFORMANCE

3.1 General Information

The graphs in Section 3.2 provide information on payload-range capability of the 747-8 airplane. To use these graphs; if the trip range and zero fuel weight (OEW + payload) are known, the approximate takeoff weight can be found; limited by maximum zero fuel weight, maximum design takeoff weight, or fuel capacity.

The graphs in Section 3.3 provide information on FAA/EASA takeoff runway length requirements with typical engines and various conditions. Maximum takeoff weights shown on the graphs are the heaviest for the particular airplane models with the corresponding engines. Standard day temperatures for pressure altitudes shown on the FAA/EASA takeoff graphs are given below:

<table>
<thead>
<tr>
<th>PRESSURE ALTITUDE</th>
<th>STANDARD DAY TEMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEET METERS</td>
<td>°F</td>
</tr>
<tr>
<td>0 0</td>
<td>59.0</td>
</tr>
<tr>
<td>2,000 610</td>
<td>51.9</td>
</tr>
<tr>
<td>4,000 1,219</td>
<td>44.7</td>
</tr>
<tr>
<td>6,000 1,829</td>
<td>37.6</td>
</tr>
<tr>
<td>8,000 2,438</td>
<td>30.5</td>
</tr>
<tr>
<td>10,000 3,048</td>
<td>23.3</td>
</tr>
<tr>
<td>12,000 3,658</td>
<td>16.2</td>
</tr>
<tr>
<td>14,000 4,267</td>
<td>9.1</td>
</tr>
</tbody>
</table>

The graphs in Section 3.4 provide information on landing runway length requirements for different airplane weights and airport altitudes. The maximum landing weights shown are the heaviest for the particular airplane model.
3.2.1 Payload/Range

MODEL 747-8F

STANDARD DAY, ZERO WIND
MACH 0.845 CRUISE
STEP CLIMB AT 2000 FT INCREMENTS
NORMAL POWER EXTRACTION AND AIR CONDITIONING BLEED
TYPICAL MISSION RULES

Payload / Range

747-8F

MAX ZERO FUEL WEIGHT = 727000 LB (329762 KG)

CONSULT USING AIRLINE FOR SPECIFIC OPERATING
PROCEDURE AND OEW PRIOR TO FACILITY DESIGN
DO NOT USE FOR DISPATCH

Payload / Range

747-8

STANDARD DAY, ZERO WIND
MACH 0.855 CRUISE
STEP CLIMB AT 2000 FT INCREMENTS
NORMAL POWER EXTRACTION AND AIR CONDITIONING BLEED
TYPICAL MISSION RULES

CONSULT USING AIRLINE FOR SPECIFIC OPERATING
PROCEDURE AND OEW PRIOR TO FACILITY DESIGN

MAX ZERO FUEL WEIGHT = 651000 LB (295289 KG)

GEN PLUS PAYLOAD
(1000 LB)

660 (299)
650 (295)
700 (318)
730 (340)
800 (362)
850 (386)
900 (411)
950 (446)
987 (448)

FUEL CAPACITY
123538 (565)

RANGE (1000 NAUTICAL MILES)

0 1 2 3 4 5 6 7 8 9 10

480 500 520 540 560 580 600 620 640 660 680
3.3.1 FAA/EASA TAKEOFF RUNWAY LENGTH REQUIREMENTS - STANDARD DAY

MODEL 747-8F

DO NOT USE FOR DISPATCH

CONSULT USING AIRLINE FOR SPECIFIC OPERATING PROCEDURE PRIOR TO FACILITY DESIGN

TIRE SPEED LIMIT 235 MPH (376 KMPH)

PRESSURE ALTITUDE
FEET (METERS)
10000 (3000)
9000 (2700)
8000 (2400)
7000 (2100)
6000 (1820)
5000 (1500)
4000 (1210)
3000 (910)
2000 (610)
SEA LEVEL

ENERGY LIMIT
FLAPS 30
BRAKE

TAKEOFF FIELD LENGTH
(1000 METERS)

TAKEOFF FIELD LENGTH
(1000 FT)

(1000 LB)

OPERATIONAL TAKEOFF WEIGHT (1000 KG)
3.3.2 FAA/EASA TAKEOFF RUNWAY LENGTH REQUIREMENTS - STANDARD DAY +27°F (STD + 15°C)

MODEL 747-8F

STANDARD DAY +15°C
(STD + 27°F)

DO NOT USE FOR DISPATCH

Consult using airline for specific operating procedure prior to facility design.

Takeoff Runway Length Requirements 747-8F
3.3.3 FAA/EASA TAKEOFF RUNWAY LENGTH REQUIREMENTS -
STANDARD DAY +25°C
(STD + 45°F)
3.4 FAA/EASA TAKEOFF RUNWAY LENGTH REQUIREMENTS – STANDARD DAY + 63°F (STD + 35°C)

STANDARD DAY +35°C (STD + 63°F)

MODEL 747-8F

TAKEOFF FIELD LENGTH (1000 METERS)

TIRE SPEED LIMIT: 235 MPH (376 KMPH)

BRAKE ENERGY LIMIT

FLAPS 10

FLAPS 20

PRESSURE ALTITUDE

FEET (METERS)

10000 (3048)
8000 (2438)
6000 (1829)
4000 (1219)
2000 (610)
SEA LEVEL

TEMPERATURE

CELSIUS

34.2
38.1
42.1
46.0
50.0

TAKEOFF WEIGHT (1000 LB)

OPERATIONAL TAKEOFF WEIGHT (1000 KG)

500 550 600 650 700 750 800 850 900 950 1000

240 260 280 300 320 340 360 380 400 420 440

DO NOT USE FOR DISPATCH

CONSULT USING AIRLINE FOR SPECIFIC OPERATING PROCEDURE PRIOR TO FACILITY DESIGN

ZERO RUNWAY GRADIENT
ZERO WIND
DRY RUNWAY
AIR CONDITIONING OFF
FORWARD CG LIMIT

DECEMBER 2012 REV B

D6-S83-26-3

REV B
3.3.5 FAA/EASA TAKEOFF RUNWAY LENGTH REQUIREMENTS - STANDARD DAY

MODEL 747-8

DO NOT USE FOR DISPATCH

Takeoff Runway Length Requirements
747-8

CONSULT USING AIRLINE FOR SPECIFIC OPERATING PROCEDURE PRIOR TO FACILITY DESIGN

ZERO RUNWAY GRADIENT
ZERO WIND
DRY RUNWAY
AIR CONDITIONING OFF
FORWARD CG LIMIT

STANDARD DAY

TIRE SPEED LIMIT 235 MPH (374 KMPH)

ENERGY LIMIT

PRESSURE ALTITUDE
FET (METERS)
10000 (32810)
8000 (24380)
6000 (18288)
4000 (12192)
2000 (6096)
SEA LEVEL

30
60
90
120
150

OPERATIONAL TAKEOFF WEIGHT (1000 KG)

500 550 600 650 700 750 800 850 900 950 1000

TAKEOFF FIELD LENGTH (1000 METERS)

4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

TAKEOFF WEIGHT (1000 LB)

240 260 280 300 320 340 360 380 400 420 440
Takeoff Runway Length Requirements

747-8

STANDARD DAY +35°C
(STD + 63°F)

DO NOT USE FOR DISPATCH

CONSULT USING AIRLINE FOR SPECIFIC OPERATING PROCEDURE PRIOR TO FACILITY DESIGN

3.3.8 FAA/EASA TAKEOFF RUNWAY LENGTH REQUIREMENTS – STANDARD DAY +63°F (STD + 35°C)

MODEL 747-8

ZERO RUNWAY GRADIENT
ZERO WIND
DRY RUNWAY
AIR CONDITIONING OFF
FORWARD CG LIMIT

TIRE SPEED LIMIT 235 MPH (376 KMPH)

BRAKE ENERGY LIMIT

FLAPS 10

FLAPS 20

PRESSURE ALTITUDE

FEET (METERS)

10000 (3048)
6000 (1828)
4000 (1219)
2000 (610)
SEA LEVEL

TEMPERATURE

Celsius

30.2
34.2
38.1
42.1
46.0
50.0

OPERATIONAL TAKEOFF WEIGHT (1000 KG)

240 260 280 300 320 340 360 380 400 420 440

(1000 FT)

TAKEOFF FIELD LENGTH

(1000 METERS)

4 6 8 10 12 14 16

TAKEOFF FIELD LENGTH REQUIREMENTS – STANDARD DAY +63°F (STD + 35°C)
3.4.1 FAA/EASA Landing Runway Length Requirements - Flaps 30

