

6.0 JET ENGINE WAKE AND NOISE DATA

6.1 Jet Engine Exhaust Velocities and Temperatures

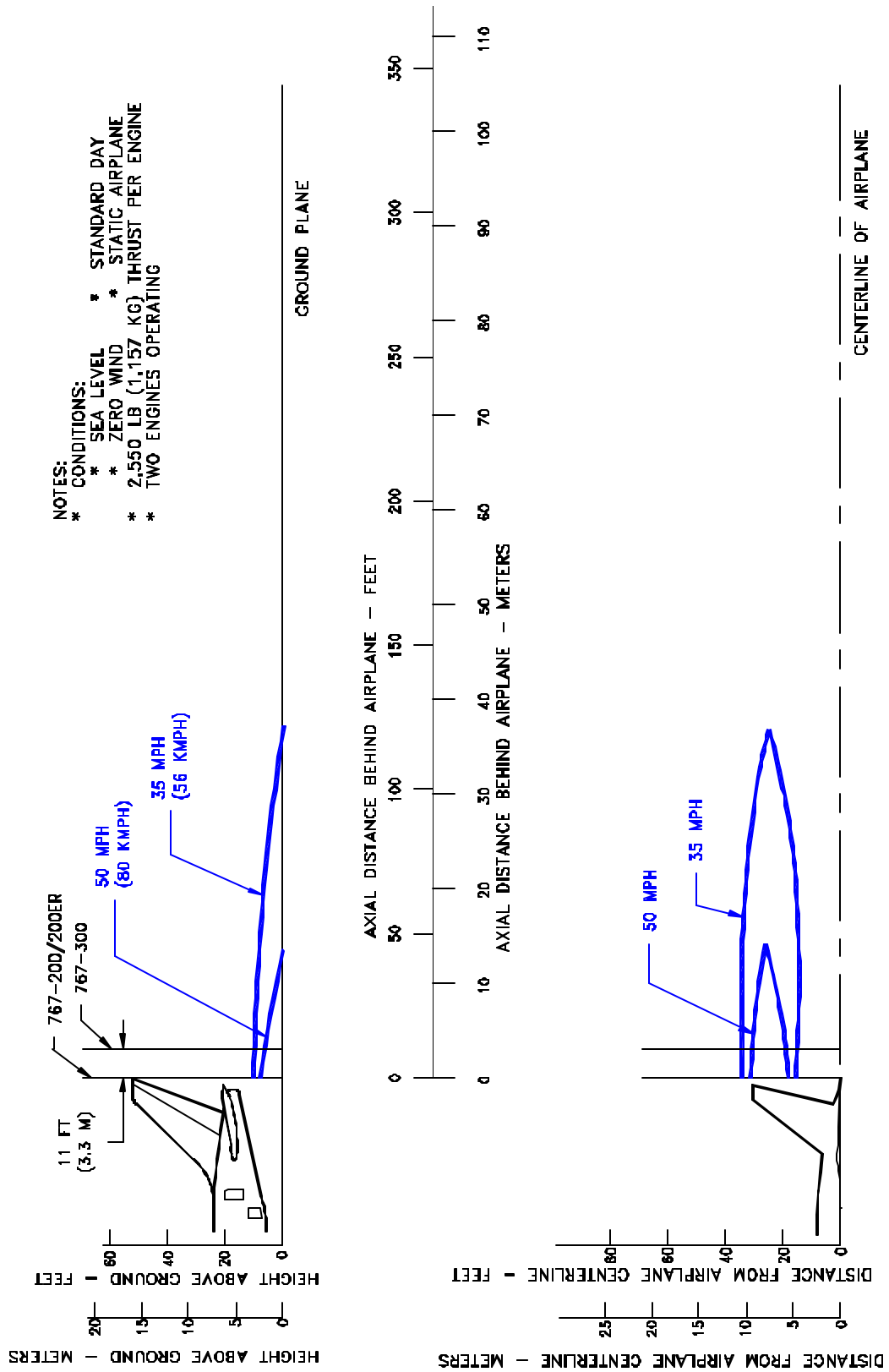
6.2 Airport and Community Noise

6.0 JET ENGINE WAKE AND NOISE DATA

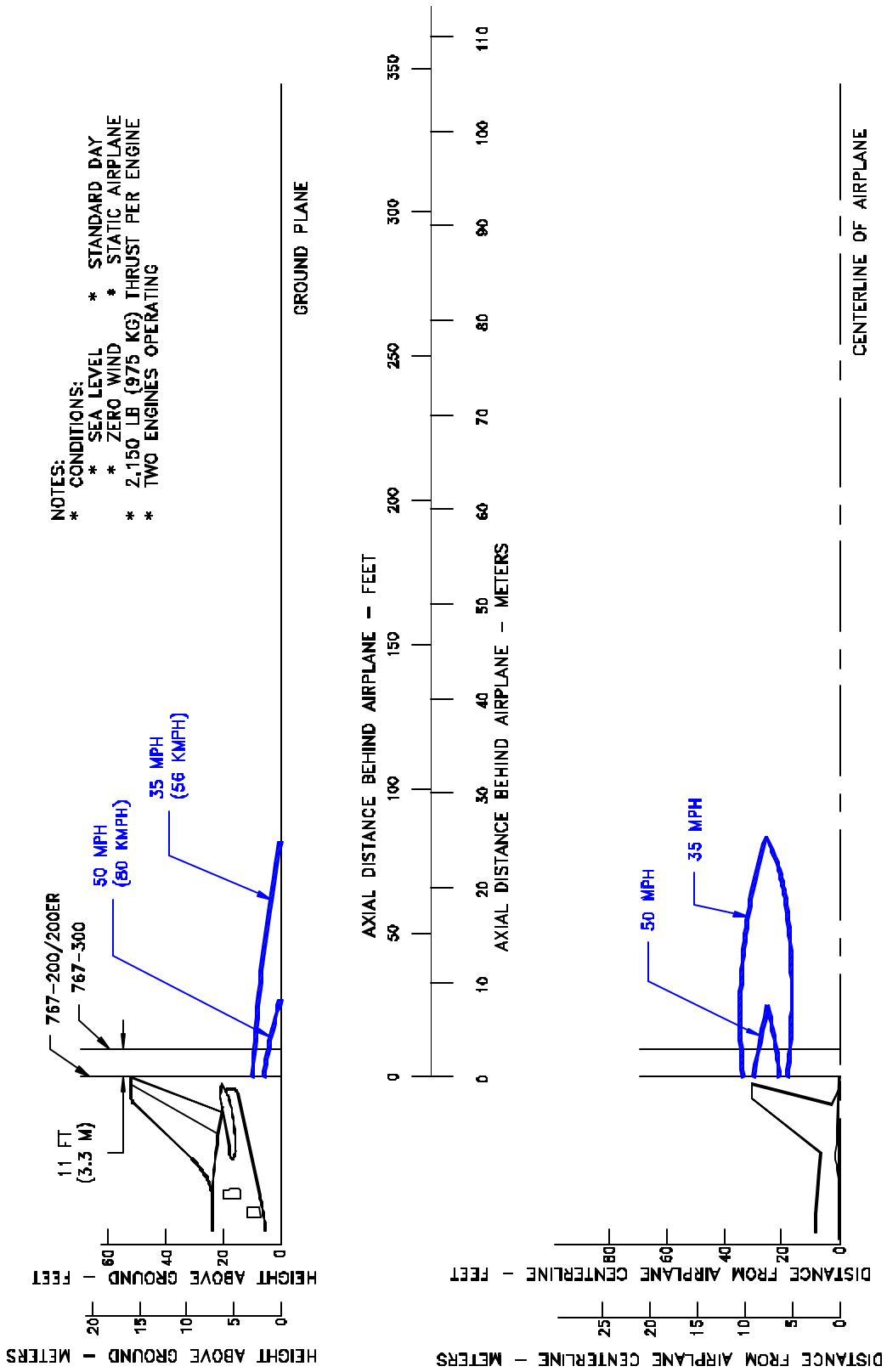
6.1 Jet Engine Exhaust Velocities and Temperatures

This section shows exhaust velocity and temperature contours aft of the 767-200, -300, -400ER airplane. 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 for representative engines. The results are valid for sea level, static, standard day conditions. The effect of wind on jet wakes is 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.

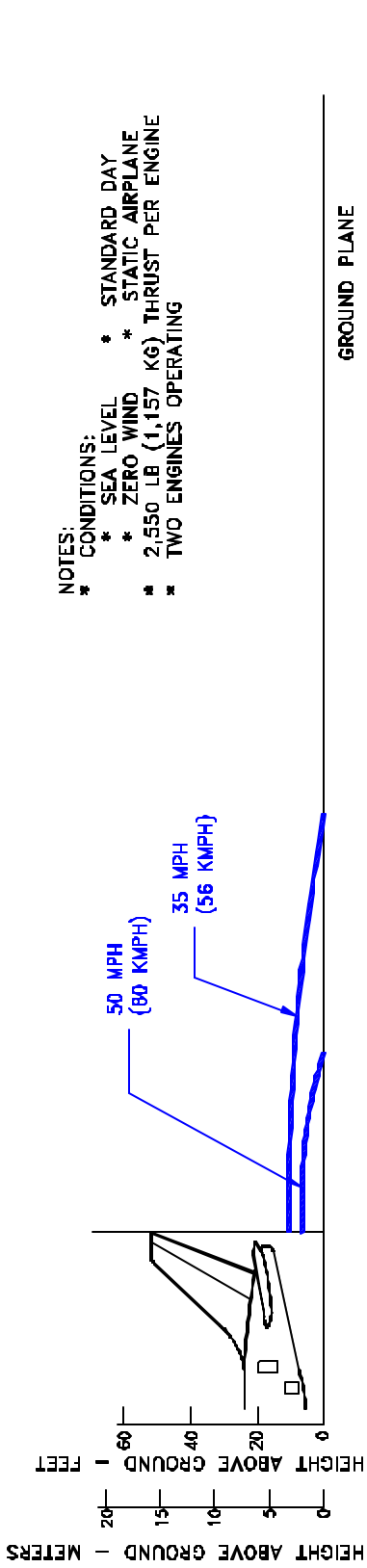


**6.1.1 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- IDLE THRUST**
MODEL 767-200, -200ER, -300 (JT9D-7R4D, -7R4E ENGINES)

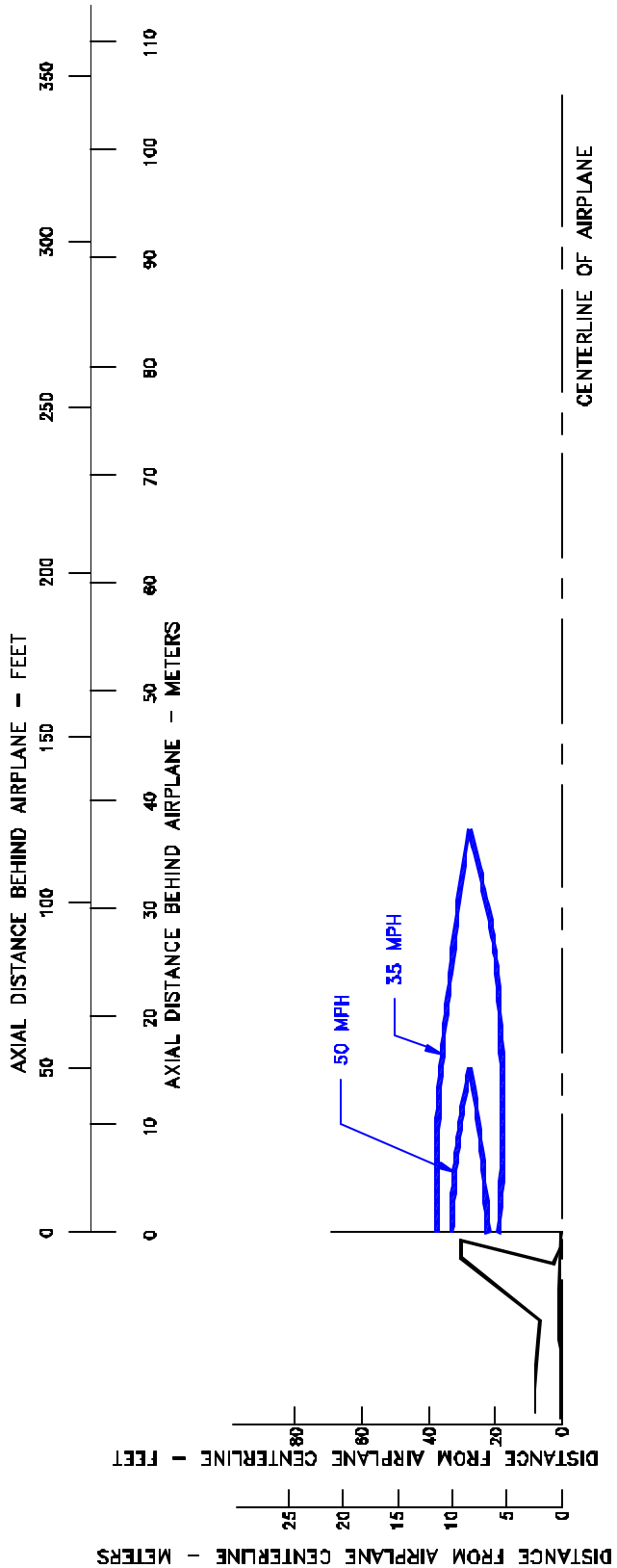


**6.1.2 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
 - IDLE THRUST**

MODEL 767-200, -200ER, -300 (CF6-80A, -80A2 ENGINES)

