PART 3 - TAKEOFF

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INTRODUCTION

The takeoff performance data is important in the operation of the aircraft, since payload and range can be seriously limited by the maximum weight limitations imposed by the takeoff conditions.

Generally, the runway length available imposes the most rigorous limits on the takeoff weight. However, obstacle height and the single-engine climb performance can also determine the weight limit.

The factors which affect the takeoff and climb out operations include pressure altitude, ambient temperature, wind speed, runway slope, and the type and state of the runway.

This part of the Appendix presents the performances during takeoff and the limitations applicable for two takeoff techniques: normal takeoff and short-runway takeoff.

Normal takeoff is that done assuming an engine failure during takeoff for the calculation of the maximum takeoff weight (MTOW) limited by performance. The takeoff speeds (V_R, V_2, V_{FTO}) maintain the same stall safety margins as for FAR-25 operation. The operating criteria are basically defined by MIL-PRF-7700F. In this way, a high degree of safety for the protection of the aircraft, crew and cargo is assured. During normal takeoff the flaps are set to TO (10°).

Short-field takeoff is that done at takeoff speeds very close to the power-off stall speeds. When a military aircraft is required to operate from short runways where maximum payload is required, the aircraft is operated with the short-field takeoff technique, which reduces the safety factors. Engine failure during takeoff is not assumed for the calculation of the maximum takeoff weight (MTOW) limited by the runway length or obstacle clearance. However, the data for takeoff with both engines operative are also available, and it is for the operator to decide whether to take the possibility of an engine failure during takeoff into account, depending on the urgency of the operation or whether it is an emergency. Short-field takeoff can be carried out with the flaps at the TO or APP position (10° and 15°, respectively).

Takeoff Configuration

The takeoff configuration (initial) for normal or short-field takeoff is:

- Takeoff power on both engines. PRS selector in TOGA position.
- Autofeather system: armed.
- APR/AFU system: armed.
- ECS: off.
- Engine anti-ice: on or off (as required).
- Antiskid system: operative.
- RBS system: operative.

The effect of turning on the anti-ice system on takeoff performance is negligible. It does not affect the takeoff power available to the aircraft.

DEFINITIONS APPLICABLE TO TAKEOFF

Critical Engine Failure Speed (V_{CEF})

This is based on the critical field length, and is the speed at which one engine can fail and the same distance is required to either continue the takeoff or to stop the aircraft.

Takeoff Decision Speed (V_{EF} or V_1)

This is the speed selected by the pilot before takeoff such that if an engine failure occurs before the decision speed is reached the takeoff should be aborted. If an engine failure occurs at a speed higher than the decision speed, the takeoff should be continued.

Liftoff Speed (V_{LOF})

This is the speed at which the main gear leaves the ground.

Rotation Speed (V_R)

This is speed at which rotation to takeoff attitude begins.

Initial Climb Speed (V_2)

This is the speed recommended for obstacles clearance in a continued takeoff after engine failure. This speed must be reached and maintained before the aircraft reaches 50 feet height above the runway.

Speed at Obstacle Clearance Height (V_{SCR})

This is the speed at which the aircraft reaches 50 feet height above the runway with either one or two engines operative.

Flap Retraction Speed ($V_{TO\text{-}UP}$)

This is the speed recommended for the retraction of the flaps from takeoff configuration to the fully up position.

Flap Retraction Speed ($V_{APP\text{-}UP}$)

This is the speed recommended for the retraction of the flaps from approach configuration to the fully up position.

Final Segment Speed (V_{FTO})

This is the final segment speed of a continued takeoff after an engine failure with the flaps in the UP position.

Refusal Speed (V_{RE})

This is based on the runway available and is the maximum speed to which the aircraft can accelerate with takeoff power on both engines, suffer an engine failure, and then stop within the remainder of the available runway length with one engine inoperative and the other at ground idle power.

Ground Minimum Control Speed (V_{MCG})

This is the minimum speed during the takeoff run at which the most critical engine for directional control can fail, and, with the operative engine at maximum power, a straight path on the runway surface can be achieved and maintained using the primary flight controls.

Air Minimum Control Speed (V_{MCA})

This is the minimum airborne speed at which the most critical engine for directional control can fail, and, with the operative engine at maximum power, a straight flight path at that speed can be maintained, with maximum rudder deflection and no more than 75% of the available aileron control, or 5° of bank.

Takeoff Ground Run (TOGR)

This is the horizontal distance from the brake release point to the point at which the aircraft leaves the ground, with both engines operative.

Takeoff Distance to 50 feet (TOD)

This is the horizontal distance from the brake release point to the point at which the aircraft reaches 50 feet height over the takeoff surface, with both engines operative.

50 ft Obstacle Clearance Distance

This is the horizontal distance from the brake release point to the point at which the aircraft reaches 50 feet height over the takeoff surface, with engine failure at V_{CEF}.

Critical Field Length (CFL)

This is the length of runway required to accelerate the aircraft with all engines operating to the critical engine failure speed, experience a most critical engine failure and then continue to takeoff or stop.

TYPE OF RUNWAY SURFACE (RCR AND RFI)

The basic takeoff performance data shown in this part is only valid for a dry paved runway. However, correction grids are provided showing the increases in distances required when the aircraft is operated on unpaved runways or paved hard runways partially or completely covered with water, snow or ice.

Ground performance data for unpaved surfaces apply either hard runway surfaces (CBR of at least 7, and a modulus of soil reaction, K, of at least 180 pci) or soft runways (CBR up to 2 and a modulus K up to 50 pci).

The following parameters are used in the correction grids:

- Runway condition reading (RCR). This is a value related to the average braking effectiveness on the airplane on a particular runway surface. The recommended RCR value is used when scheduling any performance which involves braking, such as critical field length and refusal speed.

  In compliance with ICAO recommendations, paved runway surface braking conditions are reported by civil airport authorities by means of the 'Good/Medium/Poor' categorization of braking action. When a RCR value is not available for a given runway, the table below maybe used to obtain an acceptable RCR value to be used in the corrections grids.

PAVED RUNWAY CONDITION	ICAO REPORT	RCR
Dry	Good	23
Wet	Medium	12
Icy	Poor	5

On unpaved runways, an equivalent RCR value appropriate to the roughness characteristics of the runway surface.

Type of unpaved runway surface	Equivalent RCR
Smooth surface	16
Wavy surface	10

NOTE

Always use an equivalent RCR value of 10 (i.e.,wet or mowed grass runways, stubble fields, or when in the presence of runway undulations which are known to prevent full unrestricted braking in the event of a rejected takeoff),unless assured that the unpaved runway roughness features are smooth enough to allow full unrestricted braking, in which case an equivalent RCR value of 16 can be used instead.

- Rolling Friction Index (RFI). This is a value related to the rolling friction coefficient on a particular runway surface. The recommended RFI value for each type of unpaved surface is used scheduling any performance that involves acceleration, such as critical field length, refusal speed, takeoff ground run and takeoff distance to 50 ft.

  The RFI value for a paved runway (baseline) is 2. The table below indicates the recommended values of RFI for the different types of unpaved runway (hard or soft):

Classification of hardness of unpaved runway	CBR	RFI
Hard	7 and higher	3 (earth)
		4 (grass)
Soft	6	4
	5	6
	4	8
	3	11
	2	14

WIND APPLICATION TO THE TAKEOFF

WIND DEFINITIONS

The following definitions are used in the application of winds:

Steady wind value:	Reported steady wind.
Gust increment:	Reported wind in excess of steady wind value.
Headwind component:	Effective wind parallel to the runway, determined from the steady wind value and blowing in the opposite direction to takeoff.
Tailwind component:	Effective wind parallel to the runway, determined from the steady wind value plus the gust increment and blowing in the direction of takeoff.
Crosswind component:	Effective wind 90° across the runway, determined from the steady wind value plus the gust increment.

WIND DIRECTION AND VELOCITY

Winds are usually measured at a fixed point of the airfield and, within the limitations of the instruments, are valid around this point. However, if the airfield is located in an area with variable terrain, there is the possibility that the speed and direction of the wind may vary at different points along the runway. Likewise, windshear can result in varying winds during climbout and landings.

ACCOUNTING FOR WIND

The takeoff data presented here are based on non-factorized reported wind speeds measured 10 metres above the runway surface.

The conservative approach is to accept the benefits of headwind as an increased safety margin. For example, consider the use of the headwind only when necessary for mission accomplishment. When it is necessary to use the headwind, it may be decided even then to take only partial benefit. In such a case it is recommended that 50% of the headwind component and 150% of the tail wind component be applied. If the conservative approach is used, it is important to remember the following:

1. No correction for headwind should be made to any distance or speed.
2. Apply tailwinds.
3. Rotation and threshold speeds must be corrected for crosswind.

When the non conservative approach is used, the landing distances must be corrected for headwind and tailwind while planning the landing. The threshold speed must also the corrected for crosswind.

The tailwind component must always be applied. In this case it is recommended that 150% of the tailwind component be applied.

Wind Summary Table

TYPE OF WIND	HOW TO OBTAIN THE COMPONENT	USE OF THE WIND COMPONENT
Headwind	Enter the takeoff wind component graph with the steady wind value to obtain the runway component.	Use 50% of the runway component for all takeoff distances.
		Use 50% of the runway component for obstacle clearance.
Tailwind	Enter the takeoff wind components graph with steady wind value plus the gust increment to obtain runway component.	Use 150% of the runway component for all takeoff distances.
		Use 150% of the runway component for obstacle clearance.
Crosswind	Enter the takeoff wind components graph with steady wind value plus the gust increment to obtain the runway component.	Check whether it is necessary to increase rotation speed.

WIND COMPONENTS DURING TAKEOFF

The graphs in Figure 3-1 and Figure 3-2 are used to determine the 0° to 180° wind components during takeoff (headwind, tailwind and crosswind) at wind speeds of 0 to 60 knots. Figure 3-1 is applicable to normal takeoff and Figure 3-2 to short-field takeoff.

The graphs also include the rotation speed. This value represents the minimum speed for various crosswind components.

If the intersection point of the crosswind component and the minimum rotation speed is out of the recommended area, the rotation speed should be increased until the recommended area is reached or until the rotation speed has increased 10 knots, whichever gives the lower airspeed. If the recommended area has not been reached after increasing the airspeed 10 knots, caution should be exercised during take-off.

A slight yaw should be expected to occur between rotation and lift-off when taking off within the "CAUTION" area.

Takeoffs within the "NOT RECOMMENDED" area require a high degree of pilot skill for crosswind correction and are not recommended. Variations in asymmetrical power and use of less flaps than normally recommended will result in an improved crosswind capability.

Use of Graph

Enter on the chart with steady wind value and wind angle to determine headwind component (read on left hand vertical scale).

Enter on the chart with steady wind value plus the gust increment to determine the tailwind component (vertical scale) and crosswind component (horizontal scale).

Enter chart with crosswind component and minimum rotation speed (right hand vertical scale) in order to check in which area (recommended/caution/not recommended) the intersection point falls. If this intersection point is in the not recommended area, move vertically upwards following the procedure described in the previous paragraph.

TAKEOFF CROSSWIND CHART
NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST
AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5
FLAPS: TO (10º)

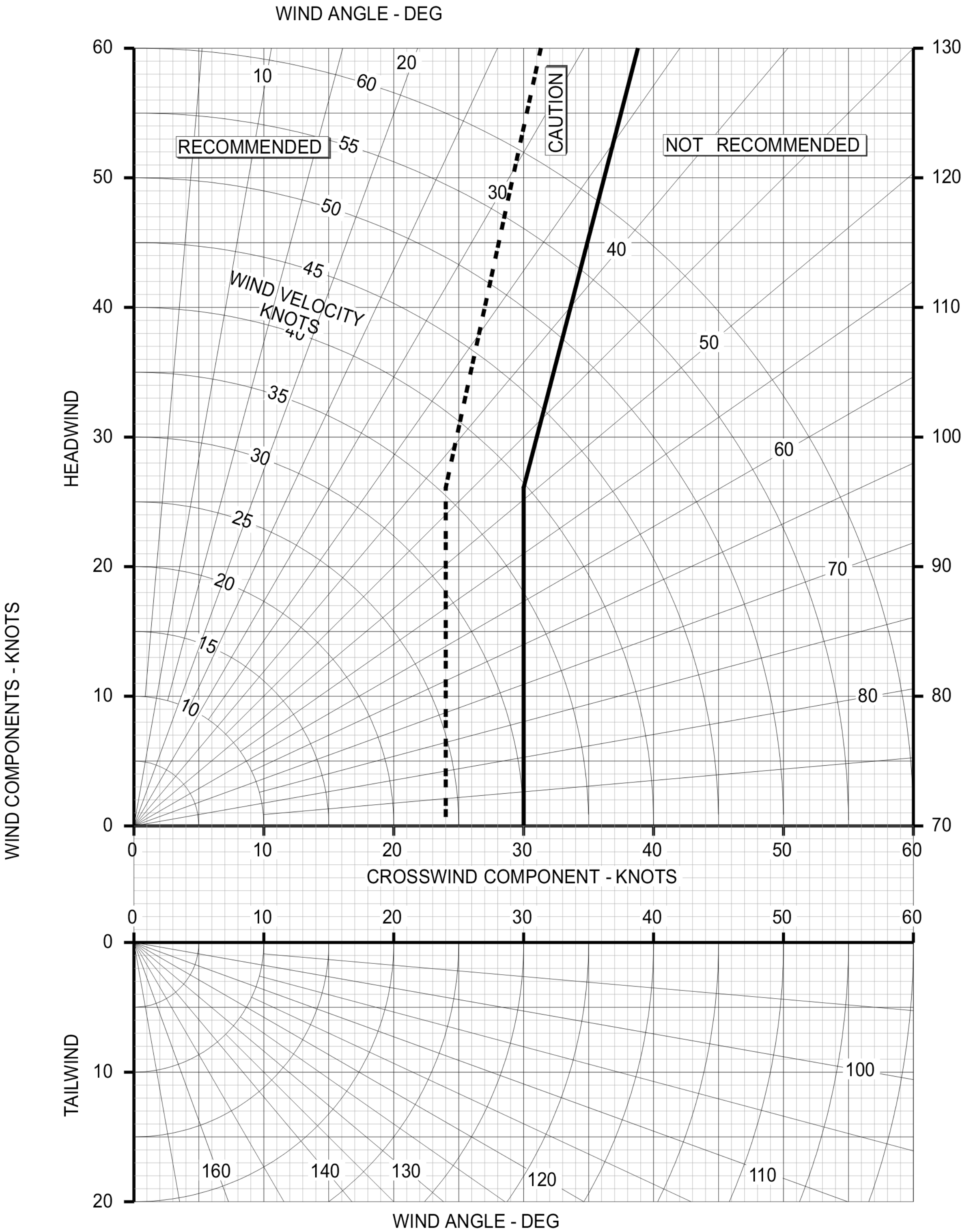

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Figure 3-1 Takeoff Crosswind Chart. Normal Takeoff

TAKEOFF CROSSWIND CHART
SHORT FIELD TAKEOFF

DATE:	JUL. 2000	**AIRCRAFT:**	C-295M	**FLAPS:**	TO (10º) and APP (15º)
DATA BASIS:	FLIGHT TEST	**ENGINES:**	PW 127-G		
		PROPELLERS:	HS 568F-5		

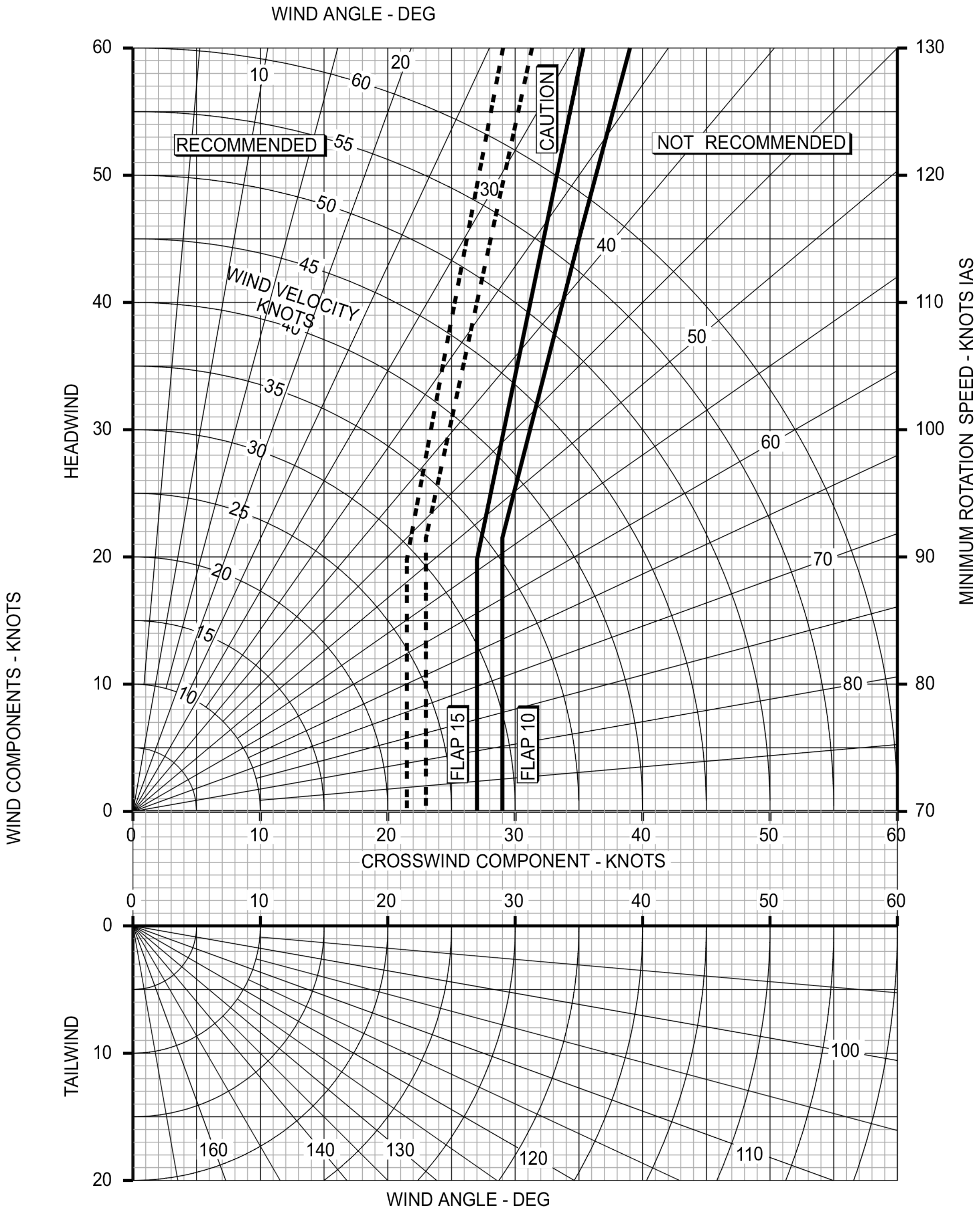

Figure 3-2 Takeoff Crosswind Chart. Short Field Takeoff

NORMAL TAKEOFF

INTRODUCTION

Normal takeoff operations with a flap deflection TO (10°) are performed using the rotation speed (V_R) and initial climbout speed (V_2) parameters obtained from Figure 3-13 using the airfield pressure altitude, airfield ambient temperature, and the actual takeoff weight (TOW). Both speeds can be selected for different values of the V_2/V_{SR} parameter (between 1.13 and 1.23) so as to allow takeoff performance to be optimized. The refusal speed (V_{RE}) is obtained by entering Figure 3-10 with the available runway length and the actual takeoff weight (TOW). If the value obtained is higher than the rotation speed, use the rotation speed as the refusal speed. The takeoff decision speed (V_1, which is the speed used as the reference to decide whether to continue the takeoff or abort it) must be between the critical engine failure speed (Figure 3-10) and the ground minimum control speed (Figure 3-9), whichever is higher, and the refusal speed.

The parameter V_2/V_{SR} = 1.13 allows to minimize the ground run, takeoff distance and critical field length. On the other hand, selecting a value of the parameter above the reference line (for example V_2 = 1.23 V_{SR}) allows to maximize the maximum takeoff weight limited by single-engine climb performance.

GRAPHICAL DESCRIPTION OF TAKEOFF

For a safety takeoff the critical field length must not exceed the available runway length. The various factors and conditions that can arise during takeoff are shown graphically in Figure 3-3, Figure 3-4 and Figure 3-5.

The normal acceleration curve with two engines shows the speed/distance characteristics of acceleration of the aircraft. The curve shows from the start of the ground run through to lift-off speed during takeoff and the end of the ground run during takeoff.

The acceleration curve with one engine shows the relationship between the speed and distance from the point at which assume the engine failure and the lift-off point during takeoff.

The maximum effort stop curve shows from the refusal point to where the stop is complete. A transition period of 3 seconds is included from the engine failure point to the point where power from the operative engine is reduced to GI and the brakes are applied. This allows the pilot to recognize the situation, make the decision to stop, reduce the power and apply the brakes.

Runway Available Longer than Critical Field Length (Recommended)

This condition is shown graphically in Figure 3-3. With this condition, the refusal speed (V_{RE}) is always higher than the critical engine failure speed (V_{CEF}). This is because V_{RE} is based on the runway available, while V_{CEF} is based on the required critical field length.

Runway Available Equal to Critical Field Length (Minimum Recommended)

This condition is shown graphically in Figure 3-4. When the runway available is equal to the critical field length and an engine failure occurs at the refusal point, the distance to continue on single-engine just equals the distance to stop. Therefore, that for this condition, the refusal speed and the critical engine failure speed are coincident. The ground minimum control speed must be less than V_{CEF} or V_{RE}.

Runway Available Less than Critical Field Length (Not Recommended)

This condition is shown graphically in Figure 3-5. In this condition, there is a region, just past the refusal point, where, if an engine failure occurs, it is not possible to either stop or continue the takeoff within the remaining runway. It is pointed out that it is impossible to select a certain speed as decision speed. If the runway available is less than the critical field length, the aircraft should be downloaded for a safe takeoff.

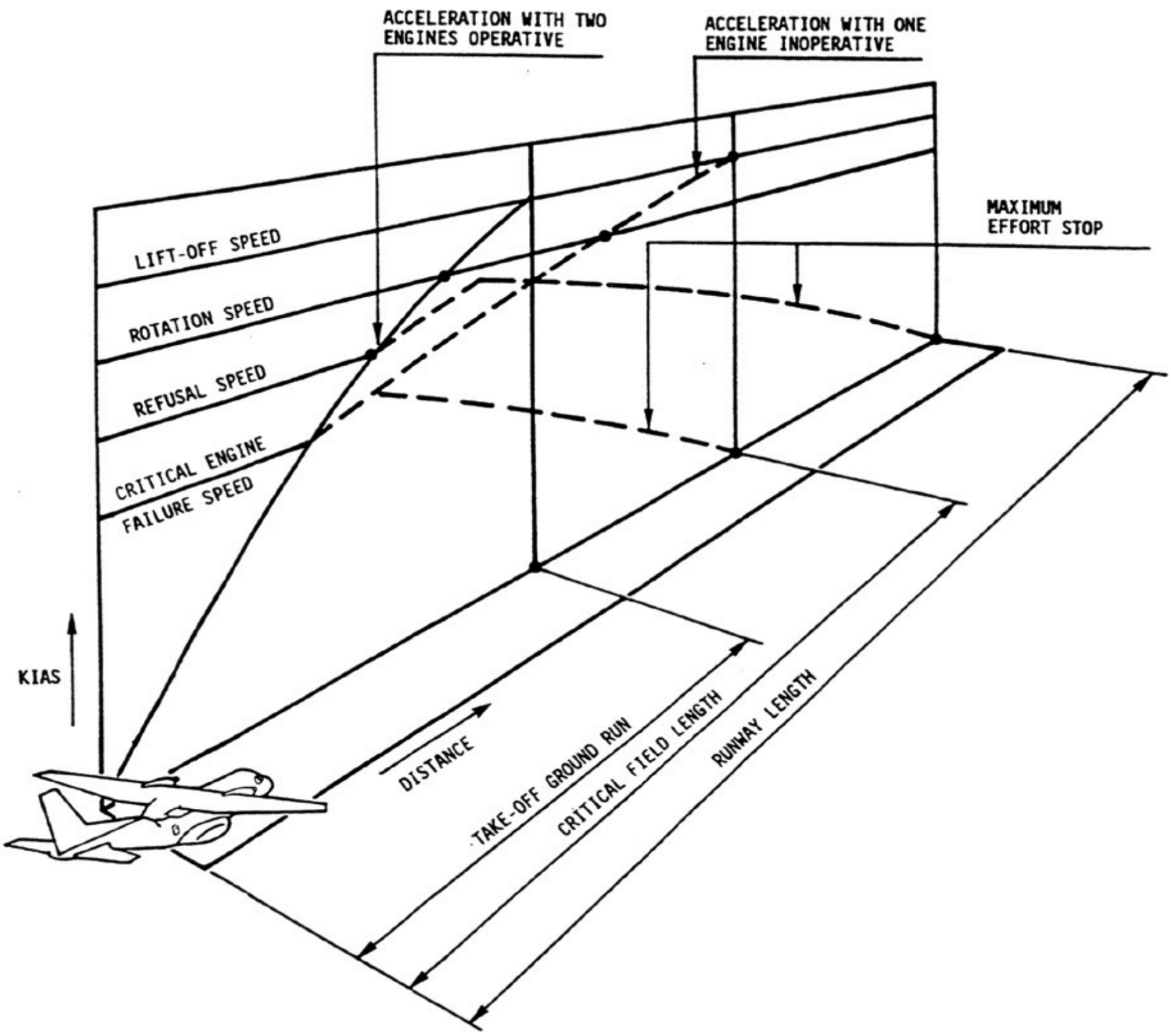

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Figure 3-3 Runway Available Longer than CFL (Recommended)

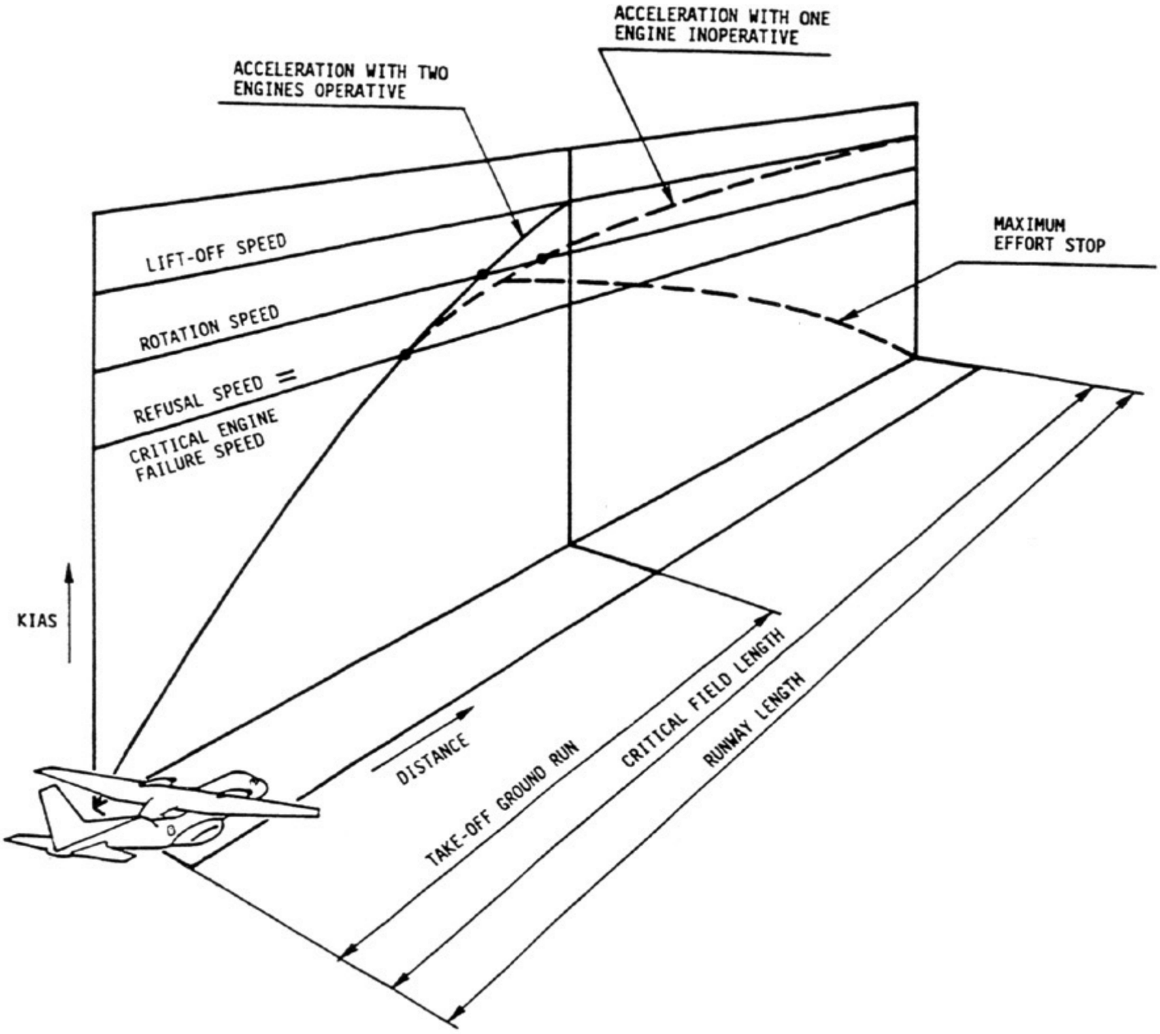

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Figure 3-4 Runway Available Equal to CFL (Minimum Recommended)

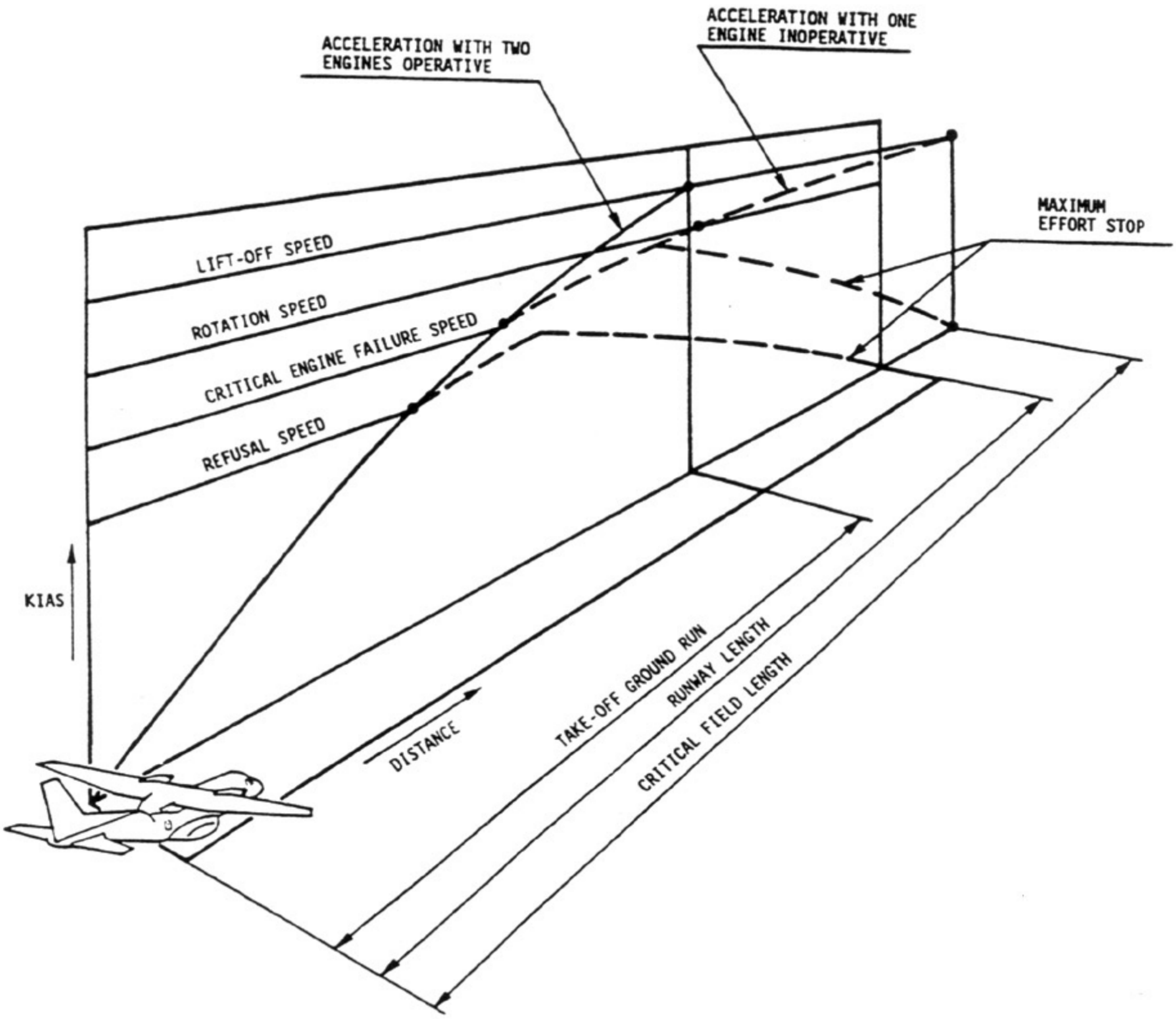

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Figure 3-5 Runway Available Less than CFL (Not Recommended)

DETERMINATION OF THE MAXIMUM TAKEOFF WEIGHT

Supposing that the conditions of the airport of takeoff are known, the maximum takeoff weight (MTOW) can be found as follows:

1. Determine the maximum takeoff weight limited by single-engine climb gradient using the chart in Figure 3-6. Use the minimum gradient (or minimum rate of climb) required according to the criteria defined by the competent authorities or command centre.
2. Determine the maximum weight limited by runway length using the charts of critical field length and distance from lift-off to 50 ft height (Figure 3-7 and Figure 3-8).
3. Select the minimum weight (provisional MTOW). This should be either the weight obtained in point 1 and point 2 and the maximum structural takeoff weight (see Section 1 of Volume I).
4. Determine the value of V_{MCG} using Figure 3-9.
5. If the weight is limited by the runway length, the available runway will be the CFL. Then determine the refusal speed using Figure 3-10. The refusal speed will also be the critical engine failure speed. If this speed is less than V_{MCG} the takeoff will be limited by V_{MCG} (accelerate-stop) and the takeoff weight should be reduced to ensure a safe takeoff. Determine this new weight using Figure 3-10 again, intersecting the curve from the runway available and with V_{MCG} as the refusal speed.