Model 747-8F and 747-8
3.4.2 FAA/EASA LANDING RUNWAY LENGTH REQUIREMENTS - FLAPS 25

MODEL 747-8F AND 747-8
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 747-8 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 747-8 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 747-8 is expected to follow the same maneuvering characteristics.
4.1.1 GENERAL INFORMATION – BODY GEAR STEERING SYSTEM

MODEL 747-8, 747-8F

NOSE GEAR/BODY GEAR TURN RATIOS
NOTES: DATA SHOWN FOR AIRPLANE WITH BODY GEAR STEERING
ACTUAL OPERATING TURNING RADI May BE GREATER THAN SHOWN
CONSULT WITH AIRLINE FOR SPECIFIC OPERATING PROCEDURE
DIMENSIONS ROUNDED TO NEAREST FOOT AND 0.1 METER

<table>
<thead>
<tr>
<th>STEERING ANGLE</th>
<th>R1 INNER GEAR</th>
<th>R2 OUTER GEAR</th>
<th>R3 NOSE GEAR</th>
<th>R4 WINGTIP</th>
<th>R5 NOSE</th>
<th>R6 TAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DEG)</td>
<td>FT</td>
<td>M</td>
<td>FT</td>
<td>M</td>
<td>FT</td>
<td>M</td>
</tr>
<tr>
<td>30</td>
<td>139</td>
<td>42.4</td>
<td>181</td>
<td>55.2</td>
<td>188</td>
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<td>35</td>
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<td>89</td>
<td>27.1</td>
<td>131</td>
<td>39.9</td>
<td>147</td>
<td>44.8</td>
</tr>
<tr>
<td>45</td>
<td>72</td>
<td>21.9</td>
<td>113</td>
<td>34.4</td>
<td>134</td>
<td>40.8</td>
</tr>
<tr>
<td>50</td>
<td>57</td>
<td>17.4</td>
<td>98</td>
<td>29.9</td>
<td>124</td>
<td>37.8</td>
</tr>
<tr>
<td>55</td>
<td>44</td>
<td>13.4</td>
<td>86</td>
<td>26.2</td>
<td>116</td>
<td>35.4</td>
</tr>
<tr>
<td>60</td>
<td>33</td>
<td>10.1</td>
<td>74</td>
<td>22.6</td>
<td>110</td>
<td>33.5</td>
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<td>65</td>
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<td>6.7</td>
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<td>70 (MAX)</td>
<td>13</td>
<td>4.0</td>
<td>55</td>
<td>16.8</td>
<td>101</td>
<td>30.8</td>
</tr>
</tbody>
</table>

4.2.1 TURNING RADI – NO SLIP ANGLE – WITH BODY GEAR STEERING
MODEL 747-8, 747-8F
NOTES: DATA SHOWN FOR AIRPLANE WITH BODY GEAR STEERING INOPERATIVE
ACTUAL OPERATING TURNING RADIUS MAY BE GREATER THAN SHOWN
CONSULT WITH AIRLINE FOR SPECIFIC OPERATING PROCEDURE
DIMENSIONS ROUNDED TO NEAREST FOOT AND 0.1 METER

<table>
<thead>
<tr>
<th>STEERING ANGLE (DEG)</th>
<th>R1 INNER GEAR</th>
<th>R2 OUTER GEAR</th>
<th>R3 NOSE GEAR</th>
<th>R4 WINGTIP</th>
<th>R5 NOSE</th>
<th>R6 TAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FT</td>
<td>M</td>
<td>FT</td>
<td>M</td>
<td>FT</td>
<td>M</td>
</tr>
<tr>
<td>30</td>
<td>148</td>
<td>45.1</td>
<td>190</td>
<td>57.9</td>
<td>198</td>
<td>60.4</td>
</tr>
<tr>
<td>35</td>
<td>118</td>
<td>36.0</td>
<td>160</td>
<td>48.8</td>
<td>173</td>
<td>52.7</td>
</tr>
<tr>
<td>40</td>
<td>95</td>
<td>29.0</td>
<td>137</td>
<td>41.8</td>
<td>155</td>
<td>47.2</td>
</tr>
<tr>
<td>45</td>
<td>77</td>
<td>23.5</td>
<td>118</td>
<td>36.0</td>
<td>141</td>
<td>43.0</td>
</tr>
<tr>
<td>50</td>
<td>61</td>
<td>18.6</td>
<td>103</td>
<td>31.4</td>
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<td>39.6</td>
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<td>14.3</td>
<td>89</td>
<td>27.1</td>
<td>122</td>
<td>37.2</td>
</tr>
<tr>
<td>60</td>
<td>36</td>
<td>11.0</td>
<td>77</td>
<td>23.5</td>
<td>116</td>
<td>35.4</td>
</tr>
<tr>
<td>65</td>
<td>25</td>
<td>7.6</td>
<td>66</td>
<td>20.1</td>
<td>111</td>
<td>33.8</td>
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<td>70 (MAX)</td>
<td>15</td>
<td>4.6</td>
<td>57</td>
<td>17.4</td>
<td>107</td>
<td>32.6</td>
</tr>
</tbody>
</table>

4.2.2 TURNING RADIUS – NO SLIP ANGLE – BODY GEAR STEERING INOPERATIVE
MODEL 747-8, 747-8F
Notes:

- 6° Tire Slip Angle – Approximate Only For 70° Maximum Turn Angle
- Consult Airline For Actual Operating Data.

<table>
<thead>
<tr>
<th>AIRPLANE MODEL</th>
<th>EFFECTIVE TURNING ANGLE (DEG)</th>
<th>X</th>
<th>Y</th>
<th>A</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
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<tr>
<td>747-8, 747-8F</td>
<td>64</td>
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<td>46</td>
<td>14.0</td>
<td>172</td>
<td>52.4</td>
<td>105</td>
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</tbody>
</table>

NOTE: DIMENSIONS ARE ROUNDED TO THE NEAREST FOOT AND 0.1 METER.
Notes:

- Body Gear Steering Inoperative Rarely Occurs. Data Provided As Reference Only
- 9° Tire Slip Angle – Approximate Only For 60° Turn Angle (Optimum Max Steering Angle)
- Consult Airline For Actual Operating Data.

<table>
<thead>
<tr>
<th>AIRPLANE MODEL</th>
<th>EFFECTIVE TURNING ANGLE (DEG)</th>
<th>X</th>
<th>Y</th>
<th>A</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
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<td>79</td>
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<td>228</td>
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<td>129</td>
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NOTE: DIMENSIONS ARE ROUNDED TO THE NEAREST FOOT AND 0.1 METER.

4.3.2 CLEARANCE RADIUS – BODY GEAR STEERING INOPERATIVE
MODEL 747-8, 747-8F
4.4 VISIBILITY FROM COCKPIT IN STATIC POSITION

MODEL 747-8, 747-8F

NOTES:
- VISUAL ANGLES THROUGH WINDSHIELD
- VISUAL ANGLES THROUGH SIDE WINDOW
- VISUAL ANGLES FROM NORMAL POSITION
- VISUAL ANGLES FROM ALERT POSITION. HEAD MOVED OUTBOARD 5 IN (0.13 M)
- VISUAL ANGLES WITH HEAD MOVED OUTBOARD 7 IN (0.18 M)
- HEAD IS ROTATED ABOUT A POINT 3 IN (0.08 M) AFT OF PILOT'S EYE POSITION
- AIRPLANE IN STATIC TAXI ATTITUDE
- APPROX 5 DEGREE NOSE-DOWN
- TIRES COMPRESSED (CALCULATED USING ROLLING RADIUS OF TIRES AND NORMAL STRUT COMPRESSION AT MTOW)
- GROUND DISTANCE
4.5.1 RUNWAY AND TAXIWAY TURNPATHS - RUNWAY-TO-TAXIWAY, 90 DEGREES, COCKPIT OVER CENTERLINE (FAA GROUP VI RADIUS/FILLET TO GROUP V TAXIWAY)

MODEL 747-8, 747-8F

Notes:
- Symmetrical Thrust
- 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.

75 FT (23 M)

FAA Lead-in to Fillet

36 FT (11 M)

170 FT (52 M)

85 FT (26 M)

150 FT (45 M)

Path of Outside Edge of Wing Gear Tires

Cockpit Over Centerline Steering
(Dimensions - Turn Radius and Fillet are FAA Group VI / Taxiway is FAA Group V)
4.5.2 RUNWAY AND TAXIWAY TURNPATHS - RUNWAY-TO-TAXIWAY, 90 DEGREES, COCKPIT OVER CENTERLINE (FAA GROUP VI RADIUS/FILLET TO GROUP VI TAXIWAY)

MODEL 747-8, 747-8F

Notes:
- Symmetrical Thrust
- 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.