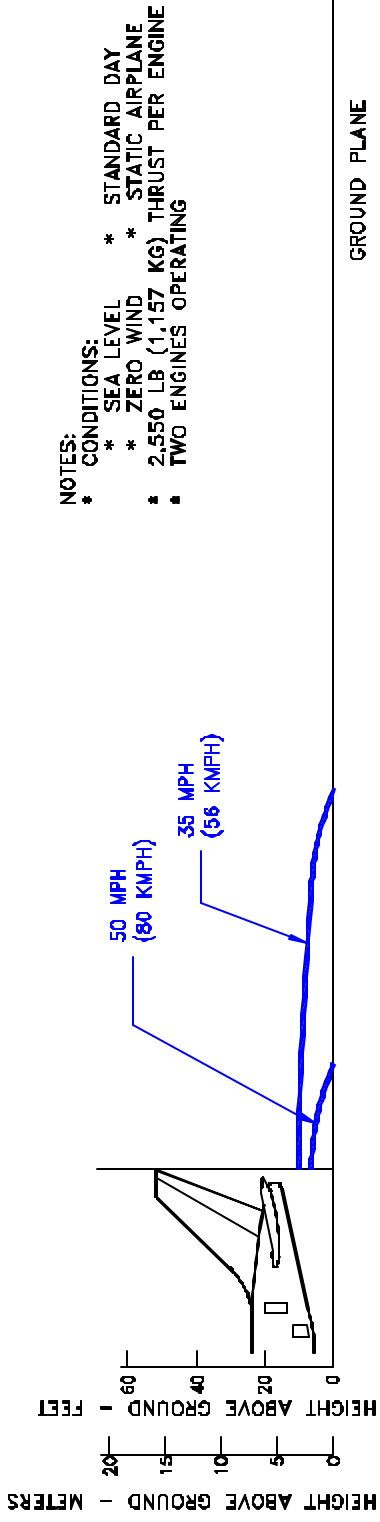


NOTES:
 * CONDITIONS:
 * SEA LEVEL * STANDARD DAY
 * ZERO WIND * STATIC AIRPLANE
 * 2,550 LB (1,157 KG) THRUST PER ENGINE
 * TWO ENGINES OPERATING

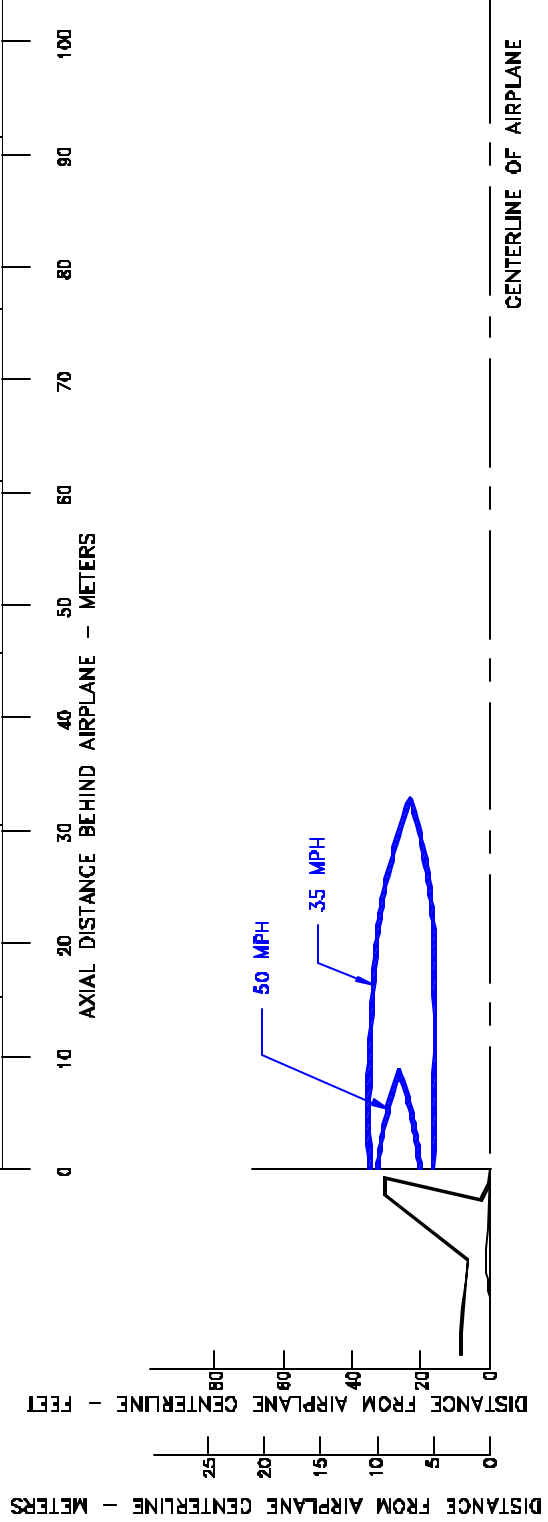


**6.1.3 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
 - IDLE THRUST**

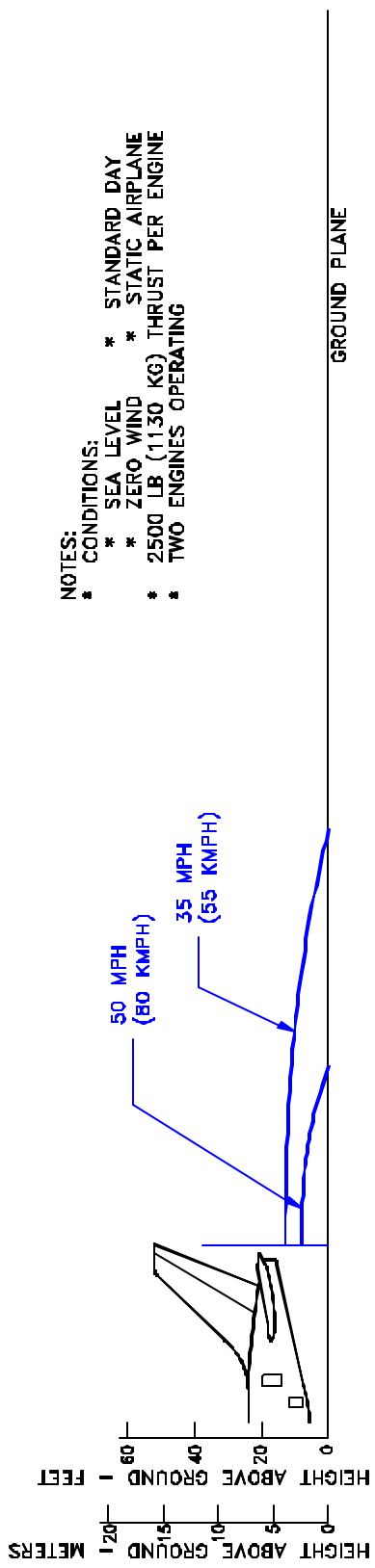
MODEL 767-300, -300ER, -300 FREIGHTER (PW4000, CF6-80C2 SERIES ENGINES)



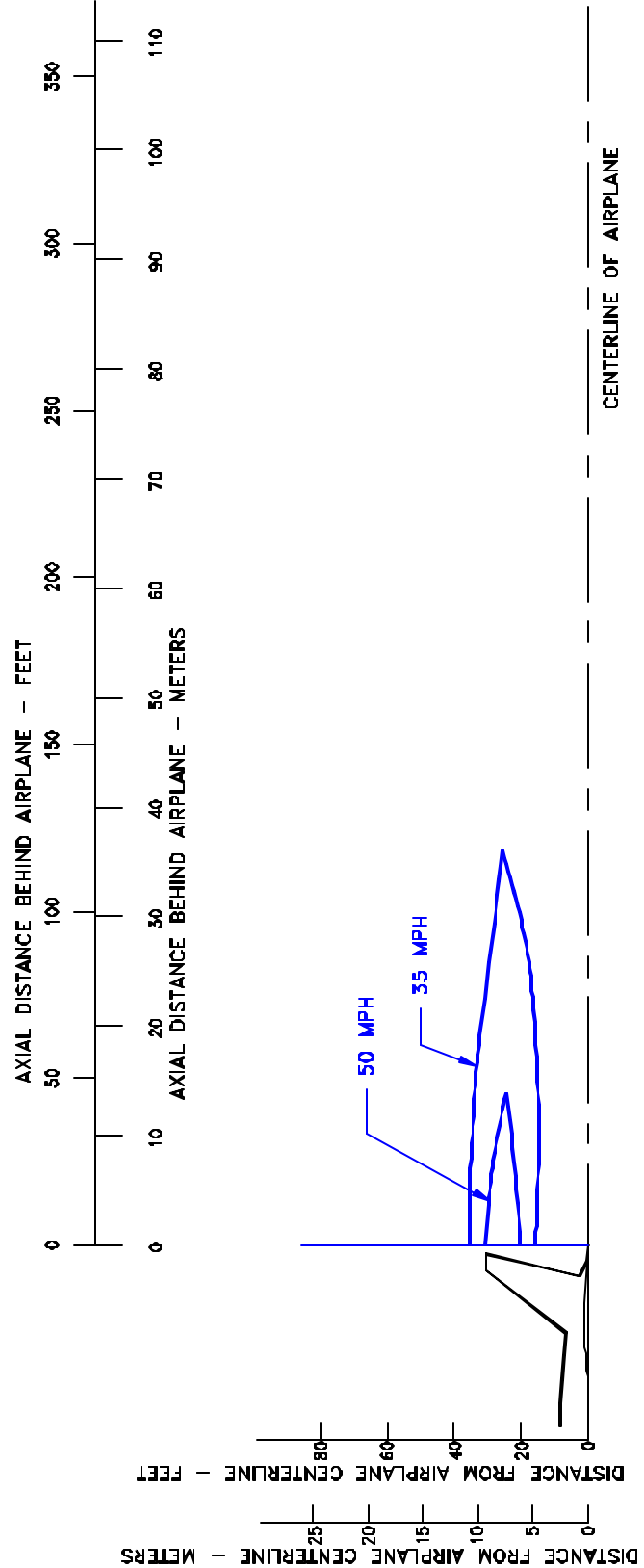
NOTES:
 * CONDITIONS:
 * SEA LEVEL * STANDARD DAY
 * ZERO WIND * STATIC AIRPLANE
 * 2,550 LB (1,157 KG) THRUST PER ENGINE
 * TWO ENGINES OPERATING