   If, on the other hand, the refusal speed is not less than V_{MCG} use whichever is lowest of the refusal speed and the rotation speed as the decision speed.

   Check that refusal speed is not higher than the maximum brake energy speed. If it is higher, the weight should be reduced again in order to allow for safe takeoff. Then determine the MTOW again for which V_{MCG} or V_{CEF} (whichever is higher) is the same as the maximum speed within braking energy limits. The resulting speed should be used as the refusal speed.
6. If the weight is not limited by the runway, obtain the CFL for the MTOW. Determine the critical engine failure speed (V_{CEF}) and the refusal speed for MTOW using Figure 3-10. Take as the refusal speed whichever is lower of the refusal speed obtained earlier or the V_R for MTOW or the maximum brake energy speed.

   For the decision speed it is possible to use any speed between whichever is higher of V_{MCG} and V_{CEF} and the refusal speed found in the previous paragraph. If this refusal speed is less than V_{MCG} or V_{CEF} because of the braking energy limits, the weight should be reduced in order to allow for a safe takeoff. Determine this new MTOW such that which ever is higher of V_{MCG} and V_{CEF} is equal to the maximum speed allowed by the braking energy limits. This speed is the refusal speed.
7. Determine the ability to clear nearby and distant obstacles following a continued takeoff with and engine failure. To do so, use the charts in Figure 3-11. It is not possible to clear the obstacles with the takeoff weight currently selected (and the corresponding climb gradient), it will be necessary to perform iterations, reducing the weight each time until the takeoff path meets all the requirements.

MAXIMUM TAKEOFF WEIGHT LIMITED BY SINGLE-ENGINE CLIMB PERFORMANCE

The maximum takeoff weight limited by single-engine climb performance is shown in Figure 3-6 for the following configuration:

- Critical engine inoperative and its propeller feathered.
- Operating engine at APR power (PRS selector in the TOGA position).
- Engine anti-ice on or off.
- Landing gear up.
- Flaps TO (10º).
- Climb speed: V_2 (value selected between 1.13 V_{SR} and V_{SR}).
- Out of ground effect.
- ECS off.

The weight is shown on the chart as a function of the ambient temperature, runway pressure altitude, the required climb gradient or rate of climb, the takeoff speed schedule and the drag index. The effect of the anti-ice system is negligible.

The bottom of sheets 1 and 2 of the chart show a group of lines representing the climb gradient (in % - sheet 1) or rate of climb (in fpm - sheet 2) parameters.

The minimum climb gradient or minimum rate of climb must be defined in accordance with the applicable command criteria or obstacle clearance requirements.

The chart can also be used the other way around to determine the climb gradient or rate of climb for a given weight.

NOTE

Takeoff weights for which the rate of climb with the landing gear down is less than 100 feet per minute should not be used. This limitation corresponds to the following values on the charts.

Value of V_2/V_{SR} used	Value of rate of climb	Value of gradient
1.13	230 fpm	1.8%
1.23	260 fpm	1.9%

NOTE

The capability of the aircraft to climb before reaching climbout speed is considerably reduced while the landing gear is being retracted (12 seconds) and the propeller is automatically feathered (less than 1 second). The effect of the landing gear down is the following reduction:

Value of V_2/V_{SR} used	Reduction in rate of climb	Reduction in gradient
1.13	120 fpm	0.9%
1.23	160 fpm	1.1%

Use of Graphs (Figure 3-6)

Sheet 1. Enter the corresponding graph with the airfield ambient temperature, move horizontally towards the right until the pressure altitude curve is reached and then vertically downwards to the rate of climb curve. From the intersection point move horizontally towards the right until the reference line. If the speed parameter used is 1.13, continue until you meet the next reference line. Otherwise, follow the guidelines to the intersection with the value of the current speed parameter and from here to the next reference line. If the drag index is available, correct for it by following the guidelines to the current value of the drag index and from this point horizontally to the right to read off the takeoff weight from the vertical scale.

Sheet 2. Use in the same way as sheet 1.

Example

Given:

1. Airfield ambient temperature: -5°C
2. Airfield pressure altitude: 11,000 ft
3. Climb gradient: 2.4%
4. V_2/V_R parameter = 1.23
5. DI = 80
6. Engine anti-ice: off.

Results:

1. Maximum takeoff weight limited by single-engine climb performance 17800 kg (Figure 3-6, sheet 1).

CRITICAL FIELD LENGTH

The critical field length is the total length of runway required to accelerate with all engines to critical engine failure speed, experience a most critical failure, then continue to takeoff or stop.

The critical field length is presented in Figure 3-7. Data from graph assume that takeoff abort is executed without using reverse thrust and including a three-second time delay for pilot reaction.

On sheet 1 the uncorrected critical field length is given as function of airfield ambient temperature, airfield pressure altitude and weight of the aircraft, with a correction due to the operating speed ratio, with a clean aircraft, zero runway slope and a dry paved runway. The anti-skid system must be operative.

On sheet 2 graphs are given for the drag index, runway slope, wind speed, RCR and RFI.

Use of Graphs (Figure 3-7)

Sheet 1. Enter the graph with the airfield ambient temperature, move horizontally towards the right until the pressure altitude curve is reached and the vertically downwards to the aircraft weight curve. From the point of intersection move horizontally to the right until you meet the speed parameter reference line. If a parameter other than 1.13 V_{SR} is used, follow the guidelines to the speed considered and the horizontally to the right from the point of intersection in order to read the uncorrected critical field length.

Sheet 2. Enter the chart with the value obtained from sheet 1.

If the correction for drag index is applicable, move parallel to the guidelines until the actual drag index is reached, and from there horizontally to the next reference line. Otherwise, move directly to the next reference line.

From this point, move parallel to the guidelines (uphill, positive gradient; downhill, negative gradient) to the actual runway slope and then horizontally towards the right to the next reference line.

From this point, move parallel to the guidelines (upwards, tailwind; downwards headwind) until the wind speed is reached, and then, horizontally towards the right to the next reference line.

From this point, move parallel to the guidelines to the applicable RCR value for runway surface and then horizontally towards the right to the next reference line. If the runway surface is dry paved, move directly to the next reference line.

From this point, move parallel to the guidelines to the applicable RFI value for runway surface and then horizontally towards the right. If runway surface is dry-paved, move directly to the left-hand vertical scale. Read the corrected critical field length on the vertical scale.

Example

Given:

1. Airfield ambient temperature. 13°C
2. Airfield pressure altitude: 6000 ft.
3. Takeoff weight: 19,000 kg.
4. Speed ratio: 1.18 V_{SR}
5. DI: 110.
6. Runway slope: +1.3%
7. Wind speed: 46 knots headwind. (On the chart, 50% of this value will be used, i.e. 23 knots).
8. RCR: 8
9. RFI: 7.5

Results:

1.	Critical field length, uncorrected (Figure 3-7, sheet 1)	4800 ft
2.	Critical field length, corrected (Figure 3-7, sheet 2)	5400 ft

DISTANCE FROM LIFT-OFF TO 50 FEET WITH ONE ENGINE INOPERATIVE

Figure 3-8, which is valid for normal takeoff with flaps at TO (10°), presents the horizontal distance with one engine inoperative from lift-off to the point where the airplane reaches 50 ft above the runway surface for the two extreme speed rations and for varying wind speeds.

The distance read from this Figure added to the critical field length read from Figure 3-7 can be used with any takeoff decision speed as a conservative value for the takeoff distance to 50 feet with failure. When using this method it is assumed that the engine failure occurs at the critical engine failure speed.

Use of Graphs (Figure 3-8)

At the bottom left of the chart, locate the takeoff gradient obtained from Figure 3-6 for the current takeoff weight and move upwards to the appropriate speed parameter curve and then horizontally right to the wind reference line. Move parallel to the guidelines until the wind speed is reached. Continue horizontally rightwards and read the distance in the air from the vertical scale.

Example

Given:

1. Takeoff climb gradient (Figure 3-6): 2.8%.
2. V_2/V_{SR}: 1.23
3. Wind speed: 50 knots headwind. (On the chart, 50% of this value will be used, i.e. 25 knots).

Results:

1. Distance in the air (Figure 3-8) 2700 ft

MINIMUM CONTROL SPEED ON THE GROUND

The minimum control speed on ground (V_{MCG}) is the minimum speed during the takeoff run at which the engine most critical to directional control can fail and, with the operative engine at maximum takeoff power, a straight path on the runway surface can be achieved and maintained using the primary flight controls.

Figure 3-9 shows the ground minimum control speed. These values are applicable to takeoff from either paved or unpaved runways at least 77 feet wide. When operating from runways that are between 77 and 67 feet wide, increase V_{MCG} by 1 knot for each 2 feet less than a width of 77 feet. When operating from runway between 67 and 57 feet wide, increase V_{MCG} by an additional 5 knots and a further 3 knots for each 2 feet less than 67 feet wide.

The minimum ground control speed values given in Figure 3-9, are presented as a function of the airfield ambient temperature and the airfield pressure altitude, and they are based on the following conditions.

- Aircraft trimmed for takeoff.
- Most unfavourable centre of gravity position.
- APR on.
- Rudder pedal force less than 180 pounds.
- Nosewheel steering not used.
- Primary flight controls fully used, mainly ailerons and rudder.

Use of Graphs (Figure 3-9)

Locate the ambient temperature on the scale and move vertically upwards to the pressure altitude curve and then horizontally to the left. Read off the ground minimum control speed from the vertical scale.

Example

Given:

1. Airfield ambient temperature 17°C.
2. Airfield pressure altitude: 4000 ft.
3. Runway width greater than 77 feet.

Results:

1. V_{MCG} (Figure 3-9) 79 KIAS

REFUSAL SPEED AND CRITICAL ENGINE FAILURE SPEED

The refusal speed is the maximum speed to which the aircraft can accelerate and then stop in the available runway length.

Critical engine failure speed is the speed at which the most critical engine can fail and the same distance is required to either continue the takeoff or to stop the aircraft.

The refusal speed is shown in Figure 3-10. Sheet 1 shows the uncorrected refusal speed as a function of the airfield ambient temperature, airfield pressure altitude, available runway length and aircraft weight for a zero runway gradient, zero wind and a dry paved runway.

Sheet 2 gives the corrections for the runway slope, wind speed, RCR and RFI.

To obtain the refusal speed, it is assumed that the takeoff is aborted without using reverse thrust, and a delay of 3 seconds is included to allow for the pilot´s reaction time.

When the chart in Figure 3-10 is used to obtain the refusal speed, verify that the resulting value is not less than the corresponding minimum control speed on the ground read off from Figure 3-9. If it is less, reduce the proposed takeoff weight until they are the same. Then obtain the rotation speed from Figure 3-13 and take the lowest of the two speeds as the refusal speed.

When Figure 3-10 is used to determine the critical failure speed, enter graph with the critical field length rather than the available runway length.

The takeoff decision speed (V_1), which is the reference speed for deciding whether to continue the takeoff or abort it, must be at equal to or greater than the critical engine failure speed or the minimum ground control speed (whichever is higher), and no higher than the refusal speed.

Use of Graphs (Figure 3-10)

Sheet 1. Enter the graph with the airfield ambient temperature, move vertically upwards to the airfield pressure altitude curve and horizontally towards the right until the runway length available curve is reached. From this point move vertically downwards to the aircraft weight curve and the horizontally to the right. Read the uncorrected refusal speed on the vertical scale.

Sheet 2. Enter the chart with the value obtained from sheet 1.

From this point, move parallel to the guidelines (upwards: positive slope; downwards: negative slope) to the runway slope and then move horizontally to the right to the next reference line.

From this point, move parallel to the guidelines (upwards: tailwind; downwards: headwind) to the wind speed and the move horizontally to the right to the next reference line.

From this point, move parallel to the guidelines as far as the RCR value applicable at the runway surface and then move horizontally to the right until the next reference line is met. If the runway is paved and dry, move directly to the next reference line.

From this point, move parallel to the guidelines as far as the RFI value applicable at the runway surface and the move horizontally to the right until the next reference line is met. If the runway is paved and dry, move directly to the vertical scale and read off the corrected refusal speed.

To obtain the critical engine failure speed, proceed in the same way but using the critical field length rather than the available runway length.

Example

Given:

1. Airfield ambient temperature. 20°C
2. Airfield pressure altitude: 3500 ft
3. Available runway length: 5000 ft
4. Takeoff weight: 20000 kg
5. Runway slope: +2.3%
6. Speed parameter: 1.18 V_{SR}
7. DI: 110
8. Wind speed; 56 knots headwind. (on the chart, 50% of this value will be used, i.e. 28 knots)
9. RCR: 13
10. RFI: 6.5

Results:

1.	Refusal speed, uncorrected (Figure 3-10, sheet 1)	111 KIAS
2.	Refusal speed, corrected (Figure 3-10, sheet 2)	113 KIAS
3.	Rotation speed (Figure 3-13, sheet 1)	117 KIAS
4.	Refusal speed	113 KIAS
5.	Critical field length, corrected (Figure 3-7, sheet 2)	4700 ft
6.	Critical engine failure speed, uncorrected (Figure 3-10, sheet 1)	107 KIAS
7.	Critical engine failure speed, corrected (Figure 3-10, sheet 2)	111 KIAS
8.	V_{MCG} (Figure 3-9)	79 KIAS
9.	Speed interval to select a decision speed	111 to 113 (V_{CEF} and V_{RE})

SINGLE-ENGINE CLIMBOUT FLIGHT PATH

The single-engine climbout flight path charts of Figure 3-11 presents the single-engine climbout flight paths for various values of climbout gradients, which are determined from Figure 3-6.

The flight path of sheets 1 and 2 of Figure 3-11 are based on:

- Critical engine inoperative and propeller feathered throughout the climbout.
- Accelerate climb from lift-off point (1st segment): Landing gear retraction is initiated 3 seconds after lift-off. The power of the operative engine is at APR. The flaps are in the TO (10°) position. The initial speed is V_{LOF} and the final speed is V_2. This segment ends when the landing gear is retracted (15 seconds after lift-off).
- Climb at V_2 (2nd segment): The power of the operative engine is at APR. The flaps are in the TO (10°) position. Speed is held at V_2 during the climb. This segment ends when the maximum level off altitude is reached.
- Horizontal acceleration (3rd segment): The power of the engine is at APR. The aircraft accelerates during level flight to V_{FTO} (V_2 + 20 KIAS if V_2 = 1.13 V_{SR} or V_2 + 10 KIAS if V_2=1.23 V_{SR}). The flaps are retracted (fully up) when the minimum recommended flap retraction speed is reached.
- The altitude of the horizontal acceleration segment has been selected so that it can be performed at a power of APR. This segment ends five minutes after the takeoff started (brake-release point) and at this point the speed V_{FTO} should have been reached. This chart on sheet 2 of Figure 3-11 shows the length of the second segment (with a broken line) assuming a time limit of ten minutes from the start of takeoff.
- Climb at V_{FTO}: The operative engine is at maximum continuous thrust (MCT). The flaps are retracted and the speed is sustained during the climb.

The charts showing the takeoff path with one engine inoperative allow calculation of the distance from the lift-off point required to clear an obstacle of a given height as a function of the single-engine climb gradient. From the total distance required, the portion corresponding to the critical field length plus the distance in the air to 50 feet above the runway is not shown on this chart.

The charts show the height over the runway as a function of the horizontal distance from the 50 ft point. These charts include a wind grid on the horizontal scale for correction of the distance.

The takeoff path for one engine and flaps at TO (10°) is given on sheet 1 (vertical scale up to 400 feet) and sheet 2 (vertical scale up to 2400 feet).

Use of Graphs (Figure 3-11)

Enter the corresponding graph with the horizontal distance, move parallel to guidelines until the value of the wind speed is reached and continue vertically upwards. Enter the obstacle height on the vertical scale and move horizontally to the right. Read the required climb gradient at the point of intersection of both lines.

Example

Given:

1. Normal takeoff.
2. Horizontal distance to obstacle from threshold (50ft): 11400 ft.
3. Obstacle height: 285 ft.
4. Wind speed: 32 knots headwind. (On the chart 50% of this value will be used, i.e. 16 knots)

Results:

1.	Required climb gradient (Figure 3-11, sheet 1)	2.2%

AIR MINIMUM CONTROL SPEED

The air minimum control speed is the minimum speed in the air at which the most critical engine for directional control can fail while -with the operative engine at maximum take off power (APR)- still allowing straight-line flight, with maximum rudder deflection and no more than 75% of available aileron deflection or 5° bank.

Figure 3-12 shows the air minimum control speed (V_{MCA}) as a function of the ambient temperature, pressure altitude and aircraft weight.

The V_{MCA} is based on in-flight tests under the following conditions:

- Aircraft trimmed for takeoff.
- Most unfavourable center of gravity position.
- Force on the rudder pedal of less than 180 lbs and on the ailerons of 60 lbs.

Use of Graphs (Figure 3-12)

Locate the ambient temperature on the scale of the relevant chart and move vertically upwards to the pressure altitude curve and then horizontally to the left. Correct by following the guidelines for the aircraft weight and move horizontally right to read off the air minimum control speed from the vertical scale.

Example

Given:

1. Ambient temperature. -5°C
2. Pressure altitude: 2000 ft.
3. Aircraft weight: 13250 kg

Results:

1.	V_{MCA} (Figure 3-11, sheet 1)	98.5 KIAS

TAKEOFF SPEEDS

Rotation speed (V_R) is the speed at which rotation from the three-point attitude to the takeoff attitude is initiated by applying back pressure to the control column.

Climbout speed (V_2) is the recommended speed for single-engine obstacle clearance.

The climbout speed can be selected anywhere in the range from 1.13 V_{SR} to 1.23 V_{SR}, where 1.13 V_{SR} is the nominal V_2 speed. This speed is limited by 1.05 V_{MCA}. For each speed V_2 within the range there is an associated rotation speed.

The minimum flap retraction speed ($V_{TO\text{-}UP}$) is the minimum speed at which the flaps can be retracted. It is defined as V_2 + 10 KIAS when V_2 = 1.13 V_{SR} or as V_2 when V_2 = 1.23 V_{SR}.

The minimum flap retraction speed is defined as being approximately equal to 1.21 V_{SR}.

The speed in the final segment (V_{FTO}) will be V_2 + 20 KIAS if V_2 = 1.13 V_{SR} or V_2 + 10 KIAS if V_2 = 1.23 V_{SR}.

The different operating speeds used during normal takeoff are shown in Figure 3-13.

Use of Graphs (Figure 3-13)

Locate the airfield ambient temperature on the scale and move horizontally to the right as far as the airfield pressure altitude curve. Proceed vertically downwards to the appropriate takeoff weight line so as to obtain the minimum V_R. Continue downwards back to the appropriate takeoff weight line to correct for the takeoff speed parameter (V_2/V_{SR}) on the left-hand scale and obtain the value of V_R. From the point of intersection with the weight curve above, continue downwards to intercept the appropriate weight curve to obtain the minimum value of V_2. Locate the aircraft takeoff weight on the horizontal (weight) scale again on the bottom left-hand chart. Proceed vertically upwards to intercept the curve and read the speed from the right-hand vertical scale, now corrected for the takeoff speed parameter (V_2/V_{SR}). Compare the initial climb speed values and take the higher of the two.

Example

Given:

1. Takeoff weight: 14000 kg
2. Normal takeoff
3. OAT: 32
4. Pressure altitude: 2000 ft
5. Speed parameter: 1.2 V_{SR}

Results:

1.	V_2 (Figure 3-13)	95 KIAS
2.	V_2 (Figure 3-13)	100 KIAS
3.	$V_{F10\text{-}0}$ (100 + 13)	113 KIAS

TAKEOFF GROUND RUN

The takeoff ground run is the distance travelled on the ground to the point where the aircraft lifts off with all engines operative.

The normal takeoff ground run is shown in Figure 3-14. Sheet 1 shows the uncorrected critical field length as a function of ambient temperature, pressure altitude and aircraft weight, with a correction due to the operating speed ratio, with a clean aircraft, zero runway slope and a dry paved runway.

Sheet 2 gives the corrections for the drag index, runway slope, wind speed and RFI.

Use of Graphs (Figure 3-14)

Sheet 1. Locate the ambient temperature on the left-hand vertical axis of the relevant chart and move horizontally towards the pressure altitude curve. Having reached the curve, move vertically downwards to the aircraft weight curve. From the point of intersection move horizontally to the right until you meet the takeoff speed parameter reference line. If a value of the takeoff speed parameter other than the basic value is used, follow the guidelines to the new speed and move horizontally to the right to read the uncorrected takeoff ground run from the vertical scale.

Sheet 2. Locate the value obtained from sheet 1 on the chart.

If the drag index correction is applicable, move parallel to the guidelines until the vertical line for the current drag index value is met. From the intersection move horizontally to the next reference line. If the correction is not applicable, move directly to the next reference line.

From this point, move parallel to the guidelines (upwards: positive slope; downwards: negative slope) to the runway slope and then move horizontally to the right to the next reference line.

From this point, move parallel to the guidelines (upwards: tailwind; downwards: headwind) to the wind speed and then move horizontally to the right to the next reference line.

From this point, move parallel to the guidelines as far as the RFI value applicable at the runway surface and then move horizontally to the right until the next reference line is met. If the runway is paved and dry, move directly to the vertical scale and read off the corrected takeoff ground run.

Example

Given:

1. Airfield ambient temperature: 22°C
2. Airfield pressure altitude: 6000 ft
3. Takeoff weight: 17000 kg
4. Engine anti-ice: off
5. Runway slope: 2.8%
6. Wind speed: 50 kt headwind. (On the chart 50% of this value will be used, i.e. 25 kt)
7. RFI: 7.5
8. V_2/V_{SR}: 1.18
9. DI: 120

Results:

1.	Takeoff ground run, uncorrected (Figure 3-14, sheet 1)	3150 ft
2.	Takeoff ground run, corrected (Figure 3-14, sheet 2)	3000 ft

TAKE OFF DISTANCE TO 50 FEET

The takeoff distance to 50 feet is the ground run plus the distance in the air required to reach a height of 50 feet over the runway with both engines operative.

The takeoff distance to 50 feet for a normal takeoff is shown in Figure 3-15. Sheet 1 shows the uncorrected takeoff distance as a function of airfield ambient temperature, airfield pressure altitude and aircraft weight, with a correction due to the operating speed parameter, assuming a clean aircraft, zero runway slope and a dry paved runway.

Sheet 2 gives the corrections for the dray index, runway slope, wind speed and RFI.

Use of Graphs (Figure 3-15)

Sheet 1. Locate the ambient temperature on the left-hand vertical axis of the relevant chart and move horizontally towards the pressure altitude curve. Having reached the curve, move vertically downwards to the aircraft weight curve. From the point of intersection move horizontally to the right until you meet the takeoff speed parameter reference line. If a value of the takeoff speed parameter other than the basic value is used, follow the guidelines to the new speed and move horizontally to the right to read the uncorrected takeoff distance to 50 feet from the vertical scale.

Sheet 2. Locate the value obtained from sheet 1 on the chart.

If the drag index correction is applicable, move parallel to the guidelines until the vertical line for the current drag index value is met. From the intersection move horizontally to the next reference line. If the correction is not applicable, move directly to the next reference line.

From this point, move parallel to the guidelines (upwards: positive slope; downwards: negative slope) to the runway slope and the move horizontally to the right to the next reference line.

From this point, move parallel to the guidelines (upwards: tailwind; downwards: headwind) to the wind speed and then move horizontally to the right to the next reference line.

From this point, move parallel to the guidelines as far as the RFI value applicable at the runway surface and the move horizontally to the right until the next reference line is met. If the runway is paved and fry, move directly to the vertical scale and read off the corrected takeoff distance to 50 feet.

Example

Given:

1. Airfield ambient temperature: 22°C
2. Airfield pressure altitude: 6000 ft
3. Takeoff weight: 20000 kg
4. Engine anti-ice: off
5. Runway slope: + 1.5%
6. Wind speed: 50 knots headwind. (On the chart 50% of the value will be used. i.e. 25 knots)
7. RFI: 8.5
8. V_2/V_{SR}: 1.18
9. DI: 120

Results:

1.	Takeoff distance to 50 feet, uncorrected (Figure 3-15, sheet 1)	5400 ft
2.	Takeoff distance to 50 feet, corrected (Figure 3-15, sheet 2)	5400 ft

TWO-ENGINE CLIMBOUT GRADIENTS

Figure 3-16 shows the climb gradients with two engines. The charts are based on flight data under the following conditions.

- Takeoff power on both engines (PRS selector switch in the TOGA position).
- Landing gear up.
- Flaps at TO (10°).
- Climb speed V_2 + 10 KIAS or 140 KIAS (whichever is lower).
- No ground effect.
- ECS: off.

The climb gradient is shown on each chart as a function of the ambient temperature and runway pressure altitude and aircraft weight. Corrections due to the drag index and the takeoff speed parameter are included.

Use of Graphs (Figure 3-16)

Locate the ambient temperature on the left-hand vertical axis of the chart and move horizontally towards the pressure altitude curve. Once the curve is reached, move vertically downwards to the takeoff weight curve. From this point, move horizontally to the right until the takeoff speed parameter reference line is met. From here, continue parallel to the guidelines until the given value of the parameter is reached. Move horizontally towards the right as far as the reference line of the drag index and then parallel to the guidelines to the current value of the drag index. From this point, move horizontally to the right to read off the value of the two engines climb gradient from the vertical scale.

Example

Given:

1. Ambient temperature: 5°C
2. Pressure altitude: 5500 ft
3. Takeoff weight: 20500 kg
4. Engine anti-ice: off
5. V_2/V_{SR}: 1.23
6. DI: 80

Results:

1.	Two engines climb gradient (Figure 3-16, sheet 1)	12%

TWO-ENGINE TAKEOFF FLIGHT PATH

The charts of the takeoff paths with both engines operative in Figure 3-17 show the two-engine takeoff flight path for the different climb gradients determined in Figure 3-16.

The takeoff paths are based on acceleration using both engines from the speed V_{SCR} at 50 ft over the runway to a speed of V_2 + 10 KIAS. The power selected is TOGA on both engines and flaps set to the TO (10°) position. The aircraft will continue to climb at this speed until the landing gear is retracted (15 seconds after lift-off). If the landing gear is retracted before 400 ft height over the runway, V_2 + 10 KIAS should be maintained until 400 ft. From this point the aircraft can accelerate to 140 knots IAS, at which point flap retraction is initiated (three seconds). It continues to climb at this speed, adjusting the power on both engines to the maximum climb power (CLB).

The charts showing the takeoff path with two engines operative allow calculation of the required distance to the obstacle from the "50 ft point" to clear an obstacle of a give height, as a function of the climb gradient with two engines. Of the total distance required, the portion corresponding to the 50 ft point in the takeoff on the chart.

The charts show the height over the runway as a function of the horizontal distance from the 50-ft point. These charts include a wind grid on the horizontal scale for correction of the distance.

The takeoff path for flaps at TO (10°) is given on sheet 1 (vertical scale up to 1,000 feet) and sheet 2 (vertical scale up to 8,000 feet).

Use of Graphs (Figure 3-17)

Locate the horizontal distance on the axis and move horizontally parallel to the guidelines until you reach the wind speed value. Then continue vertically upwards. Locate the obstacle height on the vertical scale and move horizontally to the right. Read off the required climb gradient at the point where the two lines intersect.

MAXIMUM REFUSAL SPEED LIMITED BY BRAKE ENERGY

The maximum refusal speed limited by brake energy is the value of the speed at which the energy absorbed by the brakes while stopping the aircraft is the maximum energy the brakes are able to absorb (37.32 MJ).

The chart in Figure 3-18 gives the maximum refusal speed limited by brake energy (37.32 MJ), as a function of airfield ambient temperature, pressure altitude, takeoff weight, runway slope and wind speed.

Use of Graphs (Figure 3-18)

Locate the temperature on the left-hand vertical axis of the chart and move horizontally towards the pressure altitude curve. Once the curve is reached, move vertically downwards to the takeoff weight curve. Move horizontally right to the first reference line and then parallel to the guidelines (upwards: positive slope; downwards: negative slope) until the runway slope is reached, and then move right to the next reference line. From this point, move parallel to the guidelines (upwards: headwind; downwards: tailwind) to the wind speed and then move horizontally to the right to read the maximum refusal speed from the vertical scale.

Example

Given:

1. Takeoff weight: 21000 kg
2. Airfield pressure altitude: 5000 ft
3. Airfield ambient temperature: 20°C
4. Runway slope: 2.4%
5. Wind speed: 28 knots headwind. (On the chart 50% of this value will be used, i.e. 14 knots)

Results:

1.	Maximum refusal speed (Figure 3-18)	132 KIAS
2.	If V_{CEF} or V_{RE} are lower, the maximum capacity will not be exceeded.	