Cockpit Over Centerline Steering
(Dimensions - Turn Radius and Fillet are FAA Group VI / Taxiway is FAA Group VI)
4.5.3 RUNWAY AND TAXIWAY TURNPATHS - RUNWAY-TO-TAXIWAY, 90 DEGREES,
JUDGMENTAL OVERSTEER (FAA GROUP V RADIUS/FILLET TO GROUP V TAXIWAY)
MODEL 747-8, 747-8F

Notes:
- Symmetrical Thrust
- 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.
4.5.4 RUNWAY AND TAXIWAY TURNPATHS - RUNWAY-TO-TAXIWAY, MORE THAN 90 DEGREES, COCKPIT OVER CENTERLINE (FAA GROUP VI RADIUS TO GROUP V TAXIWAY)

MODEL 747-8, 747-8F

52 DECEMBER 2012

Notes:
- Symmetrical Thrust
- 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.

Path of Outside Edge of Wing Gear Tires

Cockpit Over Centerline
(Dimensions - Turn Radius and Fillet are FAA Group VI / Taxiway is FAA Group V)
4.5.5 RUNWAY AND TAXIWAY TURNPATHS - RUNWAY-TO-TAXIWAY, MORE THAN 90 DEGREES, COCKPIT OVER CENTERLINE (FAA GROUP VI RADIUS TO GROUP VI TAXIWAY)

MODEL 747-8, 747-8F

Notes:
- Symmetrical Thrust
- 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.

Path of Outside Edge of Wing Gear Tires

FAA Lead-In to Fillet

Cockpit Over Centerline

(Dimensions - Turn Radius and Fillet are FAA Group VI / Taxiway is FAA Group VI)
4.5.6 RUNWAY AND TAXIWAY TURNPATHS - RUNWAY-TO-TAXIWAY, MORE THAN 90 DEGREES, JUDGMENTAL OVERSTEER (FAA GROUP V RADIUS TO GROUP V TAXIWAY)

MODEL 747-8, 747-8F

Notes:
- Symmetrical Thrust
- 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.

Judgmental Oversteer
(Dimensions - Turn Radius and Fillet are FAA Group V / Taxiway is FAA Group V)
4.5.7 RUNWAY AND TAXIWAY TURNPATHS - TAXIWAY -TO-TAXIWAY, 90 DEGREES, COCKPIT OVER CENTERLINE (FAA GROUP VI RADIUS TO GROUP V TAXIWAYS)

MODEL 747-8, 747-8F

Notes:
- Symmetrical Thrust
- 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.
4.5.8 RUNWAY AND TAXIWAY TURNPATHS - TAXIWAY TO TAXIWAY, 90 DEGREES, COCKPIT OVER CENTERLINE (FAA GROUP VI RADIUS TO GROUP VI TAXIWAYS)

MODEL 747-8, 747-8F

Notes:
- Symmetrical Thrust
- 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.

Cockpit Over Centerline Steering
(Dimensions - Turn Radius and Fillet are FAA Group VI / Taxiways are FAA Group VI)

(D6-58326-3) 56 DECEMBER 2012 REV B
4.5.9 RUNWAY AND TAXIWAY TURNPATHS - TAXIWAY -TO-TAXIWAY, 90 DEGREES, JUDGMENTAL OVERSTEER (FAA GROUP V RADIUS TO GROUP V TAXIWAY)

MODEL 747-8, 747-8F
4.6 RUNWAY HOLDING BAY
MODEL 747-8, 747-8F

NOTES:
* SYMMETRICAL THRUST
* 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.
5.0 TERMINAL SERVICING

5.1 Airplane Servicing Arrangement - Typical Turnaround
5.2 Terminal Operations - Turnaround Station
5.3 Terminal Operations - En Route Station
5.4 Ground Servicing Connections
5.5 Engine Starting Pneumatic Requirements
5.6 Ground Pneumatic Power Requirements
5.7 Conditioned Air Requirements
5.8 Ground Towing Requirements
5.0 TERMINAL SERVICING

During turnaround at the terminal, certain services must be performed on the aircraft, usually within a given time, to meet flight schedules. This section shows service vehicle arrangements, schedules, locations of service points, and typical service requirements. The data presented in this section reflect ideal conditions for a single airplane. Service requirements may vary according to airplane condition and airline procedure.

Section 5.1 shows typical arrangements of ground support equipment during turnaround. When the auxiliary power unit (APU) is used, the electrical, air start, and air-conditioning service vehicles may not be required. Passenger loading bridges or portable passenger stairs could be used to load or unload passengers.

Sections 5.2 and 5.3 show typical service times at the terminal. These charts give typical schedules for performing service on the airplane within a given time. Service times could be rearranged to suit availability of personnel, airplane configuration, and degree of service required.

Section 5.4 shows the locations of ground service connections in graphic and in tabular forms. Typical capacities and service requirements are shown in the tables. Services with requirements that vary with conditions are described in subsequent sections.

Section 5.5 shows typical sea level air pressure and flow requirements for starting different engines. The curves are based on an engine start time of 90 seconds.

Section 5.6 shows pneumatic requirements for heating and cooling (air conditioning) using high pressure air to run the air cycle machine. The curves show airflow requirements to heat or cool the airplane within a given time and ambient conditions. Maximum allowable pressure and temperature for air cycle machine operation are 60 psia and 450°F, respectively.

Section 5.7 shows pneumatic requirements for heating and cooling the airplane, using low pressure conditioned air. This conditioned air is supplied through an 8-in ground air connection (GAC) directly to the passenger cabin, bypassing the air cycle machines.

Section 5.8 shows ground towing requirements for various ground surface conditions.
5.1.1 AIRPLANE SERVICING ARRANGEMENT - TYPICAL TURNAROUND

MODEL 747-8
5.1.2 AIRPLANE SERVICING ARRANGEMENT - TYPICAL Turnaround

MODEL 747-8F
### 5.2.1 TERMINAL OPERATIONS - TURNAROUND STATION – ALL PASSENGER MODEL 747-8

#### 747-8 TURNTIME ANALYSIS
**467 PASSENGERS, 2 DOORS**
**100.5 MINUTES**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time (Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGINE SHUTDOWN/ CHECKS OFF</td>
<td>1.0</td>
</tr>
<tr>
<td>POSITION PAX BRIDGE AND DOOR OPEN</td>
<td>7.0</td>
</tr>
<tr>
<td>DEPLACE PASSENGERS</td>
<td>7.0</td>
</tr>
<tr>
<td>SERVICE CABIN</td>
<td>07.0</td>
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<tr>
<td>SERVICE FORWARD GALLEY</td>
<td>10.0</td>
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<tr>
<td>SERVICE MID AND UPPER GALLEY</td>
<td>07.0</td>
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<tr>
<td>SERVICE AFT GALLEY</td>
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<tr>
<td>BOARD PASSENGERS</td>
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<tr>
<td>REMOVE PAX BRIDGE AND CLOSE DOOR</td>
<td>1.0</td>
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<tr>
<td>UNLOAD FORWARD COMPARTMENT</td>
<td>22.0</td>
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<tr>
<td>UNLOAD AFT COMPARTMENT</td>
<td>16.0</td>
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<tr>
<td>UNLOAD AND LOAD BULK CARGO</td>
<td>04.5</td>
</tr>
<tr>
<td>LOAD FORWARD COMPARTMENT</td>
<td>22.0</td>
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<tr>
<td>LOAD AFT COMPARTMENT</td>
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<tr>
<td>FUEL AIRPLANE</td>
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<tr>
<td>SERVICE POTABLE WATER</td>
<td>14.0</td>
</tr>
<tr>
<td>SERVICE LAVATORIES</td>
<td>14.0</td>
</tr>
</tbody>
</table>

#### Parameters:
- 100% PASSENGER AND CARGO EXCHANGE
- 467 PASSENGERS, 3 CLASSES, 2 DOORS
- (1) LAVATORY SERVICE TRUCK
- (3) GALLEY SERVICE TRUCKS (84 CARTS)
- (2) LOWER LOBE CARGO LOADERS
- 59053 GALLONS (223540 LITERS) OF FUEL LOADED, 5000 GALLONS (18927 LITERS) RESERVE
- (4) NOZZLE HYDRANT, FUELING AT 50 PSIG
- CABIN SERVICE IS AVAILABLE TIME
- AFT LOWER LOBE - (16) CONTAINERS
- FORWARD LOWER LOBE - (22) CONTAINERS
5.2.2 TERMINAL OPERATIONS - TURNAROUND STATION - ALL CARGO, NOSE DOOR LOADING

