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 737 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 as well as engine tilt and toe-in. 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 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.
6.1.1 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS

MODEL 737-100, -200

NOTES:
- STANDARD DAY
- ZERO WIND
- JT8D ENGINES
- SEA LEVEL
- STATIC AIRPLANE

737-200
737-100
70 MPH (110 KMPH)
35 MPH (56 KMPH)

GROUND PLANE

HEIGHT ABOVE GROUND

FEET

METERS

AFT END OF AIRPLANE

3.3 FT (1.0 M)

DISTANCE FROM AIRPLANE CENTERLINE

FEET

METERS

AXIAL DISTANCE BEHIND AIRPLANE

0 20 40 60 80 100 120 140 160 180 200 220

0 10 20 30 40

OCTOBER 2005

405
6.1.2 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- IDLE THRUST
MODEL 737-300, -400, -500
6.1.3 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS

- IDLE THRUST

MODEL 737-600, -700, -800, -900, ALL MODELS

NOTES:

- STANDARD DAY
- ZERO WIND
- SEA LEVEL
- STATIC AIRPLANE

GROUND PLANE

FEET 0 20 40 60 80 100 120 140 160 180 200 220

AXIAL DISTANCE BEHIND AIRPLANE

METERS 0 10 20 30 40 50 60 70

HEIGHT ABOVE GROUND

FEET 0 12 24 36 48 60

METERS 0 3.6 7.2 10.8 14.4 18.0

AFT END OF AIRPLANE

35 MPH (56 KMPH)

15 FT 9 IN (4.82 M)

12 FT 8 IN (3.87 M)

3 FT 7 IN (1.10 M)

DISTANCE FROM AIRPLANE CENTERLINE

FEET 0 2 4 6 8 10 12

METERS 0 0.6 1.2 1.8 2.4 3.0 3.6

AIRPLANE

OCTOBER 2005
6.1.4 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS - BREAKAWAY THRUST

MODEL 737-100, -200

NOTES:
- STANDARD DAY
- ZERO WIND
- JT8D ENGINES
- SEA LEVEL
- STATIC AIRPLANE

- 737-200
- 737-100
- 100 MPH (160 KMPH)
- 70 MPH (110 KMPH)
- 35 MPH (56 KMPH)

AFT END OF AIRPLANE

3.3 FT (1.0 M)

HEIGHT ABOVE GROUND

FEET

METERS

FEET

METERS

AXIAL DISTANCE BEHIND AIRPLANE

DISTANCE FROM AIRPLANE CENTERLINE

C AIRPLANE
6.1.5 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS

- BREAKAWAY THRUST

MODEL 737-300, -400, -500

NOTES:
• STANDARD DAY
• ZERO WIND
• SEA LEVEL
• STATIC AIRPLANE

HEIGHT ABOVE GROUND

FEET

METERS

100 MPH (160 KMPH)
75 MPH (120 KMPH)
35 MPH (56 KMPH)

TO 510 FT (157 M)

GROUND PLANE

AFT END OF AIRPLANE

4 FT 0 IN (1.22 M)
7 FT 4 IN (2.24 M)

FEET

METERS

AXIAL DISTANCE BEHIND AIRPLANE

DISTANCE FROM AIRPLANE CENTERLINE

100 MPH
75 MPH
35 MPH

© AIRPLANE
6.1.7 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS - TAKEOFF THRUST

MODEL 737-100, -200

NOTES:
- STANDARD DAY
- ZERO WIND
- SEA LEVEL
- STATIC AIRPLANE
- JT8D-17 ENGINES, OTHER JT8D ENGINES EXHIBIT SMALLER VELOCITY CONTOURS

AFT END OF AIRPLANE

HEIGHT ABOVE GROUND

737-200
737-100

70 MPH (110 KM/PH)
100 MPH (160 KM/PH)
50 MPH TO 370 FT (80 KM/PH TO 113 M)

150 MPH (240 KM/PH)
200 MPH (320 KM/PH)
300 MPH (480 KM/PH)

3.3 FT (1.0 M)

GROUND PLANE

AXIAL DISTANCE BEHIND AIRPLANE

DISTANCE FROM AIRPLANE CENTERLINE

FEET

METERS

0 20 40 60 80 100 120 140 160 180 200 220
0 10 20 30 40 50 60 70

0 2 4 6 8 10 12

300 MPH
200 MPH
150 MPH
100 MPH
70 MPH

© AIRPLANE

50 MPH
70 MPH
6.1.8 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS

- TAKEOFF THRUST

MODEL 737-300, -400, -500

NOTES:
- STANDARD DAY
- ZERO WIND
- SEA LEVEL
- STATIC AIRPLANE

HEIGHT ABOVE GROUND

FEET

METERS

AXIAL DISTANCE BEHIND AIRPLANE

FEET

METERS

DISTANCE FROM AIRPLANE CENTERLINE

FEET

METERS

737-400
737-300
737-500
200 MPH (320 KMPH)
150 MPH (240 KMPH)
100 MPH (160 KMPH)
75 MPH (120 KMPH)
35 MPH (56 KMPH)

