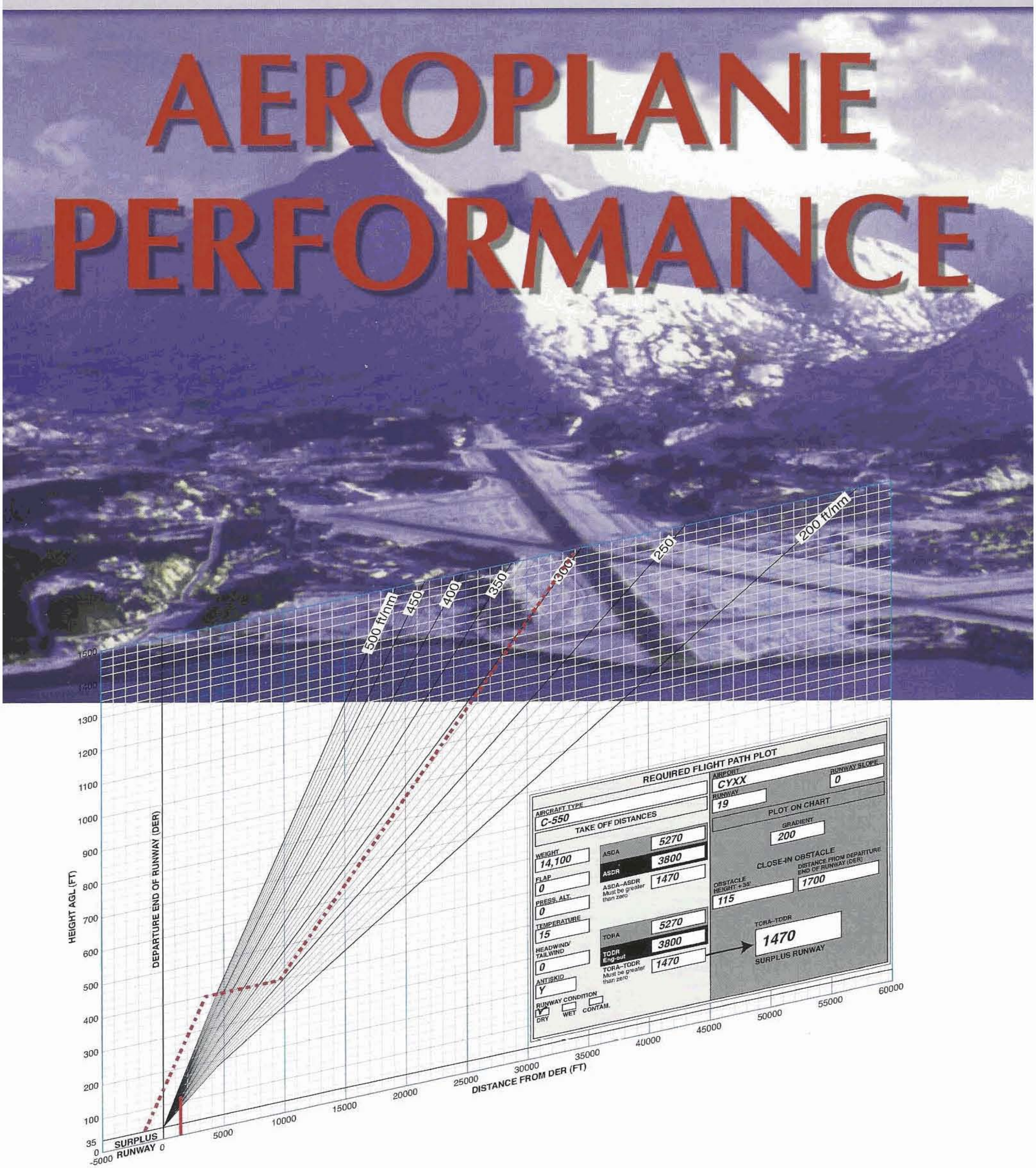
Transport Canada / Transports Canada

TP 12772E
(09/1996)

AEROPLANE PERFORMANCE



REQUIRED FLIGHT PATH PLOT

AIRCRAFT TYPE	C-550
AIRPORT	CYXX
RUNWAY SLOPE	0
RUNWAY	19

TAKE OFF DISTANCES

WEIGHT	14,100
FLAP	0
PRESS. ALT.	0
TEMPERATURE	15
HEADWIND/ TAILWIND	0
ANTISKID	Y

RUNWAY CONDITION: ☑ DRY ☐ WET ☐ CONTAM.