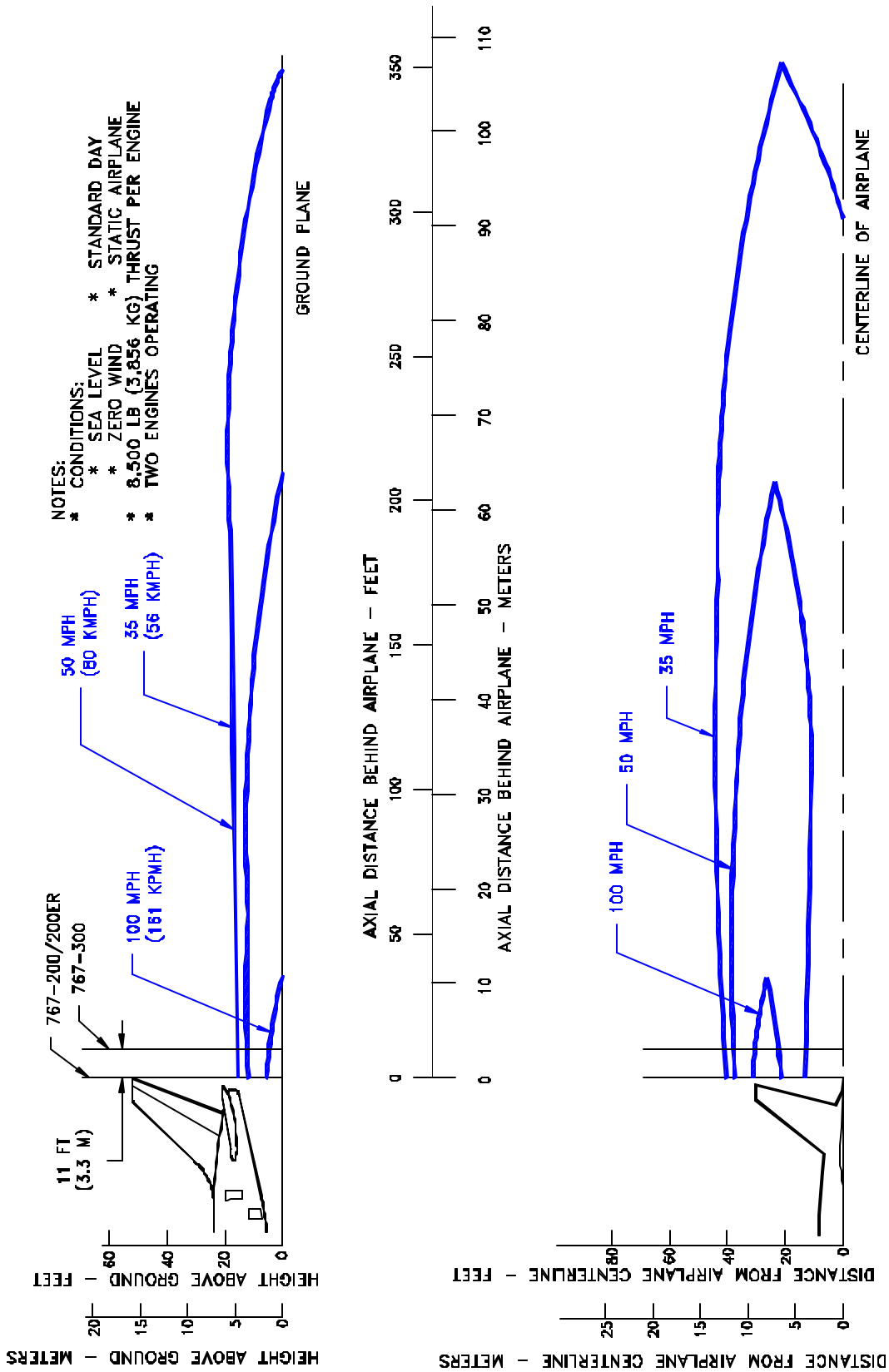
6.1.4 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
 - IDLE THRUST
 MODEL 767-300, -300ER, -300 FREIGHTER (RB211-524 ENGINES)



- NOTES:
- * CONDITIONS:
 - * SEA LEVEL * STANDARD DAY
 - * ZERO WIND * STATIC AIRPLANE
 - * 2500 LB (1130 KG) THRUST PER ENGINE
 - * TWO ENGINES OPERATING

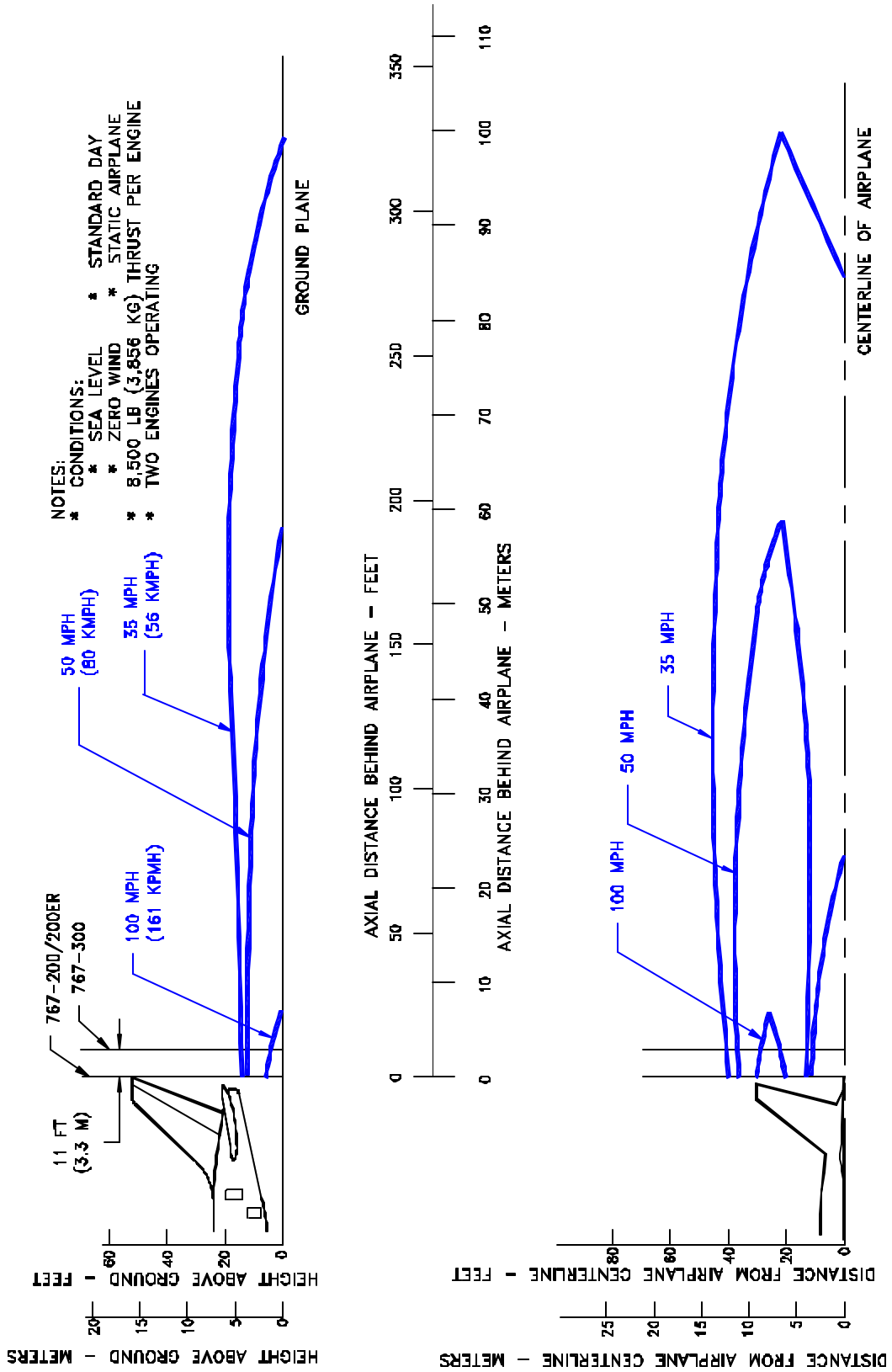


6.1.5 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- IDLE THRUST
MODEL 767-400ER (ALL ENGINES)

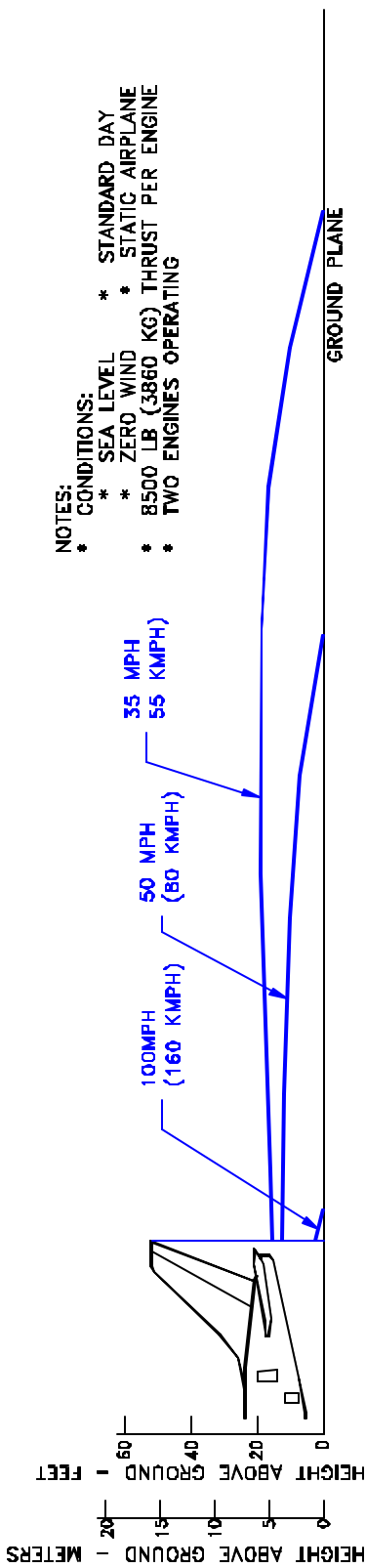


**6.1.6 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- LOW BREAKAWAY THRUST**

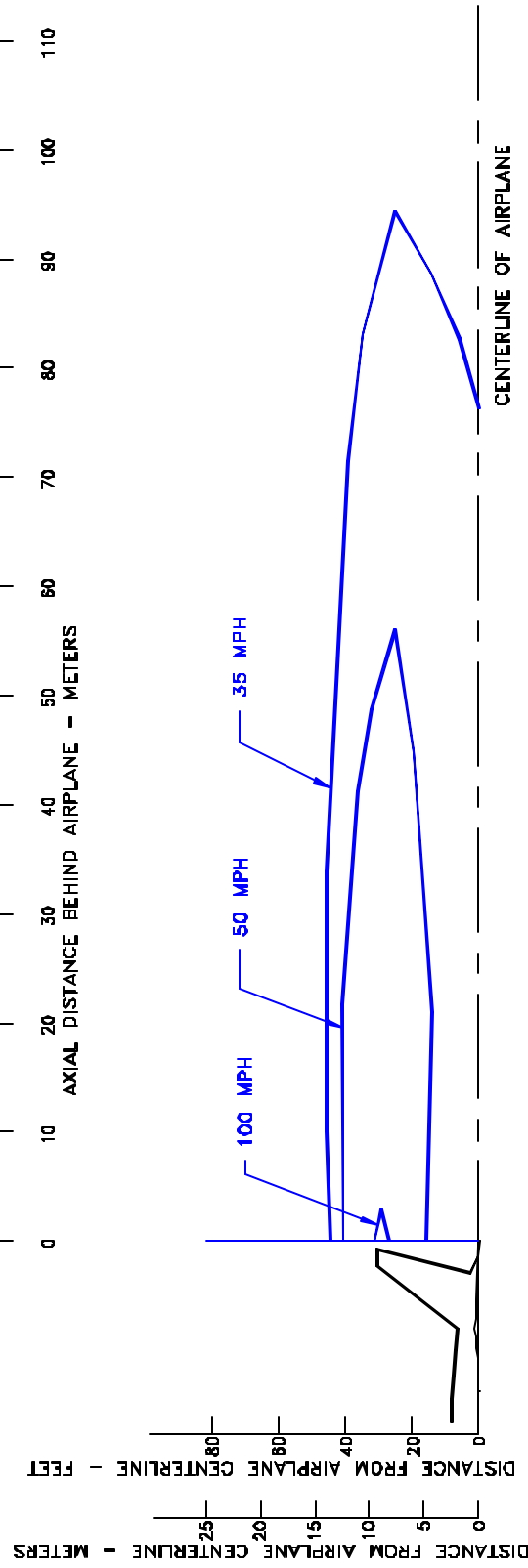
MODEL 767-200, -200ER, -300 (JT9D-7R4D, -7R4E ENGINES)