MAXIMUM TAKEOFF WEIGHT LIMITED BY SINGLE ENGINE CLIMB PERFORMANCE NORMAL TAKEOFF FLAPS 10º

DATE:	JUL. 2000	**AIRCRAFT:**	C-295M	**ENGINE A/I:**	OFF
DATA BASIS:	FLIGHT TEST	**ENGINES:**	PW 127-G		
		PROPELLERS:	HS 568F-5		

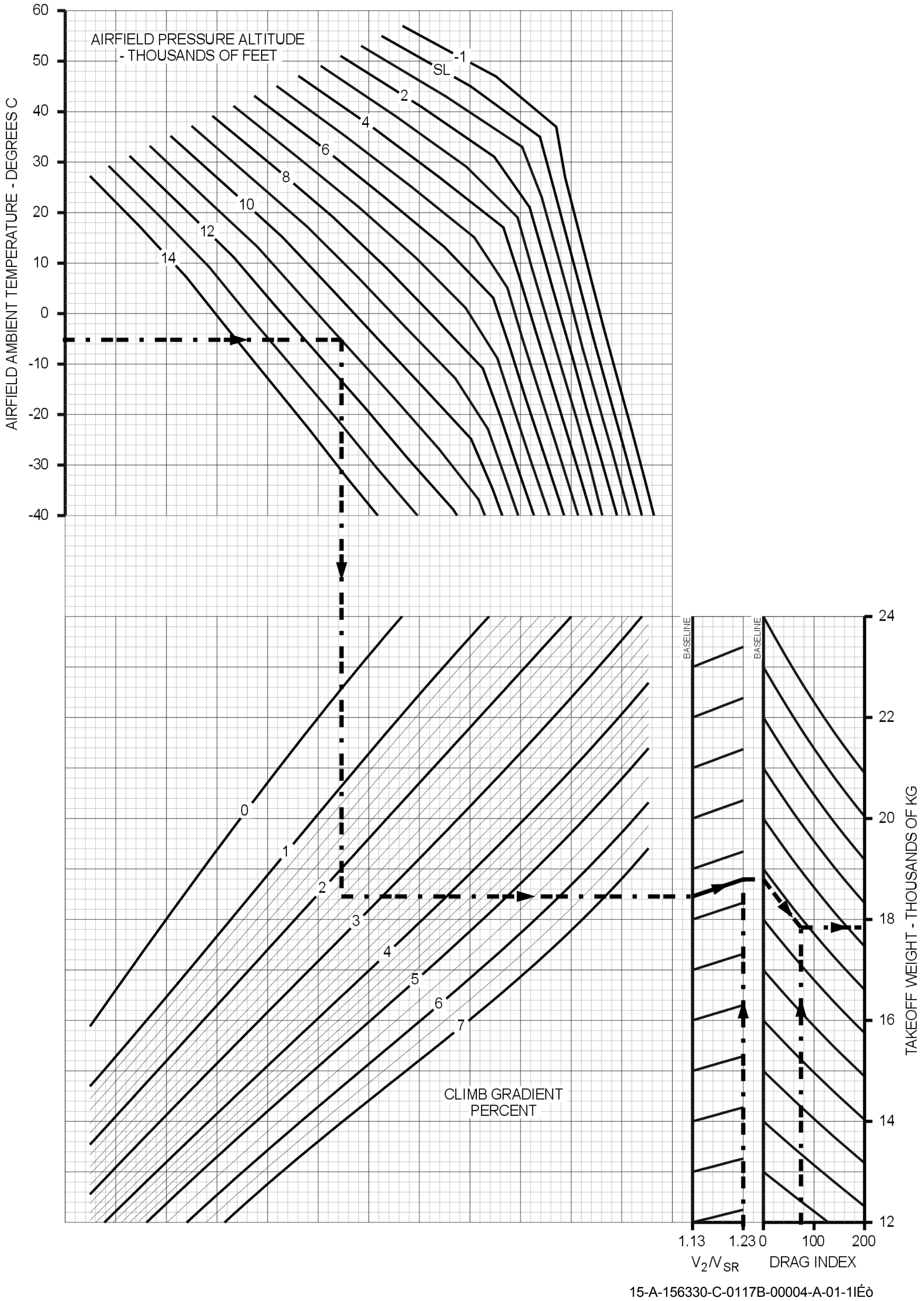

Figure 3-6 (Sheet 1 of 2) MTOW Limited by Single Engine Climb Performance. Normal Takeoff

MAXIMUM TAKEOFF WEIGHT LIMITED BY SINGLE ENGINE CLIMB PERFORMANCE NORMAL TAKEOFF FLAPS 10º

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

ENGINE A/I: OFF

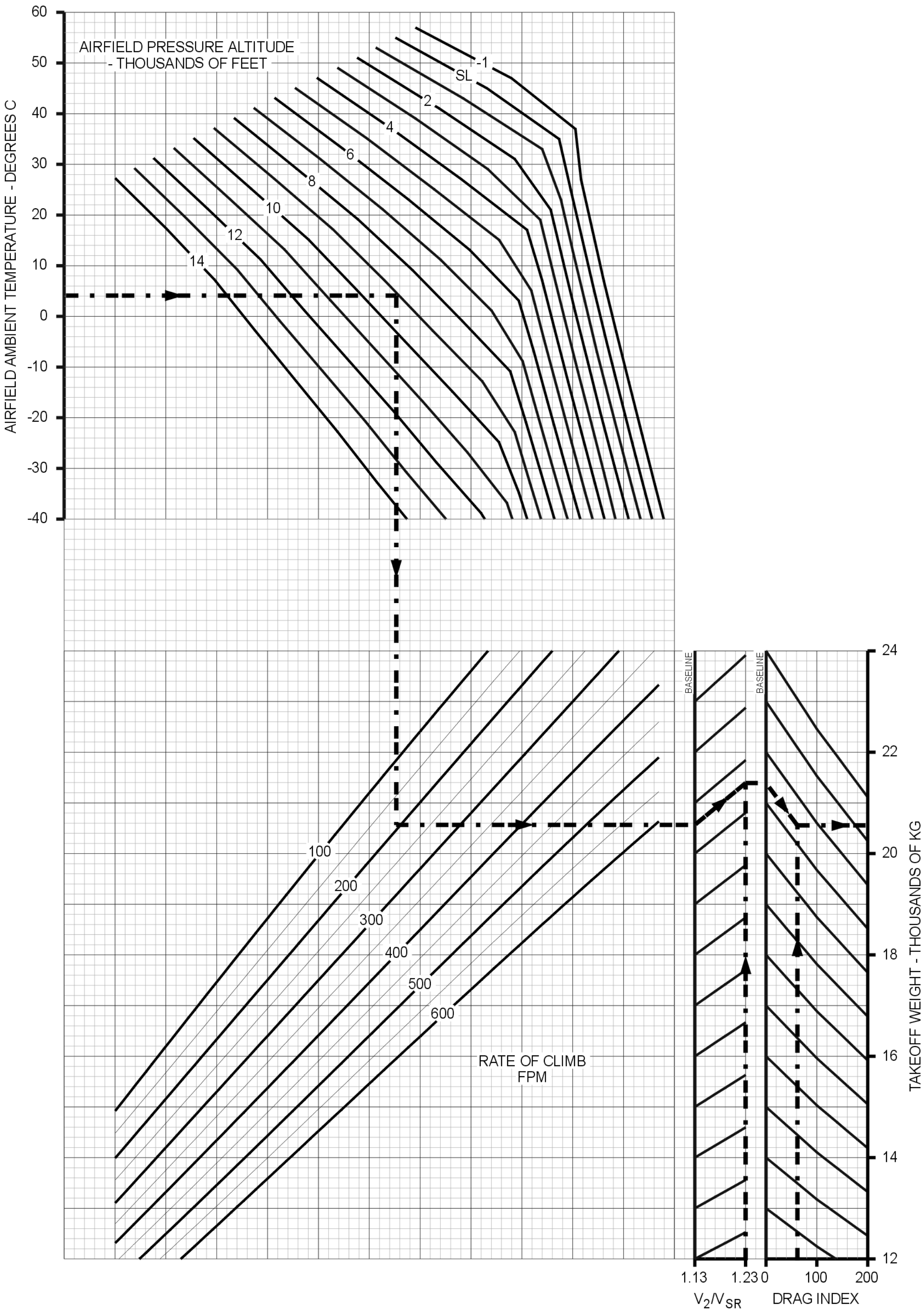

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Figure 3-6 (Sheet 2 of 2) MTOW Limited by Single Engine Climb Performance. Normal Takeoff

CRITICAL FIELD LENGTH
NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)

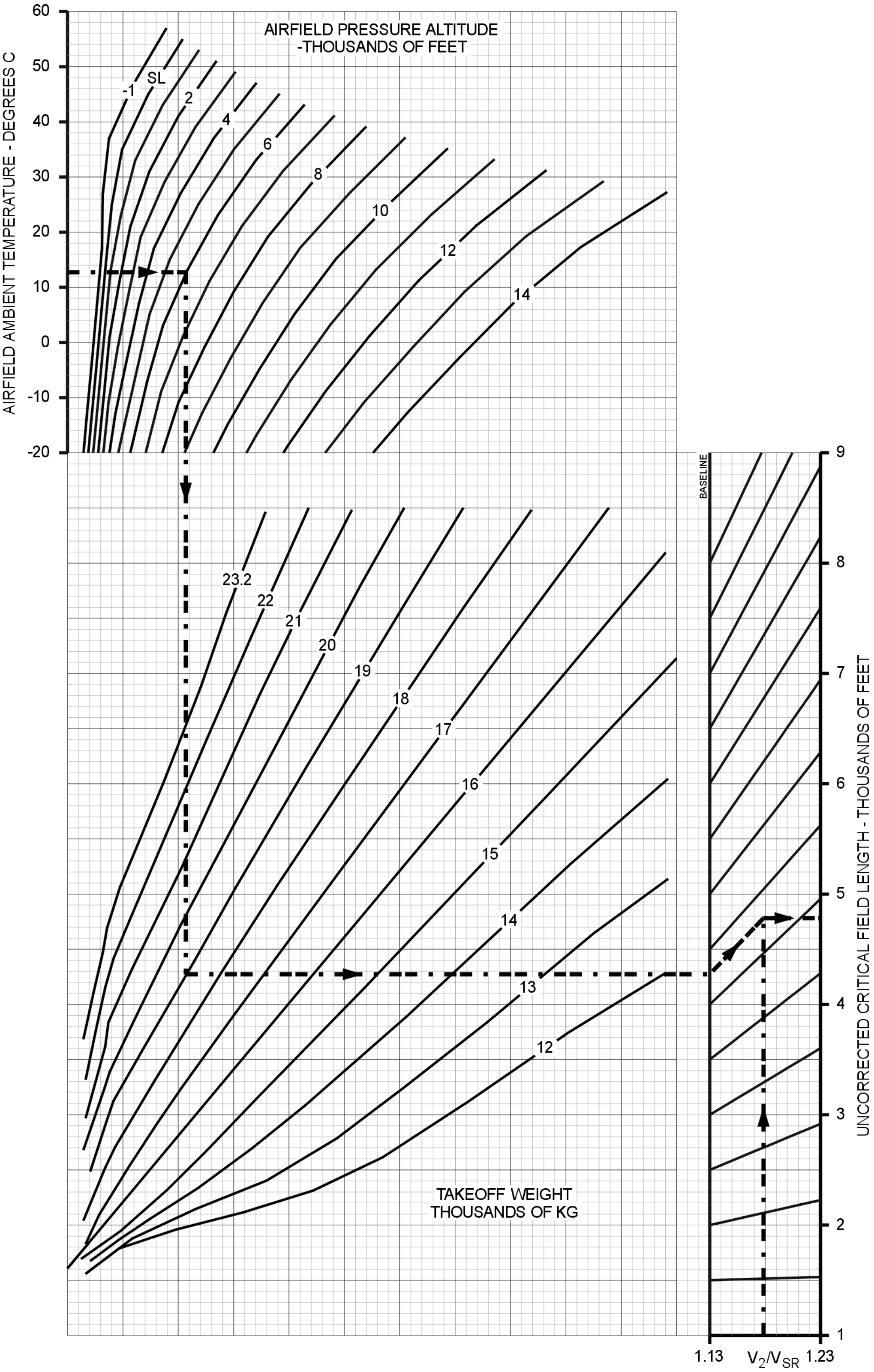

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Figure 3-7 (Sheet 1 of 2) Critical Field Length. Normal Takeoff

CRITICAL FIELD LENGTH
NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)

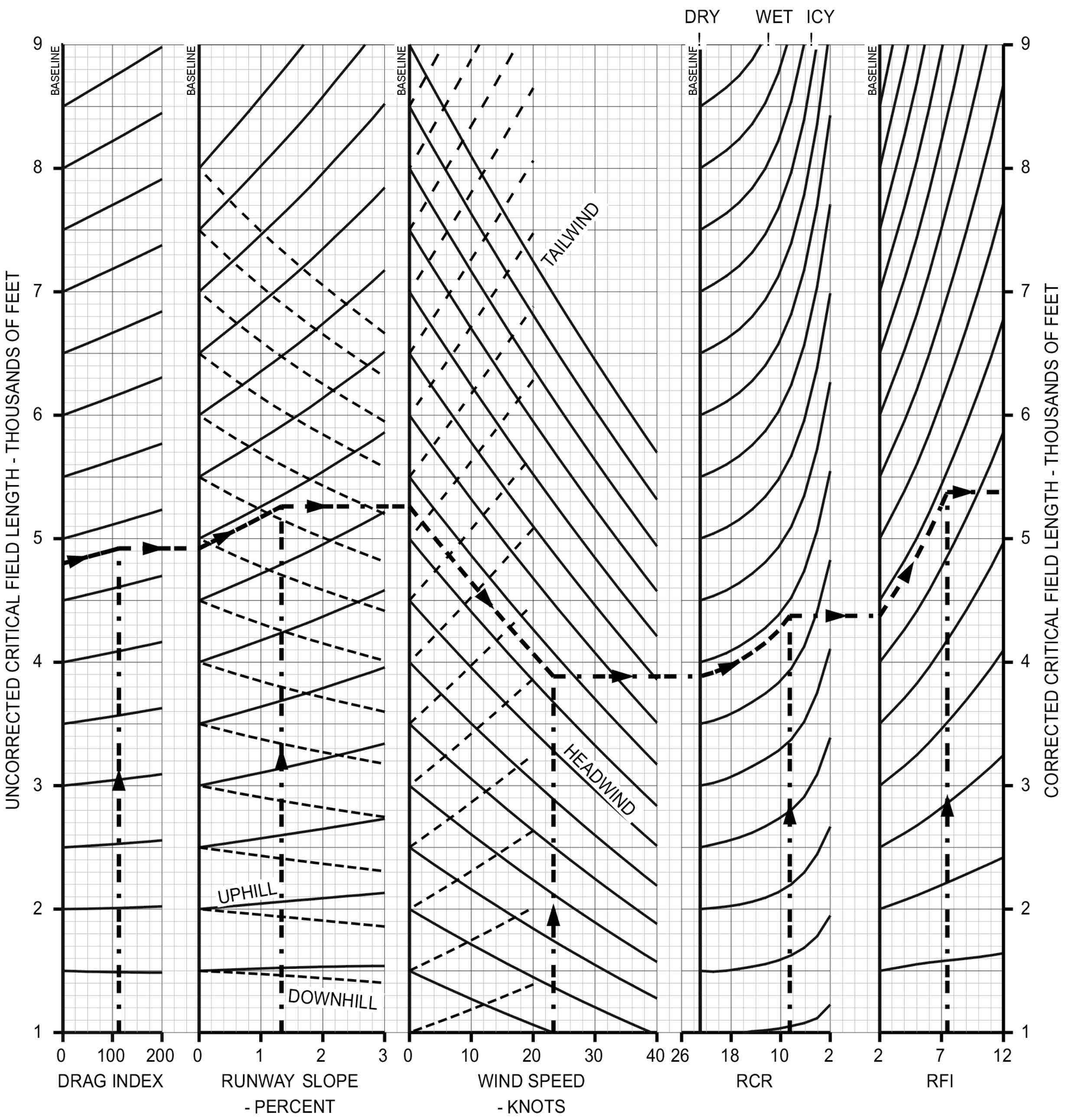

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Figure 3-7 (Sheet 2 of 2) Critical Field Length. Normal Takeoff

DISTANCE FROM LIFTOFF TO 50 FT HEIGHT
NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)
CRITICAL ENGINE INOPERATIVE

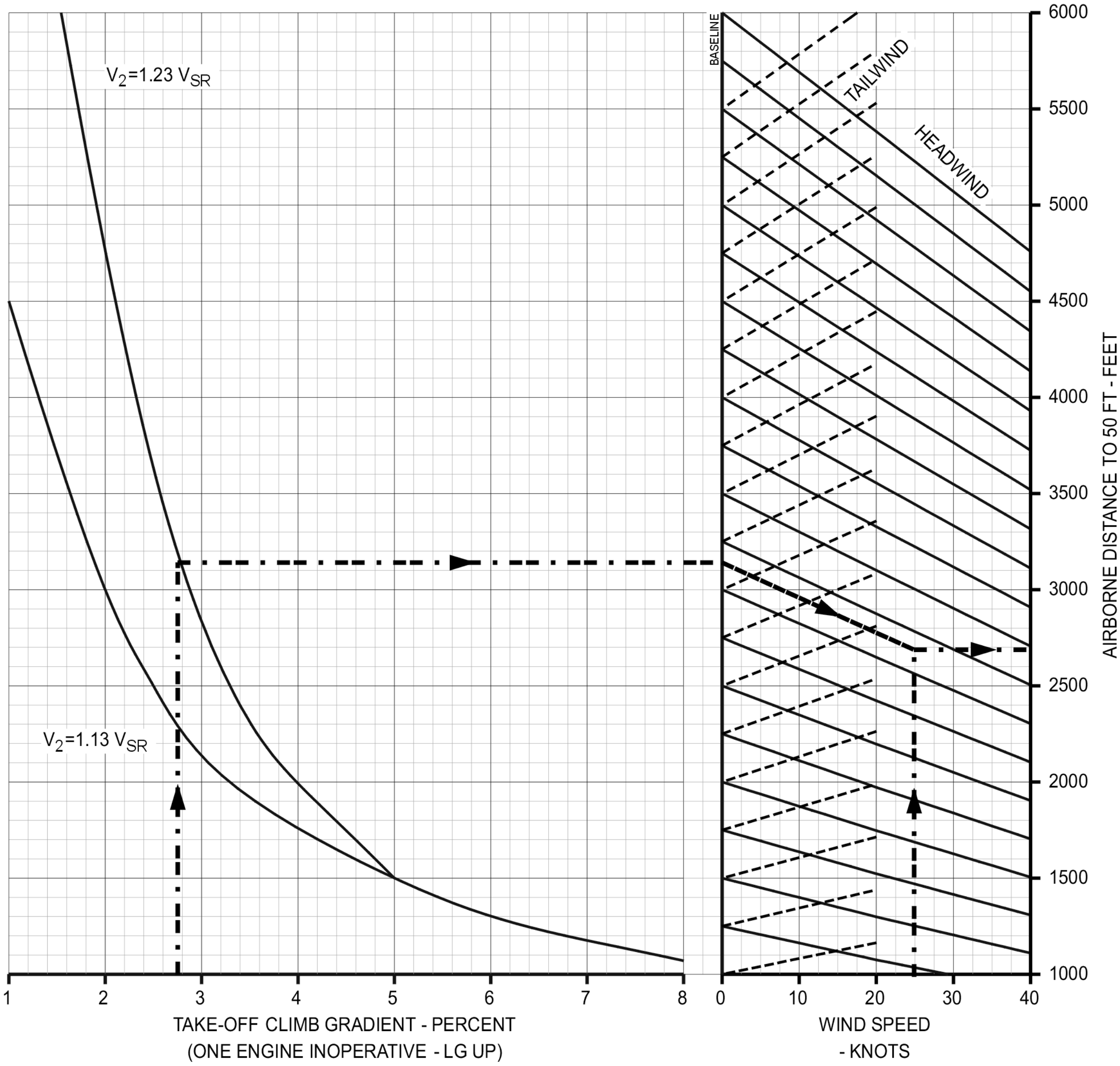

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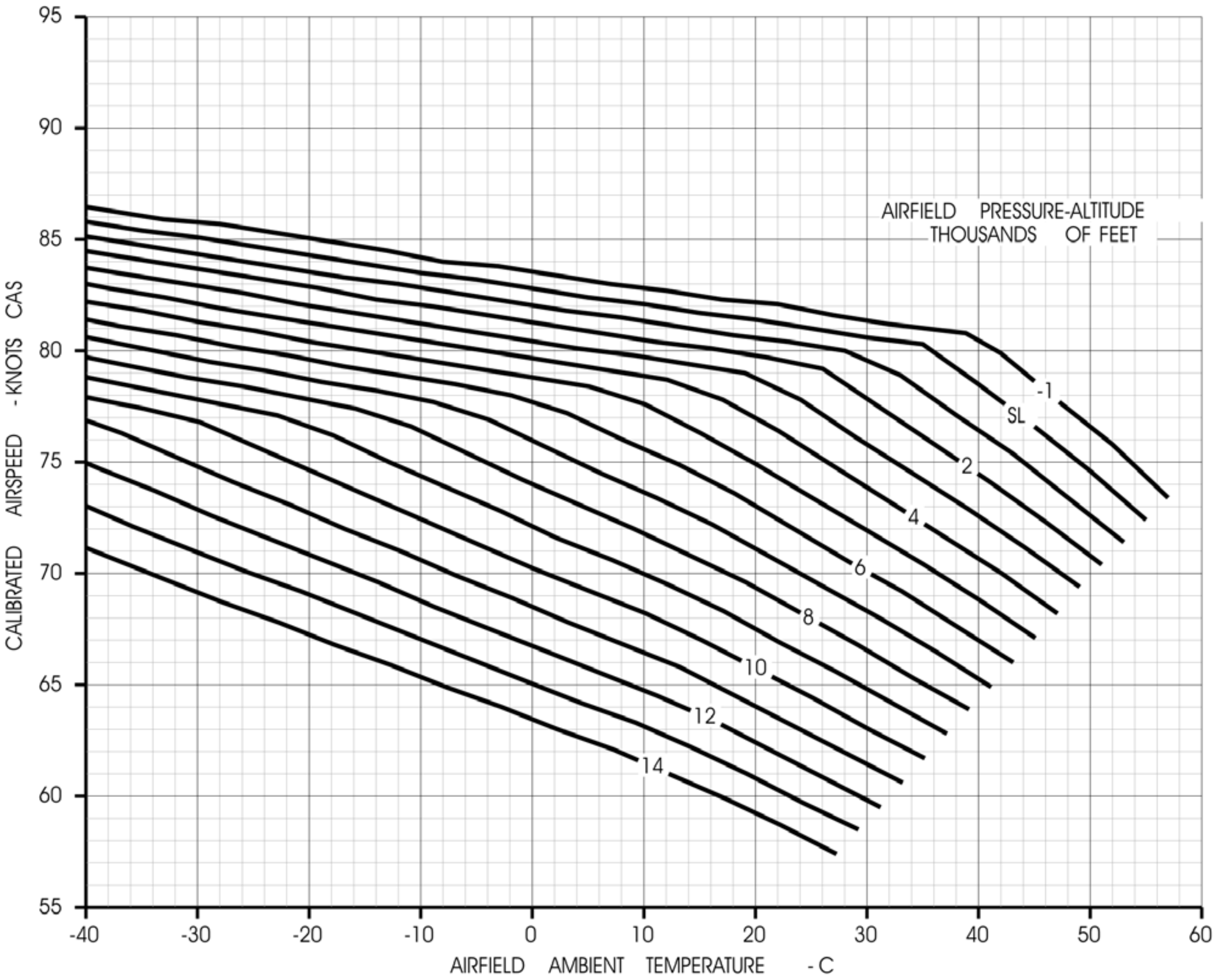
Figure 3-8 Distance From Lift - Off to 50 ft Height. Normal Takeoff

GROUND MINIMUM CONTROL SPEED
NORMAL TAKEOFF

DATE:	JUL. 2000	**AIRCRAFT:**	C-295M	**FLAPS:**	TO (10º)
DATA BASIS:	FLIGHT TEST	**ENGINES:**	PW 127-G		
		PROPELLERS:	HS 568F-5		



These values are applicable to takeoffs from either paved or unpaved runways at least 77 ft wide.

When operating from runways that are between 77 and 67 ft wide increase Vmcg by 1 knot for each 2 feet less than a width of 77 feet.

When operating from runways between 67 and 57 feet wide, increase Vmcg by an additional 5 knots and a further 3 knots for each 2 feet less than 67 feet wide.

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Figure 3-9 Ground Minimum Control Speed. Normal Takeoff

REFUSAL SPEED AND CRITICAL ENGINE FAILURE SPEED NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST
AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5
FLAPS: TO (10º)

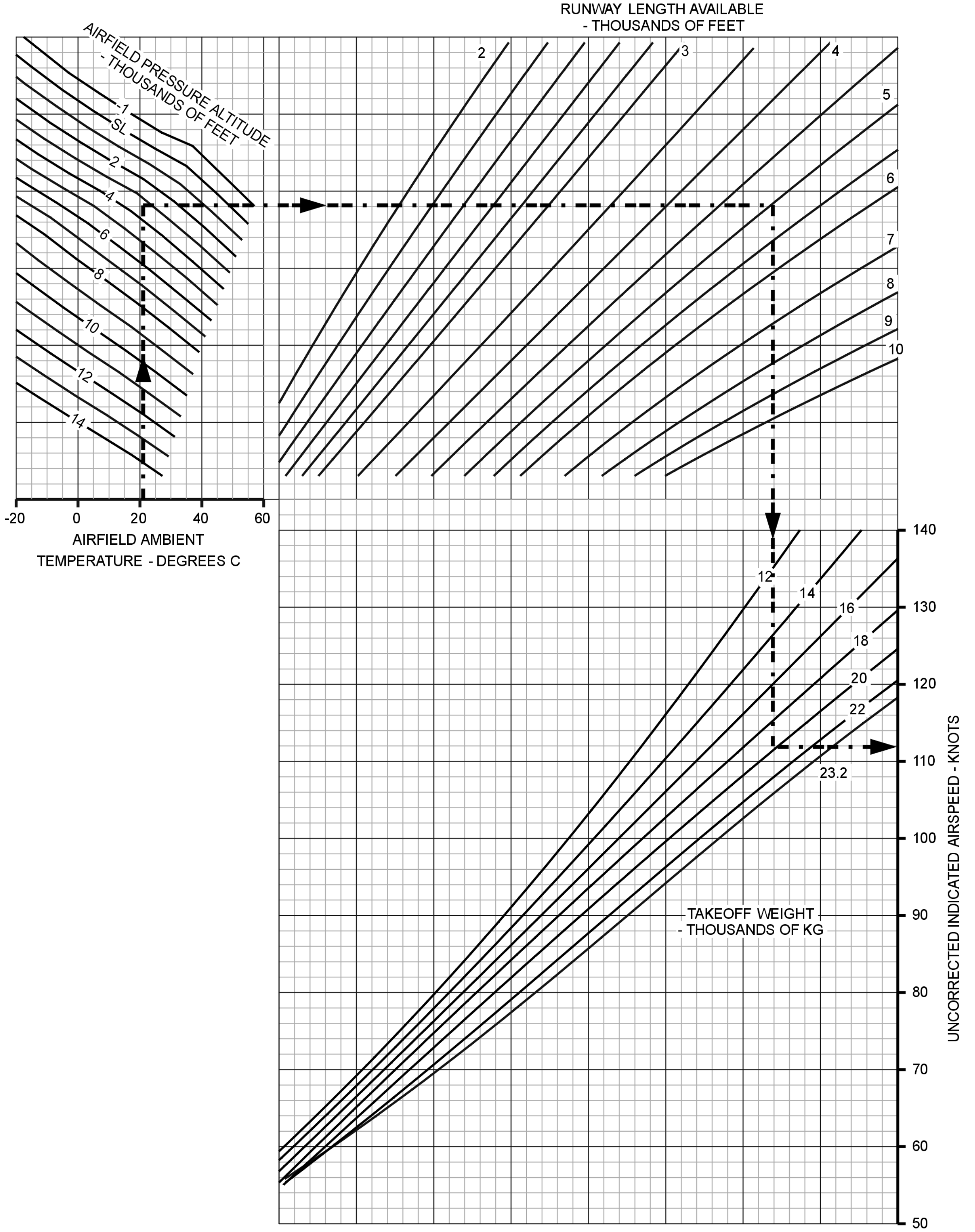

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Figure 3-10 (Sheet 1 of 2) Refusal Speed and Critical Engine Failure Speed. Normal Takeoff

REFUSAL SPEED AND CRITICAL ENGINE FAILURE SPEED NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)

NOTE:

1. WHEN REFUSAL SPEED EXCEED THE ROTATION SPEED, USE THE ROTATION SPEED AS THE REFUSAL SPEED.

2. TO DETERMINE THE CRITICAL ENGINE FAILURE SPEED, USE THE CRITICAL FIELD LENGTH AS THE RUNWAY LENGTH.

3. THE TAKEOFF DECISION SPEED MUST BE INCLUDED BETWEEN V_{CEF} OR V_{MCG} (WHICHEVER IS HIGHER) AND THE REFUSAL SPEED.

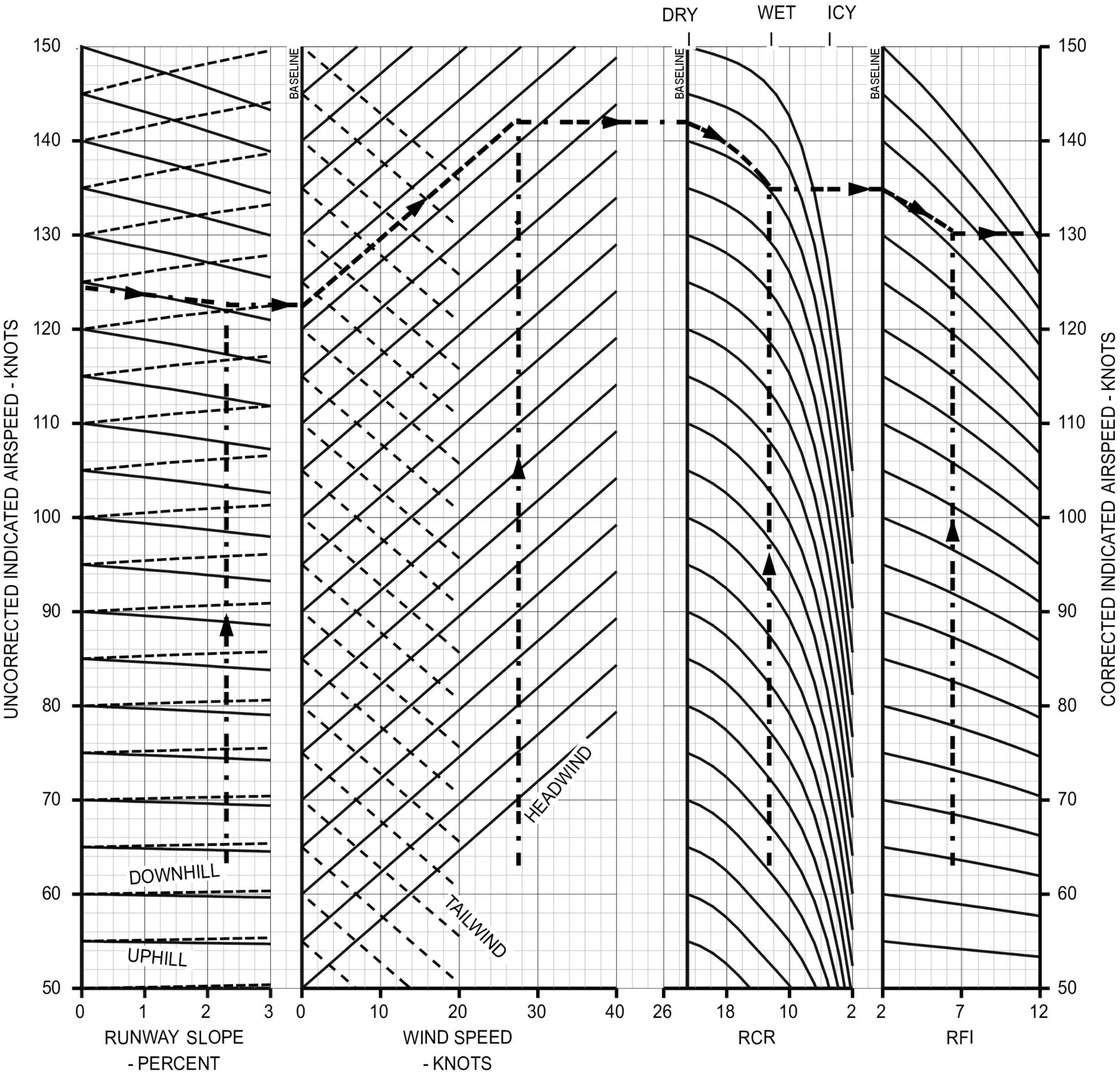

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Figure 3-10 (Sheet 2 of 2) Refusal Speed and Critical Engine Failure Speed. Normal Takeoff

TAKEOFF FLIGHT PATH
1 ENGINE, NORMAL TAKEOFF
FLAPS 10º

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

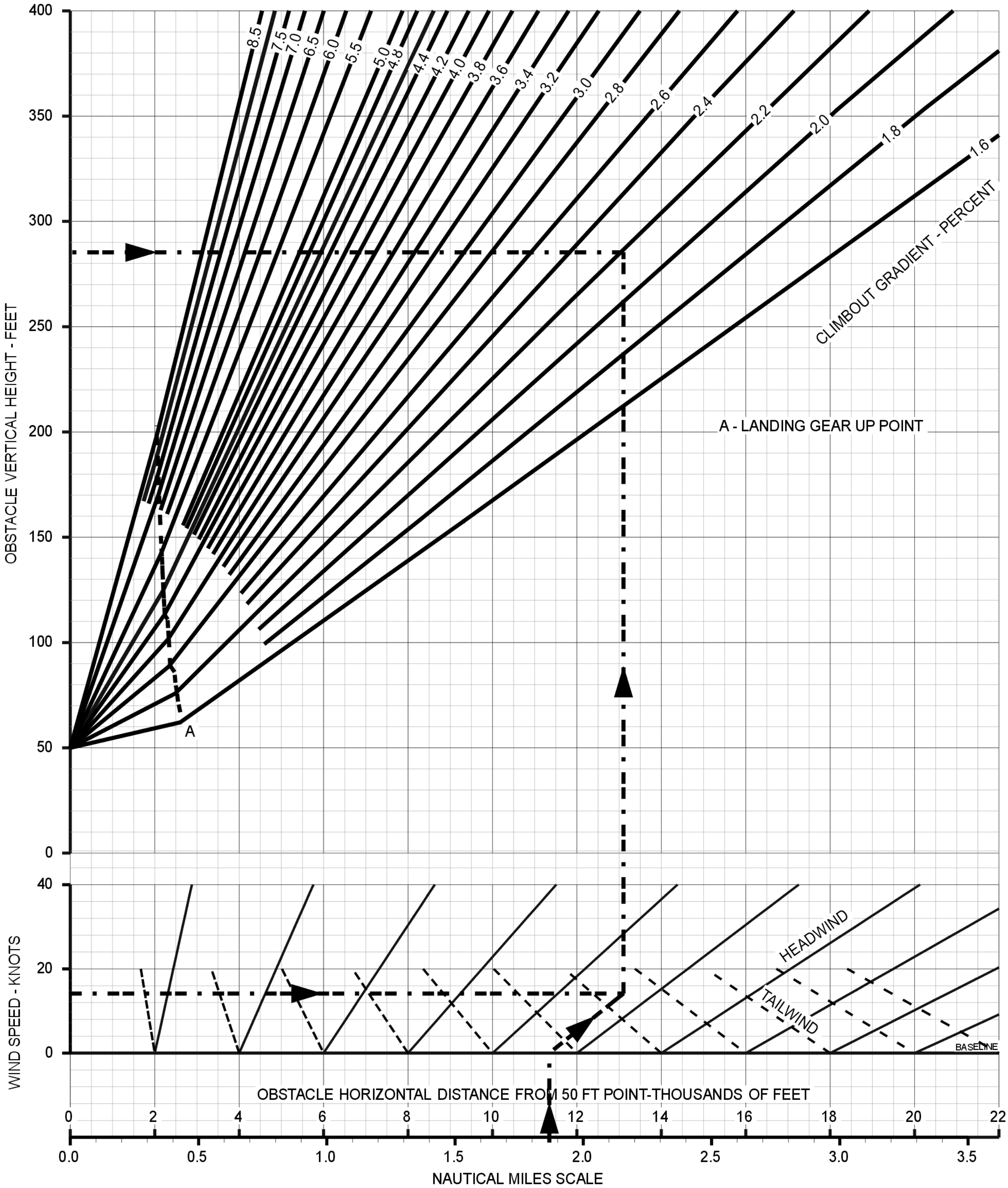

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Figure 3-11 (Sheet 1 of 2) Takeoff Flight Path. 1 Engine. Normal Takeoff