MODEL 747-8F

747-8F TURNTIME ANALYSIS USING NOSE CARGO DOOR ONLY
91 MINUTES

PARAMETERS:
- 100% CARGO EXCHANGE
- MAIN DECK LOADED USING NOSE CARGO DOOR
- MAIN DECK CARGO - (34) 96'x125' PALLETS
- FORWARD LOWER LOBE - (7) 96'x125' PALLETS
- AFT LOWER LOBE - (5) 96'x125' PALLETS AND (2) ULDs
- 56,552 GALLONS (214,074 LITERS) FUEL LOADED,
  4200 GALLONS (15,899 LITERS) RESERVE
- (4) NOZZLE HYDRANT FUELING AT 50 PSIG
- (1) MAIN DECK CARGO LOADER
- (2) LOWER LOBE CARGO LOADERS
- (1) POTABLE WATER SERVICE TRUCK
- (1) LAVATORY SERVICE TRUCK
### 5.2.3 TERMINAL OPERATIONS - TURNAROUND STATION - ALL CARGO, SIDE DOOR LOADING

#### MODEL 747-8F

<table>
<thead>
<tr>
<th>CARGO HANDLING</th>
<th>TIME (MINUTES)</th>
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<td>ENGINE SHUTDOWN/ CHECKS ON</td>
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<tr>
<td>POSITION CREW STAIRS</td>
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<tr>
<td>POSITION SUPPORT STANCHION</td>
<td>3.0</td>
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<tr>
<td>OPEN DOOR AND POSITION LOADER</td>
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<tr>
<td>UNLOAD MAIN DECK</td>
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<tr>
<td>LOAD MAIN DECK</td>
<td>45.9</td>
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<tr>
<td>CLOSE DOOR AND REMOVE EQUIPMENT</td>
<td>3.0</td>
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<tr>
<td>REMOVE CREW STAIRS</td>
<td>1.0</td>
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<td>18.0</td>
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<tr>
<td>UNLOAD FORWARD COMPARTMENT</td>
<td>20.0</td>
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<tr>
<td>UNLOAD AND LOAD BULK CARGO</td>
<td>91.8</td>
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<td>LOAD FORWARD COMPARTMENT</td>
<td>20.0</td>
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<td>14.0</td>
</tr>
<tr>
<td>SERVICE LAVATORY</td>
<td>14.0</td>
</tr>
</tbody>
</table>

**747-8F TURNTIME ANALYSIS USING SIDE CARGO DOOR ONLY**

98 MINUTES

#### PARAMETERS:
- 100% CARGO EXCHANGE
- MAIN DECK LOADED USING SIDE CARGO DOOR
- MAIN DECK CARGO - (34) 96”x125” PALLETS
- FORWARD LOWER LOBE - (7) 96”x125” PALLETS
- AFT LOWER LOBE - (5) 96”x125” PALLETS AND (2) ULDs
- 56,553 GALLONS (214,876 LITERS) FUEL LOADED,
- 4,200 GALLONS (15,899 LITERS) RESERVE,
- (4) NOZZLE HYDRANT FUELING AT 50 PSIG
- (1) MAIN DECK CARGO LOADER
- (2) LOWER LOBE CARGO LOADERS
- (1) POTABLE WATER SERVICE TRUCK
- (1) LAVATORY SERVICE TRUCK
5.2.4 TERMINAL OPERATIONS – TURNAROUND STATION – ALL CARGO, NOSE AND SIDE DOOR LOADING

MODEL 747-8F

747-8F TURNAROUND ANALYSIS
USING NOSE AND SIDE CARGO DOORS
51 MINUTES

<table>
<thead>
<tr>
<th>Time (Minutes)</th>
<th>Position Equipment</th>
<th>Procedure Time</th>
<th>Critical Path</th>
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<td>CHECKS ON</td>
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<tr>
<td>1.0</td>
<td>POSITION CREW STAIRS</td>
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<tr>
<td>3.0</td>
<td>POSITION SUPPORT STANCHION</td>
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<td>OPEN DOORS AND POSITION LOADERS</td>
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<td>1.0</td>
<td>CLOSE DOOR AND REMOVE EQUIPMENT</td>
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<td>UNLOAD AND LOAD BULK CARGO</td>
<td>AVAILABLE TIME</td>
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<td>44.0</td>
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<td>0.0</td>
<td>CHECKS OFF/PUSH BACK</td>
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PARAMETERS:
- 100% CARGO EXCHANGE
- MAIN DECK LOADED USING NOSE AND SIDE CARGO DOORS
- MAIN DECK CARGO = (34) 96"x125" PALLETS
- FORWARD LOWER LOBE = (7) 96"x125" PALLETS
- AFT LOWER LOBE = (5) 96"x125" PALLETS AND (2) ULDs
- 56,553 GALLONS [214,076 LITERS] FUEL LOADED, (4) NOZZLE HYDRANT FUELING AT 50 PSIG
- (1) MAIN DECK CARGO LOADER
- (2) LOWER LOBE CARGO LOADERS
- (1) POTABLE WATER SERVICE TRUCK
- (1) LAVATORY SERVICE TRUCK
5.3.1 TERMINAL OPERATIONS - EN ROUTE STATION - ALL PASSENGER

MODEL 747-8

747-8 TURNTIME ANALYSIS
EN ROUTE, 50% PASSENGER EXCHANGE
40.5 MINUTES

PARAMETERS:
- 50% PASSENGER AND CARGO EXCHANGE
- 234 PASSENGERS EXCHANGED AT DOOR L1
- (2) GALLEY SERVICE TRUCKS (38 CARTS)
- (1) LOWER LOBE CARGO LOADER
- 20000 GALLONS (75708 LITERS) FUEL LOADED
- NOZZLE HYDRANT FUELING AT 50 PSIG
- CABIN SERVICE IS AVAILABLE TIME
- AFT LOWER LOBE - (8) CONTAINERS EXCHANGED
5.4.1 GROUND SERVICE CONNECTIONS

MODEL 747-8F
5.4.2 GROUND SERVICE CONNECTIONS

MODEL 747-8
<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>DISTANCE AFT OF NOSE</th>
<th>DISTANCE FROM AIRPLANE CENTERLINE</th>
<th>HEIGHT ABOVE GROUND</th>
<th>ELECTRICAL</th>
<th>TWO CO-LOCATED CONNECTORS - 90 KVA, 115/120 V AC 400 HZ, 3-PHASE EA.</th>
<th>FUEL</th>
<th>OUTBOARD UNDER-WING PRESSURE CONNECTORS (2 EACH WING)</th>
<th>INBOARD UNDER-WING PRESSURE CONNECTORS (2 EACH WING)</th>
<th>MAX FUELING RATE 500 US GPM (1,890 LPM) PER NOZZLE</th>
<th>TOTAL MAX FUEL PRESSURE 50 PSIG (3.52 KG/CM²)</th>
<th>FUELING CONTROL PANEL</th>
<th>WING FUEL VENT</th>
<th>TAIL FUEL VENT [1]</th>
</tr>
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<tbody>
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<td></td>
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<td>- 3 - 4 1.02</td>
<td>8 - 1 2.46</td>
<td>9 - 3 2.82</td>
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<td>15 - 4 4.67</td>
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<td>15 - 3 4.65</td>
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<td>117 - 3 35.74</td>
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<td>26 - 9 8.15</td>
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<td>1534 EACH</td>
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<td>64,352</td>
<td></td>
</tr>
<tr>
<td>HORIZONTAL STABILIZER</td>
<td>U.S. GALLONS</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>TOTAL USABLE</td>
<td>U.S. GALLONS</td>
<td>59,734</td>
<td>59,734</td>
<td>59,734</td>
<td>226,113</td>
<td>226,113</td>
<td>226,113</td>
<td>226,113</td>
<td>226,113</td>
<td>226,113</td>
<td>226,113</td>
<td>226,113</td>
<td></td>
</tr>
</tbody>
</table>