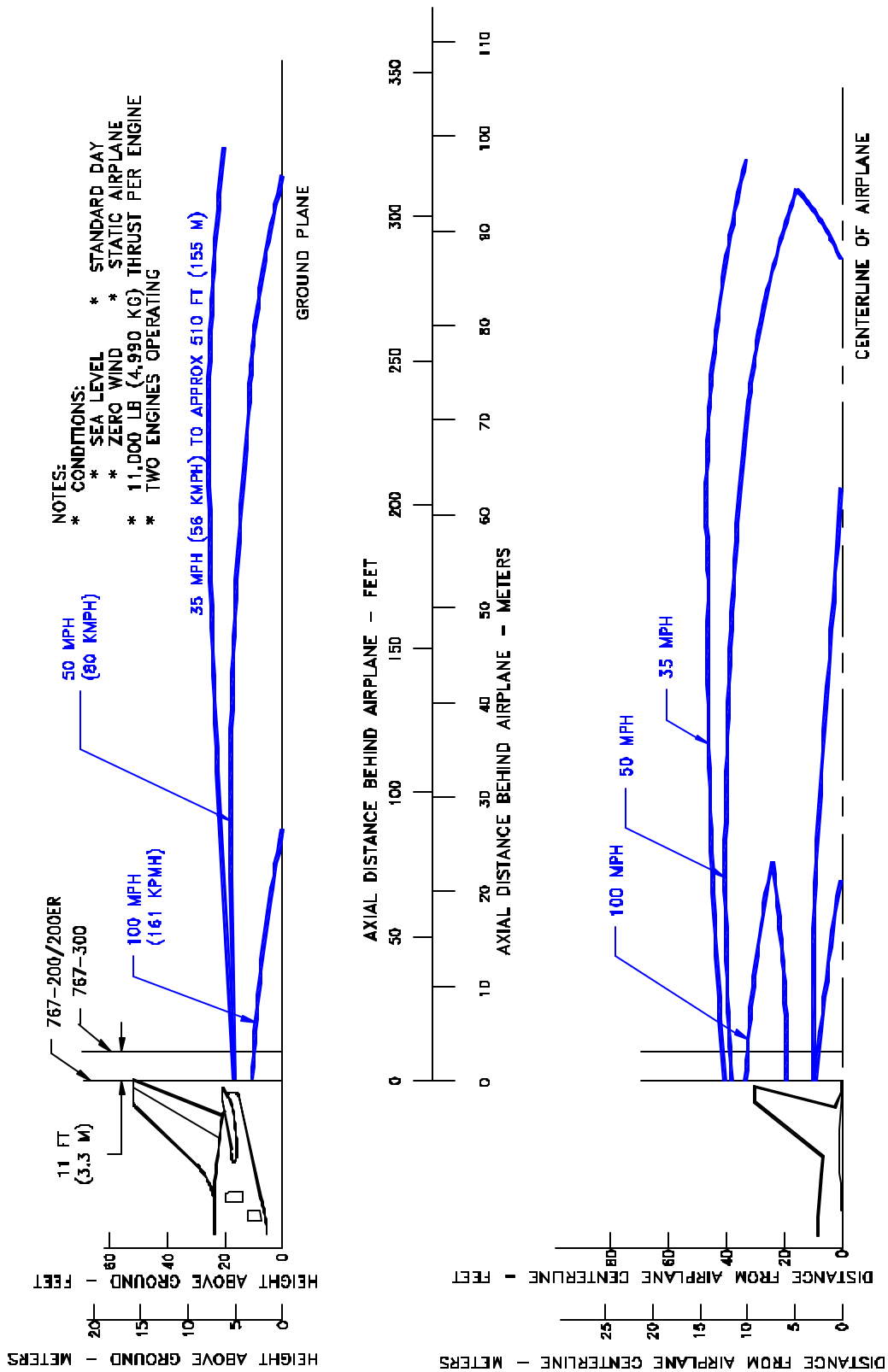
6.1.7 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- LOW BREAKAWAY THRUST
MODEL 767-200, -200ER, -300 (CF6-80A, -80A2 ENGINES)



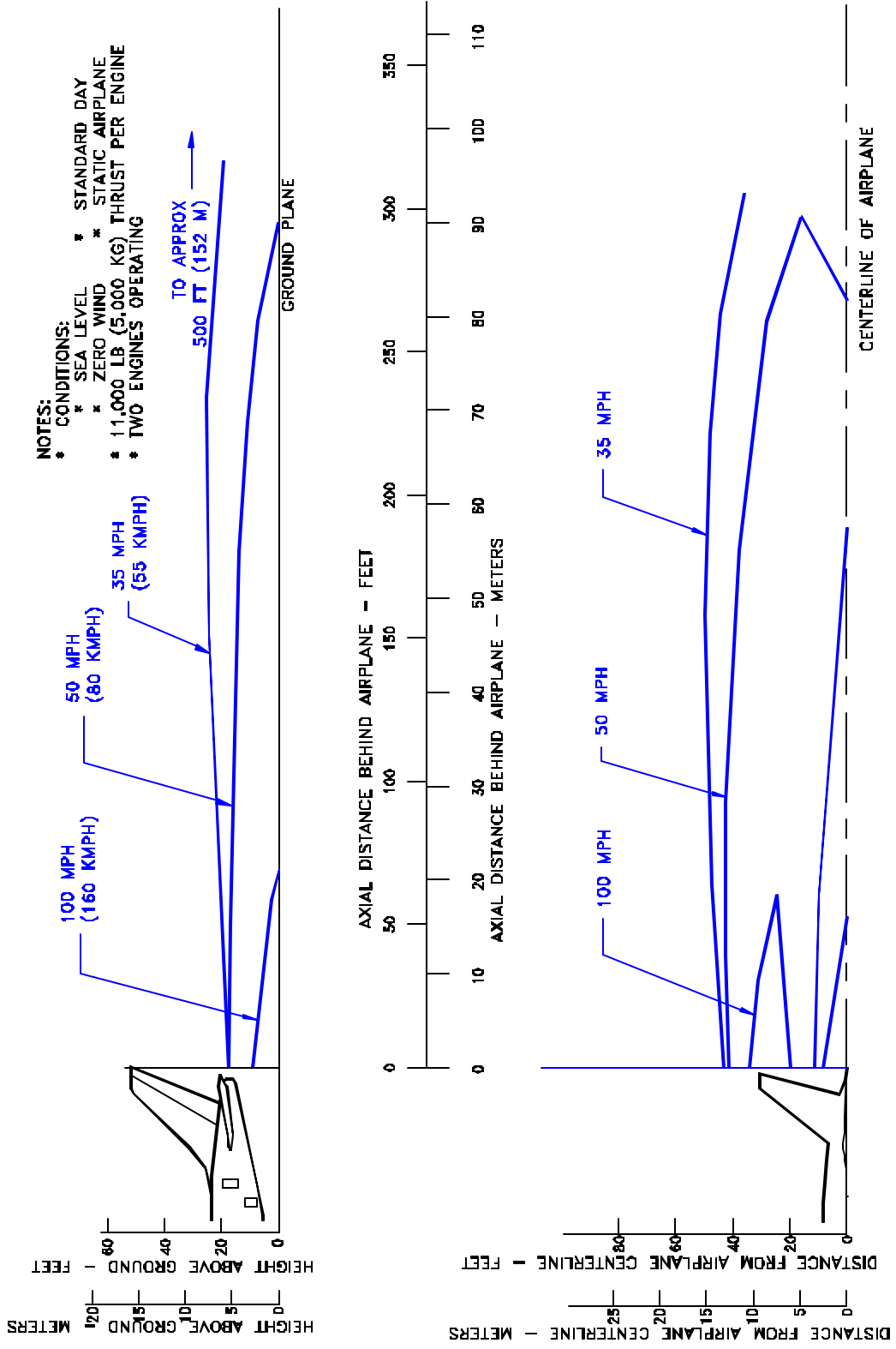
NOTES:
 * CONDITIONS:
 * SEA LEVEL * STANDARD DAY
 * ZERO WIND * STATIC AIRPLANE
 * 8500 LB (3860 KG) THRUST PER ENGINE
 * TWO ENGINES OPERATING



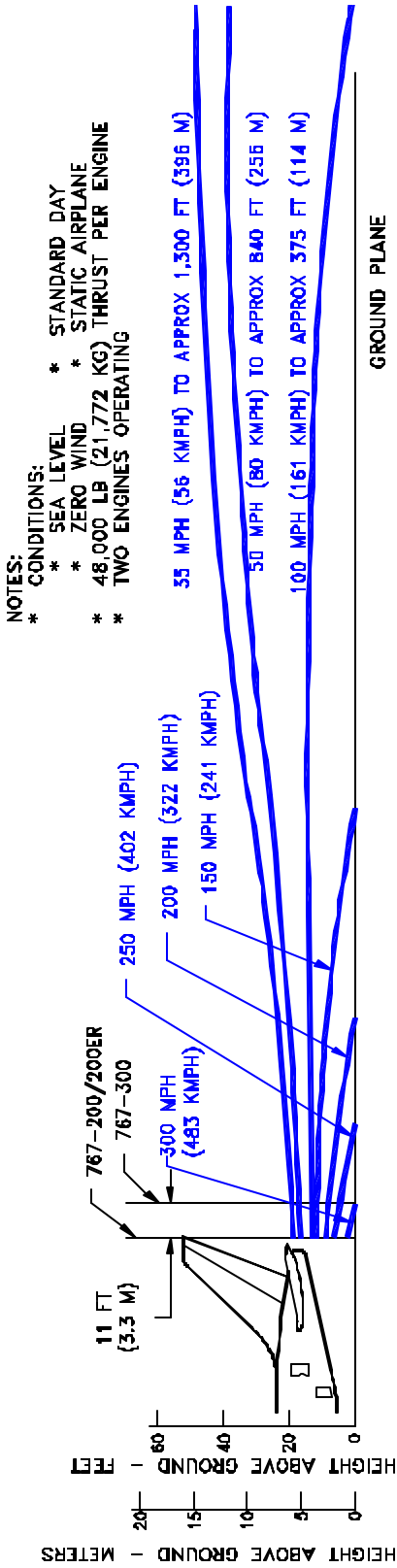
6.1.8 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- LOW BREAKAWAY THRUST
MODEL 767-400ER (ALL ENGINES)



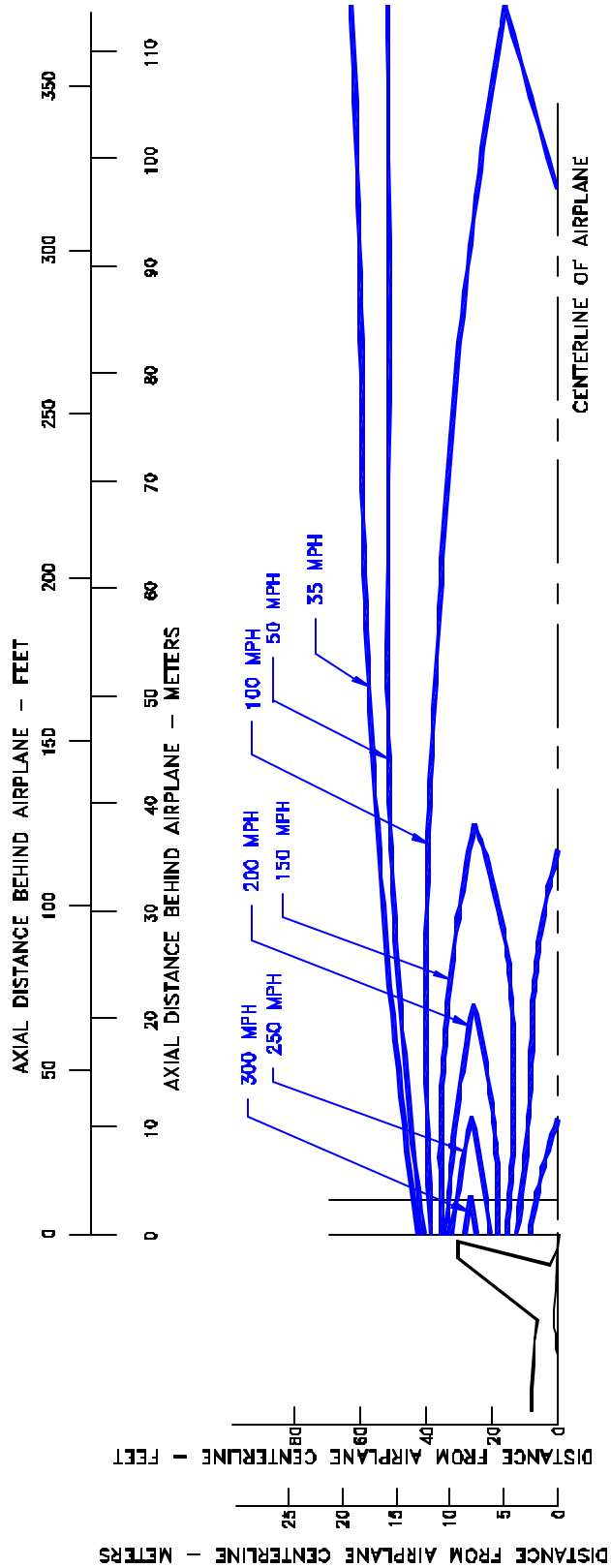
6.1.9 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- HIGH BREAKAWAY THRUST
MODEL 767-200, -200ER, 300, -300ER, -300 FREIGHTER (ALL ENGINES)



6.1.10 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- HIGH BREAKAWAY THRUST
MODEL 767-400ER (ALL ENGINES)