ASDA	5270
ASDR	3800
ASDA–ASDR Must be greater than zero	1470
TORA	5270
TODR Eng-out	3800
TORA–TODR Must be greater than zero	1470

PLOT ON CHART

GRADIENT: 200

CLOSE-IN OBSTACLE

OBSTACLE HEIGHT + 35'	115
DISTANCE FROM DEPARTURE END OF RUNWAY (DER)	1700

TORA–TODR: 1470
SURPLUS RUNWAY

TC-1000189

Canada

Also available in French.

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INTRODUCTION

For many commercial aircraft operators the introduction of the Canadian Aviation Regulations (CARs) signalled a change in how they operate their aircraft. For the first time, regulation requires many operators to consider aircraft performance with respect to terrain during all phases of flight.

Performance calculation requires a fundamental understanding of the capabilities of the aircraft, and methods used to express these capabilities. The most complex part of many performance problems is trying to fit the manufacturer's data to the actual problem at hand, be it determining takeoff distance or obstacle clearance. This task is sometimes further hampered by confusion over the actual meaning of technical terms.

This document is guidance material, and is intended to describe some of the practical aspects of meeting performance requirements. **This is not a legal document**. For an exact statement of your regulatory obligations, consult the relevant regulation(s) and standard(s).

Although your operation may not require you to calculate performance for all phases of the flight, we recommend that you read this document fully if you need to include engine-out performance calculations in any phase of flight planning, and encourage you to determine your aircraft performance in advance of any flight, letting good airmanship pick up where the regulations end.

We will discuss performance in six parts, as follows:

1) Terms: A basic primer/review of performance terms.

2) Airplane Certification: What is your airplane designed to do?

3) Takeoff planning: Accelerate-Stop and Accelerate-Go, wet and contaminated runway factoring;

4) Net Takeoff Flight Path: types of departures and acceptable analysis methods;

5) Enroute: required performance and driftdown; and

6) Landing: Runway factoring for props and jets, the JBI table, and the effect of enroute emergencies.

We will also provide two supplements:

I) Takeoff calculation using the *Canada Air Pilot* Climb Gradients for aircraft with certified climb capability.

II) Takeoff calculation using the *Canada Air Pilot* Climb Gradients for aircraft without certified climb capability, but with supplemental operating information.

Appendices A through D provide a summary of performance requirements and further material to aid in takeoff planning.

Part 1: Terms

Following are some basic definitions. These are not official, but they are simpler and sufficient for our purposes. Consult the regulations and standards for exact definitions.

V_1: Takeoff decision speed

This speed is relevant to aircraft that are certified for continued engine-out takeoff[1]. This is also one of the most abused and misunderstood terms in aviation, and is sometimes used aboard aircraft for which it has no meaning.

If a takeoff is rejected up to V_1, the aircraft is certified to stop within the Accelerate-Stop distance calculated for that flight. If an engine failure is recognized at or after V_1, the aircraft is certified to reach the screen height (35 feet) within the calculated engine-out takeoff distance.

In the correct context, V_1 may be considered the speed at which you are committed to takeoff, since if you spot a problem right at V_1, you cannot initiate a Rejected Takeoff (RTO) quickly enough to stop within the planned Accelerate Stop Distance.

There is a small margin built-in for pilot reaction time, but those pilots who have interpreted this margin as extra decision room and rejected a takeoff above V_1 have often lived (sometimes briefly) to regret it. *High speed RTO's are among the leading causes of aeroplane accidents.*

Review the definition for V_1 in your AFM.

Some Normal Category[2] aircraft use the term V1 when the aircraft can't actually satisfy the Accelerate/Go requirement. More than one light twin pilot has continued a takeoff with an engine failure that occurred after V_1 thinking that they had the performance to climb away. What they did do was get airborne, decelerate to V_{mc} or V_s, lose control of the aircraft and crash.

Pilots of Normal Category aircraft should plan to reject a takeoff if a problem occurs up to (and sometimes beyond) V_R. This is not a risk-free prospect. If you have access to a simulator, include high-speed rejects and emergency relands in your training program. If you train in the aircraft, rejects should not be practiced above the lower of the practice speed recommended by the manufacturer or 1/2 the rotation speed.

V_1 is discussed further in Part 3, Takeoff Planning.

V_R: Rotation speed

For airplanes that are not certified for engine-out takeoff performance (i.e. Part 23 Normal), this is the point the takeoff decision is normally made – but check your manual. You may find that an engine failure even after V_R may preclude a climb, and you are left with only one option – land straight ahead.

V_2: Takeoff Safety Speed

For airplanes capable of engine-out climb this is the speed used for the initial climb in takeoff configuration, and is the speed you need to hold if you want the certified performance.