[1] PASSENGER AIRPLANE ONLY

5.4.3 GROUND SERVICE CONNECTIONS
MODEL 747-8, 747-8F

D6-58326-3
<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>DISTANCE AFT OF DISTANCE FROM AIRPLANE CENTERLINE</th>
<th>HEIGHT ABOVE GROUND</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOSE FT-IN</td>
<td>M</td>
</tr>
<tr>
<td>LAVATORY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ONE SERVICE PANEL:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THREE CONNECTIONS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRAIN: ONE 4-IN (10.0 CM)</td>
<td>178 – 4</td>
<td>54.37</td>
</tr>
<tr>
<td>FLUSH: TWO 1-IN (3.0 CM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLUSH REQS: FLOW: 10 GPM (38 LPM), 30 PSIG (2.11 KG/CM²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL CAPACITY, 4 TANKS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300 US GAL (1,135 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PNEUMATIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWO 3-IN (7.67 CM) HIGH-PRESSURE PORTS</td>
<td>109-10</td>
<td>33.48</td>
</tr>
<tr>
<td>TWO 8-IN (20 CM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GROUND CONDITIONED AIR CONNECTIONS</td>
<td>118 – 8</td>
<td>36.17</td>
</tr>
<tr>
<td>TANK CAPACITIES:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POTABLE WATER - ONE CONNECTION, SIZE 3/4 IN (1.90 CM), CAPACITY – 345 U.S. GAL (1,306 L), MAX FILL PRESSURE – 60 PSIG (414 kPa), TYPICAL FILL RATE – 30 GPM (114.5 LPM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRAIN SIZE 1 IN (2.54 CM) -8F - SECOND CONNECTION</td>
<td>145 - 6</td>
<td>44.35</td>
</tr>
<tr>
<td>HYDRAULIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ONE SERVICE PANEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 RESERVOIRS</td>
<td>127 - 4</td>
<td>38.82</td>
</tr>
<tr>
<td>ENG 1 - 9.5 U.S. GAL (35.9 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENG 2 - 5.5 U.S. GAL (20.8 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENG 3 - 5.5 U.S. GAL (20.8 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENG 4 - 9.5 U.S. GAL (35.9 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENG 7 - 7.5 U.S. GAL (28.9 L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 PSI (10.6 KG/CM²) MAX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OXYGEN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ONE CONNECTION - SIZE 3/16 IN (0.48 CM)</td>
<td>39 - 2</td>
<td>11.94</td>
</tr>
</tbody>
</table>

5.4.4 GROUND SERVICING CONNECTIONS
MODEL 747-8, 747-8F
5.5.1 ENGINE START PNEUMATIC REQUIREMENTS - SEA LEVEL

MODEL 747-8, 747-8F
5.5.2 ENGINE START PNEUMATIC REQUIREMENTS – 5,000 FT
MODEL 747-8, 747-8F
5.5.3 ENGINE START PNEUMATIC REQUIREMENTS – 10,000 FT
MODEL 747-8, 747-8F
5.6.1 GROUND PNEUMATIC POWER REQUIREMENTS - HEATING/COOLING

MODEL 747-8, 747-8F
5.7.1 CONDITIONED AIR FLOW REQUIREMENTS
MODEL 747-8, 747-8F
5.8.1 GROUND TOWING REQUIREMENTS - ENGLISH UNITS

NOTES:
- UNUSUAL BREAKAWAY CONDITIONS NOT SHOWN
- STRAIGHT-LINE TOW
- COEFFICIENTS OF FRICTION \( \mu \) ARE ESTIMATED FOR RUBBER-TIRED TOW VEHICLES
- FOR TOWING DATA RELATED TO TURNING, SEE SECTION 4.2

![Graph showing ground towing requirements.](image-url)
5.8.2 GROUND TOWING REQUIREMENTS - METRIC UNITS

MODEL 747-8, 747-8F

NOTES:
- UNUSUAL BREAKAWAY CONDITIONS NOT SHOWN
- STRAIGHT-LINE TOW
- COEFFICIENTS OF FRICTION (μ) ARE ESTIMATED FOR RUBBER-TIRED TOW VEHICLES
- FOR TOWING DATA RELATED TO TURNING, SEE SECTION 4.2
6.0  JET ENGINE WAKE AND NOISE DATA

6.1  Jet Engine Exhaust Velocities and Temperatures

6.2  Airport and Community Noise
6.0 JET ENGINE WAKE AND NOISE DATA

6.1 Jet Engine Exhaust Velocities and Temperatures

This section shows exhaust velocity and temperature contours aft of the 747-8 and 747-8 Freighter airplanes due to the use of the same engine and same weight for both airplanes. The contours were calculated from a standard computer analysis using three-dimensional viscous flow equations with mixing of primary, fan, and free-stream flow. The presence of the ground plane is included in the calculations. Mixing of flows from the engines is also calculated. The analysis does not include thermal buoyancy effects which tend to elevate the jet wake above the ground plane. The buoyancy effects are considered to be small relative to the exhaust velocity and therefore are not included.

The graphs show jet wake velocity and temperature contours for a representative engine. The results are valid for sea level, static, standard day conditions. The effect of wind on jet wakes was not included. There is evidence to show that a downwind or an upwind component does not simply add or subtract from the jet wake velocity, but rather carries the whole envelope in the direction of the wind. Crosswinds may carry the jet wake contour far to the side at large distances behind the airplane.

The users of these exhaust velocity contour data should understand that these data reflect steady-state at maximum taxi weight and not transient-state exhaust velocities. A steady-state is achieved with the aircraft in a fixed location, engine running at a given thrust level and measured when the contours stop expanding and stabilize in size, which could take several seconds. The steady-state condition, therefore, is conservative. Contours shown also do not account for performance variables such as ambient temperature or field elevation. For the terminal area environment, the transient-state is a more accurate representation of the actual exhaust contours when the aircraft is in motion and encountering static air with forward or turning movement, but it is very difficult to model on a consistent basis due to aircraft weight, weather conditions, the high degree of variability in terminal and apron configurations, and intensive numerical calculations. If the contours presented here are overly restrictive for terminal operations, The Boeing Company recommends conducting an analysis of the actual exhaust contours experienced by the using aircraft at the airport.
6.1.1 JET ENGINE EXHAUST VELOCITY CONTOURS – IDLE THRUST
MODEL 747-8, 747-8F
6.1.2 JET ENGINE EXHAUST VELOCITY CONTOURS – BREAKAWAY THRUST – LEVEL PAVEMENT

MODEL 747-8, 747-8F
6.1.3 JET ENGINE EXHAUST VELOCITY CONTOURS – BREAKAWAY THRUST -
1% PAVEMENT UPSLOPE

MODEL 747-8, 747-8F

NOTES:
- ENGINE THRUST, BREAKAWAY SETTINGS
- CONTOURS CALCULATED FROM COMPUTER DATA
- STANDARD DAY
- SEA LEVEL
- NEGLIGIBLE WIND
- 1% APRON SLOPE
- MTW - 990,000 LB (449,056 KG)
- SHOWN ARE STEADY-STATE, NOT TRANSIENT-
STATE EXHAUST CONTOURS
6.1.4 JET ENGINE EXHAUST VELOCITY CONTOURS - BREAKAWAY THRUST - 1.5% PAVEMENT UPSLOPE

MODEL 747-8, 747-8F
6.1.5 JET ENGINE EXHAUST VELOCITY CONTOURS - TAKEOFF THRUST

MODEL 747-8, 747-8F

NOTES:
- ENGINE THRUST, TAKEOFF SETTINGS
- CONTOURS CALCULATED FROM COMPUTER DATA
- STANDARD DAY
- SEA LEVEL
- NEGLIGIBLE WIND
- MTOW = 987,000 LB (447,696 KG)
- SHOWN ARE STEADY-STATE, NOT TRANSIENT-STATE EXHAUST CONTOURS

FEET  METERS

HEIGHT ABOVE GROUND

150 MPH TO ~241 FT
(241 KM/HR TO ~74 M)

100 MPH TO ~531 FT
(161 KM/HR TO ~162 M)

35 MPH TO ~2,588 FT
(56 KM/HR TO ~789 M)

50 MPH TO ~1,748 FT
(89 KM/HR TO ~533 M)

200 MPH TO ~64 FT
(322 KM/HR TO ~20 M)

GROUND PLANE

DISTANCE FROM AFT END OF AIRPLANE

150 MPH TO ~241 FT
(241 KM/HR TO ~74 M)

100 MPH TO ~531 FT
(161 KM/HR TO ~162 M)

35 MPH TO ~2,588 FT
(56 KM/HR TO ~789 M)

50 MPH TO ~1,748 FT
(89 KM/HR TO ~533 M)

200 MPH TO ~64 FT
(322 KM/HR TO ~20 M)

AIRPLANE CENTERLINE

DISTANCE FROM AIRPLANE CENTERLINE

FEET  METERS

PLAN
6.1.6 JET ENGINE EXHAUST TEMPERATURE CONTOURS – IDLE AND BREAKAWAY

MODEL 747-8, 747-8F

TEMPERATURE CONTOURS FOR
IDLE AND BREAKAWAY POWER CONDITIONS
ARE NOT SHOWN BECAUSE THE
MAXIMUM TEMPERATURE AFT OF THE AIRPLANE
IS PREDICTED TO BE
LESS THAN 100°F (38°C)
FOR STANDARD DAY AMBIENT
CONDITIONS OF 59°F (15°C)
6.1.7 JET ENGINE EXHAUST TEMPERATURE CONTOURS - TAKEOFF THRUST