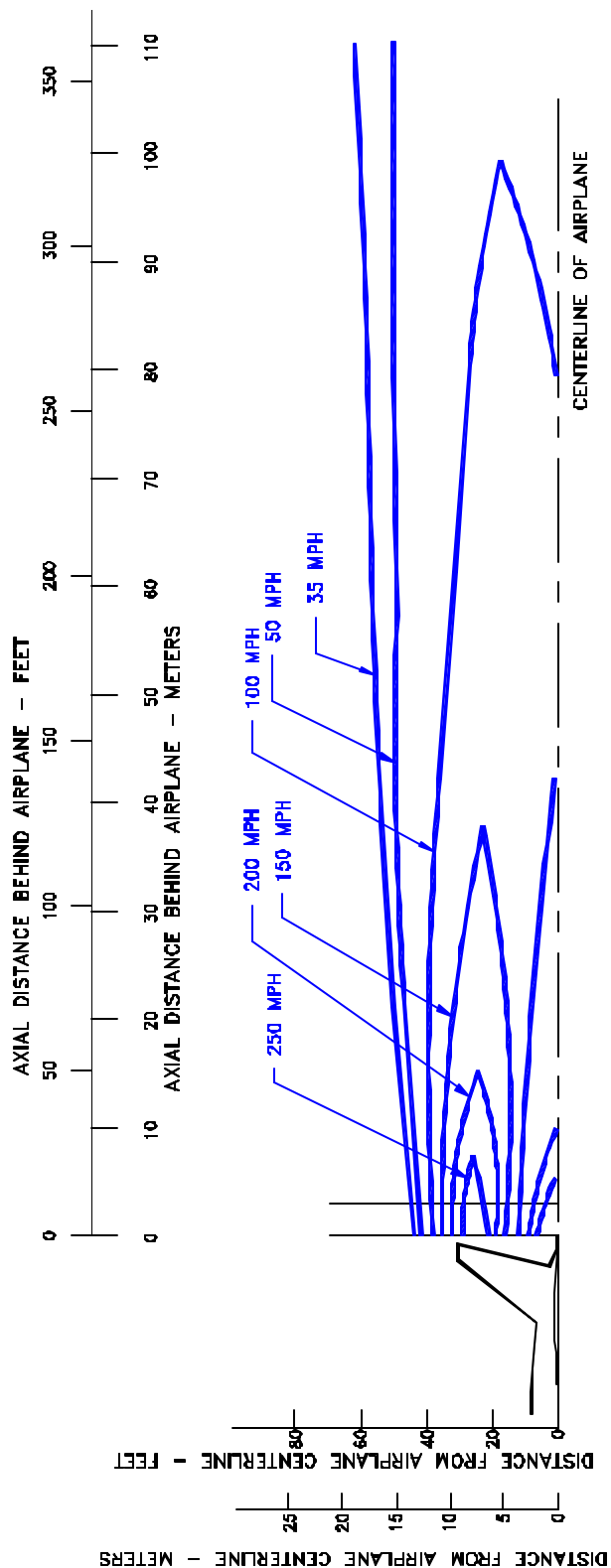
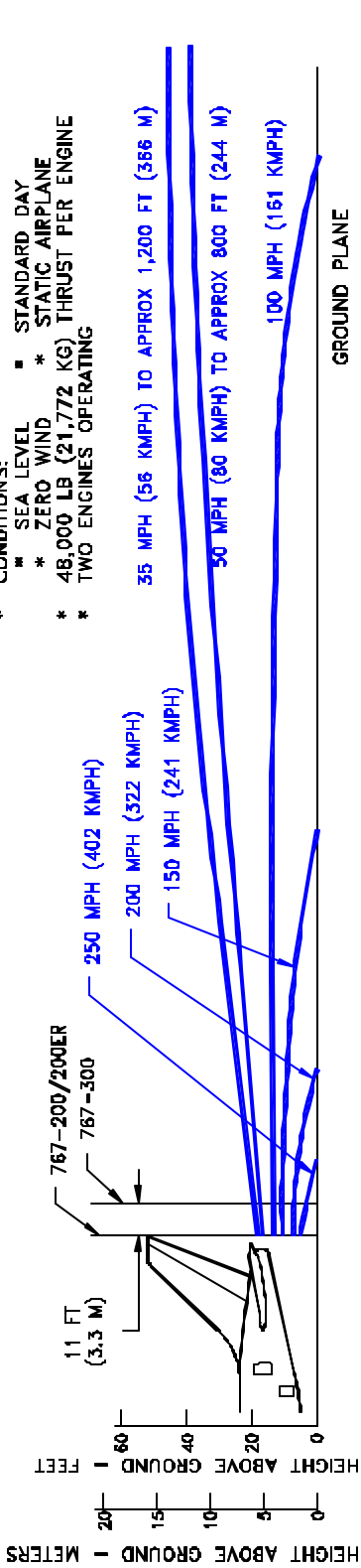


NOTES:
 * CONDITIONS:
 * SEA LEVEL * STANDARD DAY
 * ZERO WIND * STATIC AIRPLANE
 * 48,000 LB (21,772 KG) THRUST PER ENGINE
 * TWO ENGINES OPERATING

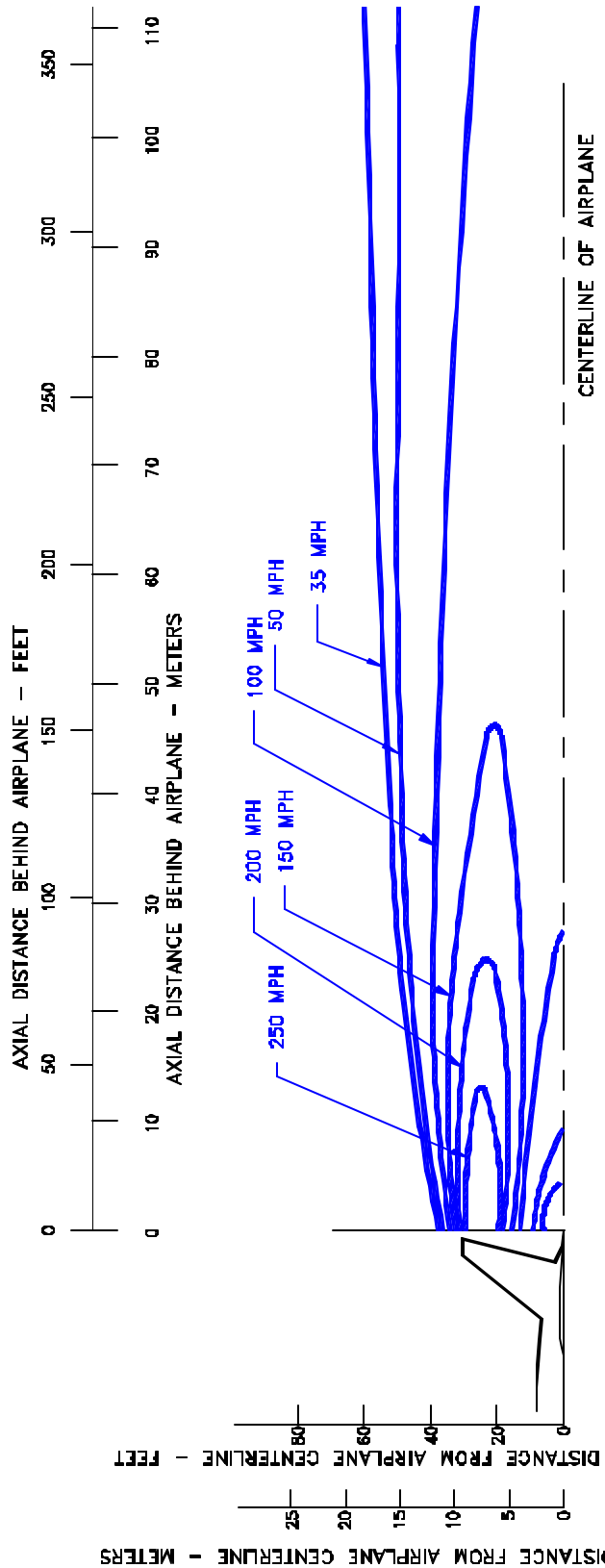
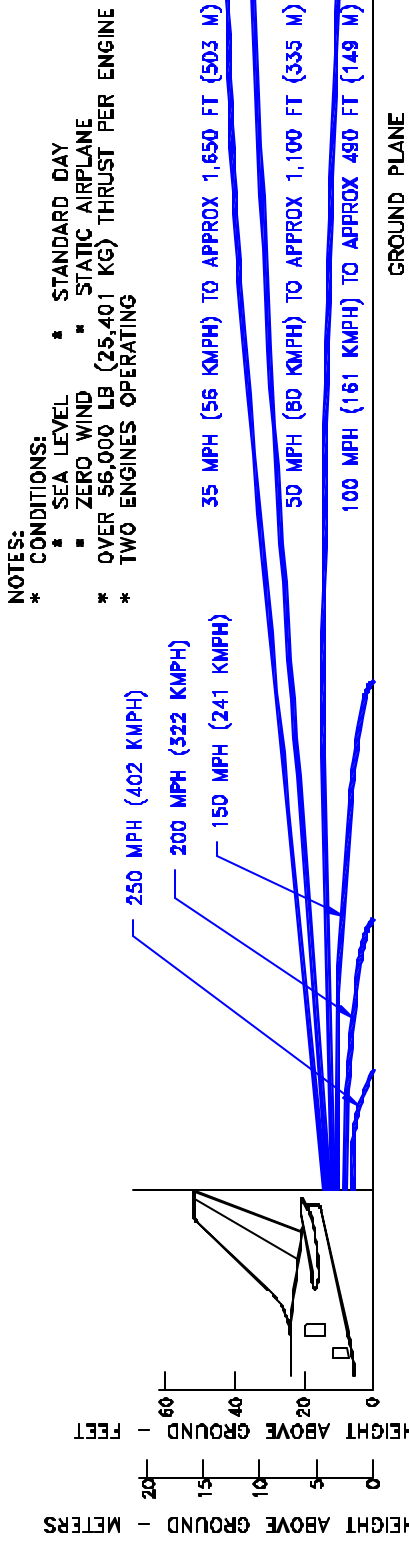


6.1.11 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- TAKEOFF THRUST
MODEL 767-200, -200ER, -300 (JT9D-7R4D, -7R4E ENGINES)

- NOTES:
 * CONDITIONS:
 * SEA LEVEL * STANDARD DAY
 * ZERO WIND * STATIC AIRPLANE
 * 48,000 LB (21,772 KG) THRUST PER ENGINE
 * TWO ENGINES OPERATING

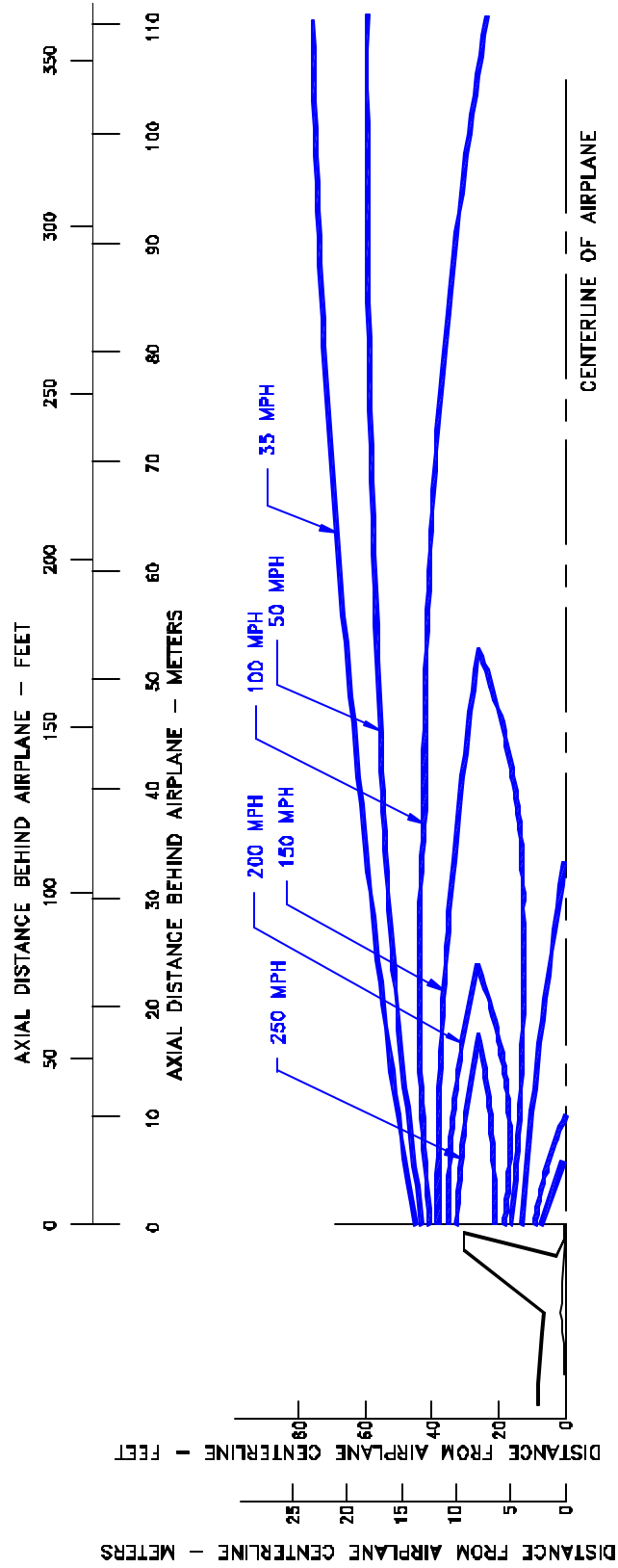
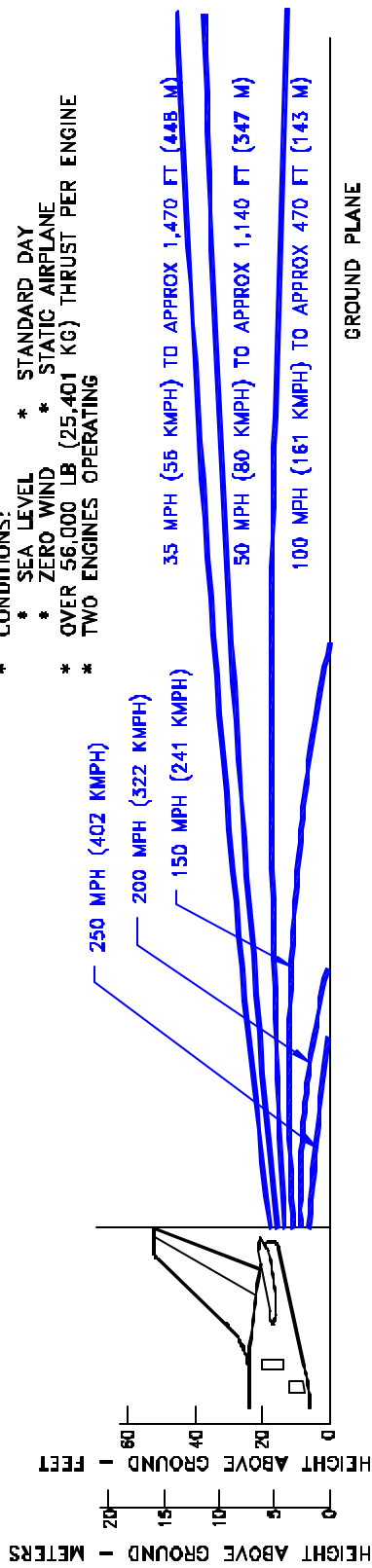