TO 1,900 FT (580 M)

4 FT 0 IN (1.22 M)

7 FT 4 IN (2.24 M)
6.1.9 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- TAKEOFF THRUST
MODEL 737-600, -700, -800, -900 ALL MODELS
6.1.12 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS

EXHAUST TEMPERATURES AFT OF AIRPLANE ARE LESS THAN 100°F (38°C) AT BREAKAWAY THRUST

NOTES:
○ STANDARD DAY
○ ZERO WIND
○ SEA LEVEL
○ STATIC AIRPLANE

HEIGHT ABOVE GROUND

AFT END OF AIRPLANE

GROUND PLANE

DISTANCE FROM AIRPLANE CENTERLINE

FEET 0 20 40 60 80 100 120 140 160 180 200 220

METERS 0 10 20 30 40 50 60 70

AXIAL DISTANCE BEHIND AIRPLANE

© AIRPLANE
6.1.13 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS

- BREAKAWAY THRUST

MODEL 737-100, -200

NOTES:
- STANDARD DAY
- ZERO WIND
- SEA LEVEL
- STATIC AIRPLANE

JT8D-17 ENGINES

HEIGHT ABOVE GROUND

FEET 0 20 40 60 80 100 120 140 160 180 200 220

METERS 0 10 20 30 40 50 60 70

AXIAL DISTANCE BEHIND AIRPLANE

FEET 0 2 4 6 8 10 12

METERS 0 2 4 6 8 10

DISTANCE FROM AIRPLANE CENTERLINE

3.3 FT (1.0 M)

150°F (66°C)

100°F (38°C)
6.1.14 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS

- BREAKAWAY THRUST

MODEL 737-300, -400, -500

EXHAUST TEMPERATURES AFT OF AIRPLANE
ARE LESS THAN 100°F (38°C)
AT IDLE THRUST

NOTES:
- STANDARD DAY
- ZERO WIND
- SEA LEVEL
- STATIC AIRPLANE
6.1.15 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS - BREAKAWAY THRUST

MODEL 737-600, -700, -800, -900 ALL MODELS

EXHAUST TEMPERATURES AFT OF AIRPLANE ARE LESS THAN 100° F (38°C) AT BREAKAWAY THRUST

NOTES:
- STANDARD DAY
- ZERO WIND
- SEA LEVEL
- STATIC AIRPLANE

OCTOBER 2005
6.1.16  PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS

- TAKEOFF THRUST

MODEL 737-100, -200

NOTES:
- STANDARD DAY
- ZERO WIND
- SEA LEVEL
- STATIC AIRPLANE

- JT8D-17 ENGINES, OTHER JT8D ENGINES EXHIBIT SMALLER VELOCITY CONTOURS

- 200°F (93°C)
- 150°F (66°C)
- 100°F TO 255 FT (38°F TO 78 M)

GROUND PLANE

AFT END OF AIRPLANE

3.3 FT (1.0 M)
6.1.17 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS

MODEL 737-300, -400, -500

NOTES:
- STANDARD DAY
- ZERO WIND
- SEA LEVEL
- STATIC AIRPLANE

HEIGHT ABOVE GROUND

FEET

METERS

AXIAL DISTANCE BEHIND AIRPLANE

FEET

METERS

DISTANCE FROM AIRPLANE CENTERLINE

GROUND PLANE

4 FT 0 IN (1.22 M)

7 FT 4 IN (2.24 M)

100°F (38°C)

100°F
6.1.18 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS - TAKEOFF THRUST

MODEL 737-600, -700, -800, -900 ALL MODELS

NOTES:
- STANDARD DAY
- ZERO WIND
- SEA LEVEL
- STATIC AIRPLANE

100°F (38°C)

15 FT 9 IN (4.82 M)
12 FT 8 IN (3.87 M)
3 FT 7 IN (1.10 M)
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 distance to be traveled, en route winds, payload, and anticipated 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 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 appreciably. 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 Structural Landing Weight</td>
<td>Maximum Gross Takeoff Weight</td>
</tr>
<tr>
<td>10-knot Headwind</td>
<td>Zero Wind</td>
</tr>
<tr>
<td>3° Approach</td>
<td>84 °F</td>
</tr>
<tr>
<td>84 °F</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 Structural Landing Weight</td>
<td>80% of Maximum Gross Takeoff Weight</td>
</tr>
<tr>
<td>10-knot Headwind</td>
<td>10-knot Headwind</td>
</tr>
<tr>
<td>3° Approach</td>
<td>59 °F</td>
</tr>
<tr>
<td>59 °F</td>
<td>Humidity 70%</td>
</tr>
<tr>
<td>Humidity 70%</td>
<td></td>
</tr>
</tbody>
</table>
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.