MODEL 747-8, 747-8F

NOTES:
- ENGINE THRUST, TAKEOFF SETTINGS
- CONTOURS CALCULATED FROM COMPUTER DATA
  - STANDARD DAY
  - SEA LEVEL
  - NEGLIGIBLE WIND
  - MTOW = 987,000 LB (447,696 KG)
- SHOWN ARE STEADY-STATE, NOT TRANSIENT-STATE EXHAUST TEMPERATURE CONTOURS
6.2 Airport and Community Noise

Airport noise is of major concern to the airport and community planner. The airport is a major element in the community's transportation system and, as such, is vital to its growth. However, the airport must also be a good neighbor, and this can be accomplished only with proper planning. Since aircraft noise extends beyond the boundaries of the airport, it is vital to consider the impact on surrounding communities. Many means have been devised to provide the planner with a tool to estimate the impact of airport operations. Too often they oversimplify noise to the point where the results become erroneous. Noise is not a simple subject; therefore, there are no simple answers.

The cumulative noise contour is an effective tool. However, care must be exercised to ensure that the contours, used correctly, estimate the noise resulting from aircraft operations conducted at an airport.

The size and shape of the single-event contours, which are inputs into the cumulative noise contours, are dependent upon numerous factors. They include the following:

1. Operational Factors
   (a) **Aircraft Weight** - Aircraft weight is dependent on operating empty weight, distance to be traveled, en route winds, payload, and reserve fuel anticipated from a potential aircraft delay upon reaching the destination.
   (b) **Engine Power Settings** - The rates of ascent and descent and the noise levels emitted at the source are influenced by the power setting used.
   (c) **Airport Altitude** - Higher airport altitude will affect engine performance and thus can influence noise.

2. Atmospheric Conditions-Sound Propagation
   (a) **Wind** - With stronger headwinds, the aircraft can take off and climb more rapidly relative to the ground. Also, winds can influence the distribution of noise in surrounding communities.
   (b) **Temperature and Relative Humidity** - The absorption of noise in the atmosphere along the transmission path between the aircraft and the ground observer varies with both temperature and relative humidity.
3. Surface Condition - Shielding, Extra Ground Attenuation (EGA)

(a) **Terrain** - If the ground slopes down after takeoff or up before landing, noise will be reduced since the aircraft will be at a higher altitude above ground. Additionally, hills, shrubs, trees, and large buildings can act as sound buffers.

All these factors can alter the shape and size of the contours appreciable. To demonstrate the effect of some of these factors, estimated noise level contours for two different operating conditions are shown below. These contours reflect a given noise level upon a ground level plane at runway elevation.

**Condition 1**

<table>
<thead>
<tr>
<th>Landing</th>
<th>Takeoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Design Landing Weight</td>
<td>Maximum Design Takeoff Weight</td>
</tr>
<tr>
<td>10-knot Headwind</td>
<td>Zero Wind</td>
</tr>
<tr>
<td>3° Approach</td>
<td>84 °F (29 °C)</td>
</tr>
<tr>
<td>84 °F (29 °C)</td>
<td>Humidity 15%</td>
</tr>
<tr>
<td>Humidity 15%</td>
<td></td>
</tr>
</tbody>
</table>

**Condition 2**

<table>
<thead>
<tr>
<th>Landing:</th>
<th>Takeoff:</th>
</tr>
</thead>
<tbody>
<tr>
<td>85% of Maximum Design Landing Weight</td>
<td>80% of Maximum Design Takeoff Weight</td>
</tr>
<tr>
<td>10-knot Headwind</td>
<td>10-knot Headwind</td>
</tr>
<tr>
<td>3° Approach</td>
<td>59 °F (15 °C)</td>
</tr>
<tr>
<td>59 °F (15 °C)</td>
<td>Humidity 70%</td>
</tr>
<tr>
<td>Humidity 70%</td>
<td></td>
</tr>
</tbody>
</table>

---

CONDITION 1

CONDITION 2
As indicated from these data, the contour size varies substantially with operating and atmospheric conditions. Most aircraft operations are, of course, conducted at less than maximum gross weights because average flight distances are much shorter than maximum aircraft range capability and average load factors are less than 100%. Therefore, in developing cumulative contours for planning purposes, it is recommended that the airlines serving a particular city be contacted to provide operational information.

In addition, there are no universally accepted methods for developing aircraft noise contours or for relating the acceptability of specific zones to specific land uses. It is therefore expected that noise contour data for particular aircraft and the impact assessment methodology will be changing. To ensure that the best currently available information of this type is used in any planning study, it is recommended that it be obtained directly from the Office of Environmental Quality in the Federal Aviation Administration in Washington, D.C.

It should be noted that the contours shown herein are only for illustrating the impact of operating and atmospheric conditions and do not represent the single-event contour of the family of aircraft described in this document. It is expected that the cumulative contours will be developed as required by planners using the data and methodology applicable to their specific study.
7.0 PAVEMENT DATA

7.1 General Information
7.2 Landing Gear Footprint
7.3 Maximum Pavement Loads
7.4 Landing Gear Loading on Pavement
7.5 Flexible Pavement Requirements - U.S. Army Corps of Engineers Method S-77-1
7.6 Flexible Pavement Requirements - LCN Conversion
7.7 Rigid Pavement Requirements - Portland Cement Association Design Method
7.8 Rigid Pavement Requirements - LCN Conversion
7.9 Rigid Pavement Requirements - FAA Design Method
7.10 ACN/PCN Reporting System - Flexible and Rigid Pavements
7.11 Nose Gear Tethering
7.0 PAVEMENT DATA

7.1 General Information

A brief description of the pavement charts that follow will help in their use for airport planning. Each airplane configuration is depicted with a minimum range of six loads imposed on the main landing gear to aid in interpolation between the discrete values shown. All curves for any single chart represent data based on rated loads and tire pressures considered normal and acceptable by current aircraft tire manufacturer's standards. Tire pressures, where specifically designated on tables and charts, are at values obtained under loaded conditions as certificated for commercial use.

Section 7.2 presents basic data on the landing gear footprint configuration, maximum design taxi loads, and tire sizes and pressures.

Maximum pavement loads for certain critical conditions at the tire-to-ground interface are shown in Section 7.3, with the tires having equal loads on the struts.

Pavement requirements for commercial airplanes are customarily derived from the static analysis of loads imposed on the main landing gear struts. The chart in Section 7.4 is provided in order to determine these loads throughout the stability limits of the airplane at rest on the pavement. These main landing gear loads are used as the point of entry to the pavement design charts, interpolating load values where necessary.

The flexible pavement design curves (Section 7.5) are based on procedures set forth in Instruction Report No. S-77-1, "Procedures for Development of CBR Design Curves," dated June 1977, and as modified according to the methods described in ICAO Aerodrome Design Manual, Part 3, Pavements, 2nd Edition, 1983, Section 1.1 (The ACN-PCN Method), and utilizing the alpha factors approved by ICAO in October 2007. Instruction Report No. S-77-1 was prepared by the U.S. Army Corps of Engineers Waterways Experiment Station, Soils and Pavements Laboratory, Vicksburg, Mississippi. The line showing 10,000 coverages is used to calculate Aircraft Classification Number (ACN).

The following procedure is used to develop the curves, such as shown in Section 7.5:

1. Having established the scale for pavement depth at the bottom and the scale for CBR at the top, an arbitrary line is drawn representing 10,000 coverages.

2. Values of the aircraft weights on the main landing gear are then plotted.

3. Additional annual departure lines are drawn based on the load lines of the aircraft gross weights already established.
All Load Classification Number (LCN) curves (Sections 7.6 and 7.8) have been developed from a computer program based on data provided in International Civil Aviation Organization (ICAO) document 9157-AN/901, *Aerodrome Design Manual*, Part 3, "Pavements," Second Edition, 1983. LCN values are shown directly for parameters of weight on main landing gear, tire pressure, and radius of relative stiffness (l) for rigid pavement or pavement thickness or depth factor (h) for flexible pavement.