6.1.12 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- TAKEOFF THRUST
MODEL 767-200, -200ER, -300 (CF6-80A, -80A2 ENGINES)



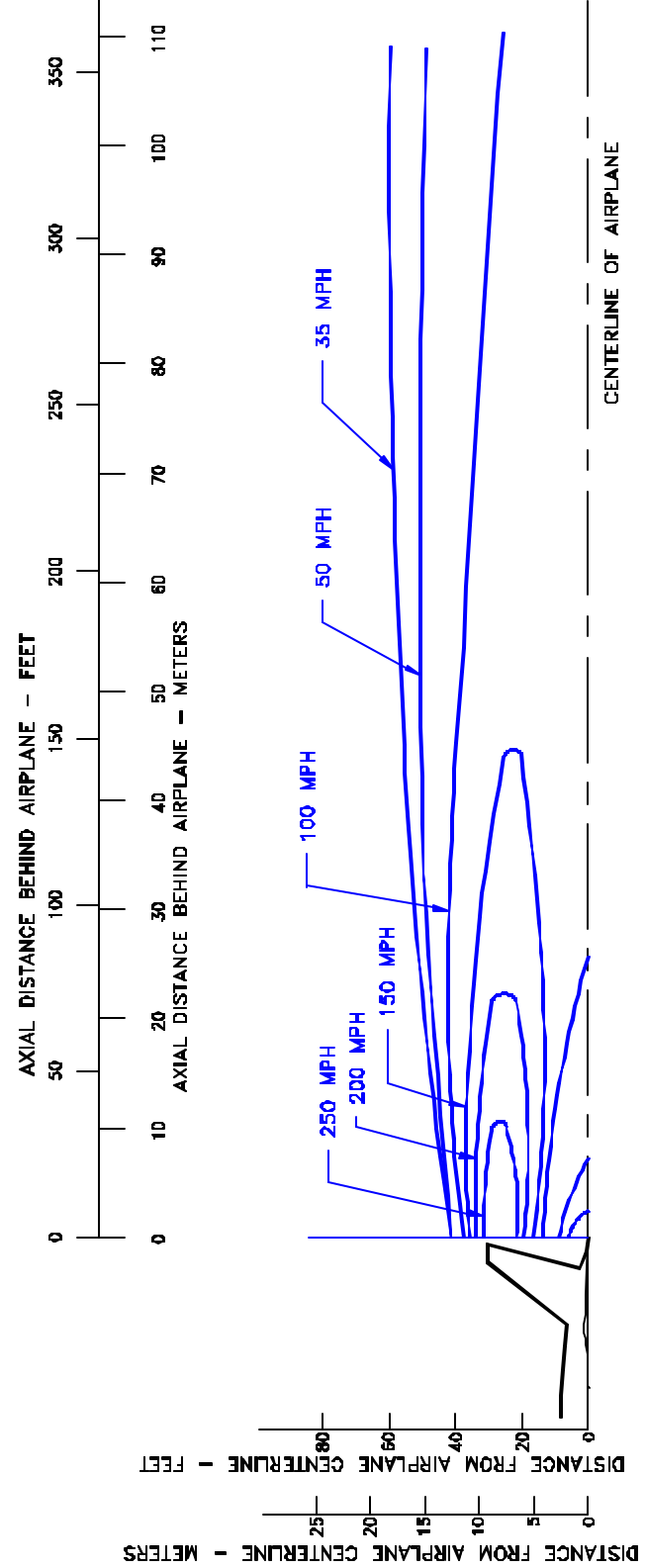
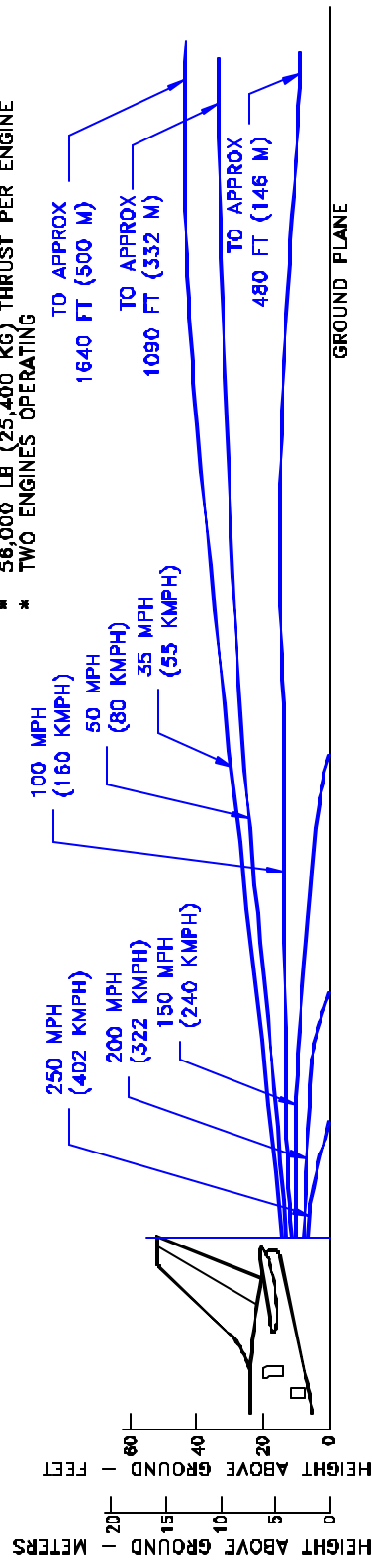
6.1.13 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
- TAKEOFF THRUST
 MODEL 767-300ER, -300 FREIGHTER (PW4056, CF6-80C2 ENGINES)

- NOTES:
 * CONDITIONS:
 * STANDARD DAY
 * SEA LEVEL
 * ZERO WIND
 * STATIC AIRPLANE
 * OVER 56,000 LB (25,401 KG) THRUST PER ENGINE
 * TWO ENGINES OPERATING

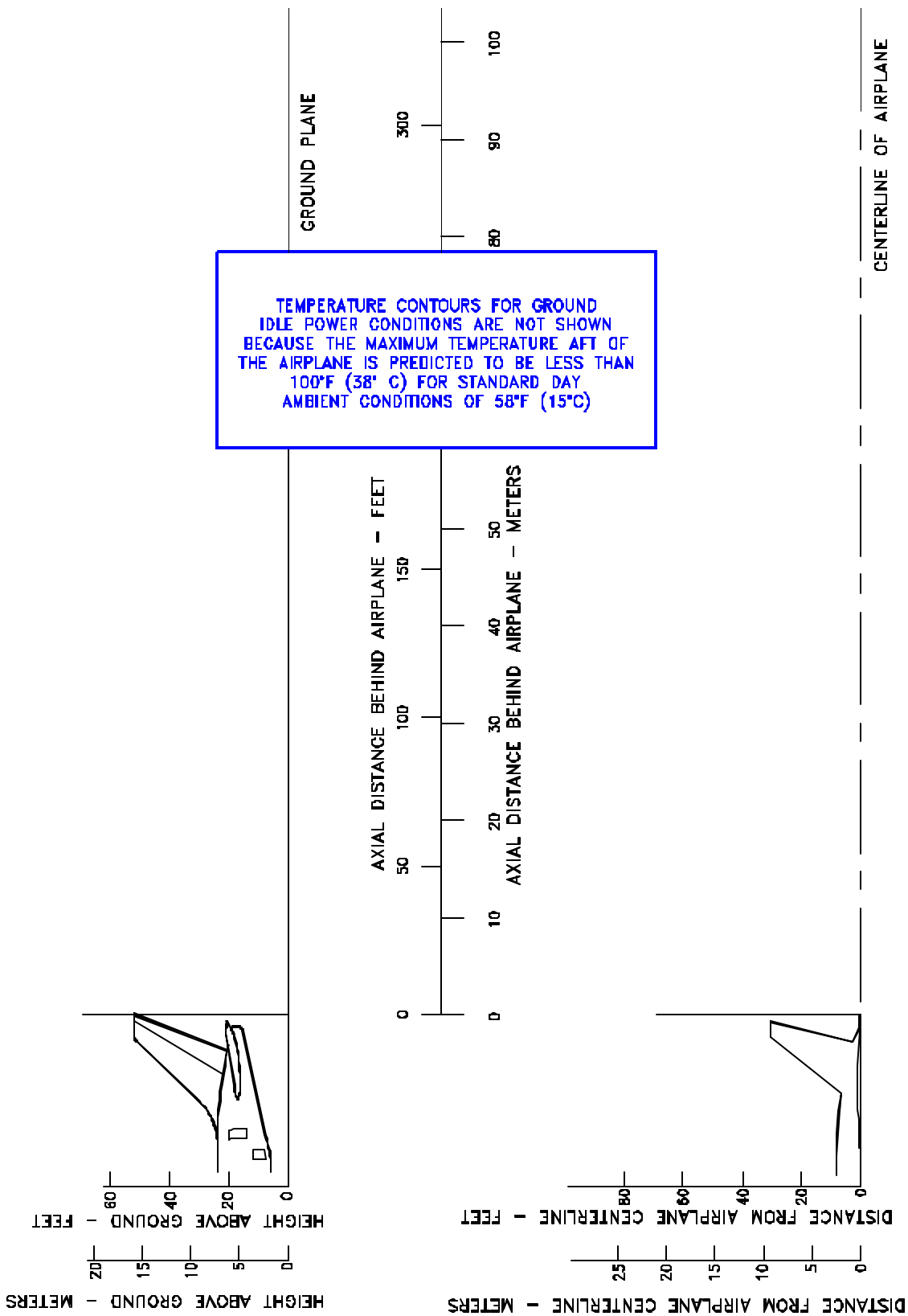


6.1.14 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
 - TAKEOFF THRUST
 MODEL 767-300, -300ER, -300 FREIGHTER (RB211-524 ENGINES)

NOTE:
 * CONDITIONS:
 * SEA LEVEL * STANDARD DAY
 * ZERO WIND * STATIC AIRPLANE
 * 56,000 LB (25,400 KG) THRUST PER ENGINE
 * TWO ENGINES OPERATING