TAKEOFF FLIGHT PATH
1 ENGINE, NORMAL TAKEOFF
FLAPS 10º

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

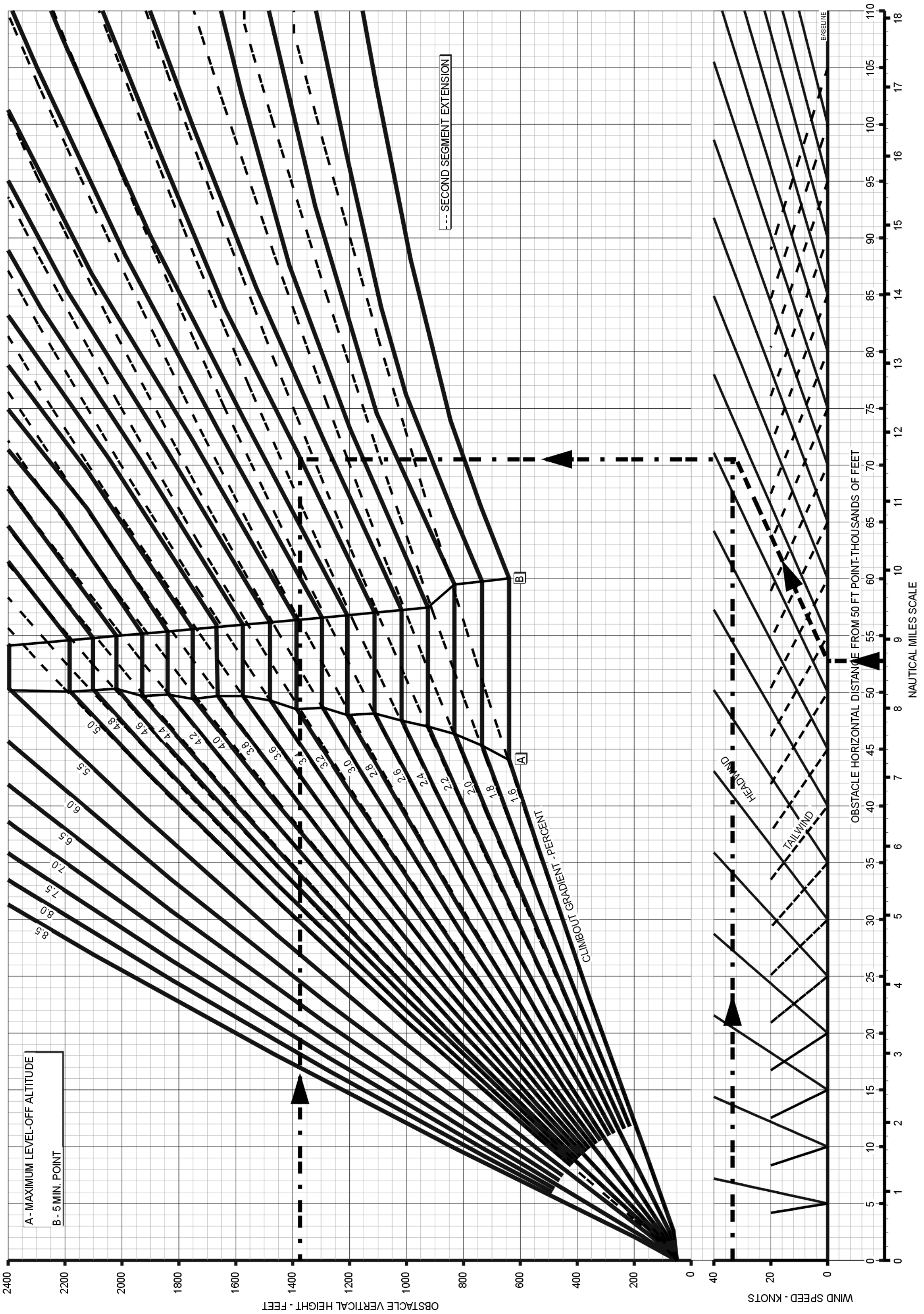

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Figure 3-11 (Sheet 2 of 2) Takeoff Flight Path. 1 Engine. Normal Takeoff

AIR MINIMUM CONTROL SPEED
NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST
AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5
FLAPS: TO (10º)

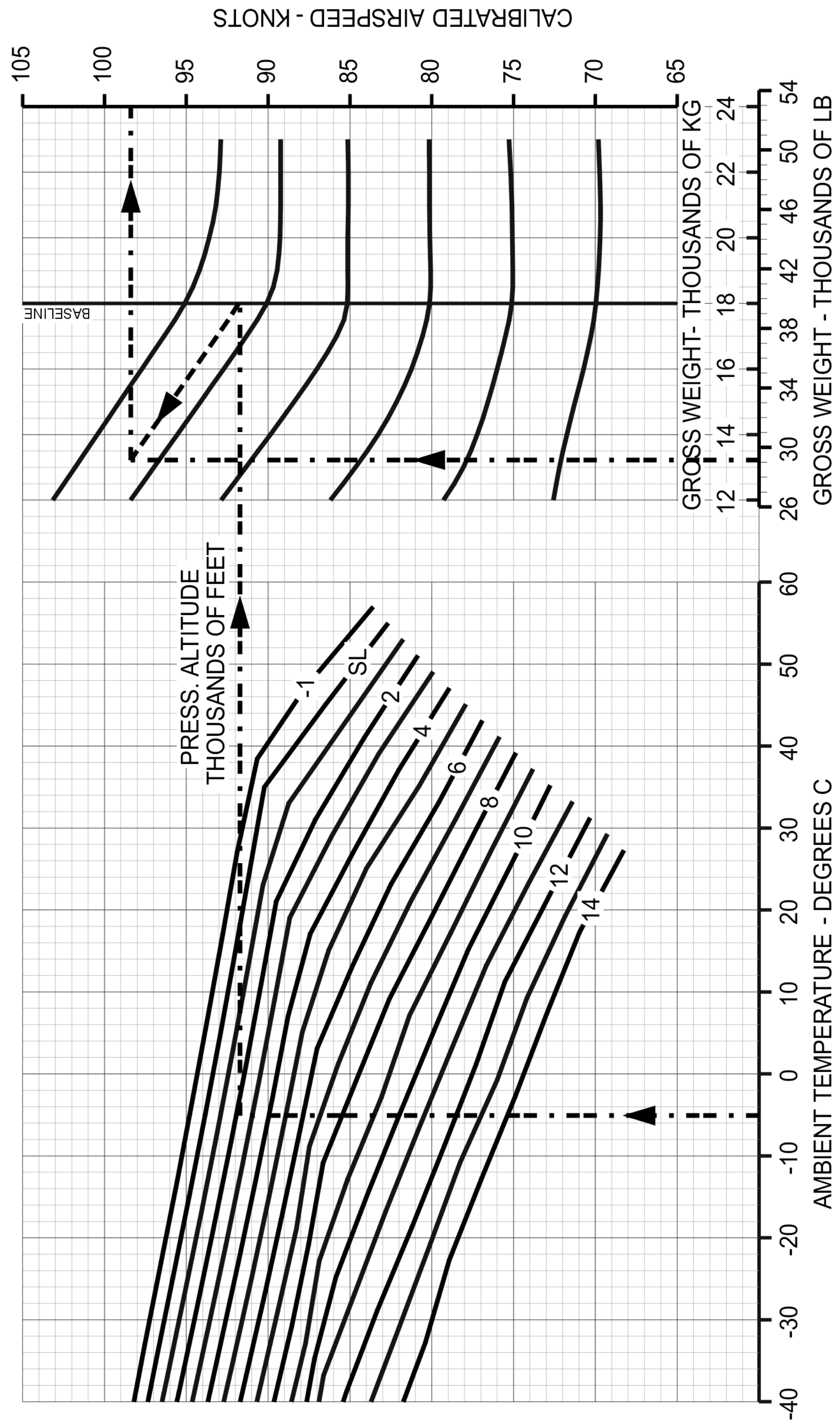

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Figure 3-12 Air Minimum Control Speed. Normal Takeoff

TAKEOFF SPEEDS, NORMAL TAKEOFF
FLAPS 10º

DATE:	JUL. 2000	**AIRCRAFT:**	C-295M
DATA BASIS:	FLIGHT TEST	**ENGINES:**	PW 127-G
		PROPELLERS:	HS 568F-5

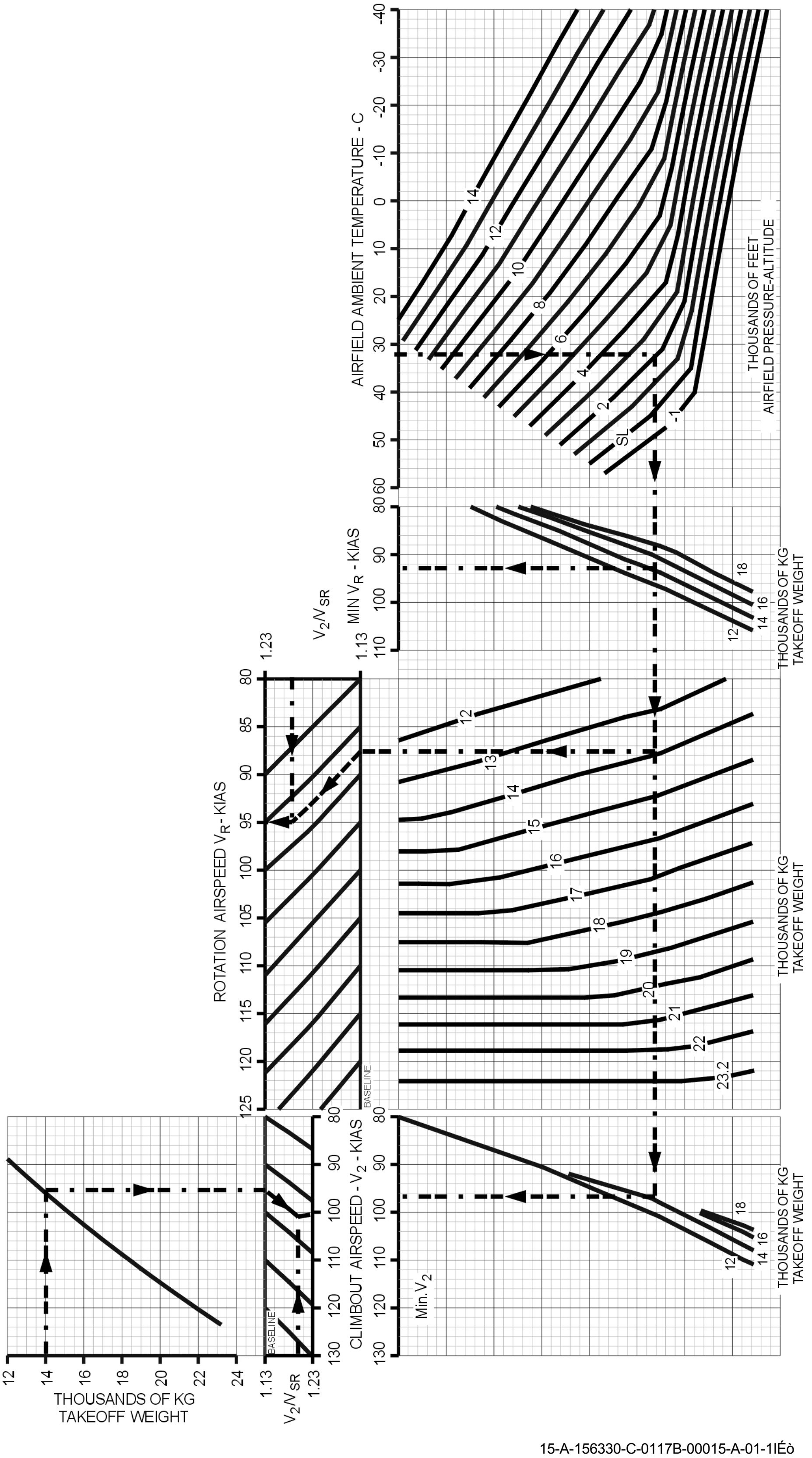

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Figure 3-13 Takeoff Speeds. Normal Takeoff

TAKEOFF GROUND RUN
2 ENGINES, NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST
AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5
FLAPS: TO (10º)

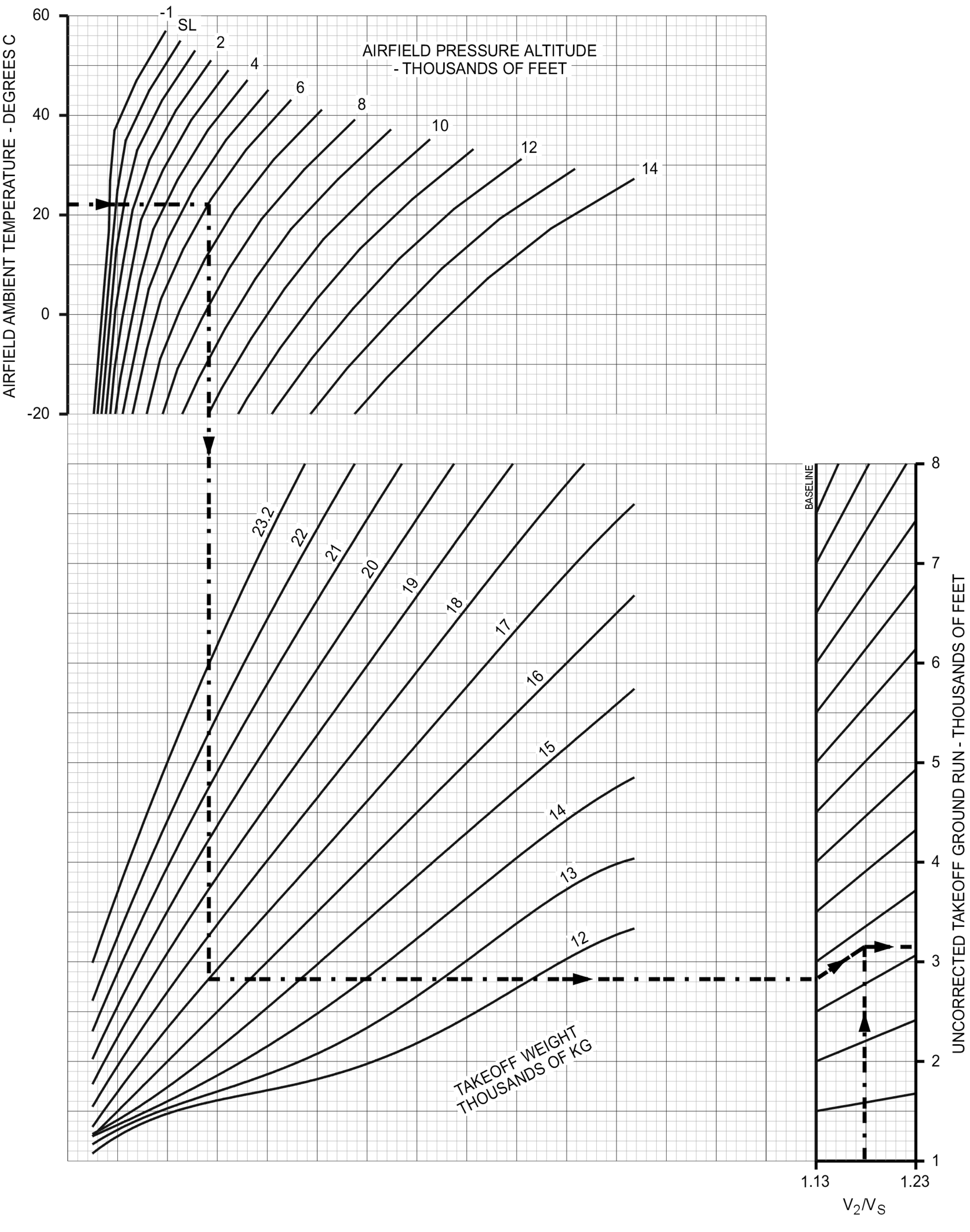

Figure 3-14 (Sheet 1 of 2) Takeoff Ground Run. 2 Engines. Normal Takeoff

TAKEOFF GROUND RUN
2 ENGINES, NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)

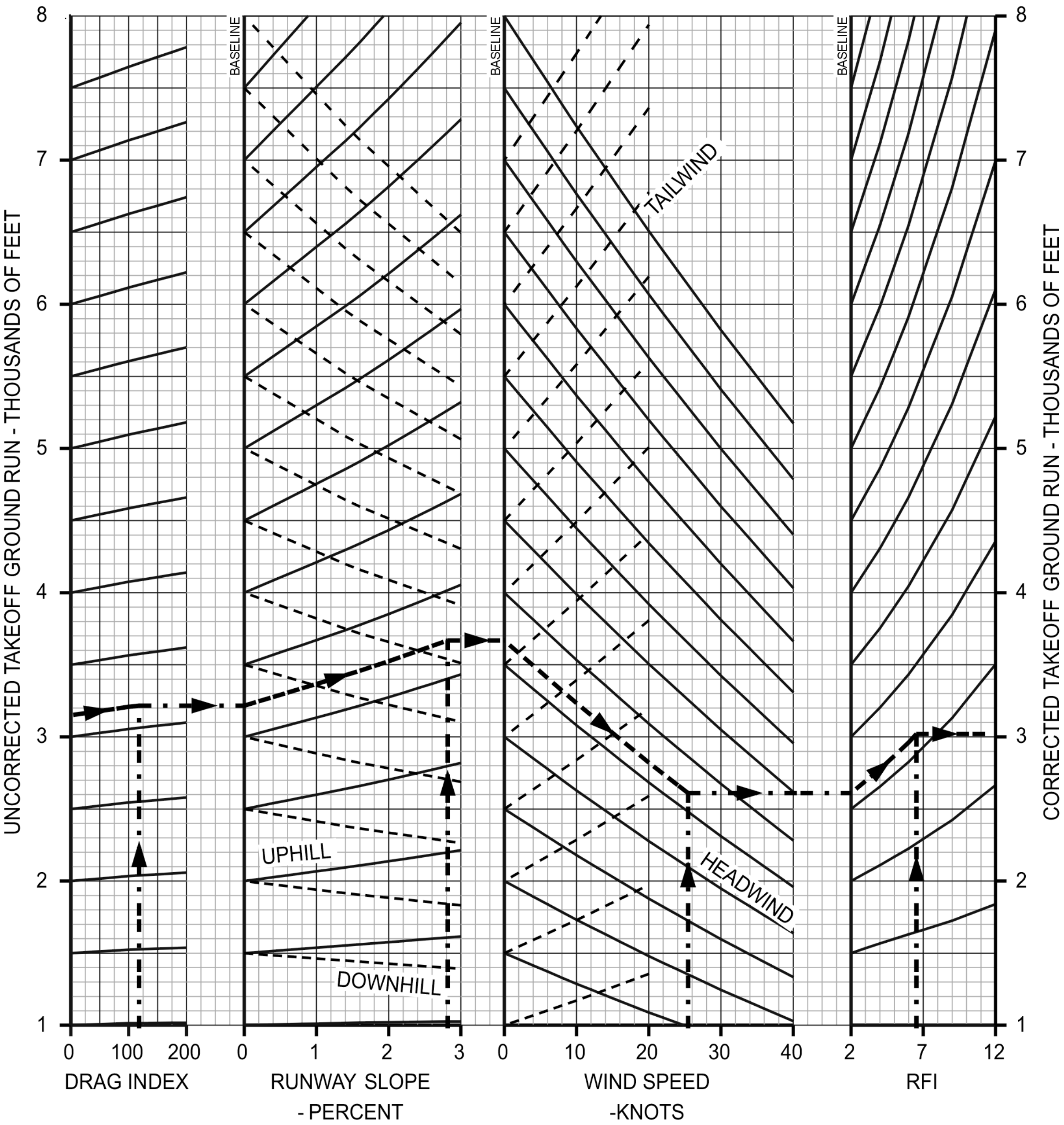

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Figure 3-14 (Sheet 2 of 2) Takeoff Ground Run. 2 Engines. Normal Takeoff

TAKEOFF DISTANCE TO 50 FT
2 ENGINES, NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST
AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5
FLAPS: TO (10º)

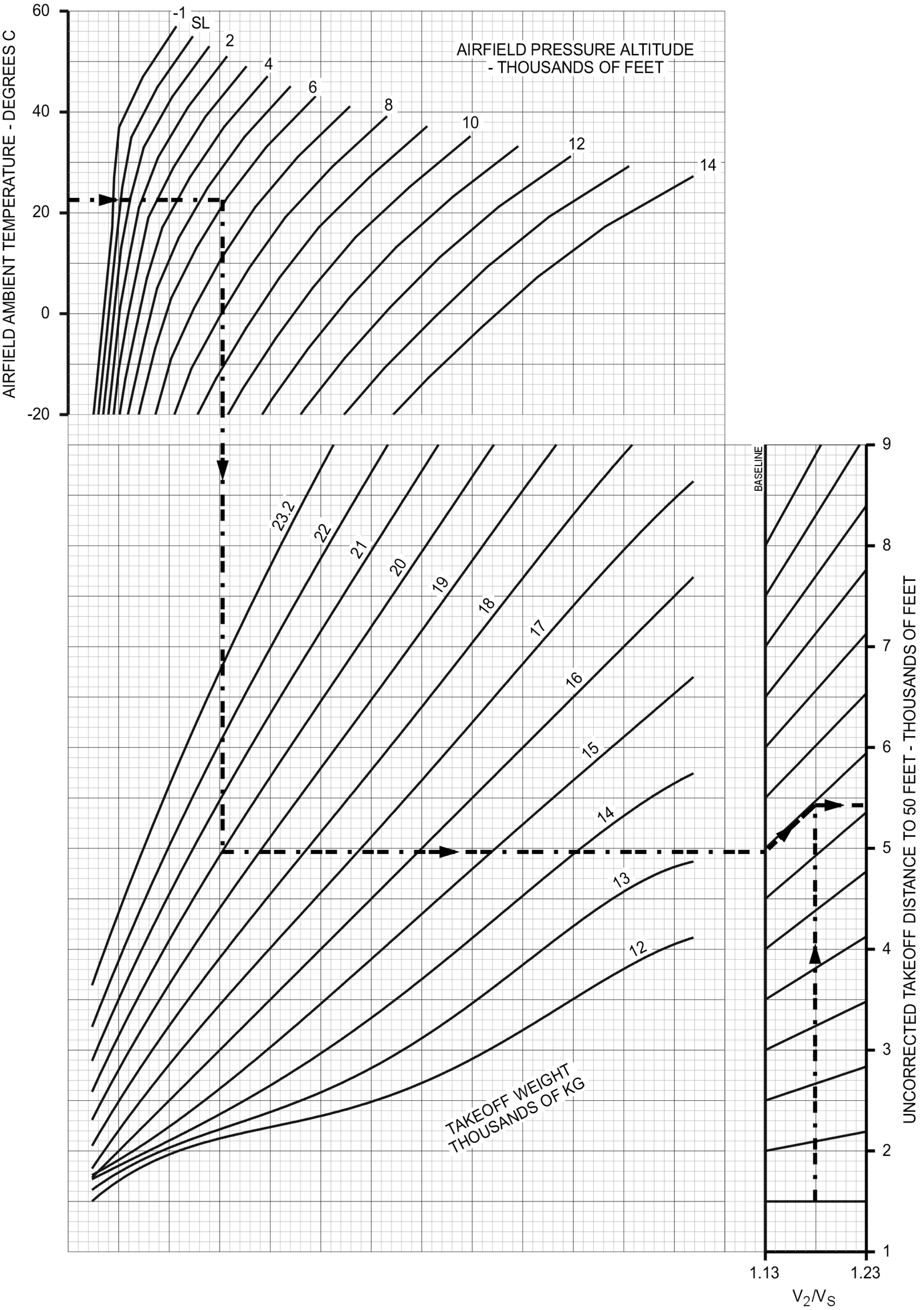

Figure 3-15 (Sheet 1 of 2) Takeoff Distance to 50 ft. 2 Engines. Normal Takeoff

TAKEOFF DISTANCE TO 50 FT
2 ENGINES NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST
AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5
FLAPS: TO (10º)

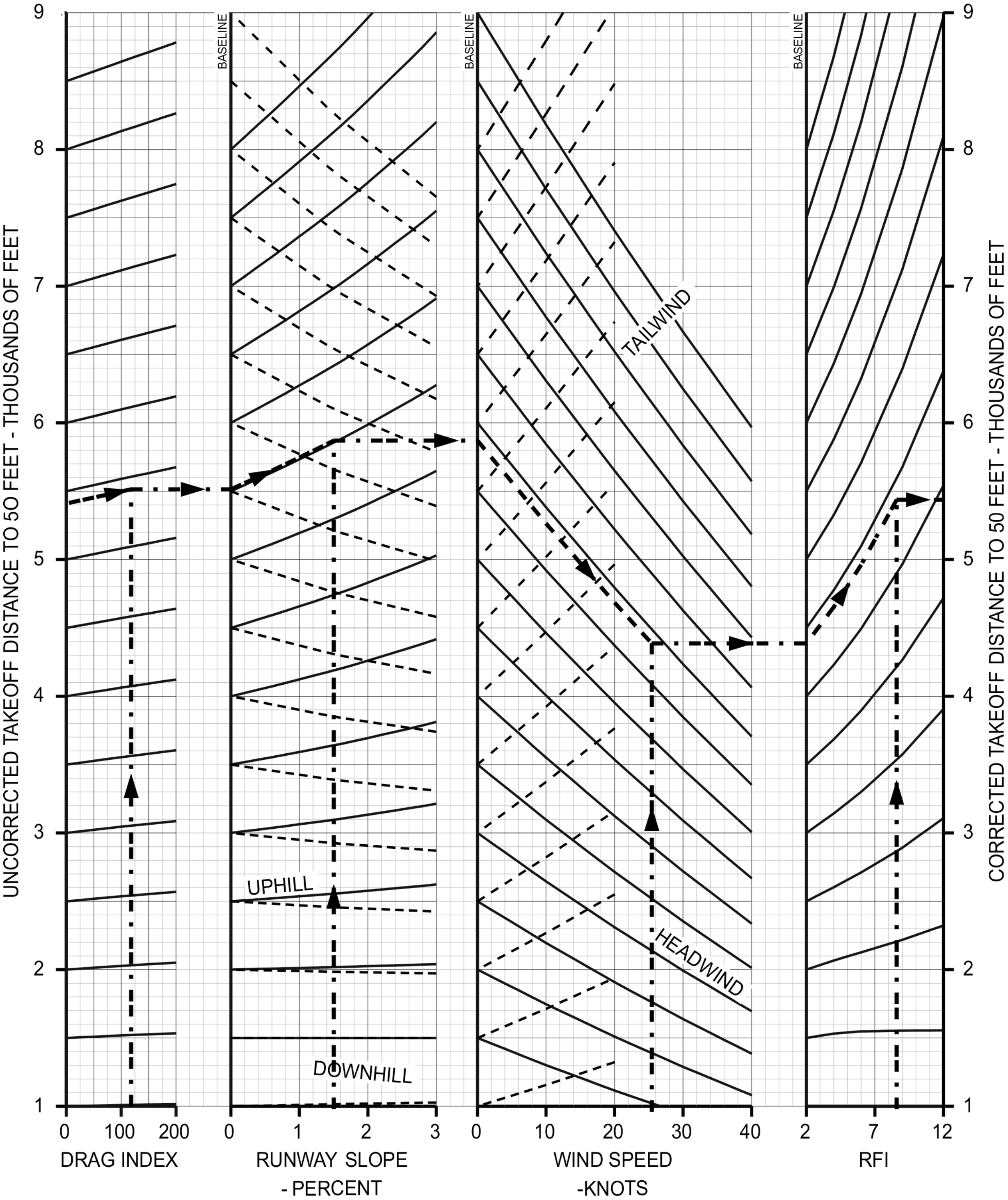

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Figure 3-15 (Sheet 2 of 2) Takeoff Distance to 50 ft. 2 Engines. Normal Takeoff

CLIMB GRADIENT
2 ENGINES, NORMAL TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST
AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5
FLAPS: TO (10º)

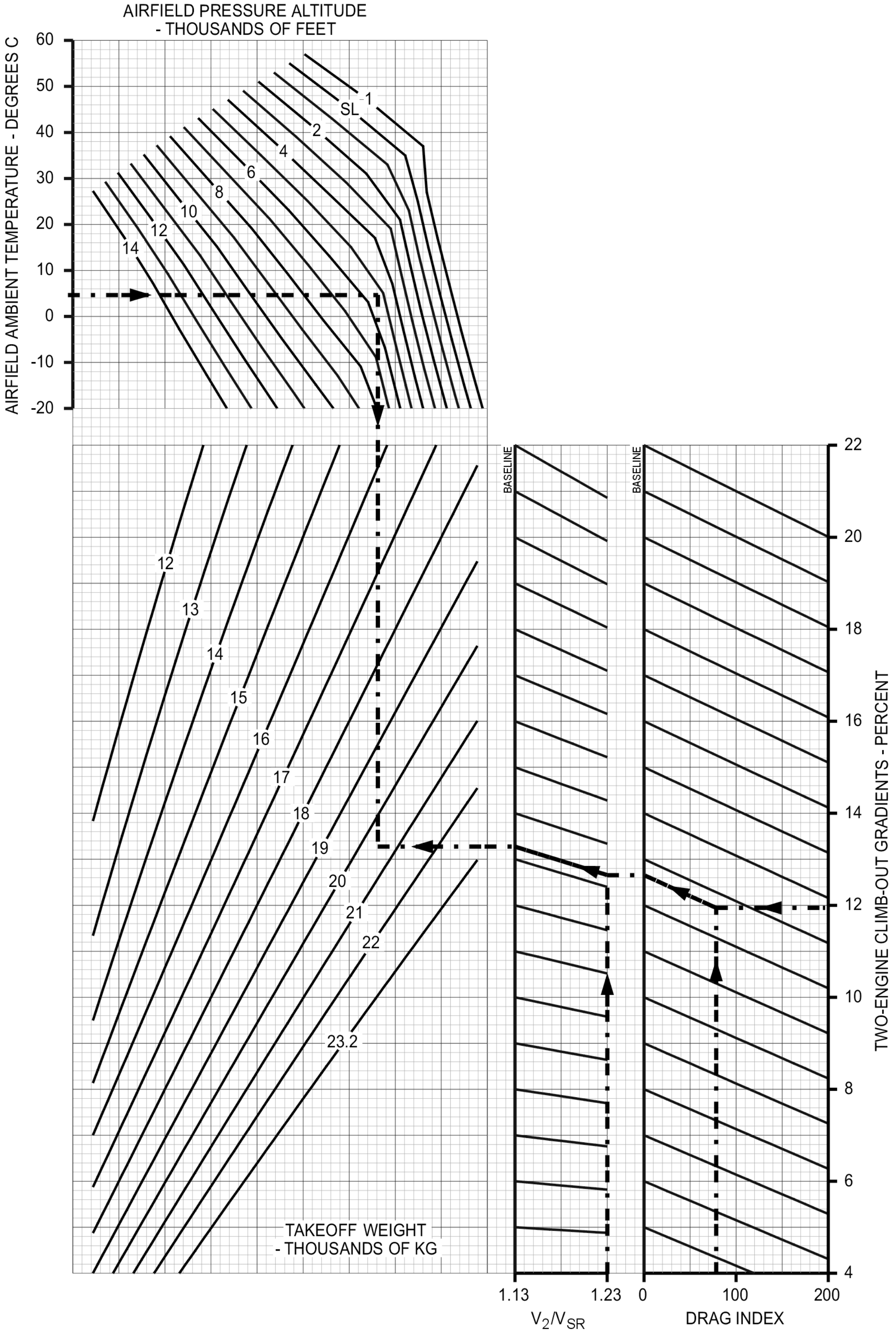

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Figure 3-16 Climb Gradient. 2 Engines. Normal Takeoff

TAKEOFF FLIGHT PATH
2 ENGINES, NORMAL TAKEOFF
FLAPS 10º

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST
AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

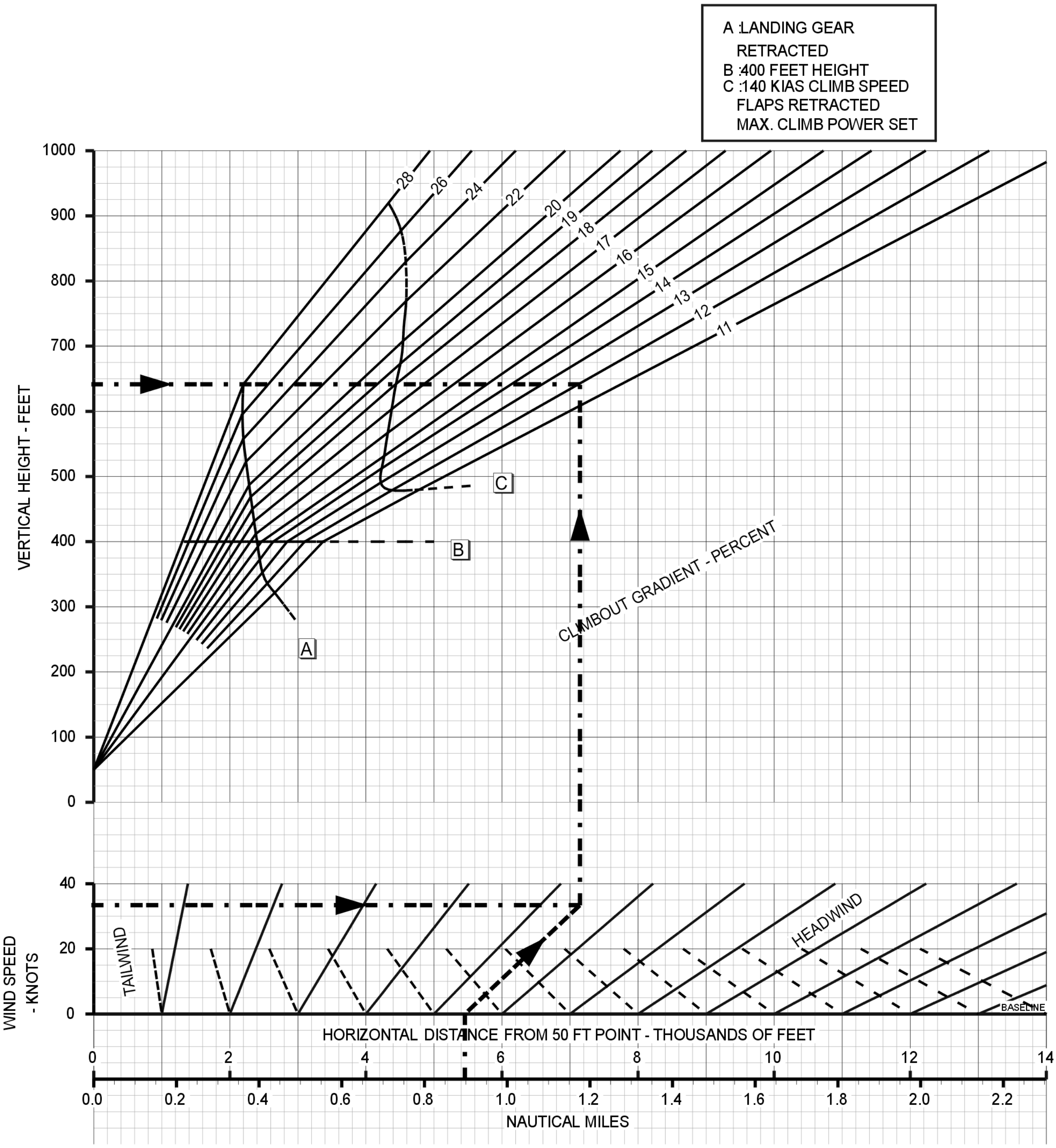

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Figure 3-17 (Sheet 1 of 2) Takeoff Flight Path. 2 Engine. Normal Takeoff