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[1] FAR 25, sFAR41(c) ICAO Annex 8, Part 23 Commuter, Part 135 Appendix A or Canadian Airworthiness Manual Part 525

[2] Part 23 aircraft are not certified in many performance areas. Other certification standards with similar performance gaps include sFAR 23, CAR 3, and Canadian Airworthiness Manual 523 Normal Category

V_{climb} : Enroute climb speed

For airplanes capable of engine-out climb, this is the optimum speed for single-engine climb in the clean configuration at Maximum Continuous Thrust. This speed is described by a myriad of other names, depending on the manufacturer and country of certification.

For aircraft that express climb in terms of segments, this is the speed and configuration typically held during fourth, or final segment climb.

V_{yse} : Best Single-engine rate of climb speed (blue line)

This is Normal Category's answer to V_2 and enroute climb speed. Many manufacturers base their Single-Engine Rate of Climb charts on V_{yse}. **BUT** this speed normally relates to an aircraft in a **climb** configuration with landing gear up (if retractable), and flaps up. Most aircraft are not configured for V_{yse} at takeoff. This means that, in the absence of supplemental data from the manufacturer, there will be an unknown area of performance from the end of the takeoff until the aircraft is at the speed and configuration for enroute climb.

V_S : Stall Speed

This is the stalling speed or the minimum steady flight speed at which the airplane is controllable.

Variants by configuration include V_{so} and V_{s1}

V_{mc} : Minimum control speed with the critical engine inoperative

V_{mc} includes two terms: V_{mca} and V_{mcg}.

V_{mca} is the calibrated airspeed at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the airplane in straight flight with an angle of bank of not more than 5 degrees.

This speed is fundamental to control of the aircraft. As a result, many of the minimum speeds associated with takeoff, landing and climb are based on a margin above V_{mc}. On some aircraft, V_{mc} is close to, or below, V_S. Consider the pilot who, while trying to hold altitude (or climb) with an engine out, decides to sacrifice too much speed for altitude. As speed slows to V_S or V_{mca} the aircraft will depart controlled flight suddenly, likely in a spin. A classic light twin accident.

V_{mcg} refers to the minimum speed at which directional control can be maintained on the ground using only aerodynamic control surfaces with the critical engine failed. This is a factor when determining V_1.

Many aircraft use only the term V_{mc}. In this case, $V_{mc} = V_{mca}$.

Accelerate-Go: (Single-Engine Takeoff Distance)

This is the distance required to continue takeoff to a height of 35 feet when an engine failure has been recognized too late to reject the takeoff at or before V_1 (or V_R for Part 23 airplanes). Note also that Part 23 Normal Category airplanes that provide Accelerate Go information may do so to 50 feet, not 35.

Accelerate-Stop: Distance Required (ASDR)

The distance required to stop on the runway (plus stopway, when provided) when the takeoff is rejected as the result of an engine failure and the reject is commenced at V_1 (V_R for Part 23).

Balanced Field:

When Accelerate-Stop and Accelerate Go distances are equal, the field is "balanced". Under normal conditions a balanced field permits takeoff with the maximum payload while meeting performance requirements.

Clearway:

An area beyond the runway surface (including stopway, see below) that permits the climb from the surface to 35 feet and is clear of all obstacles except frangible (break away) lights. Where clearway is available, Takeoff Distance Available (TODA) = runway + clearway.

Clearway distance can often be used for takeoff calculations (up to a point), but cannot exceed half the runway length (current certification rules) or half of the takeoff run (early Transport Category certification rules). Also note that certain Net Takeoff Flight Path analysis methods (including those based on the _Canada Air Pilot_) cannot be used with Clearway.

Climb Gradient:

Measured in percent (not degrees) or feet per nautical mile, this indicates required climb performance relative to the ground.

$$\text{Gradient (percent)} = \left(\frac{\text{Vertical Distance}}{\text{Horizontal Distance}} \right) \times 100$$

A gradient of 200 feet per nautical mile equates to 3.3 percent (1 nautical mile = 6080 feet).

Climb Gradients published in the _Canada Air Pilot_ start at 35 feet AGL over the departure end of the runway and provide vertical separation above a safe "surface" called the **Obstacle Identification Surface, or OIS.** Below the OIS obstacle clearance is unpublished. Supplements I and II to this paper translate the CAP climb gradient into performance information that you can use with your Flight Manual.

Contaminated Runway:

A runway is generally considered contaminated under the following conditions:

a) Standing water or slush more than 0.125 inch (3.0mm) anywhere along the proposed takeoff run or accelerate-stop surface; or

b) Any accumulation of snow or ice along the proposed takeoff run or accelerate stop surface.