Rigid pavement design curves (Section 7.7) have been prepared with the Westergaard equation in general accordance with the procedures outlined in the *Design of Concrete Airport Pavement* (1955 edition) by Robert G. Packard, published by the Portland Cement Association, 3800 North Wilke Road, Arlington Heights, Illinois 60004-1268. These curves are modified to the format described in the Portland Cement Association publication XP6705-2, *Computer Program for Airport Pavement Design (Program PDILB)*, 1968, by Robert G. Packard.

The following procedure is used to develop the rigid pavement design curves shown in Section 7.7:

1. Having established the scale for pavement thickness to the left and the scale for allowable working stress to the right, an arbitrary load line is drawn representing the main landing gear maximum weight to be shown.
2. Values of the subgrade modulus (k) are then plotted.
3. Additional load lines for the incremental values of weight on the main landing gear are drawn on the basis of the curve for k = 300, already established.

For the rigid pavement design (Section 7.9) refer to the FAA website for the FAA design software COMFAA:

http://www.faa.gov/airports/engineering/design_software/
The ACN/PCN system (Section 7.10) as referenced in ICAO Annex 14, “Aerodromes,” Fifth Edition, July 2009, provides a standardized international airplane/pavement rating system replacing the various S, T, TT, LCN, AUW, ISWL, etc., rating systems used throughout the world. ACN is the Aircraft Classification Number and PCN is the Pavement Classification Number. An aircraft having an ACN equal to or less than the PCN can operate on the pavement subject to any limitation on the tire pressure. Numerically, the ACN is twice the derived single-wheel load expressed in thousands of kilograms, where the derived single wheel load is defined as the load on a single tire inflated to 181 psi (1.25 MPa) that would have the same pavement requirements as the aircraft. Computationally, the ACN/PCN system uses the PCA program PDILB for rigid pavements and S-77-1 for flexible pavements to calculate ACN values. The method of pavement evaluation is left up to the airport with the results of their evaluation presented as follows:

<table>
<thead>
<tr>
<th>PCN</th>
<th>PAVEMENT TYPE</th>
<th>SUBGRADE CATEGORY</th>
<th>TIRE PRESSURE CATEGORY</th>
<th>EVALUATION METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>R = Rigid</td>
<td>F = Flexible</td>
<td>A = High</td>
<td>W = No Limit</td>
<td>T = Technical</td>
</tr>
<tr>
<td>B = Medium</td>
<td>X = To 254 psi (1.75 MPa)</td>
<td>U = Using Aircraft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C = Low</td>
<td>Y = To 181 psi (1.25 MPa)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D = Ultra Low</td>
<td>Z = To 73 psi (0.5 MPa)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Section 7.10.1 shows the aircraft ACN values for flexible pavements. The four subgrade categories are:

- Code A - High Strength - CBR 15
- Code B - Medium Strength - CBR 10
- Code C - Low Strength - CBR 6
- Code D - Ultra Low Strength - CBR 3

Section 7.10.2 shows the aircraft ACN values for rigid pavements. The four subgrade categories are:

- Code A - High Strength, $k = 550$ pci (150 MN/m$^3$)
- Code B - Medium Strength, $k = 300$ pci (80 MN/m$^3$)
- Code C - Low Strength, $k = 150$ pci (40 MN/m$^3$)
- Code D - Ultra Low Strength, $k = 75$ pci (20 MN/m$^3$)
**UNITS 747-8F 747-8, 747-8F**

<table>
<thead>
<tr>
<th></th>
<th>747-8F</th>
<th>747-8, 747-8F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAXIMUM DESIGN TAXI WEIGHT</strong></td>
<td>LB</td>
<td>KG</td>
</tr>
<tr>
<td></td>
<td>978,000</td>
<td>443,613</td>
</tr>
<tr>
<td></td>
<td>449,056</td>
<td>449,056</td>
</tr>
<tr>
<td><strong>PERCENT OF WEIGHT ON MAIN GEAR</strong></td>
<td>%</td>
<td>SEE SECTION 7.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NOSE GEAR TIRE SIZE</strong></td>
<td>IN.</td>
<td>50 X 20.0 R 22, 26 PR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NOSE GEAR TIRE PRESSURE</strong></td>
<td>PSI</td>
<td>KG/CM²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>167</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.74</td>
</tr>
<tr>
<td><strong>MAIN GEAR TIRE SIZE</strong></td>
<td>IN.</td>
<td>52 X 21.0 R 22, 36 PR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MAIN GEAR TIRE PRESSURE</strong></td>
<td>PSI</td>
<td>KG/CM²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>221</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.54</td>
</tr>
</tbody>
</table>

**7.2 LANDING GEAR FOOTPRINT**

*MODEL 747-8, 747-8F*
\[ V_{NG} = \text{MAXIMUM VERTICAL NOSE GEAR GROUND LOAD AT MOST FORWARD CENTER OF GRAVITY} \]
\[ V_{MG} = \text{MAXIMUM VERTICAL MAIN GEAR GROUND LOAD AT MOST AFT CENTER OF GRAVITY} \]
\[ H = \text{MAXIMUM HORIZONTAL GROUND LOAD FROM BRAKING} \]

NOTE: ALL LOADS CALCULATED USING AIRPLANE MAXIMUM DESIGN TAXI WEIGHT

### MAXIMUM PAVEMENT LOADS

**MODEL 747-8, 747-8F**

| AIRPLANE MODEL | UNITS | MAX DESIGN WEIGHT | \( V_{NG} \) | \( V_{MG} \) | \( H \) |
|----------------|-------|-------------------|---------------|---------------|
| 747-8          | LB    | 990,000           | 70,112        | 234,348       | 76,874 |
|                | KG    | 449,056           | 31,802        | 106,299       | 34,870 |
| 747-8F         | LB    | 978,000           | 65,145        | 231,507       | 75,942 |
|                | KG    | 443,613           | 29,549        | 105,010       | 34,447 |
| 747-8F         | LB    | 990,000           | 70,112        | 234,515       | 76,874 |
|                | KG    | 449,056           | 31,802        | 105,921       | 34,870 |

\( \mu = 0.8 \)
7.4.1 LANDING GEAR LOADING ON PAVEMENT

MODEL 747-8 (990,000 LB, 449,056 KG)
7.4.2 LANDING GEAR LOADING ON PAVEMENT
MODEL 747-8F (978,000 LB, 443,613 KG)
7.4.3 LANDING GEAR LOADING ON PAVEMENT

MODEL 747-8F (990,000 LB, 449,056 KG)
7.5 Flexible Pavement Requirements - U.S. Army Corps of Engineers Method
(S-77-1)

The following flexible-pavement design chart presents the data of six incremental main-gear loads at the minimum tire pressure required at the maximum design taxi weight.

In the examples shown in Section 7.5.1 and 7.5.2, for a CBR of 30 and an annual departure level of 15,000, the required flexible pavement thickness for an airplane with a main gear loading of 800,000 pounds (362,874 kg) is 12.5 inches (31.8 cm).

The line showing 10,000 coverages is used for ACN calculations (see Section 7.10).

The FAA design method uses a similar procedure using total airplane weight instead of weight on the main landing gears. The equivalent main gear loads for a given airplane weight could be calculated from Section 7.4.
7.5.1 FLEXIBLE PAVEMENT REQUIREMENTS - U.S. ARMY CORPS OF ENGINEERS
DESIGN METHOD (S-77-1)
MODEL 747-8F (978,000 LB, 443,613 KG)
7.5.2 FLEXIBLE PAVEMENT REQUIREMENTS - U.S. ARMY CORPS OF ENGINEERS
DESIGN METHOD (S-77-1)
MODEL 747-8, 747-8F (990,000 LB, 449,056 KG)
7.6 Flexible Pavement Requirements - LCN Method

To determine the airplane weight that can be accommodated on a particular flexible pavement, both the Load Classification Number (LCN) of the pavement and the thickness must be known.

In the example shown in Section 7.6.1 and 7.6.2, flexible pavement thickness is shown at 32 in (81 cm). with an LCN of 92. For these conditions, the apparent maximum allowable weight permissible on the main landing gear is 600,000 lb (272,155 kg) for an airplane with 221-psi (15.54 kg/cm²) main gear tires.