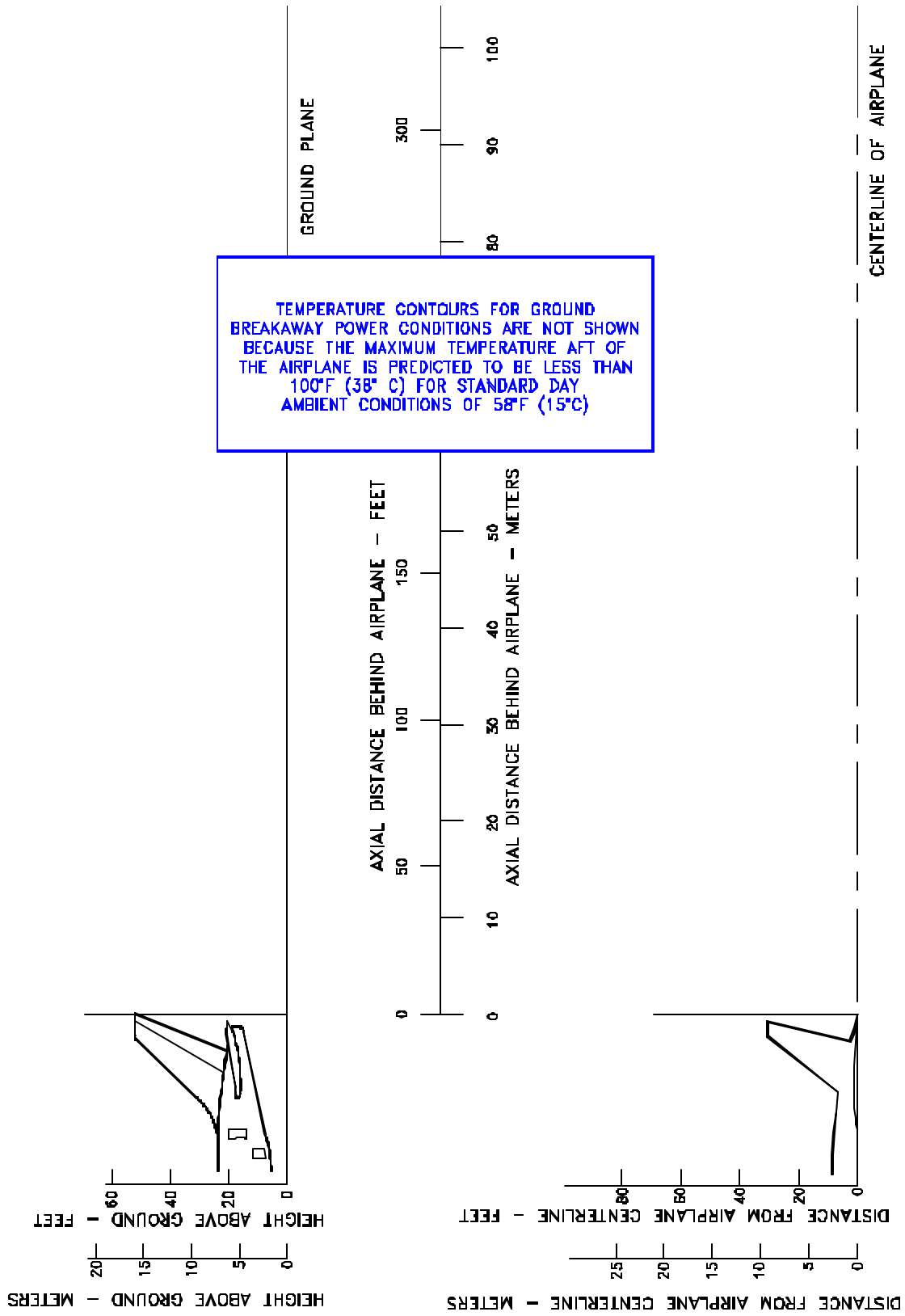


6.1.15 PREDICTED JET ENGINE EXHAUST VELOCITY CONTOURS
 - TAKEOFF THRUST
 MODEL 767-400ER (ALL ENGINES)



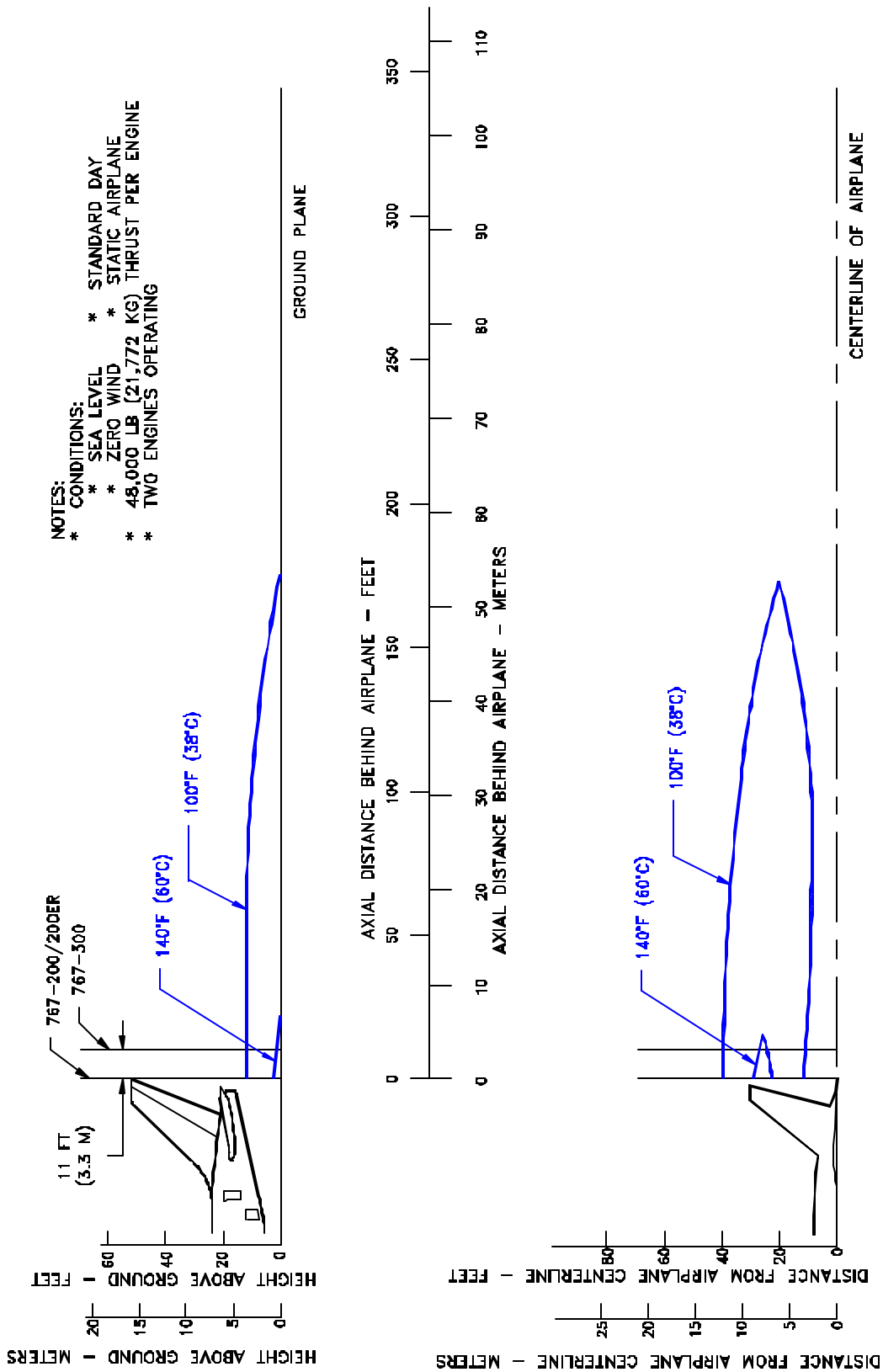
**6.1.16 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS
 - IDLE THRUST**

MODEL 767—200, -200ER, -300, -300ER, -300 FREIGHTER, -400ER (ALL ENGINES)

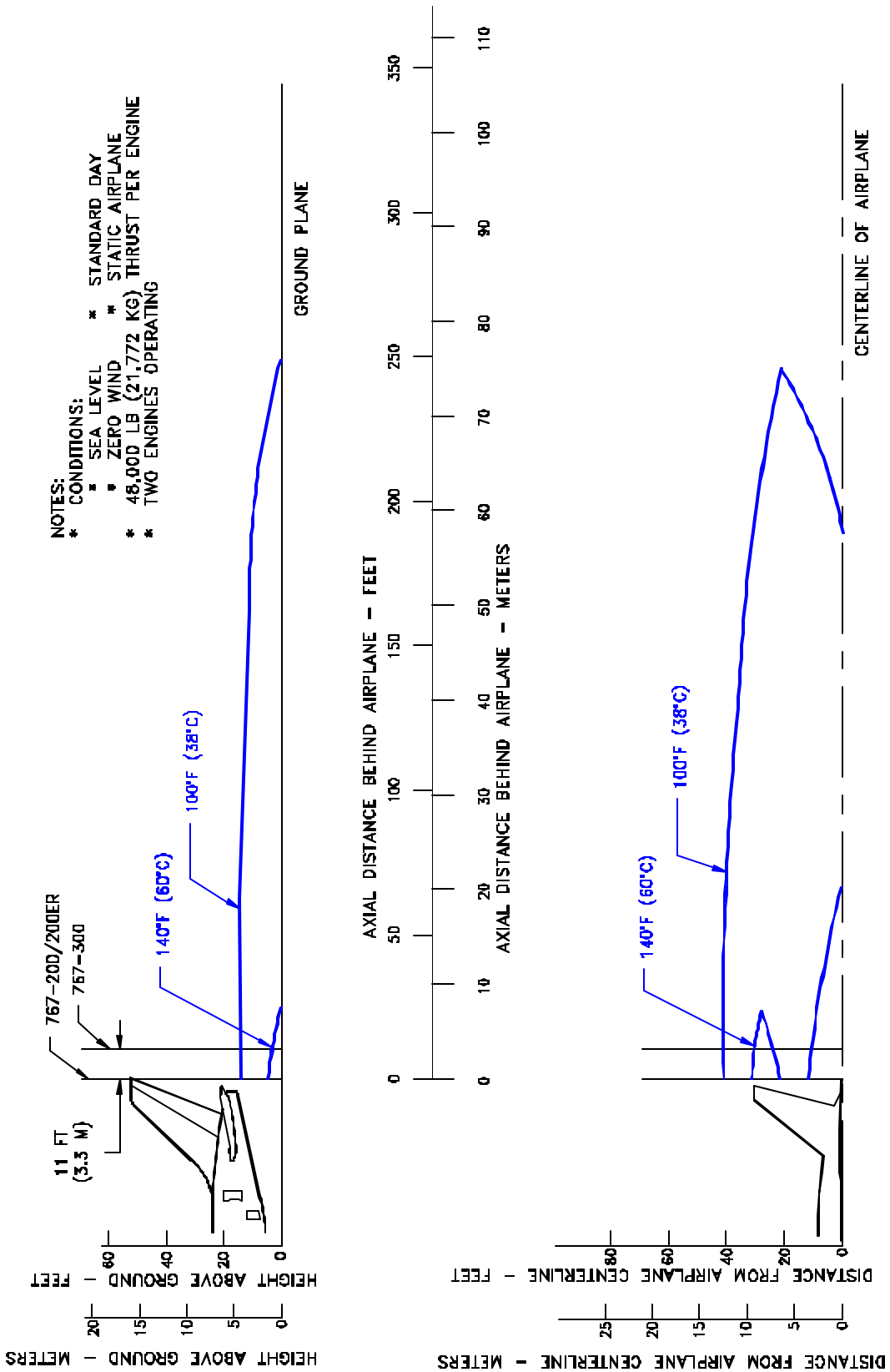


**6.1.17 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS
- BREAKAWAY THRUST**

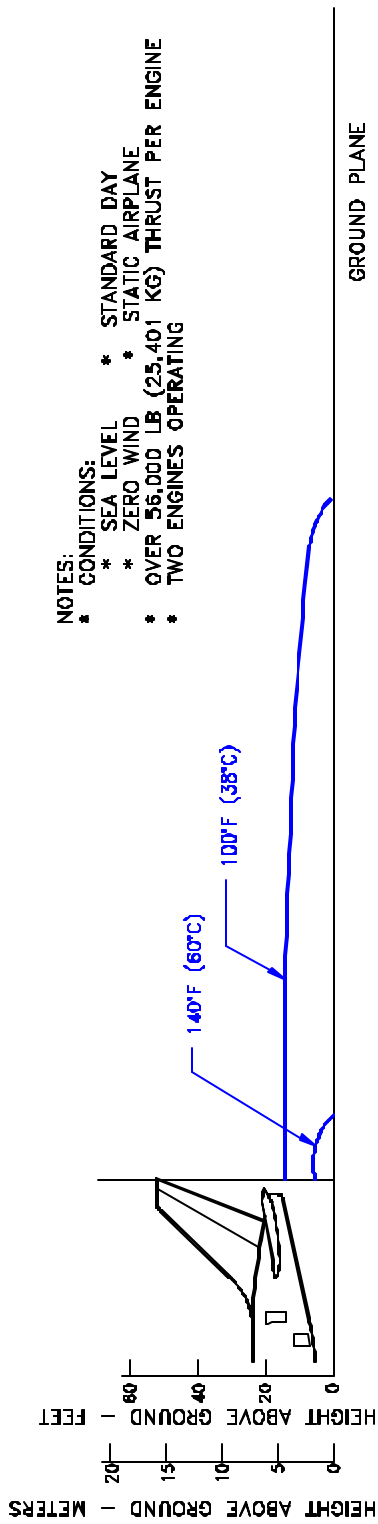
MODEL 767—200, -200ER, -300, -300ER, -300 FREIGHTER, -400ER (ALL ENGINES)