TAKEOFF FLIGHT PATH
2 ENGINES, NORMAL TAKEOFF
FLAPS 10º

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

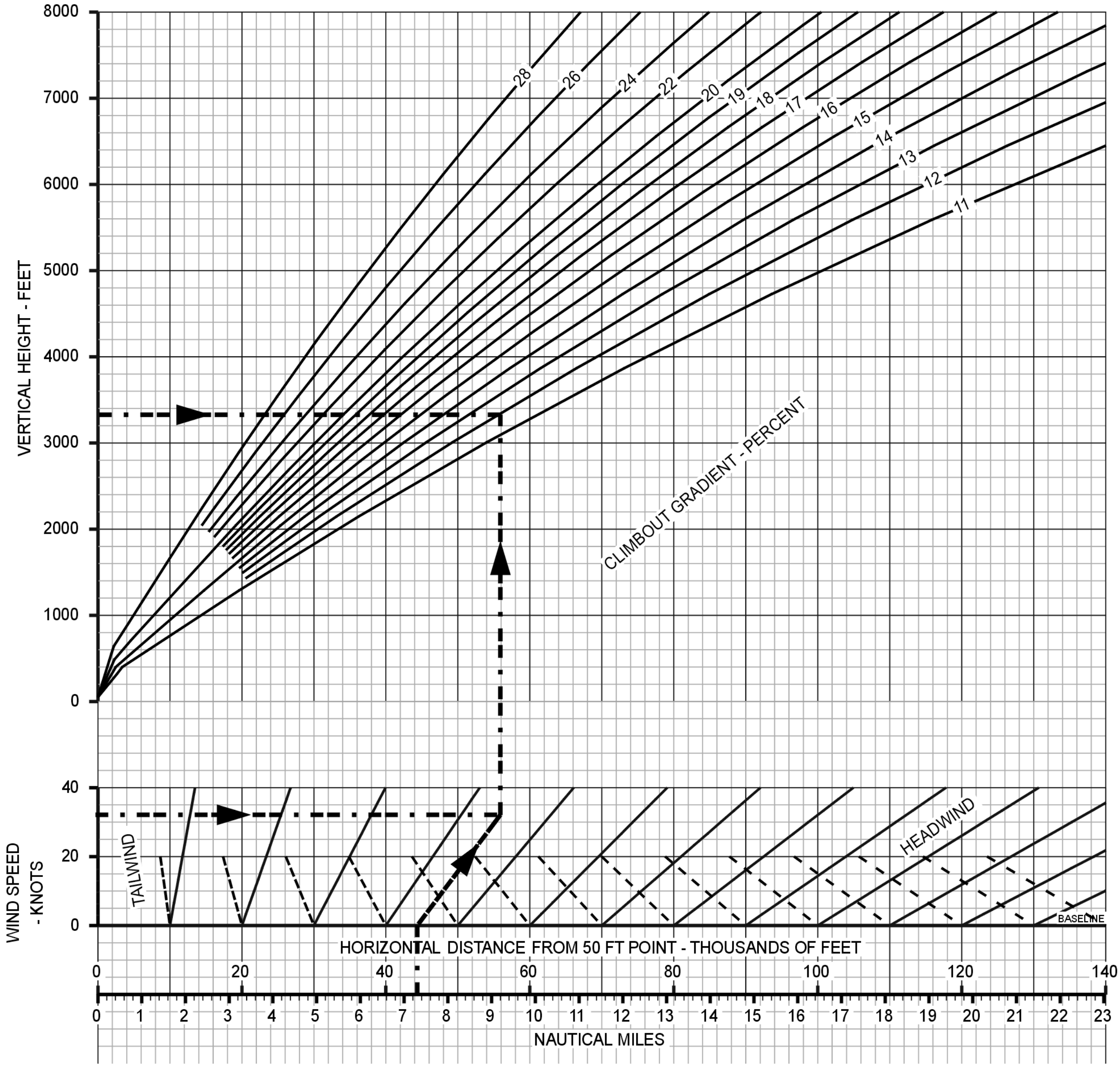

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Figure 3-17 (Sheet 2 of 2) Takeoff Flight Path. 2 Engine. Normal Takeoff

MAXIMUM REFUSAL SPEED LIMITED BY BRAKE ENERGY NORMAL TAKEOFF

DATE:	JUL. 2000	**AIRCRAFT:**	C-295M	**FLAPS:**	TO (10º)
DATA BASIS:	FLIGHT TEST	**ENGINES:**	PW 127-G		
		PROPELLERS:	HS 568F-5		

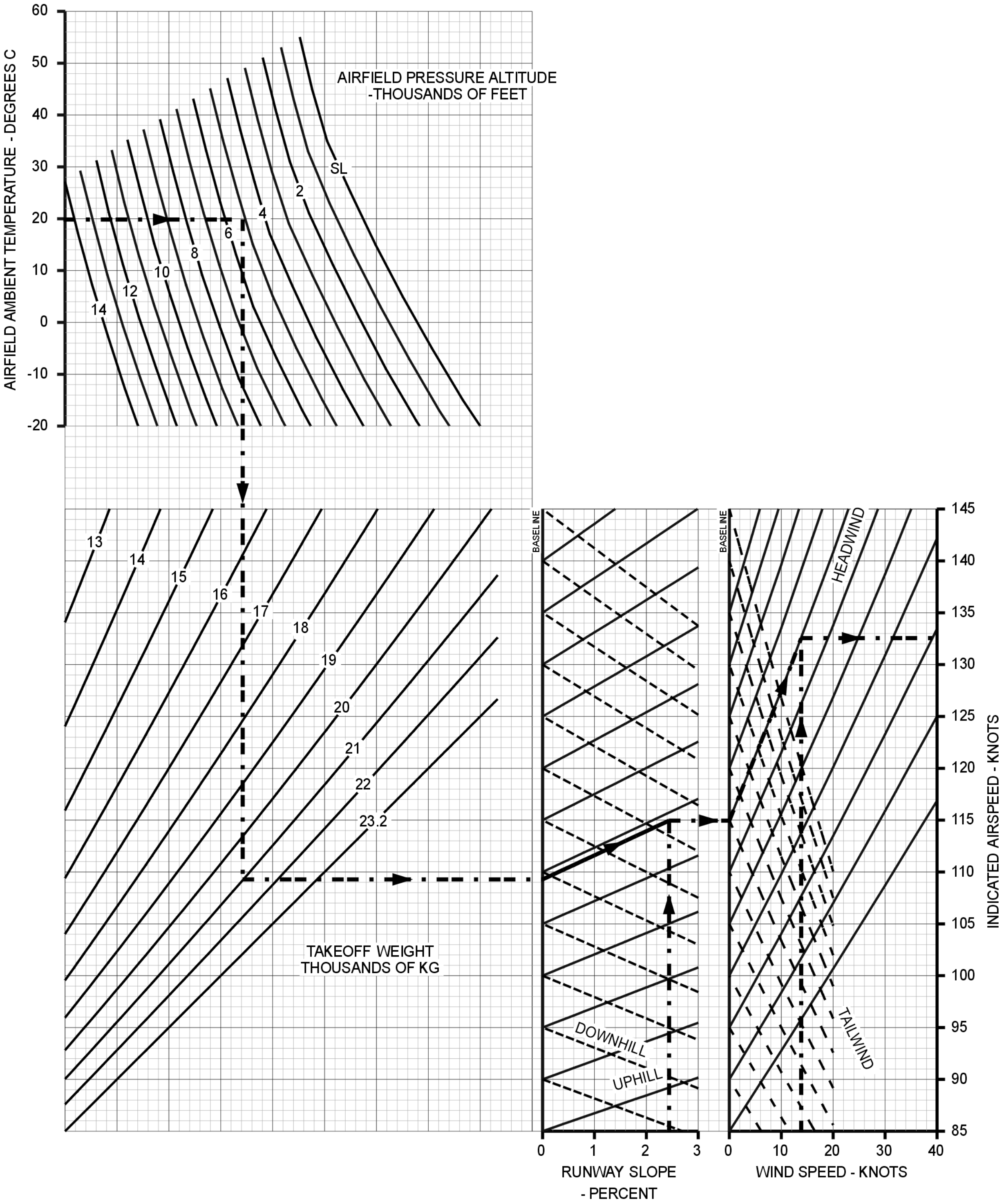

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Figure 3-18 Maximum Refusal Speed Limited by Brake Energy. Normal Takeoff

SHORT-FIELD TAKEOFF

INTRODUCTION

Short-field takeoff, also know as tactical takeoff or maximum-effort takeoff, is a takeoff technique developed to obtain shorter ground run distances while still clearing nearby obstacles. This technique is similar to that of a normal takeoff except that lower takeoff speeds are used in order to enhance ground performances.

Protection against the possibility of experiencing engine failure takeoff can be ensured if the criteria regarding CFL (critical field length), refusal speed, single-engine takeoff distance to the height of nearby obstacles and minimum climb gradients with one engine inoperative, are applied. The procedures and criteria with which to determine the maximum takeoff weight on a given runway are entirely analogous to those for normal takeoff.

If, in an emergency or case of sufficient urgency, it is necessary to takeoff from an extremely short runway, thus not taking into account the possibility of engine failure during the takeoff run, the takeoff distance values without engine failure may be used to determine the available runway length restrictions (provided that the competent authorities grant authorization). Under such circumstances the minimum single-engine climb gradient (or rate of climb) values required by command must be adhered to.

A short-field takeoff may be performed with the flaps at TO (10°) or APP (15°). The speed in the second segment is defined in each as 1.07 V_{S1g} for flaps at TO and 1.06 V_{S1g} for flaps at APP. The speed in this case is defined as a percentage of the real stall speed rather than the reference stall speed (which would be stall speed forced by the activation of the stick pusher). These speeds, like the rotation speed and minimum ground and air control speeds, have been determined by flight tests.

As a general rule, is recommended to set the flaps at APP (15°) position when limiting factor is the available runway length and at TO (10°) position when the limitation is the minimum climb capacity or presence of obstacles. However, given the long list of operational limitations involved, there is no simple rule. Is therefore recommended that the maximum takeoff weight be analysed with both flaps position and the optimal position is selected.

NOTE

The short-field (or tactical/maximum effort) takeoff technique requires that the crew have a high degree of familiarity with the flight characteristics of the aircraft and the corresponding procedures. The competent authorities must give their authorization for the use of this takeoff technique.

DESCRIPTION OF TAKEOFF

When the possibility of an engine failure during takeoff is taken into account, the criteria defined for normal takeoff are applicable (shown in Figure 3-3, Figure 3-4 and Figure 3-5).

When it is decided that the possibility of an engine failure during takeoff will not be taken into account, the takeoff distances with both engines operative must be such that the takeoff ground run is shorter than the available runway length and that when added to the distance in the air it is sufficient to clear any nearby obstacles.

DETERMINING THE MAXIMUM TAKEOFF WEIGHT

Assuming that the runway conditions are known, the maximum takeoff weight (MTOW) can be determined as follows:

1. Determine the maximum takeoff weight limited by single-engine climb performance using the charts in Figure 3-19 or Figure 3-20, depending on the flap position selected.
2. Determine the maximum weight limited by runway length using the charts of the critical field length and distance in the air to the height of the obstacle (Figure 3-21, Figure 3-22, Figure 3-23 and Figure 3-24) or if engine failure is not to be taken into account, using the charts of the ground run distance and distance in the air with all engines operative (Figure 3-33, Figure 3-34, Figure 3-35 and Figure 3-36).
3. Select the minimum weight (provisional MTOW). This should be either the weight obtained in point 1 and point 2 and the maximum structural takeoff weight (see Section 1 of Volume I).

   If you do not want to take engine failure during the takeoff run into account, the maximum takeoff weight is that obtained in the previous step. It now remains to determine the refusal speed. To do so, use the charts in Figure 3-27 or Figure 3-28, as appropriate.

   If you do want to consider the possibility of engine failure during the takeoff run to determine the runway length limitations, follow the steps below:
4. Determine the value of V_{MCG} using Figure 3-25 or Figure 3-26.
5. If the weight is limited by runway length, the available runway will be the CFL. Then determine the refusal speed using Figure 3-27 or Figure 3-28. The refusal speed will also be the critical engine failure speed. If this speed is less than V_{MCG} the takeoff will be limited by V_{MCG} (accelerate-stop) and the takeoff weight should be reduced to ensure a safe takeoff. Determine the new weight using the appropriate figure (Figure 3-27 or Figure 3-28) with the available runway length and taking V_{MCG} as the refusal speed.

   If, on the other hand, the refusal speed is not less than V_{MCG} take whichever is lowest of the refusal speed and the rotation speed as the decision speed.

   Check that the refusal speed is not higher than the maximum brake energy speed. If it is higher, the weight should be reduced again in order to allow for safe takeoff. Then determine the MTOW again for which V_{MCG} or V_{CEF} (whichever is higher) is the same as the maximum brake energy speed. The resulting speed should be used as the refusal speed.
6. If the weight is not limited by runway length, obtain the CFL for the MTOW. Determine the critical engine failure speed (V_{CEF}) and the refusal speed for MTOW using Figure 3-27 or Figure 3-28. Take as the refusal speed whichever is lower of the refusal speed obtained earlier or the V_R for MTOW or the maximum brake energy speed.

   For the decision speed it is possible to use any speed between whichever is higher of V_{MCG} and V_{CEF} and the refusal speed found in the previous paragraph. If this refusal speed is less than V_{MCG} or V_{CEF} due to the braking energy limits, the weight should be reduced in order to allow for a safe takeoff. Determine this new MTOW such that whichever is higher of V_{MCG} and V_{CEF} is equal to the maximum brake energy speed. This speed is the refusal speed.

MAXIMUM TAKEOFF WEIGHT LIMITED BY SINGLE-ENGINE CLIMB PERFORMANCE

The maximum takeoff weight limited by single-engine climb performance is shown in Figure 3-19 and Figure 3-20 for the flaps at TO and APP positions, respectively. The conditions associated with these charts are as follows:

- Critical engine inoperative and its propeller feathered.
- Operative engine at APR power (PRS selector switch in the TOGA position).
- Engine anti-ice on or off. ECS off.
- Landing gear up.
- Flpas at TO (10°) or APP (15°).
- Climb speed: V_2 (1.07 V_{S1g} for flaps at TO and 1.06 V_{S1g} for flaps at APP).
- Out of ground effect.

The weight is shown on the chart as a function of the airfield ambient temperature and runway pressure altitude, the required climb gradient or rate of climb, and the drag index.

The bottom of sheets 1 and 2 of the charts show a group of lines representing the climb gradient (in % - sheet 1) or rate of climb (in fpm - sheet 2) parameters.

The minimum climb gradient or minimum rate of climb must be defined in accordance with the applicable command criteria or obstacle clearance requirements.

The chart can also be used the other way around to determine the climb gradient or rate of climb for a given weight.

NOTE

Takeoff weights for which the rate of climb with the landing gear down is less than 100 feet per minute should not be used. This limitation corresponds to the following values on the charts.

Flap position used	Value of rate of climb	Value of gradient
TO	200 fpm	1.7%
APP	160 fpm	1.6%

NOTE

The capability of the aircraft to climb before reaching climbout speed is considerably reduced while the landing gear is being retracted (12 seconds) and the propeller is automatically feathered (under 1 second). The effect of the landing gear down is the following reduction:

Flap position used	Reduction in rate of climb	Reduction in gradient
TO	90 fpm	0.8%
APP	60 fpm	0.6%

Use of Graphs (Figure 3-19 or Figure 3-20)

Sheet 1. Locate the ambient temperature on the left-hand vertical axis of the relevant chart and move horizontally towards the pressure altitude curve. Once the curve is reached, move vertically downwards to the climb gradient curve. From the point of intersection move horizontally to the right until you meet the reference line. If the drag index is available, correct for it by following the guidelines to the current value of the drag index and from this point horizontally to the right to read off the takeoff weight from the vertical scale.

Sheet 2. Analogous method to that explained in the previous section.

Example

Given:

1. Airfield ambient temperature: 4°C
2. Airfield pressure altitude: 6,000 ft
3. Climb gradient: 4.5%
4. Flap position: APP (15°)
5. DI = 70

Results:

1. Maximum takeoff weight limited by single-engine climb performance 16,200 Kg (Figure 3-20, sheet 1)

CRITICAL FIELD LENGTH

The critical field length is the total length of runway required to accelerate with all engines to critical engine failure speed, experience a most critical failure, then continue to takeoff or stop.

The critical field lengths for flaps in the TO (10°) and APP (15°) positions are shown in Figure 3-21 and Figure 3-22. To obtain the chart it has been assumed that the takeoff is aborted without using reverse thrust. A delay of 2 seconds has been included to allow for the pilot´s reaction time.

Sheet 1 shows the uncorrected critical field length as a function of airfield ambient temperature, airfield pressure altitude and aircraft weight, assuming a clean aircraft, zero runway slope and a dry paved runway.

Sheet 2 gives the corrections for the drag index, runway slope, wind speed, RCR and RFI.

Use of Graphs (Figure 3-21 or Figure 3-22)

Sheet 1. Locate the airfield ambient temperature on the left-hand vertical axis of the relevant chart and move horizontally towards the aircraft pressure altitude curve. Having reached the curve, move vertically downwards to the aircraft weight curve. From the point of intersection move horizontally to read off the uncorrected critical field length from the vertical axis.

Sheet 2. Locate the value obtained from sheet 1 on the chart.

If the drag index correction is applicable, move parallel to the guidelines until the vertical line for the drag index value is intersected. From the intersection move horizontally to the next reference line. If the correction is not applicable, move directly to the next reference line.

From this point, move parallel to the guidelines (upwards: positive slope; downwards: negative slope) to the runway slope and then move horizontally to the right to the next reference line.

From this point, move parallel to the guidelines (upwards: tailwind; downwards: headwind) to the wind speed and then move horizontally to the right to the next reference line.

From this point, move parallel to the guidelines as far as the RCR value applicable at the runway surface and then move horizontally to the right until the next reference line is met. If the runway is paved and dry, move directly to the next reference line.

From this point, move parallel to the guidelines as far as the RFI value applicable at the runway surface and then move horizontally to the right until the next reference line is met. If the runway is paved and dry, move directly to the vertical scale and read off the corrected critical field length.

DISTANCE IN THE AIR WITH ONE ENGINE INOPERATIVE

Figure 3-23 and Figure 3-24 show the horizontal projection of the distances travelled in the air with one engine inoperative for the flaps at TO and APP positions, respectively, from the lift-off until the aircraft reaches the nearby obstacle height (which is variable) shown as a parameter.

To obtain a conservative value for the total takeoff distance from the moment the brakes are released until the desired height over the runway is reached in the case of a short-field takeoff with one engine inoperative, add the distance obtained from Figure 3-23 or Figure 3-24 to the applicable critical field length calculated in the previous paragraph.

Use of Graphs (Figure 3-23 or Figure 3-24)

Locate the takeoff climb gradient (landing gear retracted) obtained from Figure 3-19 or Figure 3-20 on the bottom left-hand scale of the chart and proceed vertically until the appropriate curve is intercepted. From the point of intersection move horizontally to the right until you meet the wind reference line.

From this point, move parallel to the guidelines (upwards: tailwind; downwards: headwind) to the wind speed and then move horizontally to the right to read off the distance in the air to the desired height.

To obtain the distance travelled from brake-release point, add the distance obtained above to the applicable critical field length.

Example

Given:

1. Airfield ambient temperature: 26°C
2. Airfield pressure altitude: 8,000 ft
3. Takeoff weight: 20,000 kg
4. Flap position: APP (15°)
5. DI: 120
6. Runway slope: +2%
7. Wind speed: 50 knots headwind. (On the chart 50% of this value will be used, i.e. 25 knots)
8. RCR: 14
9. RFI: 6

Results:

1.	Critical field length, uncorrected (Figure 3-22, sheet 1)	4,800 ft
2.	Critical field length, corrected (Figure 3-22, sheet 2)	5,200 ft

MINIMUM CONTROL SPEED ON THE GROUND

The ground minimum control speed (V_{MCG}) for short-field takeoff has been established using the same criteria and procedures as in the case of normal takeoff, thus the V_{MCG} for flaps at TO (Figure 3-25) is the same as that for normal takeoff (Figure 3-9). The V_{MCG} with flaps at APP is shown in Figure 3-26.

Use of Graphs (Figure 3-25 or Figure 3-26)

The chart is used in the same way as that in Figure 3-9.

REFUSAL SPEED AND CRITICAL ENGINE FAILURE SPEED

The refusal speed is the maximum speed to which the aircraft can accelerate and then stop in the available runway length.

Critical engine failure speed is the speed at which, if the critical engine fails, the distance required either to complete the takeoff or stop the aircraft is the same.

The refusal speed is shown in Figure 3-27 and Figure 3-28. Sheet 1 shows the uncorrected refusal speed as a function of the ambient temperature, pressure altitude, available runway length and weight of the aircraft for a zero slope runway, zero wind speed and a dry paved runway.

Sheet 2 gives the corrections for the runway slope, wind speed, RCR and RFI.

To obtain the refusal speed, it is assumed that the takeoff is aborted without using reverse thrust. A delay of 2 seconds is included to allow for the pilot´s reaction time.

When the charts in Figure 3-27 of Figure 3-28 are used to obtain the refusal speed, verify that the resulting value is not less than the corresponding ground minimum control speed read off from Figure 3-25 or Figure 3-26. If it is less, reduce the proposed takeoff weight until they are the same. Then obtain the rotation speed from Figure 3-31 or Figure 3-32 and take the lowest of the two speeds as the refusal speed.

When Figure 3-27 and Figure 3-28 are used to determine the critical engine failure speed, enter the chart with the critical field length rather than the available runway length.

The takeoff decision speed (V_1), which is the reference speed for deciding whether to continue the takeoff or abort it, must be at equal to or greater than the critical engine failure speed or the minimum ground control speed (whichever is higher), and no higher than the refusal speed.

Use of Graphs (Figure 3-27 or Figure 3-28)

The charts are used in the same way as in the case of normal takeoff.

AIR MINIMUM CONTROL SPEED

The air minimum control speed (V_{MCA}) for short-field takeoff has been established using the same criteria and procedures as in the case of normal takeoff, thus the V_{MCA} for flaps at TO (Figure 3-29) is the same as that for normal takeoff (Figure 3-12). The V_{MCA} with flaps at APP is shown in Figure 3-30.

Use of Graphs (Figure 3-29 or Figure 3-30)

The chart is used in the same way as that in Figure 3-12.

TAKEOFF SPEEDS

Rotation speed (V_R) is the speed at which rotation from the three-point attitude to the takeoff attitude is initiated by applying back pressure to the control column.

Climbout speed (V_2) is the recommended speed for single-engine obstacle clearance.

Climbout speed (V_2) will be 1.07 V_{S1g} with flaps at TO or 1.06 V_{S1g} with flaps at APP. This speed is limited by 1.0 V_{MCA}.

The minimum flap retraction speed ($V_{TO\text{-}UP}$ or $V_{APP\text{-}UP}$) is the minimum speed at which the flaps can be retracted. It is defined as V_{FTO} - 10 KIAS in both configurations.

The speed during the final takeoff segment (V_{FTO}) will be V_2 + 27 KIAS with flaps at TO and V_2 + 31 KIAS with flaps at APP.

The different operating speeds used during normal takeoff are shown in Figure 3-31 and Figure 3-32.

Use of Graphs (Figure 3-31 or Figure 3-32)

Locate the airfield ambient temperature on the scale and move horizontally to the right as far as the airfield pressure altitude curve. Proceed vertically downwards to the appropriate takeoff weight line so as to obtain the minimum V_R. Continue downwards until the appropriate takeoff weight line is intercepted so as to obtain the value of V_R. From the point of intersection with the weight curve above, continue downwards to intercept the appropriate weight curve to obtain the minimum value of V_2. Locate the aircraft takeoff weight on the horizontal (weight) scale again on the bottom left-hand chart. Proceed vertically downwards to intercept the curve and read the speed from the right-hand vertical scale. Compare the initial climb speed values and take the higher of the two.

Example

Given:

1. Takeoff weight: 18,000 kg
2. Flap position: APP (15°)
3. OAT: -5°C
4. Airfield pressure altitude: 2000 ft

Results:

1.	V_R (Figure 3-32)	91 KIAS
2.	V_2 (Figure 3-32)	98 KIAS
3.	V_{FTO} (98 + 31)	129 KIAS
4.	$V_{APP\text{-}UP}$ (129 - 10)	119 KIAS

TAKEOFF GROUND RUN

The takeoff ground run is the distance travelled on the ground to the point where the aircraft lifts off with all engines operative. The maximum takeoff ground run on short runways is shown in Figure 3-33 and Figure 3-34 for the flaps at TO and APP configurations, respectively. Sheet 1 shows the uncorrected takeoff ground run as a function of ambient temperature, pressure altitude and aircraft weight, assuming a clean aircraft, zero runway slope and a dry paved runway.

Sheet 2 gives the corrections for the drag index, runway slope, wind speed and RFI.

Use of Graphs (Figure 3-33 or Figure 3-34)

Sheet 1. Locate the ambient temperature on the left-hand vertical axis of the relevant chart and move horizontally towards the pressure altitude curve. Having reached the curve, move vertically downwards to the aircraft weight curve. From the point of intersection move horizontally to the right and read the uncorrected takeoff ground run from the vertical scale.

Sheet 2. Locate the value obtained from sheet 1 on the chart.

If the drag index correction is applicable, move parallel to the guidelines until the vertical line for the current drag index value is met. From the intersection move horizontally to the next reference line. If the correction is not applicable, move directly to the next reference line.

From this point, move parallel to the guidelines (upwards: positive slope; downwards: negative slope) to the runway slope and then move horizontally to the right to the next reference line.

From this point, move parallel to the guidelines (upwards: tailwind; downwards: headwind) to the wind speed and then move horizontally to the right to the next reference line.

From this point, move parallel to the guidelines as far as the RFI value applicable at the runway surface and then move horizontally to the right until the next reference line is met. If the runway is paved and dry, move directly to the vertical scale and read off the corrected takeoff ground run.

When you want to use these charts to determine the maximum takeoff weight limited by runway length, without taking into account the possibility of engine failure, the above procedure needs to be carried out in reverse order. That is to say, starting with sheet 2 begin by locating the runway available (less the margin required to clear nearby obstacles -see takeoff distances in the following section) on the right-hand scale.

TAKEOFF DISTANCE

Figure 3-35 and Figure 3-36 show the horizontally projection of the distances travelled in the air with the flaps at TO and APP positions, respectively, from the moment of lift-off until the aircraft reaches the variable nearby obstacle height shown as a parameter.

To obtain a conservative value of the total takeoff distance from the point where the brakes are released until the desired height over the runway is reached in the case of a short-field takeoff with two engines operative, add the distance obtained in Figure 3-35 or Figure 3-36 to the corresponding ground run distances calculated in the previous paragraph.

Use of Graphs (Figure 3-33 or Figure 3-34 and Figure 3-35 or Figure 3-36)

Locate the single-engine takeoff climb gradient (landing gear up) value obtained from Figure 3-19 or Figure 3-20 on the bottom left-hand scale of the chart and proceed vertically until the appropriate curve is intercepted. From the point of intersection move horizontally to the right until you meet the wind reference line.

From this point, move parallel to the guidelines (upwards: tailwind; downwards: headwind) to the wind speed and then move horizontally to the right to read off the distance in the air to the desired height.

To obtain the distance travelled from the brake-release point, add the distance obtained above to the corresponding ground run length.

Example

Given:

1. Flaps at TO (10°)
2. Airfield ambient temperature: 16°C
3. Airfield pressure altitude: 8,000 ft
4. Takeoff weight: 18,000 kg
5. DI = 50
6. Obstacle height: 150 ft
7. Runway slope: 2%
8. Wind speed: 48 knots headwind. (On the chart 50% of this value will be used, i.e. 24 knots)
9. RFI: 6

Results:

1.	Single-engine climb gradient (Figure 3-19)	1.8 %
2.	Takeoff ground run, uncorrected (Figure 3-33, sheet 1)	2,750 ft
3.	Takeoff ground run, corrected (Figure 3-33, sheet 2)	2,500 ft
4.	Air distance (Figure 3-35)	1380 ft
5.	Total takeoff distance with two engines (to 150 ft)	3880 ft

MAXIMUM REFUSAL SPEED LIMITED BY BRAKE ENERGY

It has been verified that Figure 3-18 can be used to give a conservative value for normal takeoff with both flap positions for short-field takeoff.