Note: If the resultant aircraft LCN is not more that 10% above the published pavement LCN, the bearing strength of the pavement can be considered sufficient for unlimited use by the airplane. The figure 10% has been chosen as representing the lowest degree of variation in LCN that is significant (reference: ICAO Aerodrome Design Manual, Part 2, “Aerodrome Physical Characteristics,” Chapter 4, Paragraph 4.1.5.7v, 2nd Edition dated 1965).
7.6.1 FLEXIBLE PAVEMENT REQUIREMENTS - LCN METHOD
MODEL 747-8F (978,000 LB, 443,613 KG)
7.6.2 FLEXIBLE PAVEMENT REQUIREMENTS - LCN METHOD

MODEL 747-8, 747-8F (990,000 LB, 449,056 KG)
7.7  Rigid Pavement Requirements - Portland Cement Association Design Method

The Portland Cement Association method of calculating rigid pavement requirements is based on the computerized version of "Design of Concrete Airport Pavement" (Portland Cement Association, 1965) as described in XP6705-2, "Computer Program for Airport Pavement Design" by Robert G. Packard, Portland Cement Association, 1968.

The rigid pavement design charts in Section 7.7.1 and 7.7.2, present the data for six incremental main gear loads at the minimum tire pressure required at the maximum design taxi weight.

In the example shown, for an allowable working stress of 550 psi (38.67 kg/cm²), a main gear load of 800,000 lb (362,874 kg), and a subgrade strength (k) of 300, the required rigid pavement thickness is 10.6 in (26.9 cm).
7.7.1 RIGID PAVEMENT REQUIREMENTS - PORTLAND CEMENT ASSOCIATION DESIGN METHOD

MODEL 747-8F (978,000 LB, 443,613 KG)
7.7.2 RIGID PAVEMENT REQUIREMENTS - PORTLAND CEMENT ASSOCIATION DESIGN METHOD
MODEL 747-8, 747-8F (990,000 LB, 449,056 KG)
7.8  Rigid Pavement Requirements - LCN Conversion

To determine the airplane weight that can be accommodated on a particular rigid pavement, both the LCN of the pavement and the radius of relative stiffness (l) of the pavement must be known.

In the examples shown in Section 7.8.2 for a rigid pavement with a radius of relative stiffness of 47 with an LCN of 91, and 7.8.3 for a rigid pavement with a radius of relative stiffness of 47 with an LCN of 87, the apparent maximum allowable weight permissible on the main landing gear is 600,000 lb (272,155 kg) for an airplane with 221-psi (15.54 kg/cm²) main tires.

Note:  If the resultant aircraft LCN is not more that 10% above the published pavement LCN, the bearing strength of the pavement can be considered sufficient for unlimited use by the airplane.  The figure 10% has been chosen as representing the lowest degree of variation in LCN that is significant (reference: ICAO Aerodrome Design Manual, Part 2, “Aerodrome Physical Characteristics,” Chapter 4, Paragraph 4.1.5.7v, 2nd Edition dated 1965).
RADIUS OF RELATIVE STIFFNESS (l)

VALUES IN INCHES

\[ l = \frac{4}{\sqrt{\frac{E d^3}{12(1-\mu^2)k}}} = 24.1652 \sqrt{\frac{d^3}{k}} \]

WHERE:  
E = YOUNG'S MODULUS OF ELASTICITY = 4 x 10^6 psi  
k = SUBGRADE MODULUS, LB PER CU IN  
d = RIGID PAVEMENT THICKNESS, IN  
\( \mu = POISSON'S \ RATIO = 0.15 \)

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7.8.1 RADIUS OF RELATIVE STIFFNESS
(REFERENCE: PORTLAND CEMENT ASSOCIATION)
7.8.2 RIGID PAVEMENT REQUIREMENTS - LCN CONVERSION

MODEL 747-8F (978,000 LB, 443,613 KG)
7.8.3 RIGID PAVEMENT REQUIREMENTS - LCN CONVERSION
MODEL 747-8, 747-8F (990,000 LB, 449,056 KG)
7.9 Rigid Pavement Requirements - FAA Design Method

For the rigid pavement design, refer to the FAA website for the FAA design software COMFAA:

http://www.faa.gov/airports/engineering/design_software/
7.10 ACN/PCN Reporting System: Flexible and Rigid Pavements

To determine the ACN of an aircraft on flexible or rigid pavement, both the aircraft gross weight and the subgrade strength category must be known. In the chart in Section 7.10.1 and 7.10.3, for an aircraft with gross weight of 900,000 lb (408,233 kg) and medium subgrade strength, the flexible pavement ACN is 62. In Section 7.10.2 and 7.10.4, for the same gross weight and subgrade strength, the rigid pavement ACN is 67.

The following table provides ACN data in tabular format similar to the one used by ICAO in the “Aerodrome Design Manual Part 3, Pavements”. If the ACN for an intermediate weight between maximum taxi weight and the empty weight of the aircraft is required, Figures 7.10.1 through 7.10.4 should be consulted.

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<th>AIRCRAFT TYPE</th>
<th>MAXIMUM TAXI WEIGHT LB (KG)</th>
<th>MINIMUM WEIGHT (1) LB (KG)</th>
<th>LOAD ON ONE MAIN GEAR LEG (%)</th>
<th>TIRE PRESSURE PSI (MPa)</th>
<th>ACN FOR RIGID PAVEMENT SUBGRADES – MN/m³</th>
<th>ACN FOR FLEXIBLE PAVEMENT SUBGRADES – CBR</th>
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(1) Minimum weight used solely as a baseline for ACN curve generation.
7.10.2 AIRCRAFT CLASSIFICATION NUMBER - RIGID PAVEMENT
MODEL 747-8F (978,000 LB, 443,613 KG)
7.10.3 AIRCRAFT CLASSIFICATION NUMBER - FLEXIBLE PAVEMENT

MODEL 747-8 and 747-8F (990,000 LB, 449,056 KG)
7.10.4 AIRCRAFT CLASSIFICATION NUMBER - RIGID PAVEMENT
MODEL 747-8 and 747-8F (990,000 LB, 449,056 KG)

NOTES:
- 52x 21 R22, 35 PR
- PRESSURE - 221 PSI (15.54 KG/CM SQ)

CODE D - k = 75 (ULTRA LOW)
CODE C - k = 150 (LOW)
CODE B - k = 300 (MEDIUM)
CODE A - k = 550 (HIGH)

NOTES:
1. TO DETERMINE MAIN LANDING GEAR LOADING,
   SEE SECTION 7.4.
2. PERCENT WEIGHT ON MAIN LANDING GEAR: 94.7 (747-8)
3. PERCENT WEIGHT ON MAIN LANDING GEAR: 94.4 (747-8F)
7.11  Nose Gear Tethering (Optional)

There are two typical methods used to provide support to prevent airplane tipping during ramp operations. During use of a tail stanchion, pavement strength is considered sufficient and there should be no additional requirements.

The alternate method of tethering the nose landing gear may also be used. Boeing does not have a tool design for straps to tether the airplane. Figure 7.11.1 is provided to supply load conditions sufficient to design and/or verify ramp strength is adequate for this purpose.

7.11.1  NOSE GEAR TETHERING (OPTIONAL)
MODEL 747-8 (990,000 LB, 449,056 KG)
8.0  FUTURE 747-8 DERIVATIVE AIRPLANES
8.0 FUTURE 747-8 DERIVATIVE AIRPLANES

As with most Boeing airplane programs, derivative models are typically being studied to provide additional capabilities of the 747-8 family of airplanes. Future growth versions could address additional passenger count, cargo capacity, increased range, or environmental performance.

Whether and/or when these or other possibilities are actually built is entirely dependent on future airline requirements. In any event, the impact on airport facilities will be a consideration in configuration and design.
9.0 SCALED 747-8 DRAWINGS

9.1 747-8, 747-8F
9.0 SCALED DRAWINGS

The drawings in the following pages show airplane plan view drawings, drawn to approximate scale as noted. The drawings may not come out to exact scale when printed or copied from this document. Printing scale should be adjusted when attempting to reproduce these drawings. Three-view drawing files of the 747-8, along with other Boeing airplane models, may be downloaded from the following website:

http://www.boeing.com/airports
NOTE: ADJUST FOR PROPER SCALING WHEN PRINTING THIS PAGE

9.1.1 SCALED DRAWING - 1:500
MODEL, 747-8F
NOTE: ADJUST FOR PROPER SCALING WHEN PRINTING THIS PAGE

9.1.2 SCALED DRAWING - 1:500

MODEL, 747-8