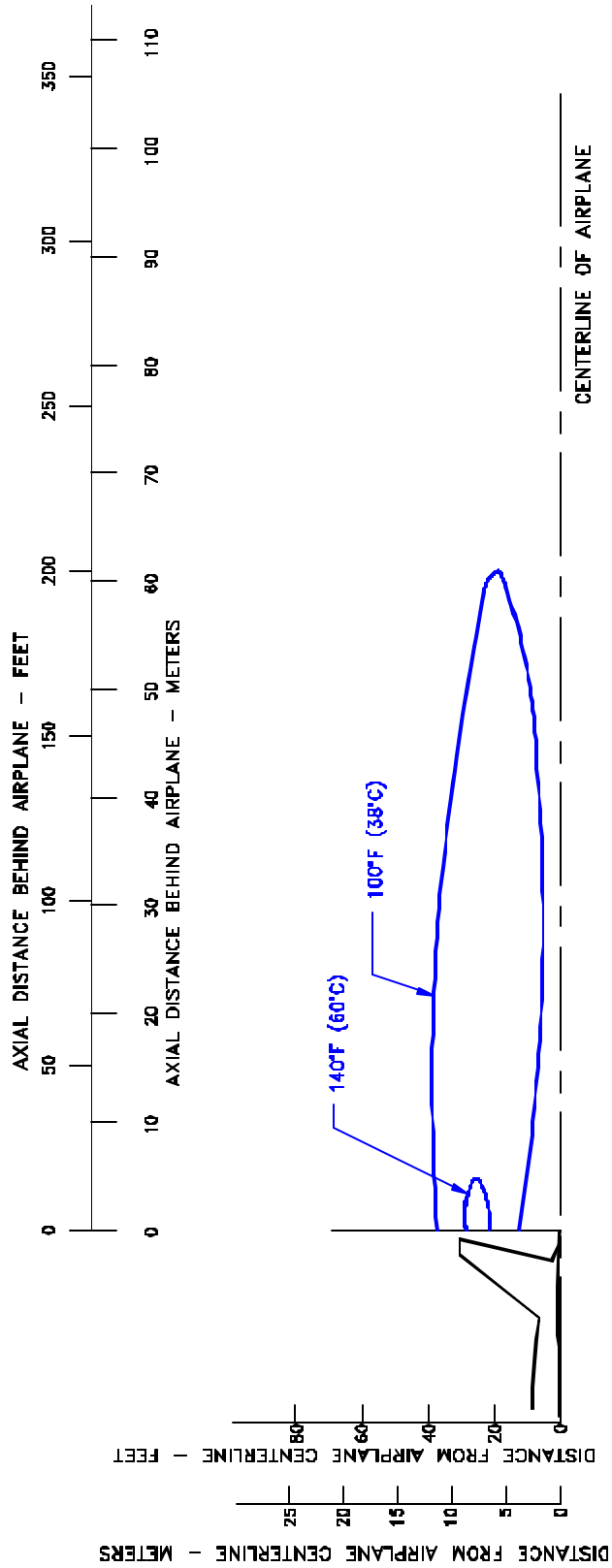
6.1.18 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS - TAKEOFF THRUST
 MODEL 767-200, -200ER, -300 (JT9D-7R4E, -7R4E ENGINES)



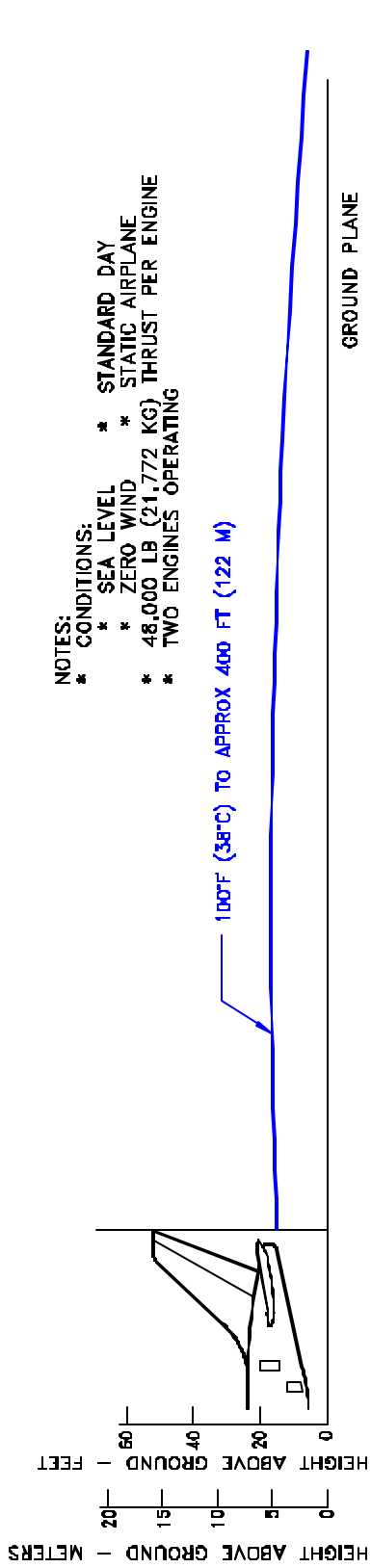
**6.1.19 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS
 - TAKEOFF THRUST**
 MODEL 767-200, -200ER, -300 (CF6-80A, -80A2 ENGINES)



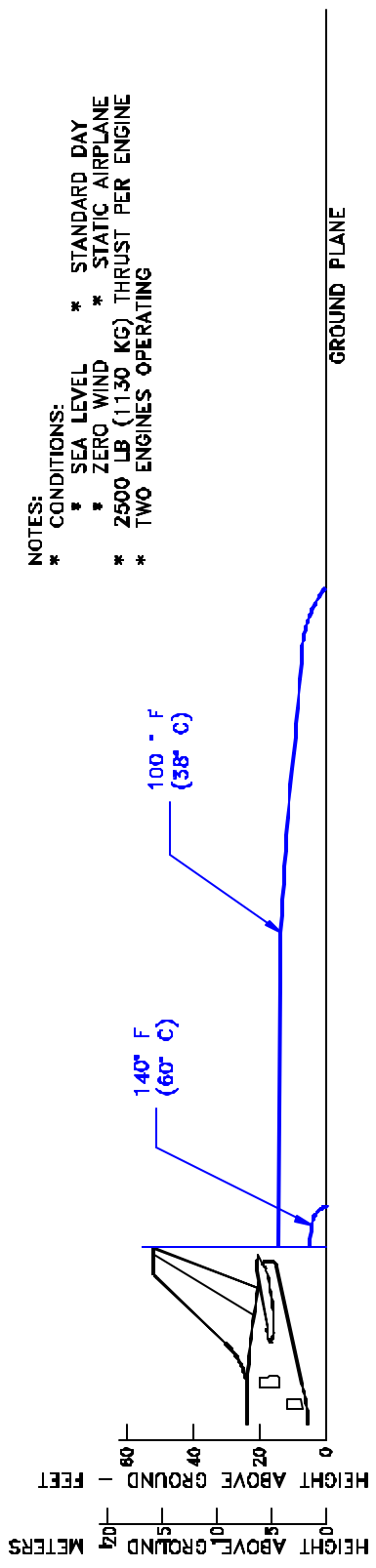
- NOTES:
- * CONDITIONS:
 - * SEA LEVEL * STANDARD DAY
 - * ZERO WIND * STATIC AIRPLANE
 - * OVER 56,000 LB (25,401 KG) THRUST PER ENGINE
 - * TWO ENGINES OPERATING



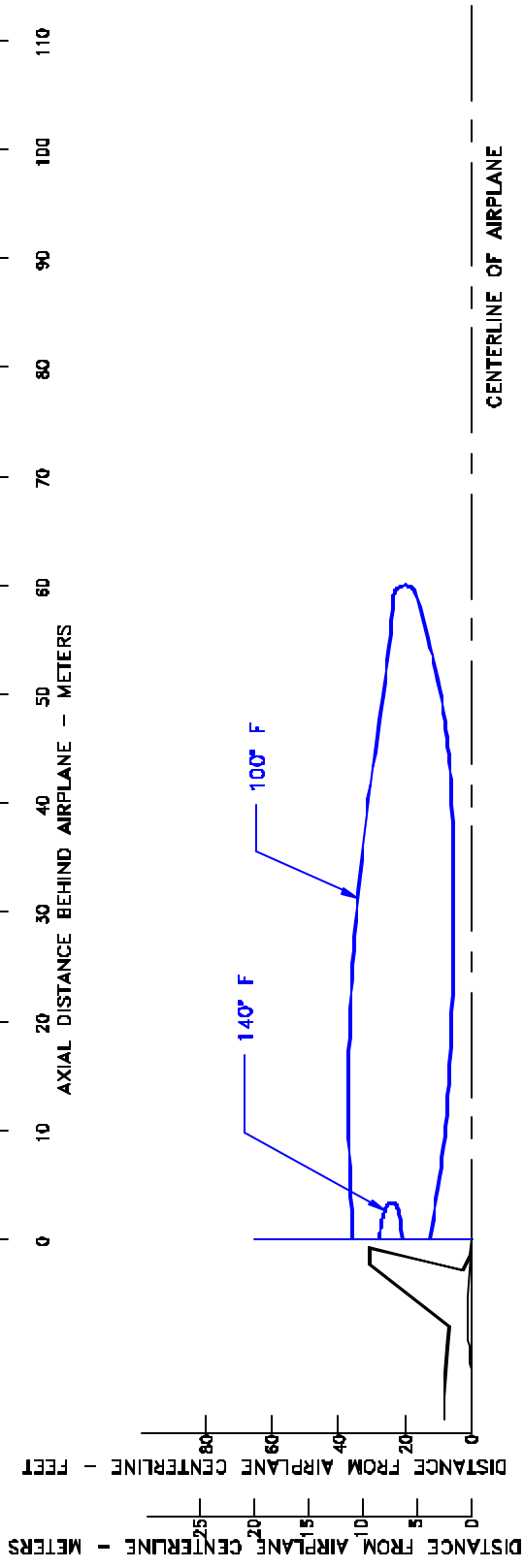
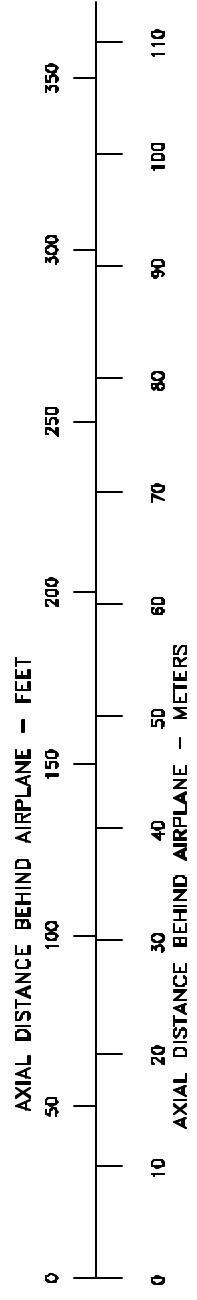
**6.1.20 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS
- TAKEOFF THRUST**
MODEL 767-300ER, -300 FREIGHTER (PW4000, CF6-80C2 ENGINES)



**6.1.21 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS
 - TAKEOFF THRUST**
 MODEL 767-300, -300ER, -300 FREIGHTER (RB211-524 ENGINES)



NOTES:
 * CONDITIONS:
 * SEA LEVEL * STANDARD DAY
 * ZERO WIND * STATIC AIRPLANE
 * 2500 LB (1130 KG) THRUST PER ENGINE
 * TWO ENGINES OPERATING



6.1.22 PREDICTED JET ENGINE EXHAUST TEMPERATURE CONTOURS
 - TAKEOFF THRUST
 MODEL 767-400ER (ALL ENGINES)

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 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 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.

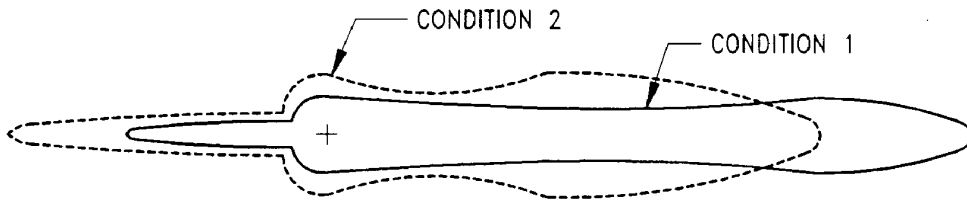
Condition 1

Landing

Takeoff

Maximum Structural Landing Weight
 10-knot Headwind
 3^o Approach
 84 °F
 Humidity 15%

Maximum Gross Takeoff Weight
 Zero Wind
 84 °F
 Humidity 15%



Condition 2

Landing:

Takeoff:

85% of Maximum Structural Landing Weight
 10-knot Headwind
 3^o Approach
 59 °F
 Humidity 70%

80% of Maximum Gross Takeoff Weight
 10-knot Headwind
 59 °F
 Humidity 70%

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.