MAXIMUM TAKEOFF WEIGHT LIMITED BY SINGLE ENGINE CLIMB PERFORMANCE SHORT FIELD TAKEOFF FLAPS 10º

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

ENGINE A/I : OFF

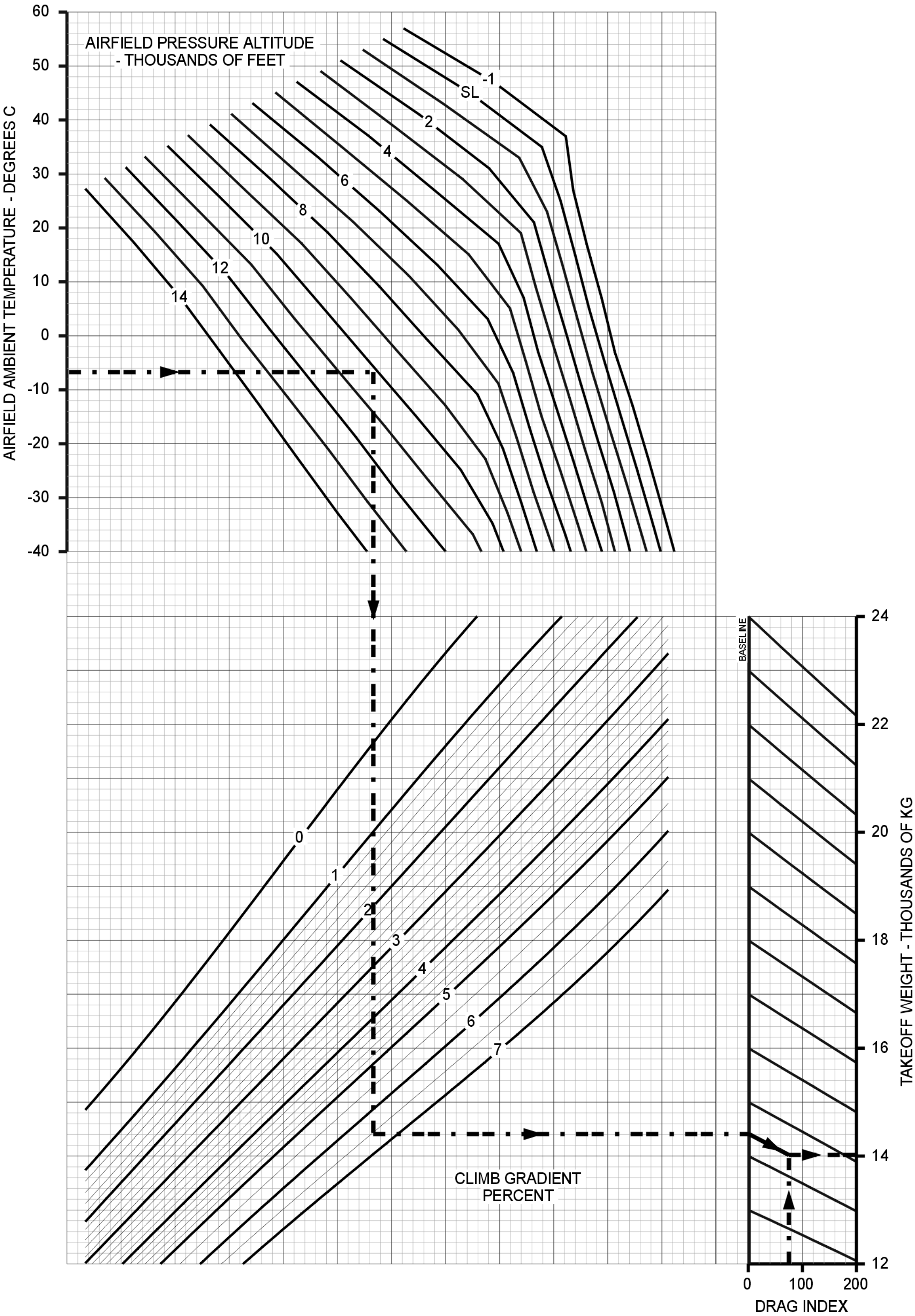

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Figure 3-19 (Sheet 1 of 2) MTOW Limited by Single Engine Climb Performance. Short Field Takeoff

MAXIMUM TAKEOFF WEIGHT LIMITED BY SINGLE ENGINE CLIMB PERFORMANCE SHORT FIELD TAKEOFF FLAPS 10º

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

ENGINE A/I : OFF

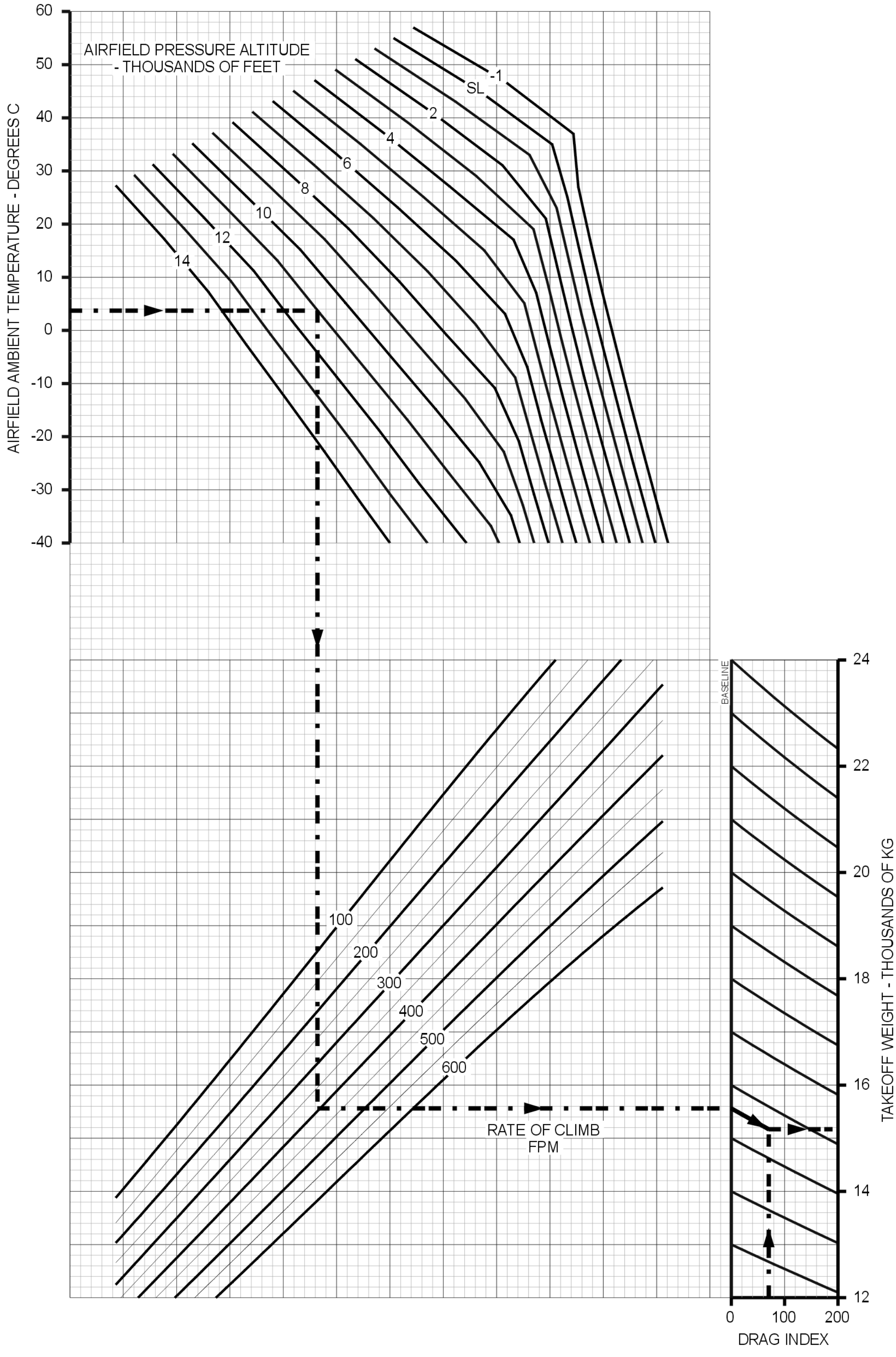

Figure 3-19 (Sheet 2 of 2) MTOW Limited by Single Engine Climb Performance. Short Field Takeoff

MAXIMUM TAKEOFF WEIGHT LIMITED BY SINGLE ENGINE CLIMB PERFORMANCE SHORT FIELD TAKEOFF FLAPS 15º

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST
AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5
ENGINE A/I : OFF

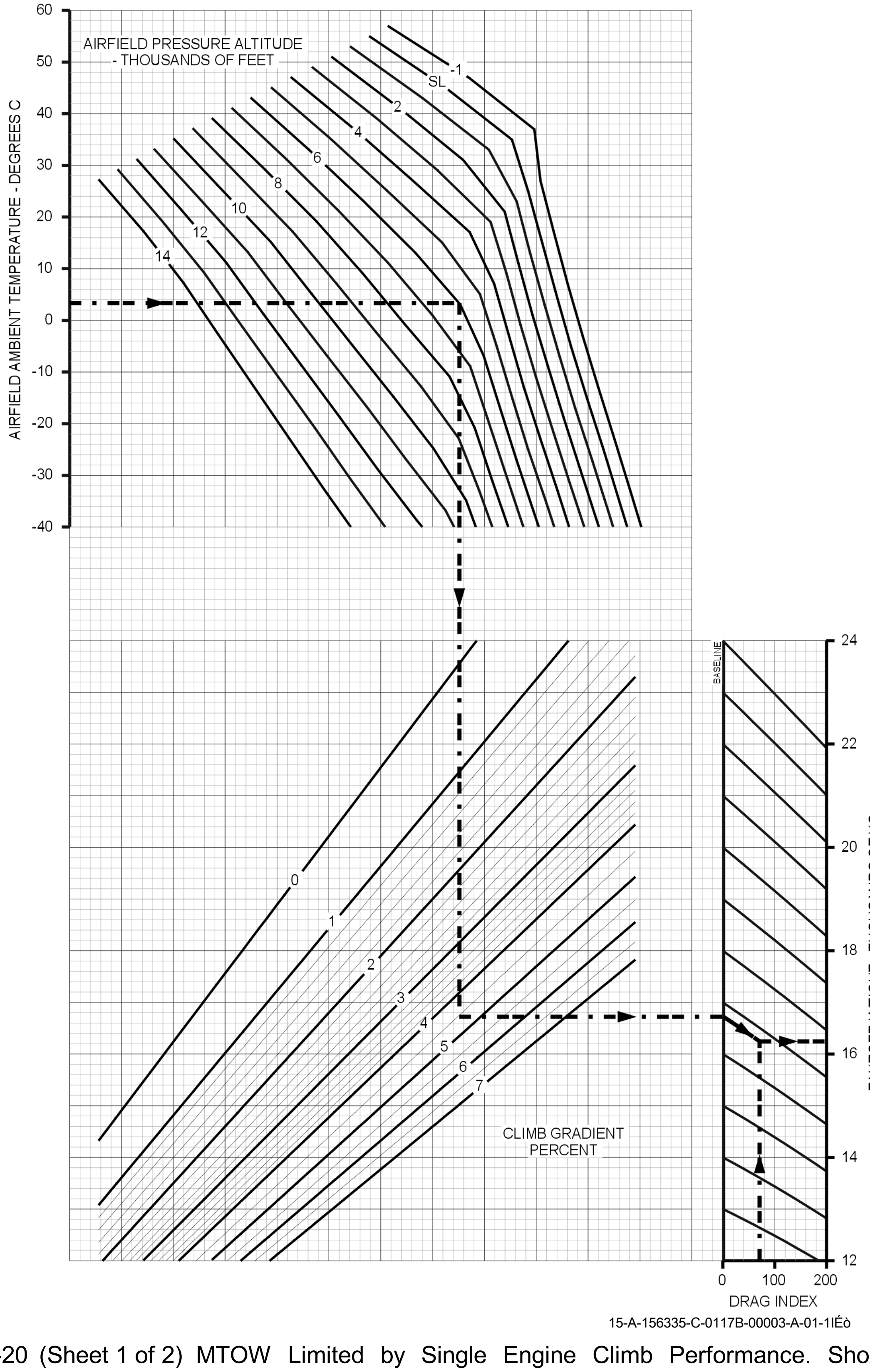

Figure 3-20 (Sheet 1 of 2) MTOW Limited by Single Engine Climb Performance. Short Field Takeoff

MAXIMUM TAKEOFF WEIGHT LIMITED BY SINGLE ENGINE CLIMB PERFORMANCE SHORT FIELD TAKEOFF FLAPS 15º

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

ENGINE A/I : OFF

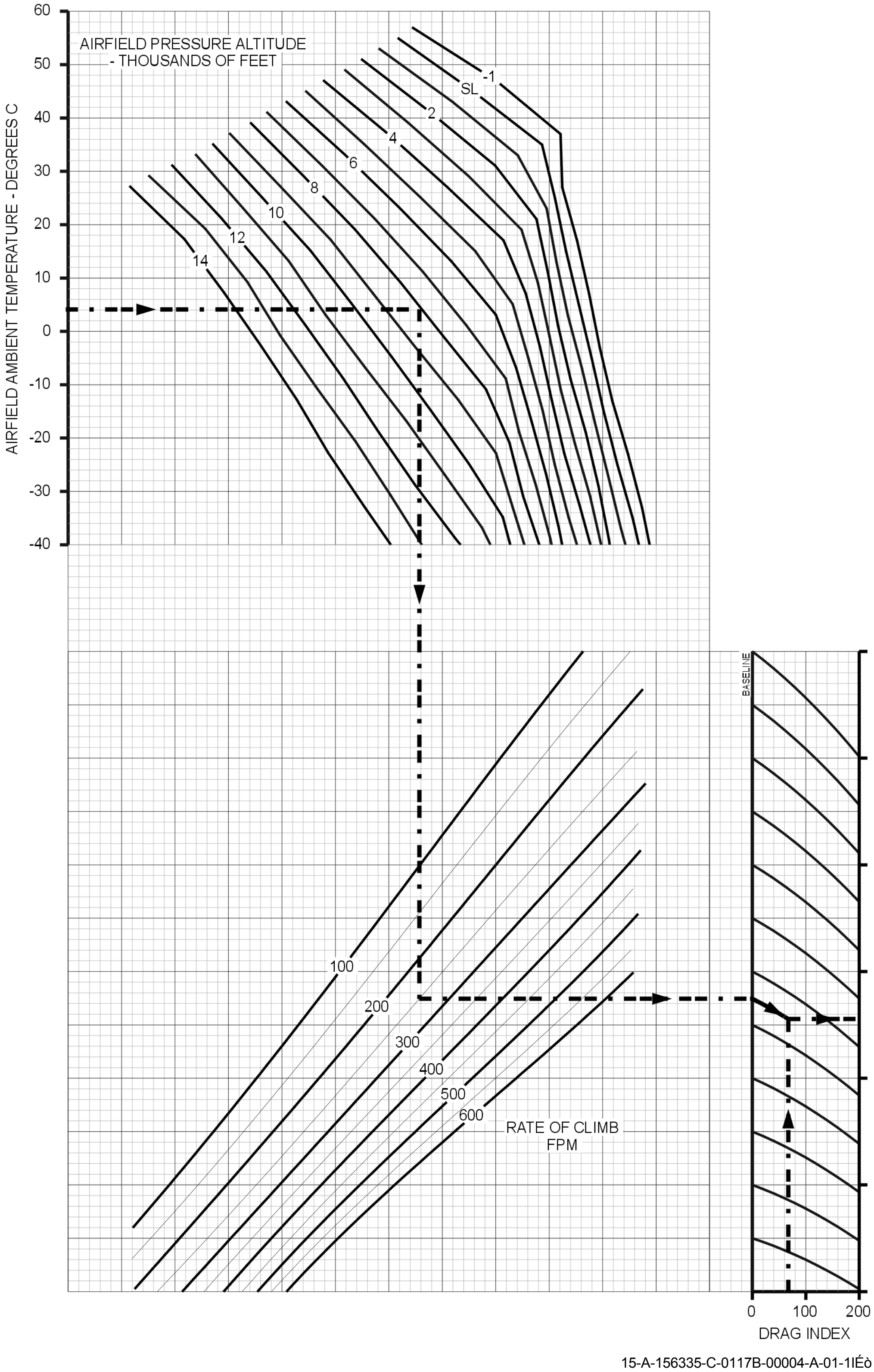

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Figure 3-20 (Sheet 2 of 2) MTOW Limited by Single Engine Climb Performance. Short Field Takeoff

CRITICAL FIELD LENGTH
SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)

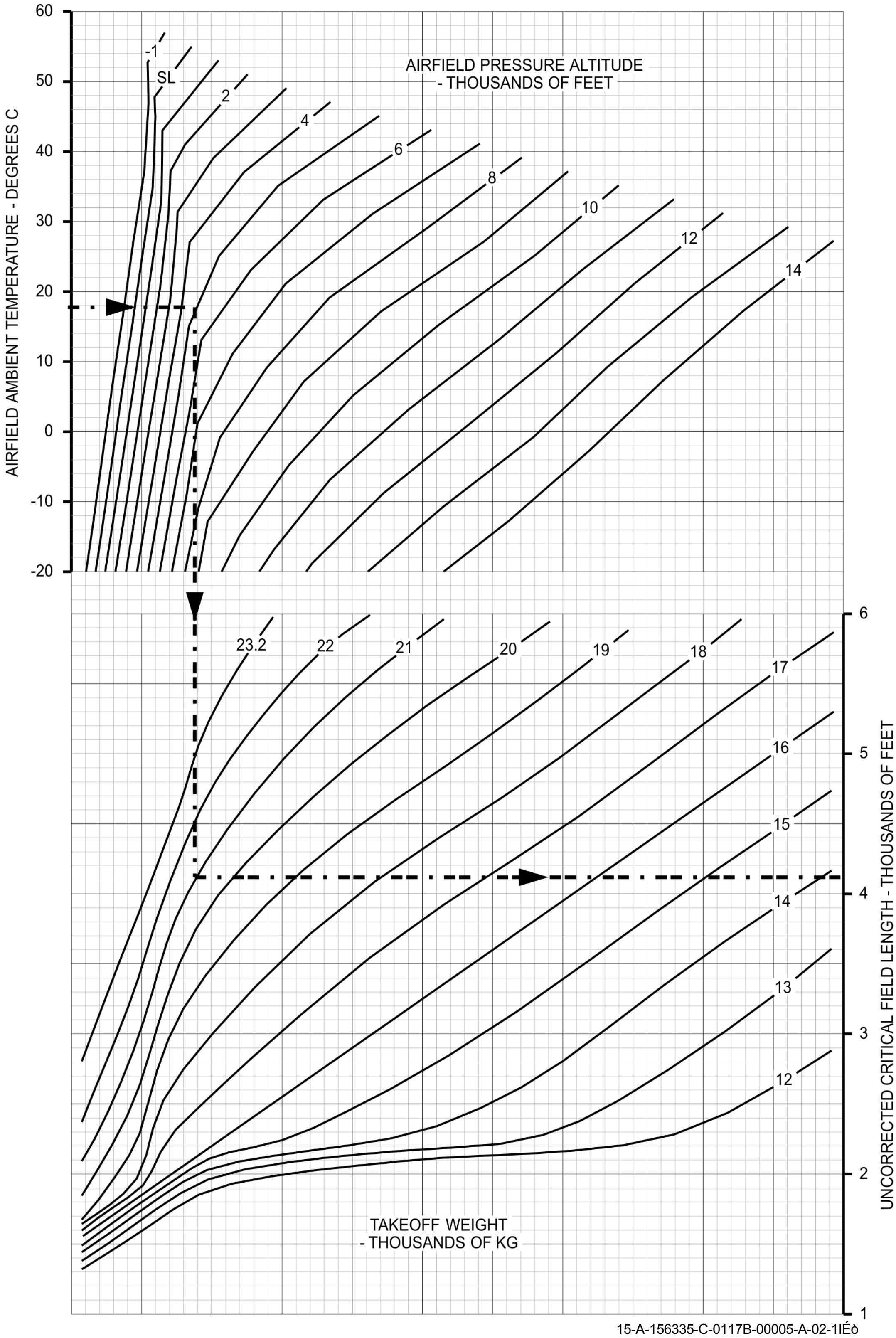

Figure 3-21 (Sheet 1 of 2) Critical Field Length. Short Field Takeoff

CRITICAL FIELD LENGTH
SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)

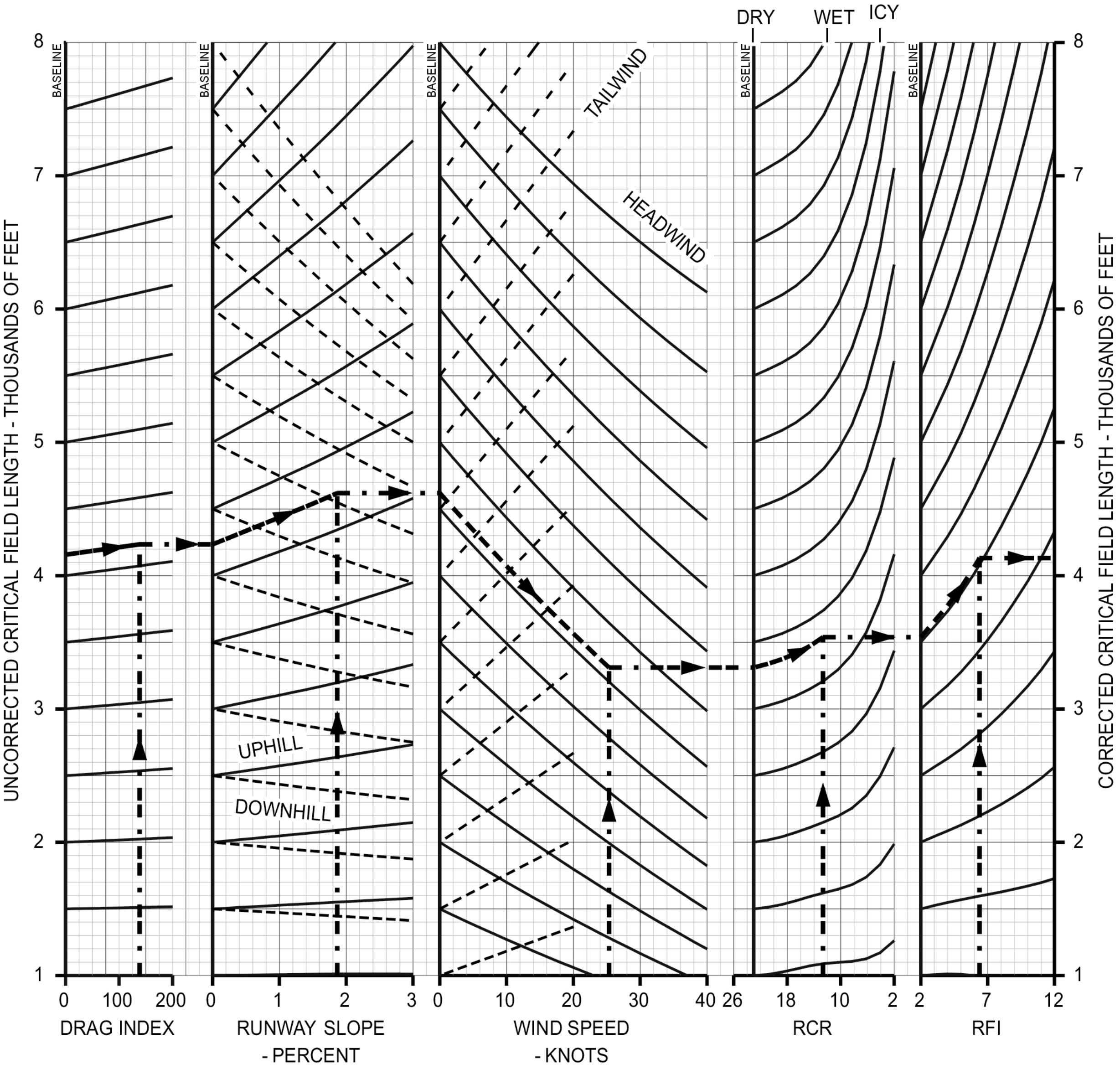

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Figure 3-21 (Sheet 2 of 2) Critical Field Length. Short Field Takeoff

CRITICAL FIELD LENGTH
SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: APP (15º)

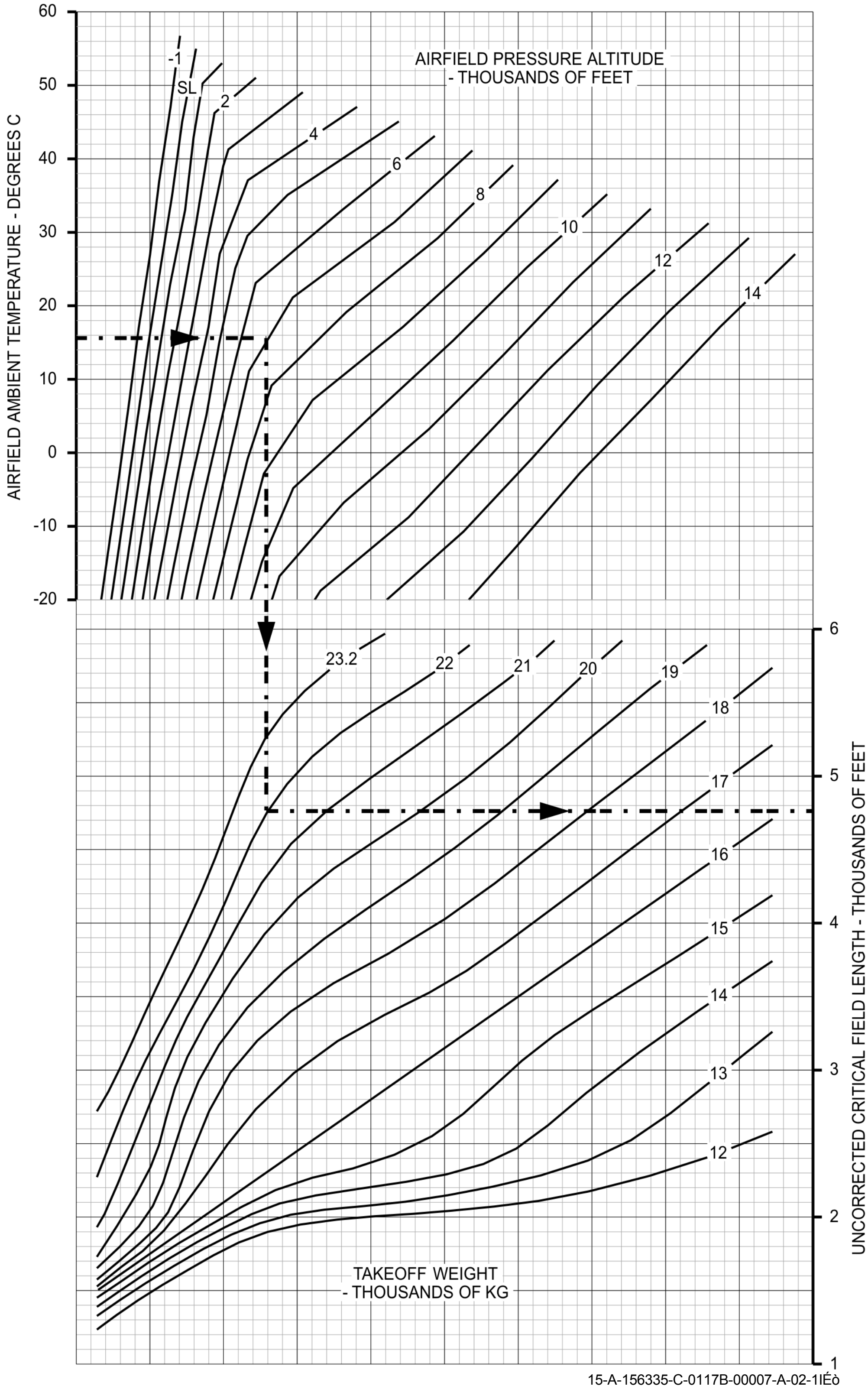

Figure 3-22 (Sheet 1 of 2) Critical Field Length. Short Field Takeoff

CRITICAL FIELD LENGTH
SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: APP (15º)

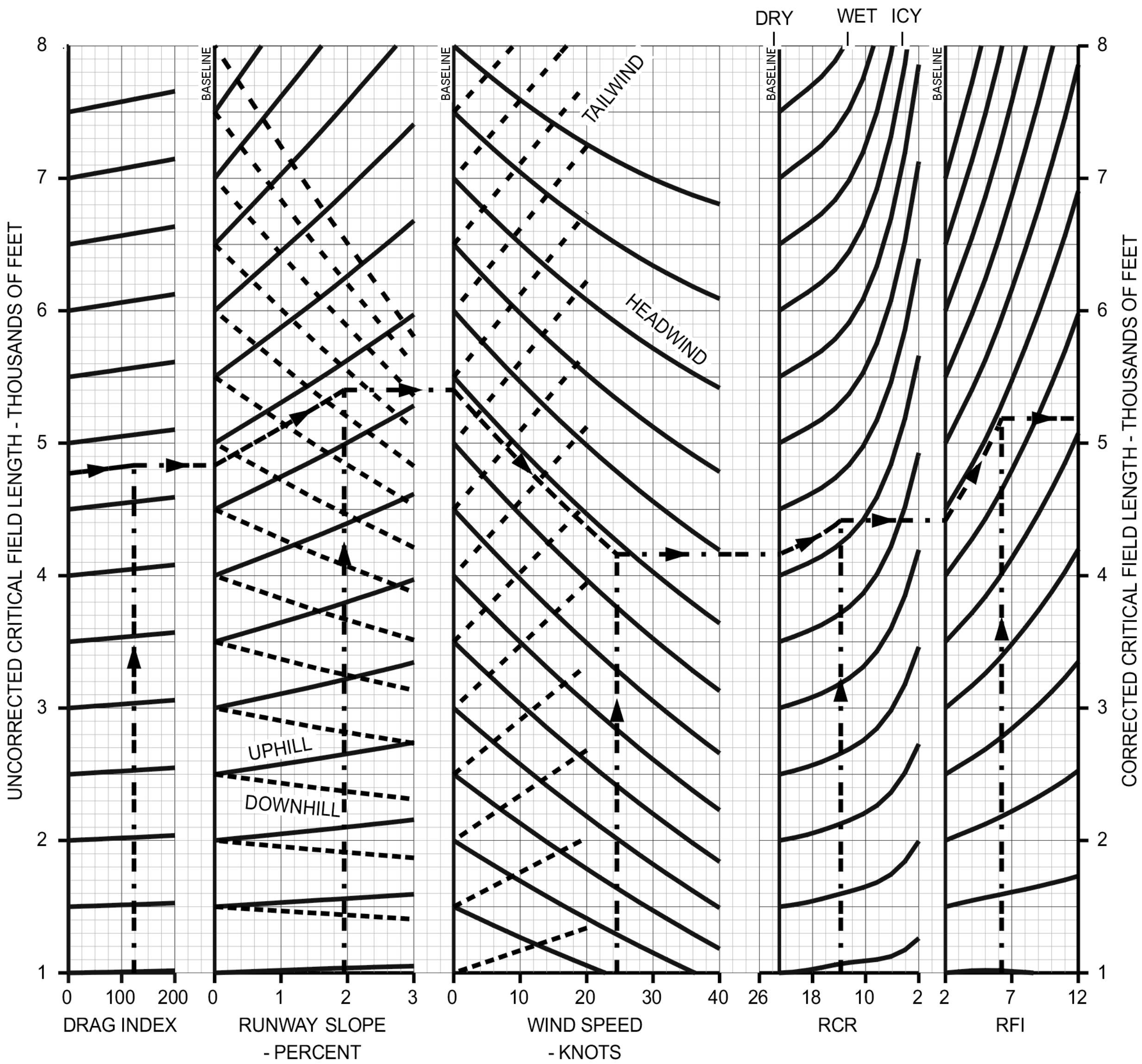

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Figure 3-22 (Sheet 2 of 2) Critical Field Length. Short Field Takeoff

SHORT FIELD TAKEOFF AIR DISTANCES TO VARYING RUNWAY SCREEN HEIGHTS

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)
CRITICAL ENGINE INOPERATIVE

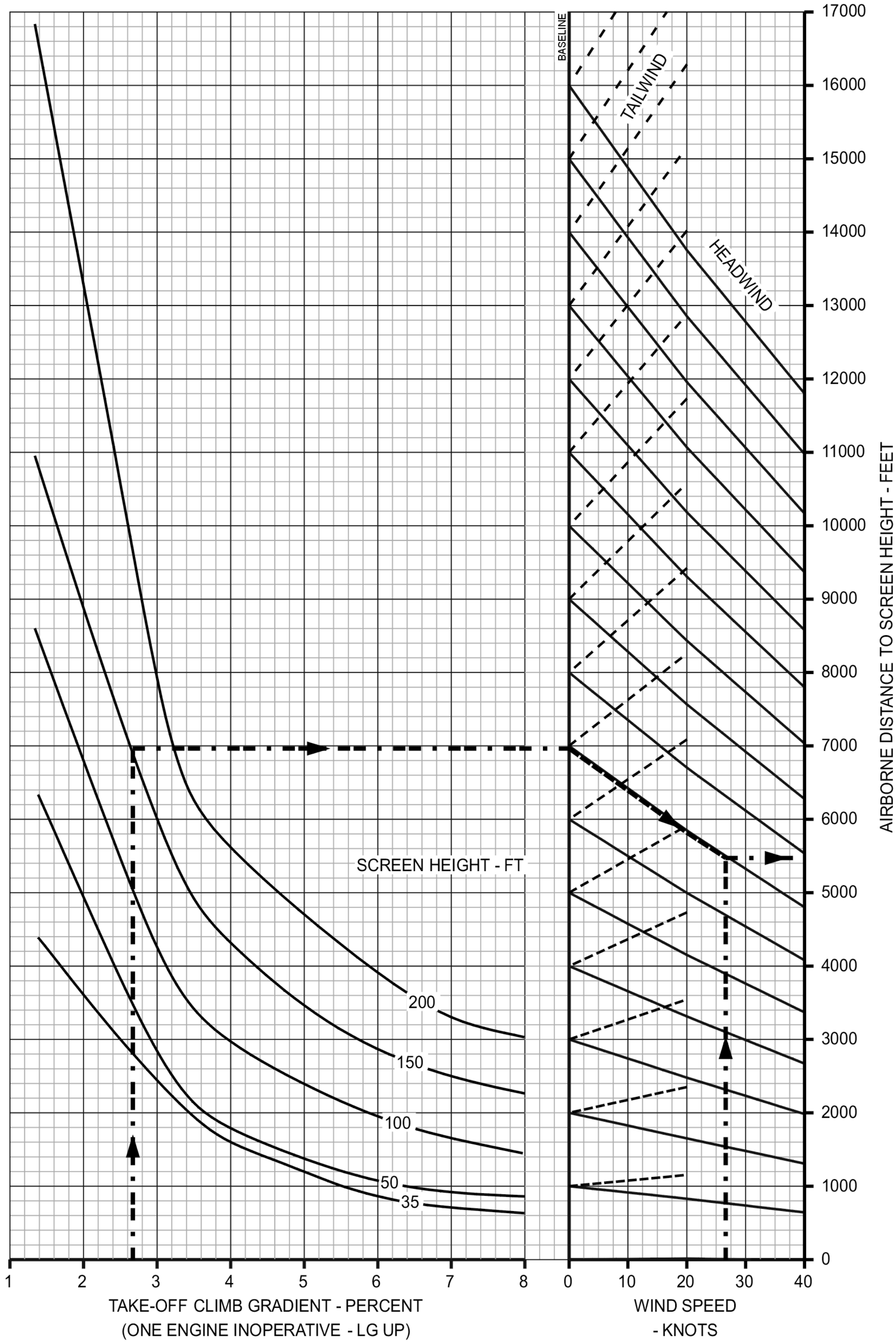

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Figure 3-23 Short Field Takeoff Air Distances to Varying Runway Screen Heights

SHORT FIELD TAKEOFF AIR DISTANCES TO VARYING RUNWAY SCREEN HEIGHTS

DATE:	JUL. 2000	**AIRCRAFT:**	C-295M	**FLAPS:**	APP (15º)
DATA BASIS:	FLIGHT TEST	**ENGINES:**	PW 127-G	**CRITICAL ENGINE**	
		PROPELLERS:	HS 568F-5	**INOPERATIVE**	

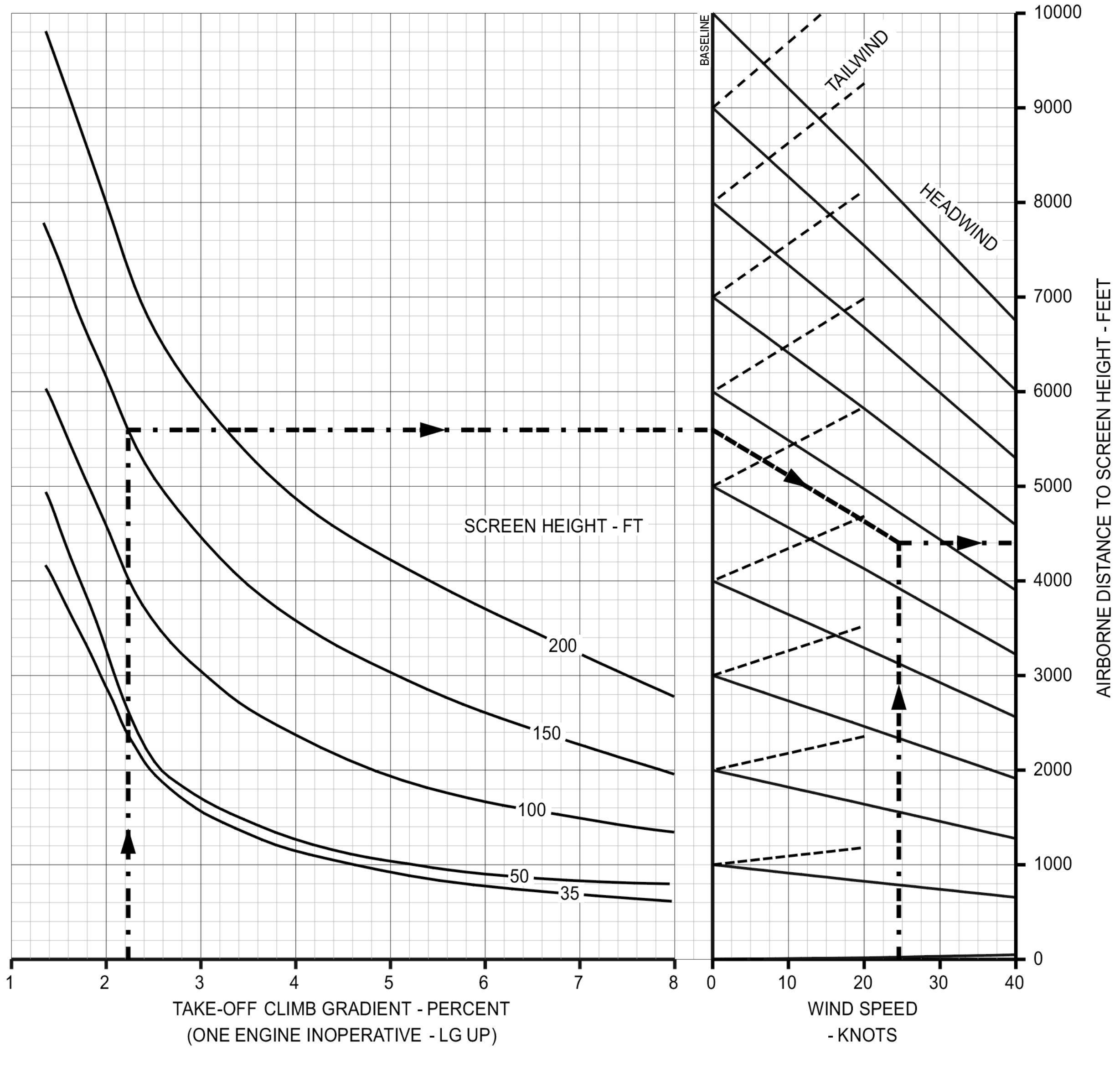

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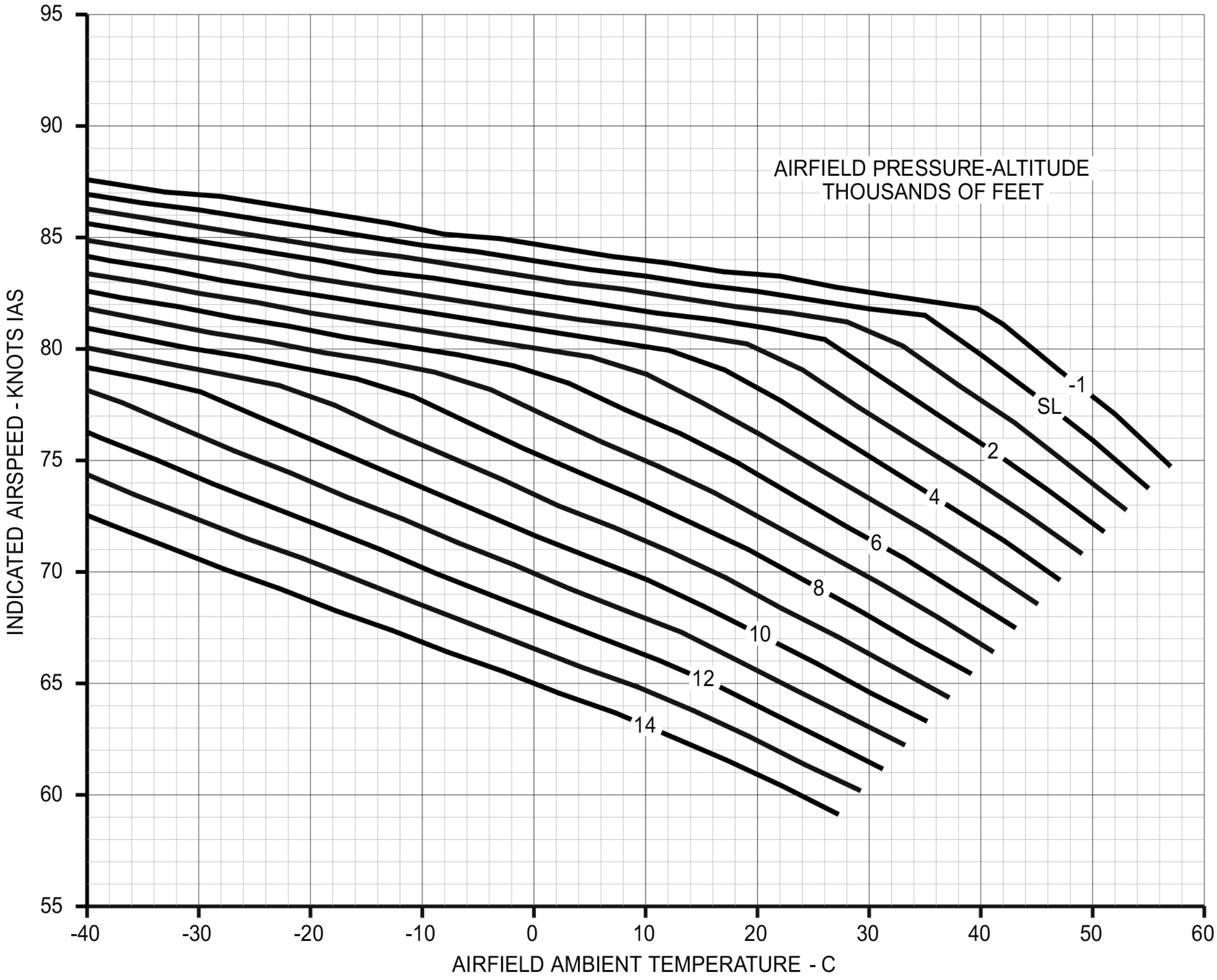
Figure 3-24 Short Field Takeoff Air Distances to Varying Runway Screen Heights

MINIMUM CONTROL SPEED ON THE GROUND
SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)



These values are applicable to takeoffs from either paved or unpaved runways at least 77 ft wide.

When operating from runways that are between 77 and 67 ft wide increase Vmcg by 1 knot for each 2 feet less than a width of 77 feet.

When operating from runways between 67 and 57 feet wide, increase Vmcg by an additional 5 knots and a further 3 knots for each 2 feet less than 67 feet wide.

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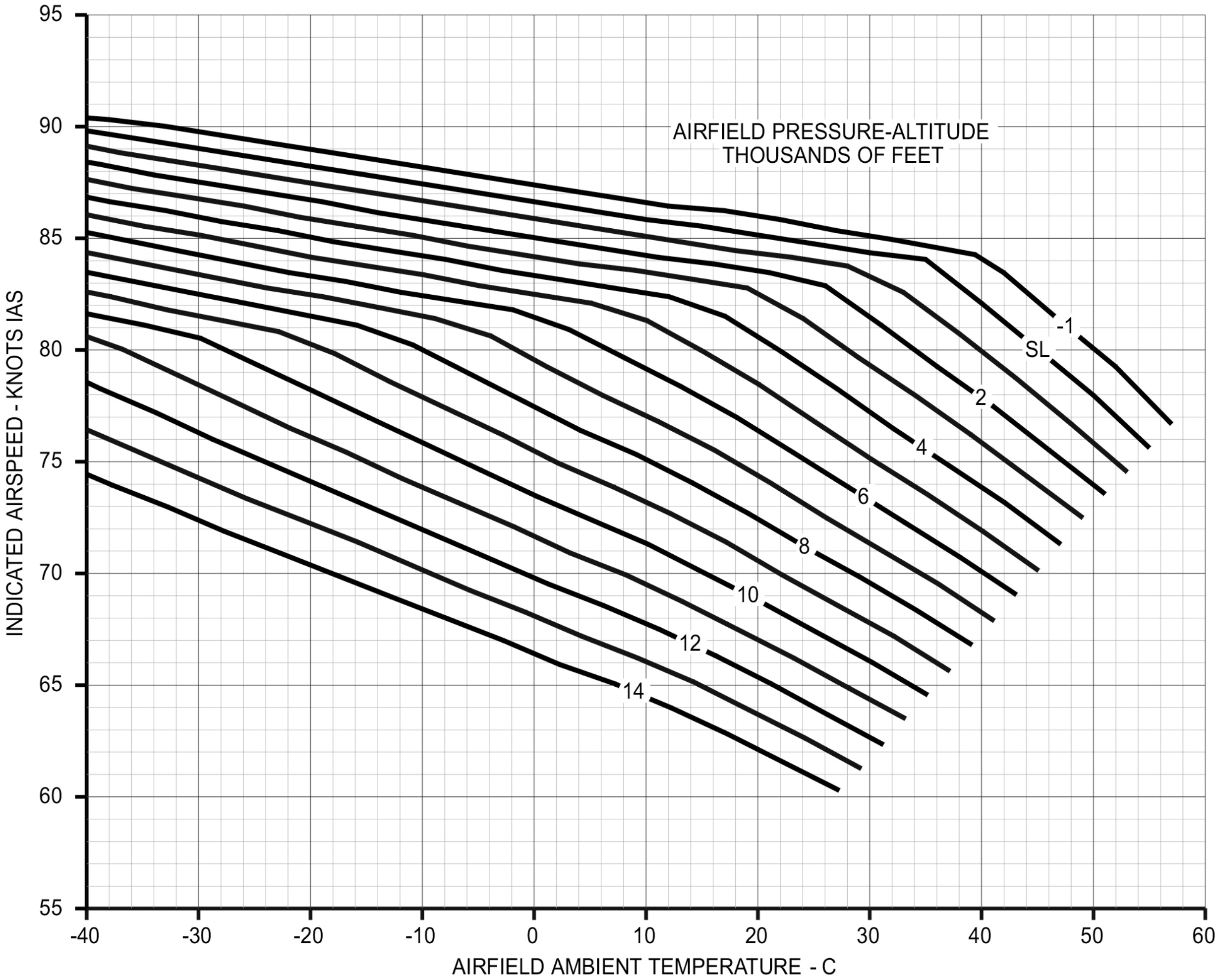
Figure 3-25 Minimum Control Speed on the Ground. Short Field Takeoff

MINIMUM CONTROL SPEED ON THE GROUND
SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: APP (15º)



These values are applicable to takeoffs from either paved or unpaved runways at least 77 ft wide.

When operating from runways that are between 77 and 67 ft wide increase Vmcg by 1 knot for each 2 feet less than a width of 77 feet.

When operating from runways between 67 and 57 feet wide, increase Vmcg by an additional 5 knots and a further 3 knots for each 2 feet less than 67 feet wide.

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Figure 3-26 Minimum Control Speed on the Ground. Short Field Takeoff

REFUSAL SPEED AND CRITICAL ENGINE FAILURE SPEED
SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)

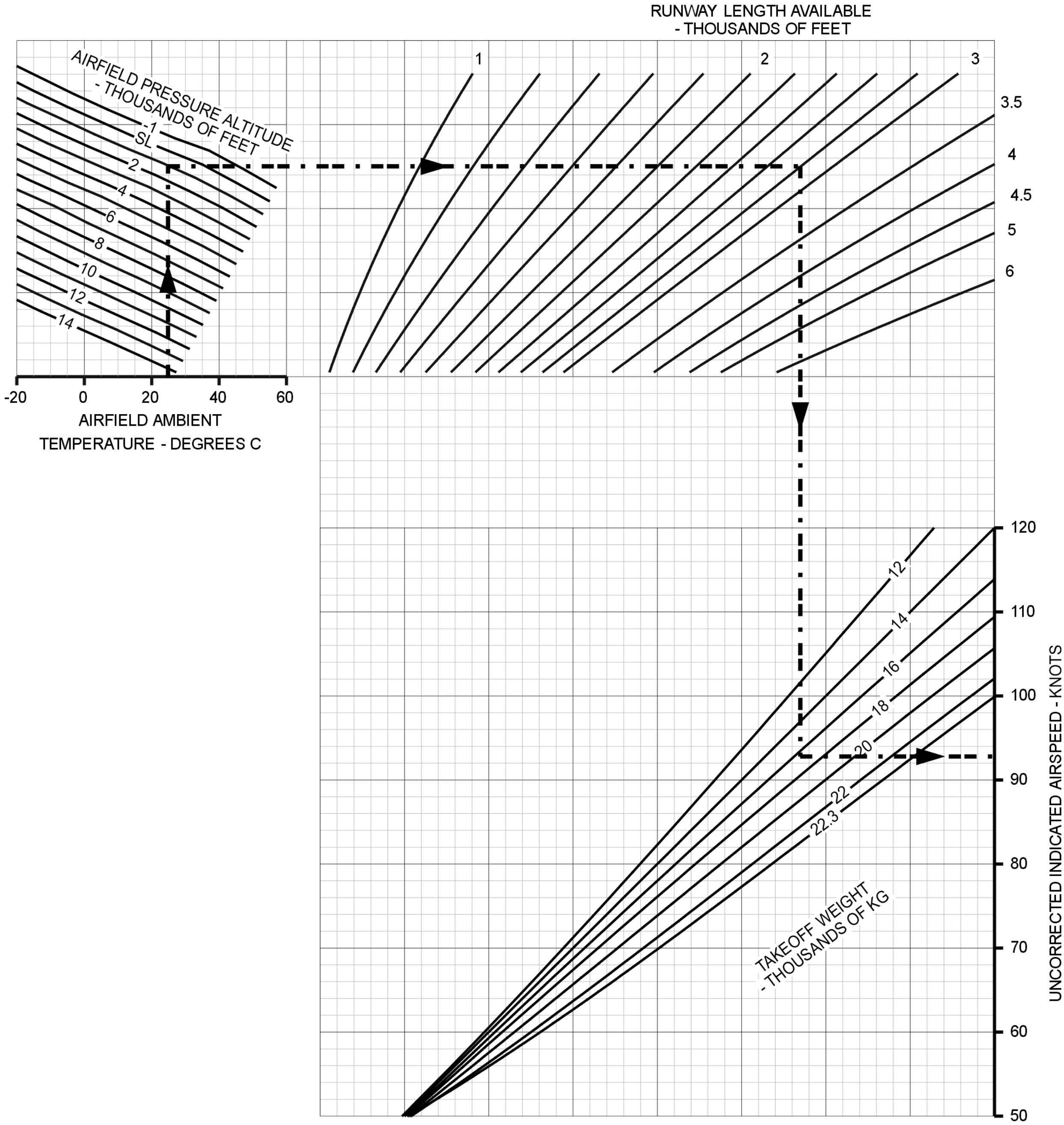

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Figure 3-27 (Sheet 1 of 2) Refusal Speed and Critical Engine Failure Speed. Short Field Takeoff

REFUSAL SPEED AND CRITICAL ENGINE FAILURE SPEED SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)

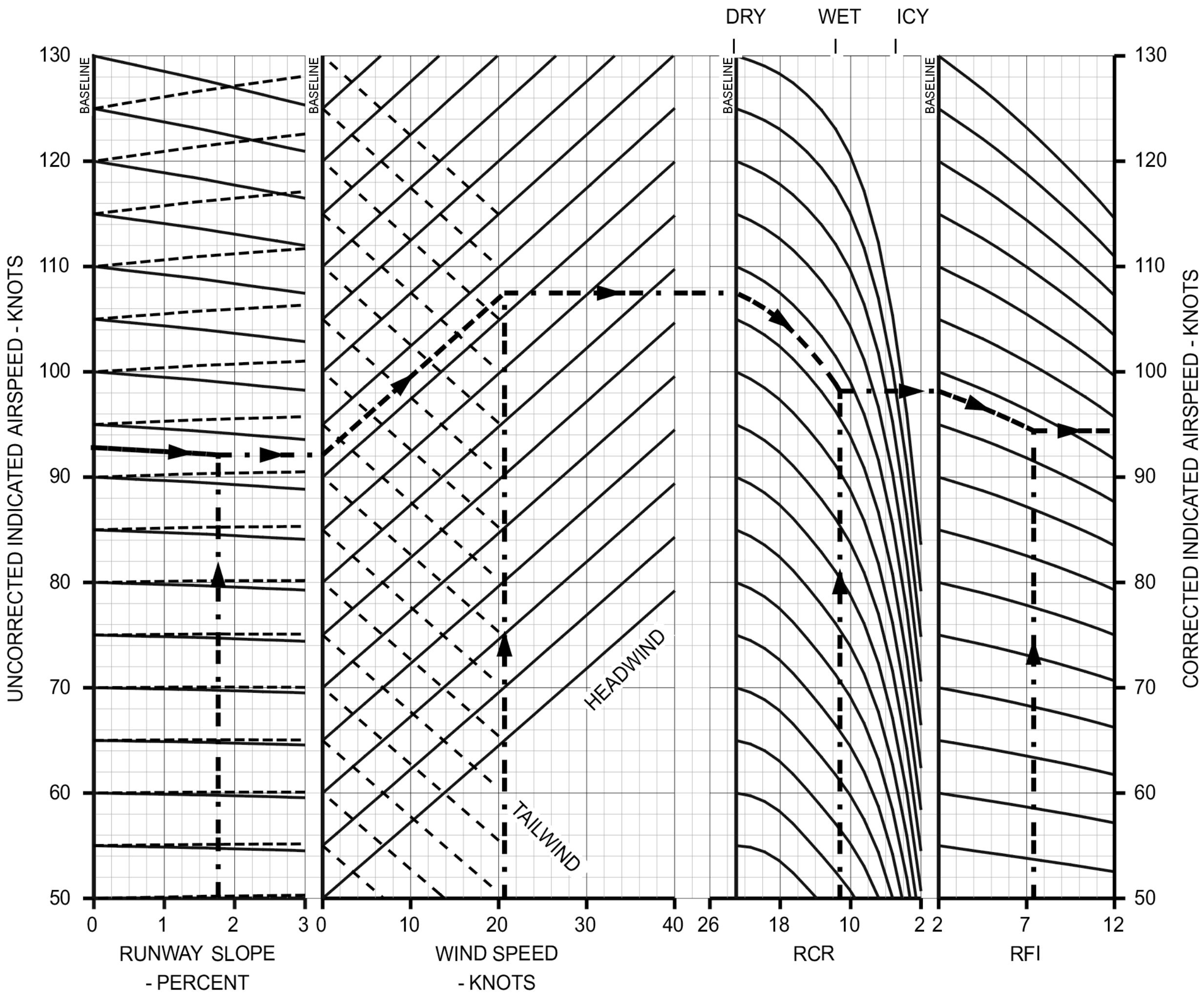

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Figure 3-27 (Sheet 2 of 2) Refusal Speed and Critical Engine Failure Speed. Short Field Takeoff

REFUSAL SPEED AND CRITICAL ENGINE FAILURE SPEED SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: APP (15º)

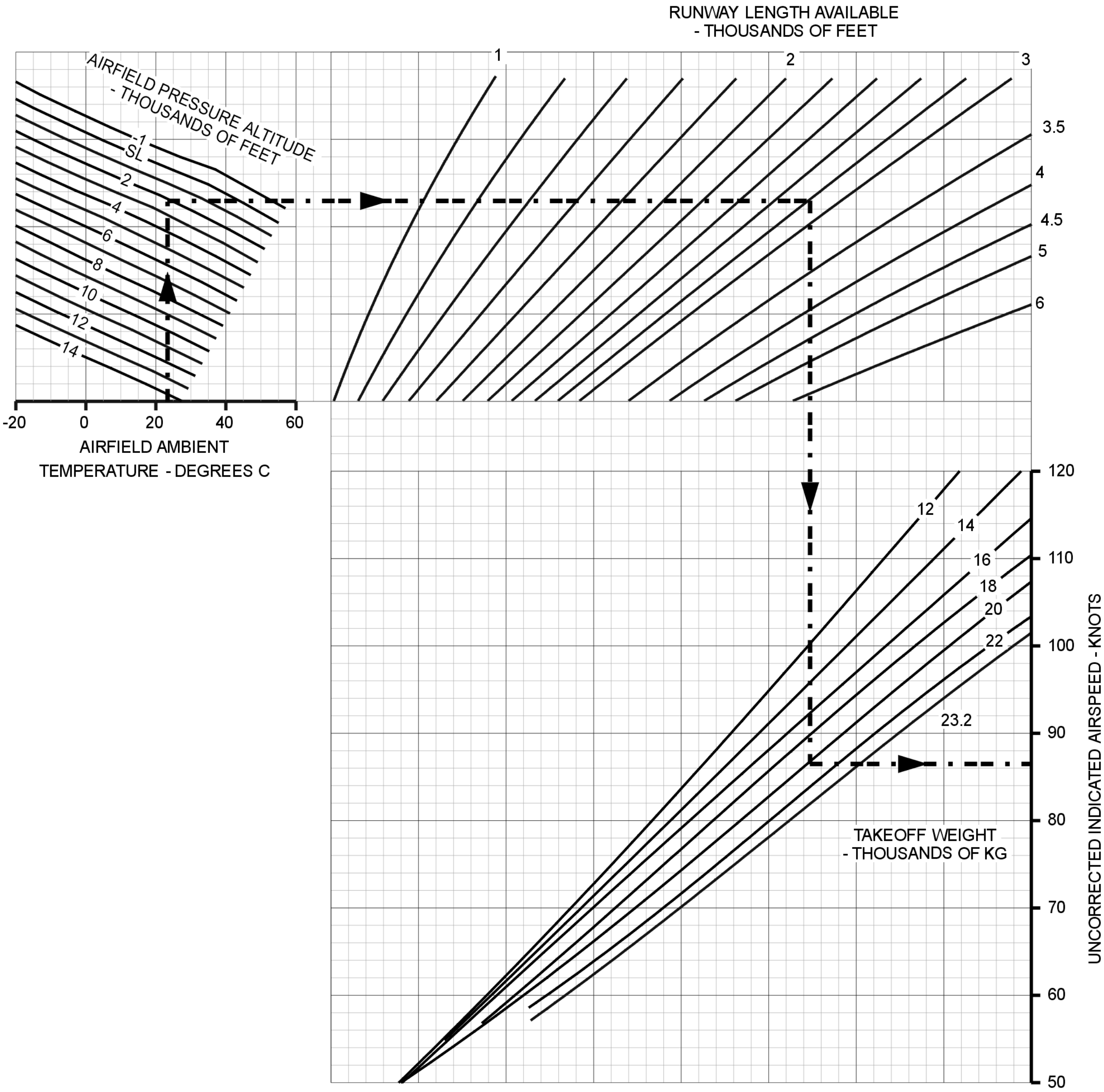

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Figure 3-28 (Sheet 1 of 2) Refusal Speed and Critical Engine Failure Speed. Short Field Takeoff

REFUSAL SPEED AND CRITICAL ENGINE FAILURE SPEED
SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: APP (15º)

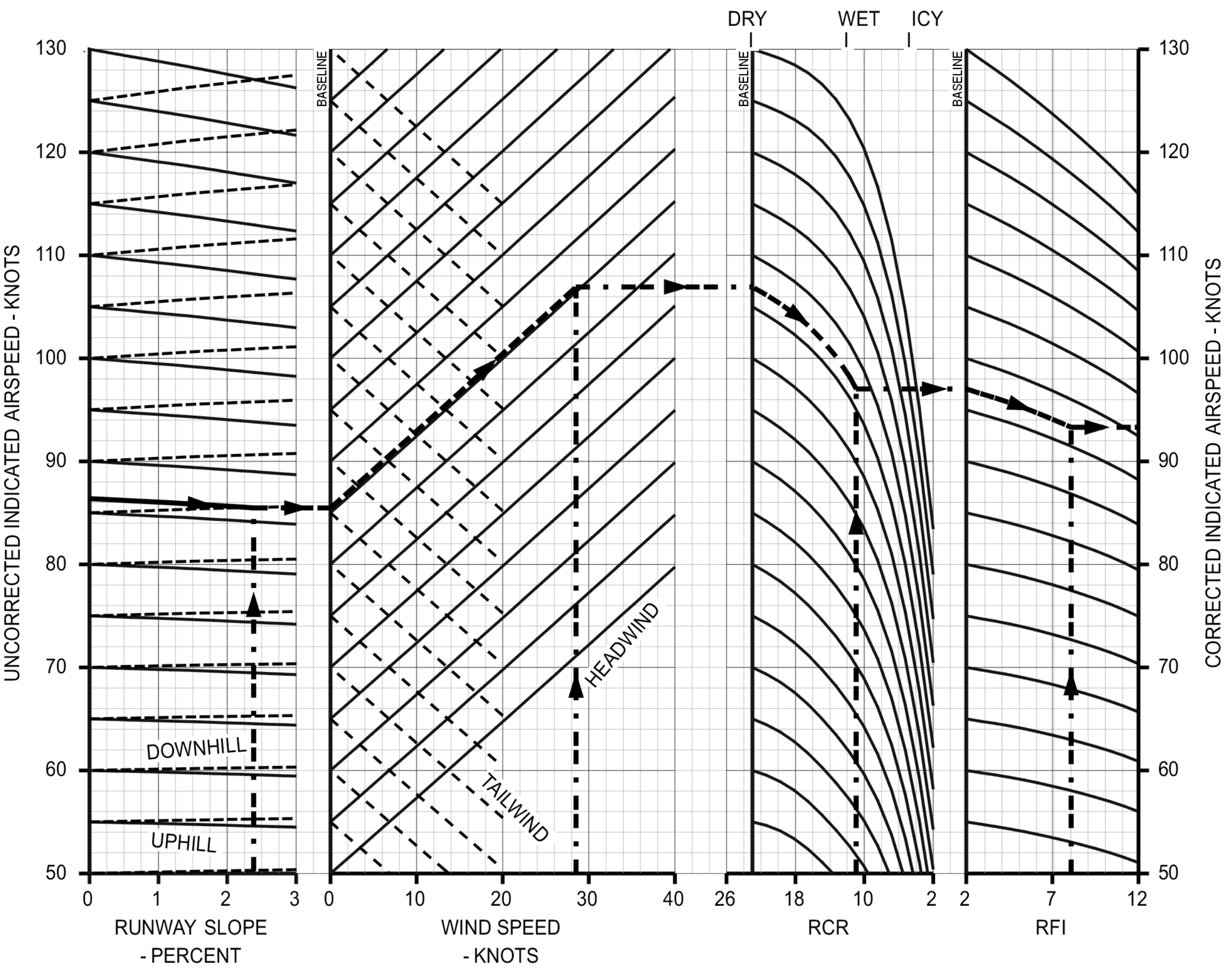

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Figure 3-28 (Sheet 2 of 2) Refusal Speed and Critical Engine Failure Speed. Short Field Takeoff

AIR MINIMUM CONTROL SPEED
SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)

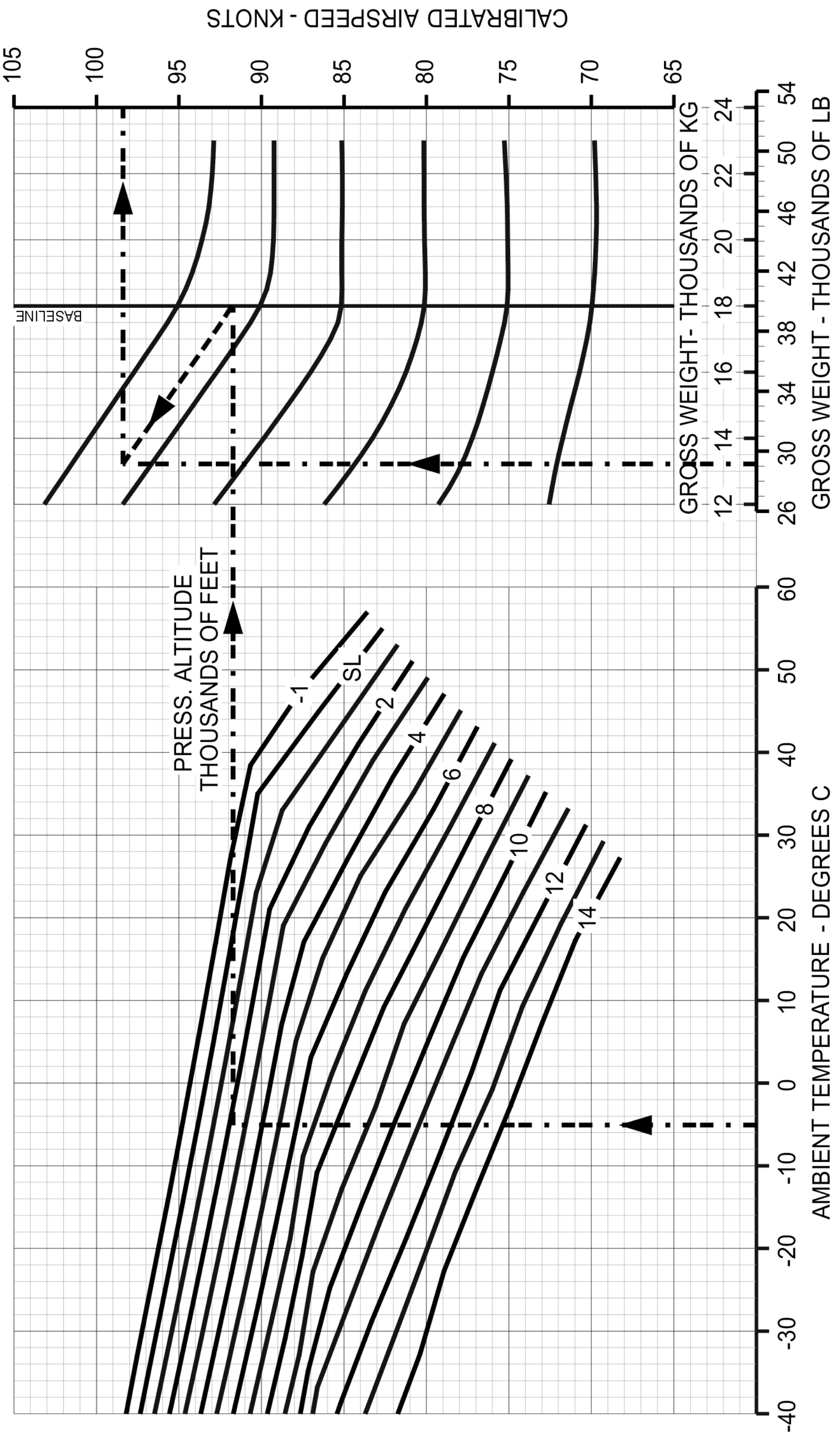

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Figure 3-29 Air Minimum Control Speed. Short Field Takeoff

AIR MINIMUM CONTROL SPEED
SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: APP (15º)

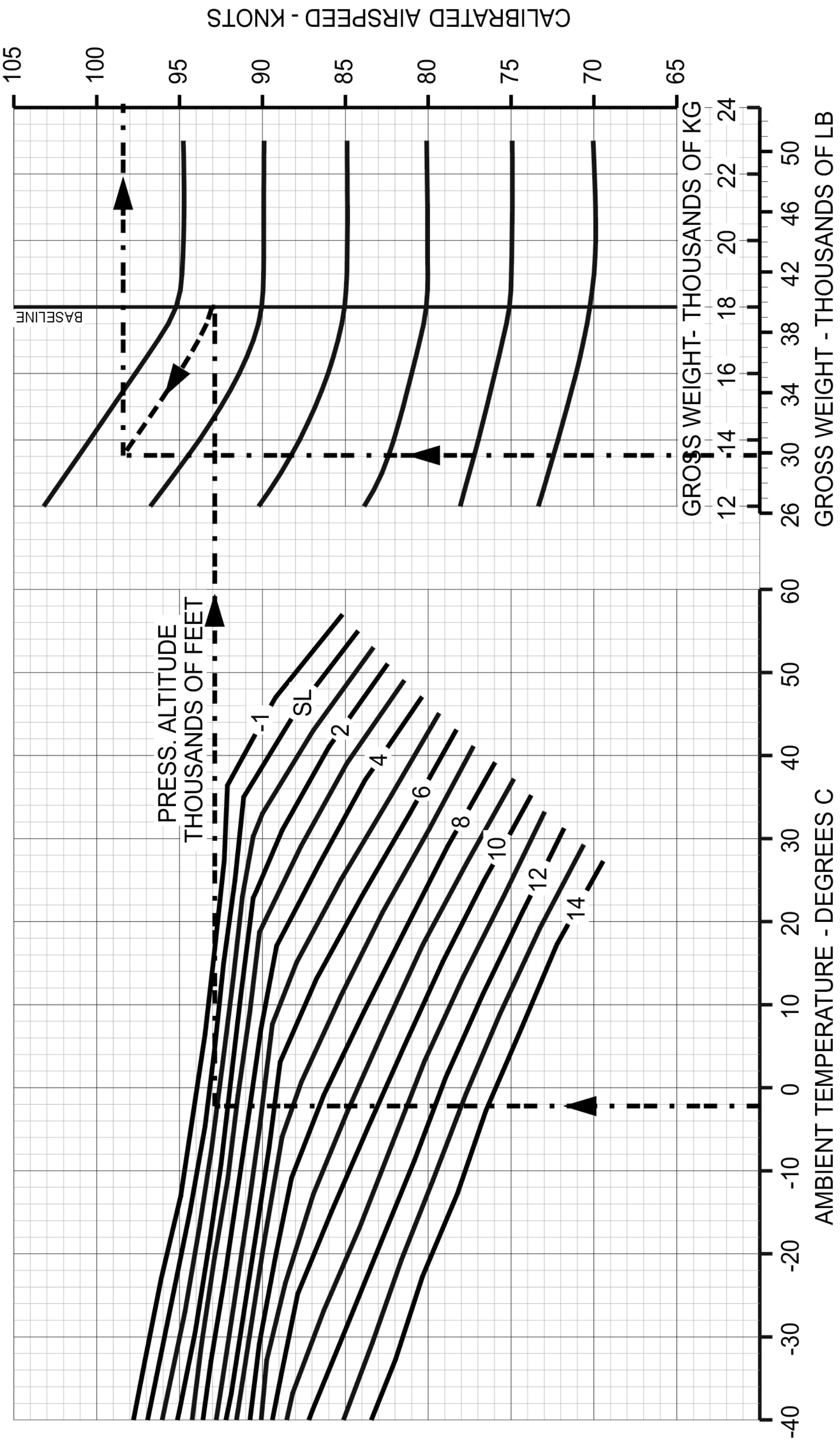

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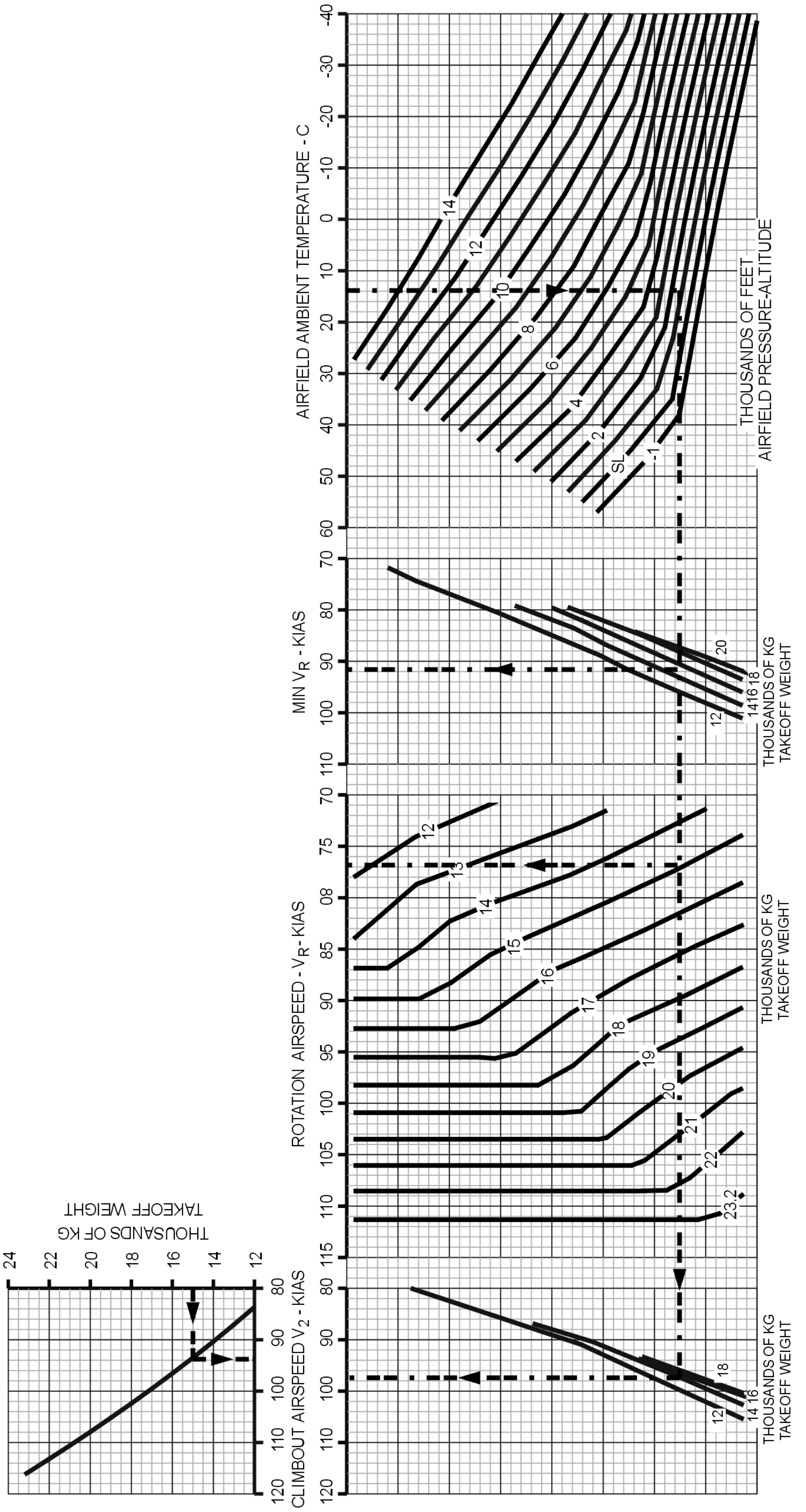
Figure 3-30 Air Minimum Control Speed. Short Field Takeoff

TAKEOFF SPEEDS, SHORT FIELD TAKEOFF
FLAPS 10º

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5



15-A-156335-C-0117B-00019-A-01-1IÉò

Figure 3-31 Takeoff Speeds. Short Field Takeoff

TAKEOFF SPEEDS, SHORT FIELD TAKEOFF
FLAPS 15º

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

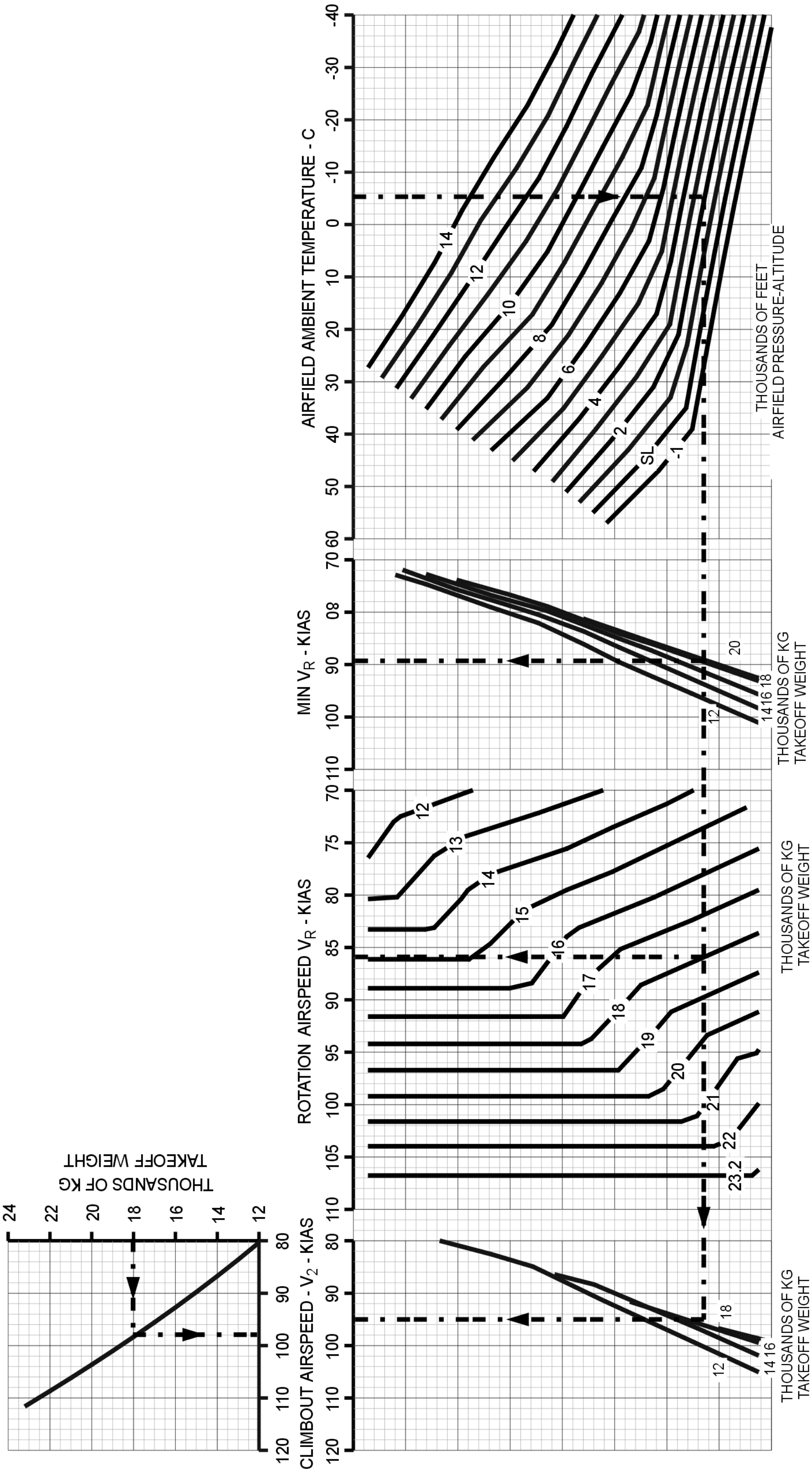


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Figure 3-32 Takeoff Speeds. Short Field Takeoff

TAKEOFF GROUND RUN
2 ENGINES, SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST
AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5
FLAPS: TO (10º)

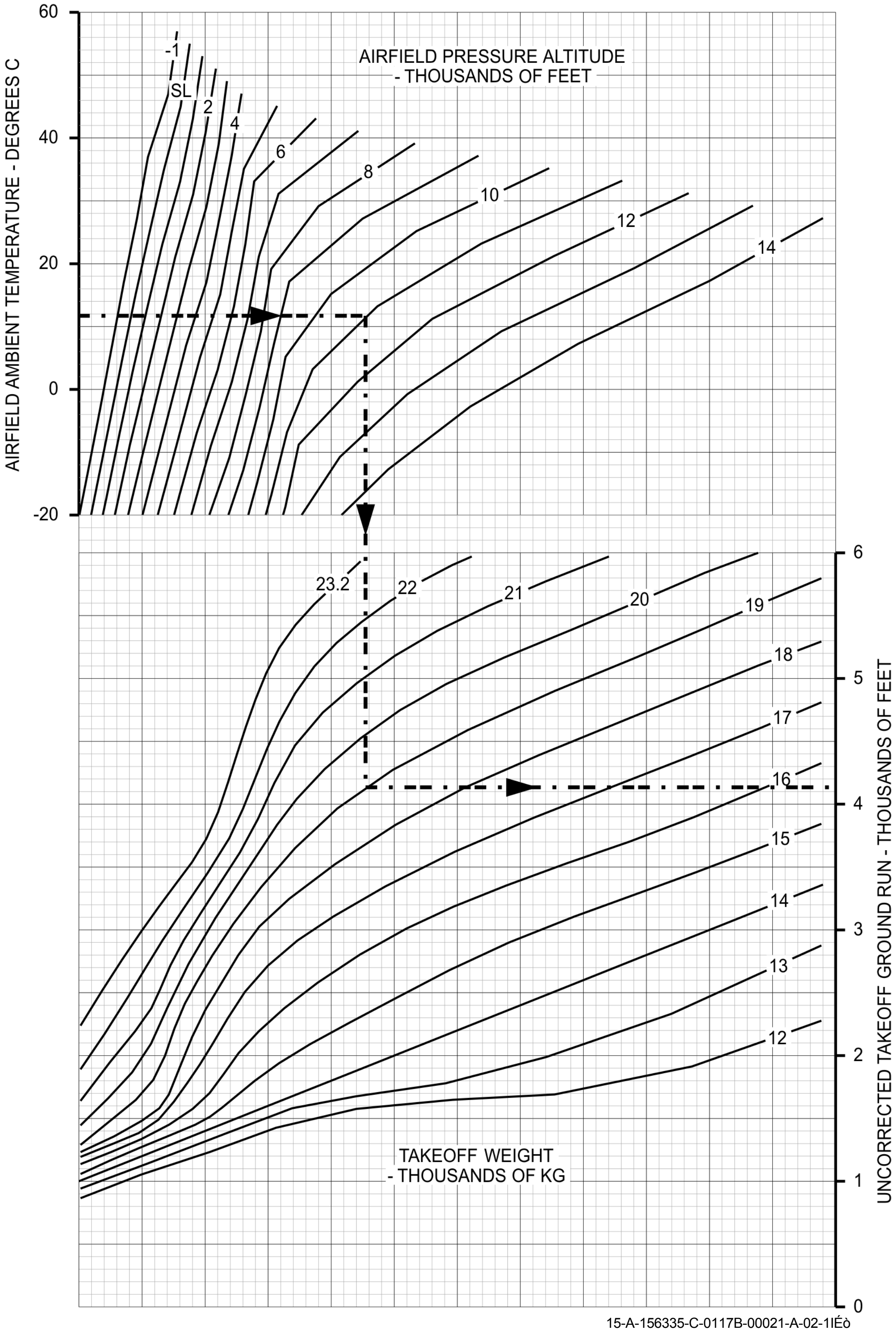

Figure 3-33 (Sheet 1 of 2) Takeoff Ground Run. 2 Engines. Short Field Takeoff

TAKEOFF GROUND RUN
2 ENGINES, SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: TO (10º)

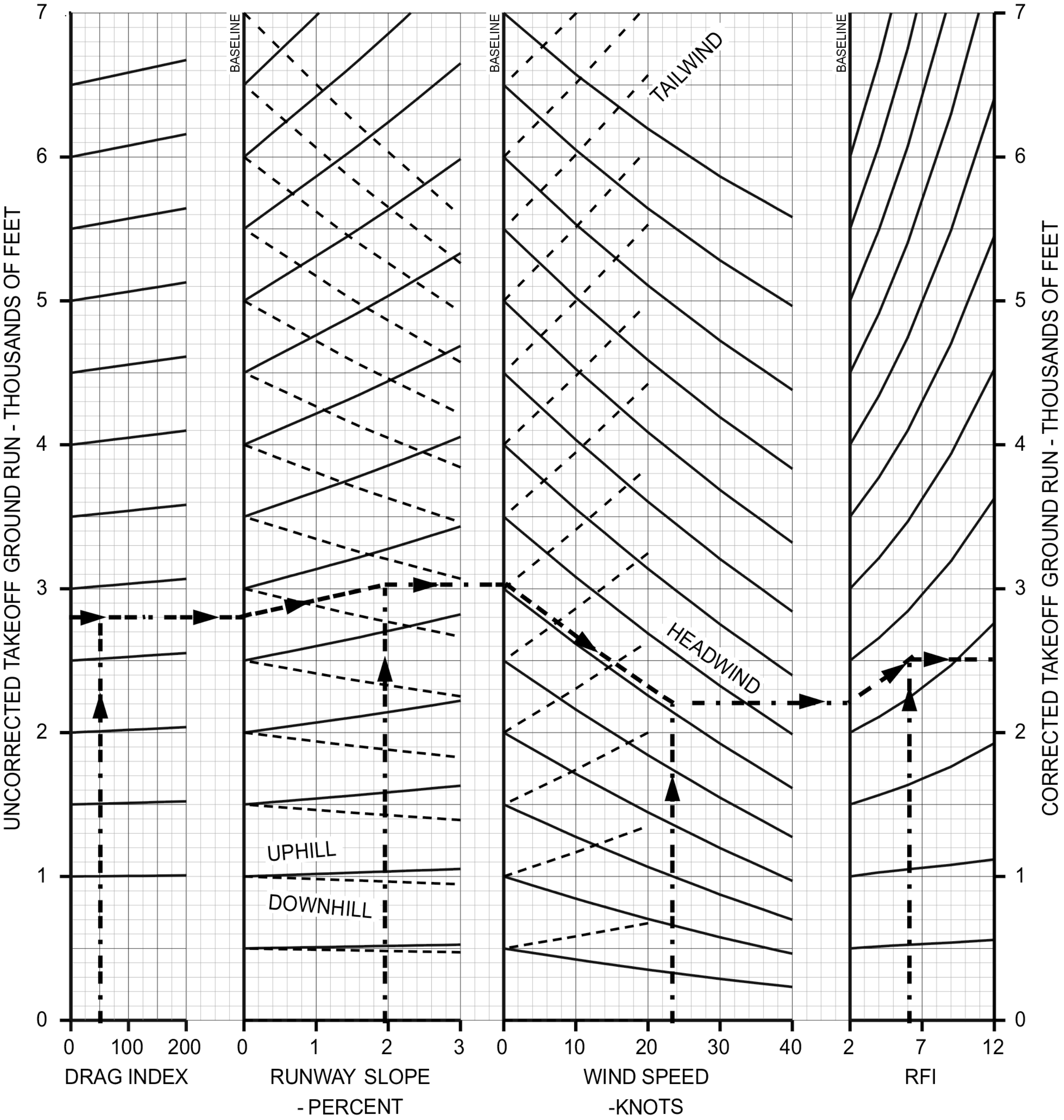

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Figure 3-33 (Sheet 2 of 2) Takeoff Ground Run. 2 Engines. Short Field Takeoff

TAKEOFF GROUND RUN
2 ENGINES, SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: APP (15º)

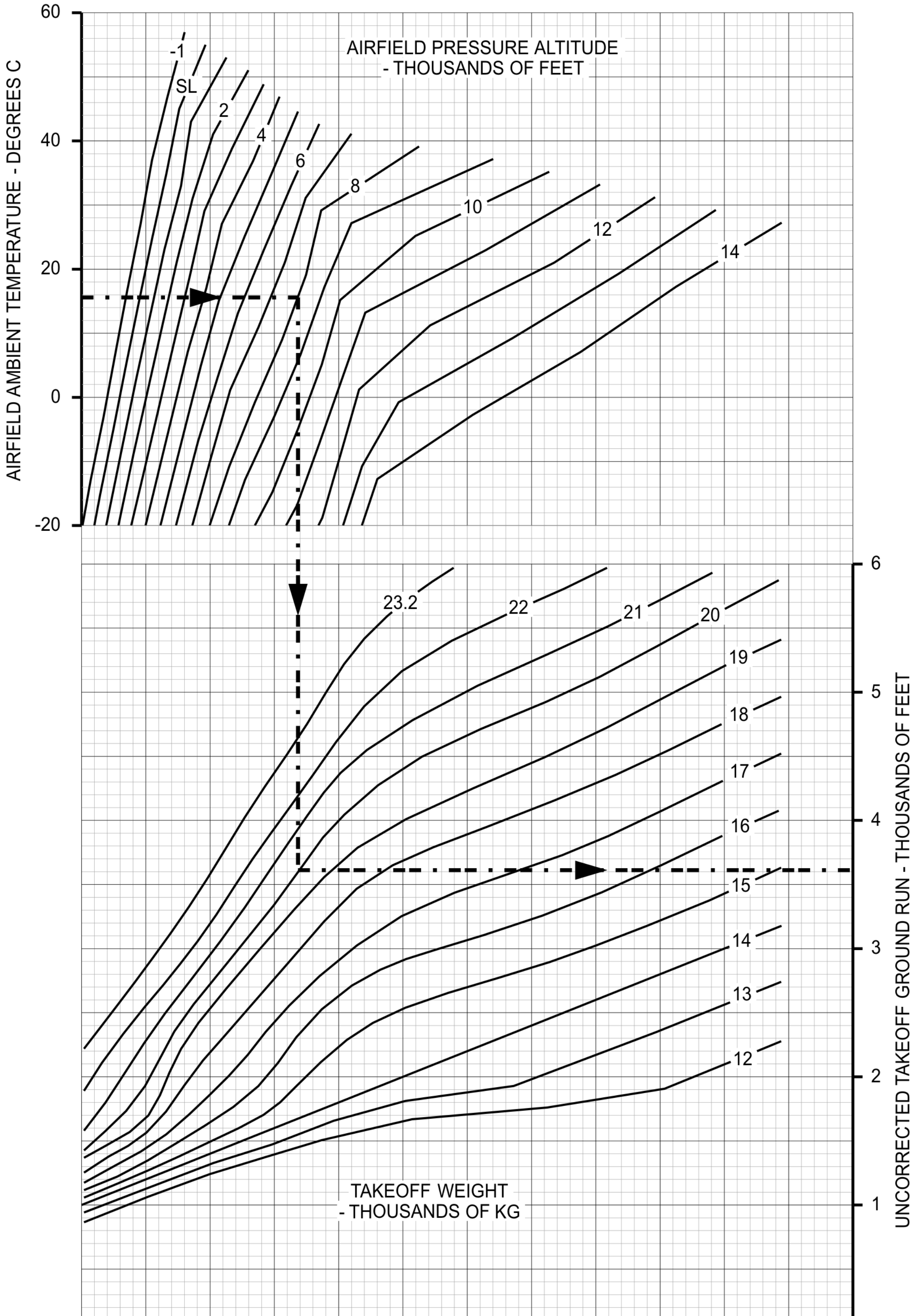

Figure 3-34 (Sheet 1 of 2) Takeoff Ground Run. 2 Engines. Short Field Takeoff

TAKEOFF GROUND RUN
2 ENGINES, SHORT FIELD TAKEOFF

DATE: JUL. 2000
DATA BASIS: FLIGHT TEST

AIRCRAFT: C-295M
ENGINES: PW 127-G
PROPELLERS: HS 568F-5

FLAPS: APP (15º)

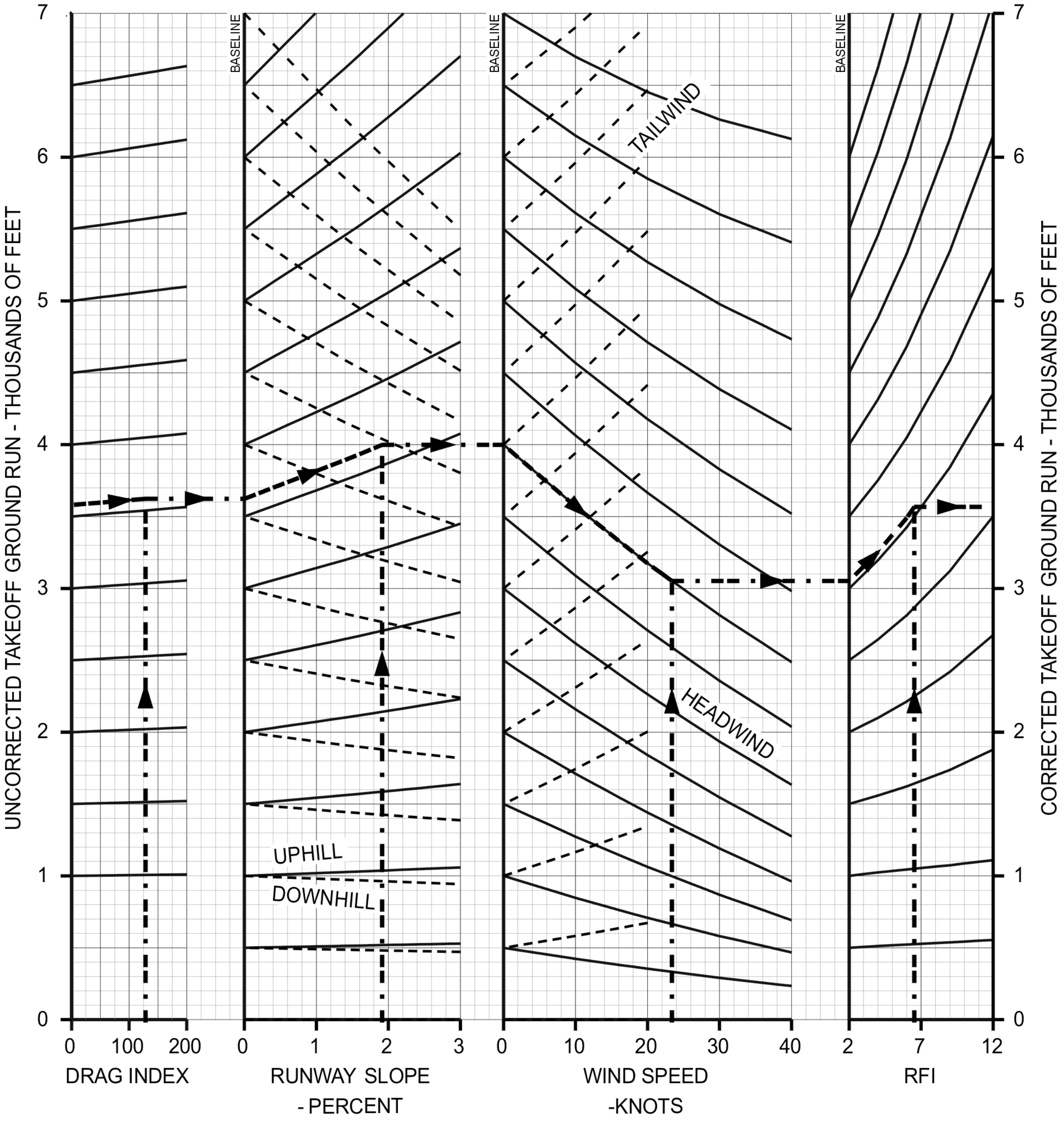

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Figure 3-34 (Sheet 2 of 2) Takeoff Ground Run. 2 Engines. Short Field Takeoff

SHORT FIELD TAKEOFF AIR DISTANCES TO VARYING RUNWAY SCREEN HEIGHTS

DATE:	JUL. 2000	**AIRCRAFT:**	C-295M	**FLAPS:**	TO (10º)
DATA BASIS:	FLIGHT TEST	**ENGINES:**	PW 127-G	**ALL ENGINES**	
		PROPELLERS:	HS 568F-5	**OPERATING**	

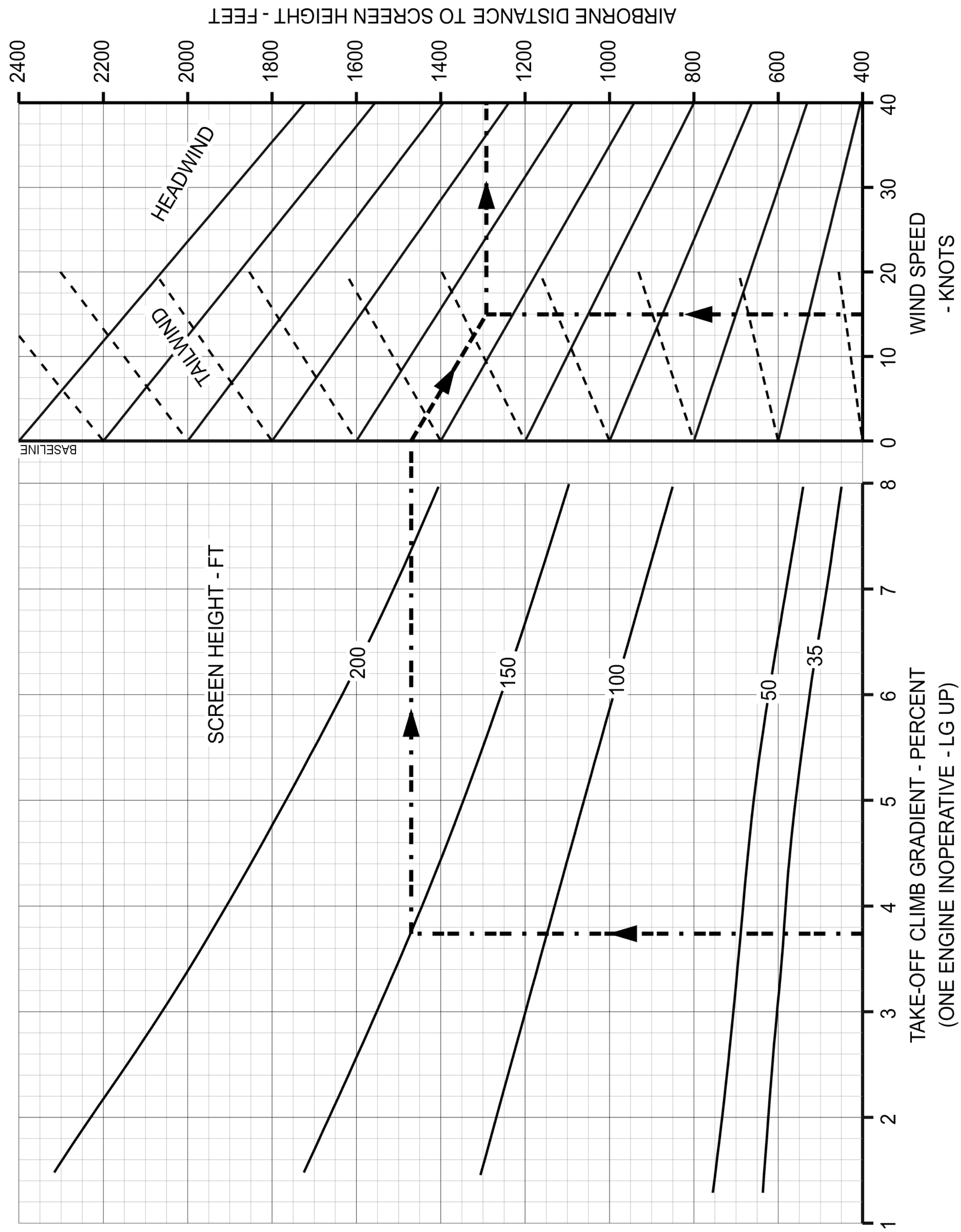

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Figure 3-35 Short Field Takeoff Air Distances to Varying Runway Screen Heights

SHORT FIELD TAKEOFF AIR DISTANCES TO VARYING RUNWAY SCREEN HEIGHTS

DATE:	JUL. 2000	**AIRCRAFT:**	C-295M	**FLAPS:** APP (15º)
DATA BASIS:	FLIGHT TEST	**ENGINES:**	PW 127-G	**ALL ENGINES**
		PROPELLERS:	HS 568F-5	**OPERATING**

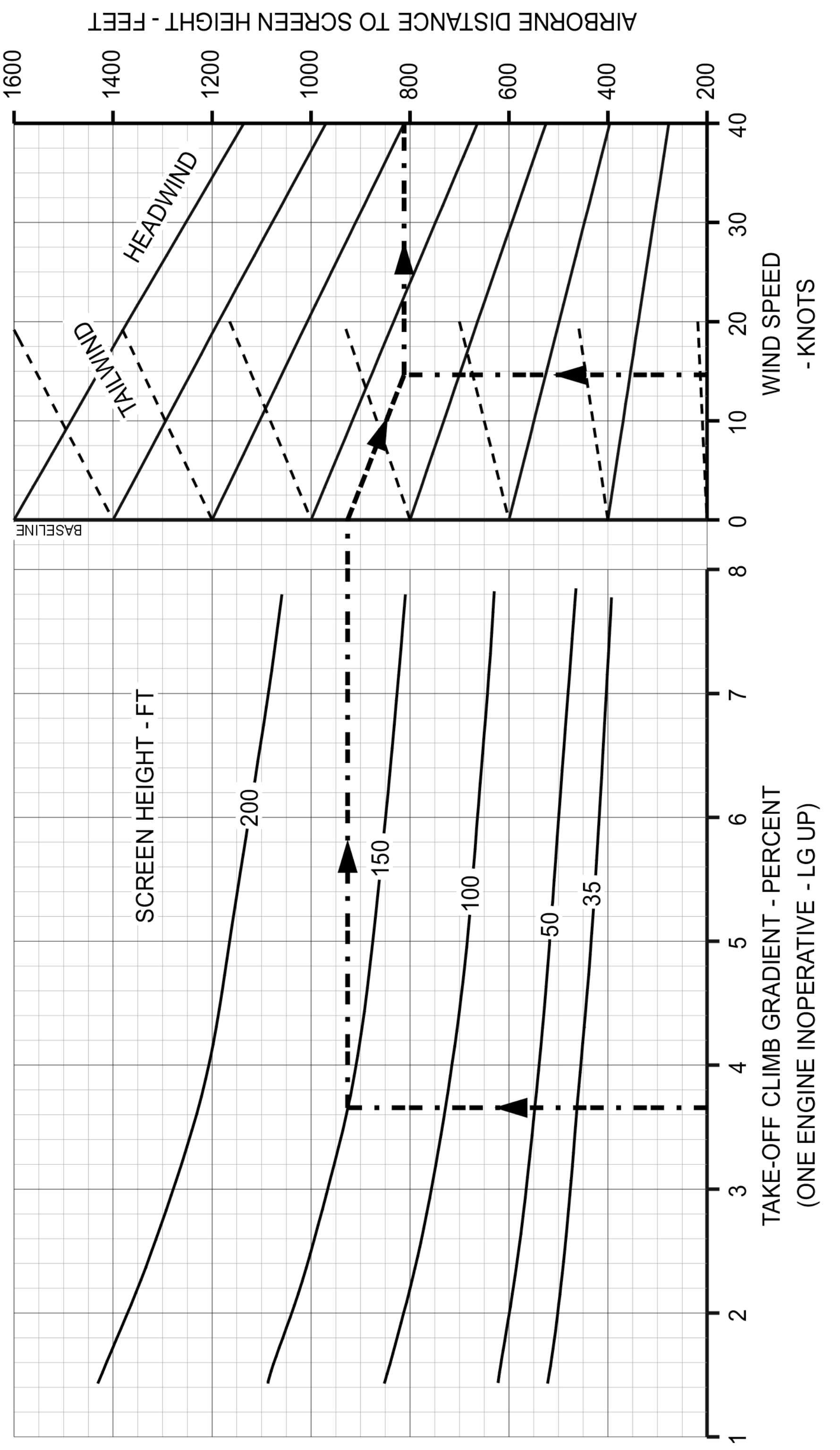

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Figure 3-36 Short Field Takeoff Air Distances to Varying Runway Screen Heights