Note: **Consult the aircraft manufacturer and current regulations to determine the definition of contaminated runway to be used in performance planning for your aircraft.**

Segments of Climb

Reference Zero:

The point at which Takeoff Distance ends and the climb begins. For Transport or Commuter Category aircraft, this is the point at which the aircraft reaches 35 feet at V_2.

First Segment:

Starts at Reference Zero and ends when the landing gear is retracted. A Part 25 Transport Category or Part 23 Commuter Category aircraft must be capable of positive single-engine climb during this segment.

Second Segment:

Starts at the end of the first segment and continues to the height at which the aircraft is levelled off for cleanup (normally 400 feet AGL).

For a Transport or Commuter Category aircraft, speed is V_2, flaps and power are at takeoff setting, and (where applicable) the propeller of the failed engine is feathered.

The required single engine climb performance varies by certification basis and number of engines.

Third Segment:

Starts at selected cleanup altitude and ends when the aircraft is ready for enroute climb.

Normally conducted in level flight at 400 feet, the aircraft accelerates to V_{climb} (V_{yse}), retracts flaps (normally to zero), and reduces power to Maximum Continuous. (Remember: many engines are rated only for 5 minutes at takeoff power).

Fourth (or Final) Segment:

Enroute climb from the cleanup altitude to 1500 feet, higher where obstacles require it.

The aircraft is normally in a clean configuration at V_{climb} (V_{yse}) with Max Continuous Power on the good engine and the failed engine shut down/feathered (if applicable).

Stopway:

A weight-bearing area beyond the runway surface that can be used for stopping the aircraft during a landing of rejected takeoff. Stopway is part of the Accelerate-Stop Distance Available, and can be used in all Accelerate Stop calculations.

Takeoff Path:

Engine-out climb performance over a flat surface with no correction for less than optimum pilot technique or equipment performance. Most Normal Category performance charts are based on this figure.

Takeoff Flight Path (also referred to as Net Takeoff Flight Path):

Engine-out climb performance adjusted to reflect less than optimum pilot and/or aircraft performance. For a two-engine aeroplane, the Net figure represents actual performance reduced by 0.8 percent.

Operational regulations require the Net Takeoff Flight Path to clear all obstacles in the departure by 35 feet vertically and 300 feet horizontally (200 feet within the airport boundary). In order to facilitate this demonstration, manufacturers may express performance in terms of segments or gradients, starting at Reference Zero.

When determining the dimensions of the Flight Path, the lowest point of the aircraft is used. Wingspan is not considered. Depending on the obstacle analysis method, the effect of crosswind on the Flight Path may need to be considered. This will be addressed in more detail in Part 4.

Wet Runway:

A runway with a shiny or glistening appearance, covered with between 0.01 inch/ 0.3mm to 0.125 inch/ 3.0mm of water, with no significant areas of standing water.

Part 2: Airplane Certification

The certification bases for aircraft are quite variable. What can you expect from your aircraft? A tabular summary is provided at the end of this Part.

Normal Category: (Includes FAR Part 23 (formerly CAR 3) and sFAR 23)

The certification standard for private aircraft, generally aircraft under 12,500 pounds Maximum Certificated Takeoff Weight (MCTOW).

Part 23 aircraft have very limited engine-out capability. There is normally **no** certification with respect to accelerate-stop, continued takeoff or initial climb with an engine failure at or after the takeoff decision is made, normally at V_R (not V_1).

sFAR 23 aircraft are basically Part 23 aircraft that meet a slightly higher standard, as follows:

- Accelerate-Slow:

  sFAR 23 aircraft have limited accelerate stop capability, called Accelerate-Slow to 35 knots. Depending on what is off the end of the runway, you may not wish to overrun the hard surface by even one knot, let alone 35.

  Most manufacturers provide a correction figure that represents the distance required to slow from 35 to zero knots. If your manual doesn't have this figure, contact the manufacturer to get it, and include it in all your calculations.

- First Segment Climb Gradient:

  sFAR 23 aircraft provide data that limit takeoff weight such that you have a non-negative rate of climb in the event of engine failure immediately after takeoff.

  Some of these manuals do not provide single engine takeoff distance, even in supplemental operating data, which means you know you'll get to 50 feet, you just can't tell when. If you have one of these aircraft you won't be able to calculate obstacle clearance unless the manufacturer gives you more data (i.e. single-engine takeoff distance).

Performance data published with Part 23 and sFAR 23 aircraft have no performance degradation. *What you see is for a perfect airplane and pilot.* You may wish to apply your own degradation. In Supplement II, which uses the Canada Air Pilot for Net Takeoff Flight Path Planning, the charts for aircraft without certified performance build in a 0.8 percent degradation. This approximates the performance margins inherent in Part 23 Commuter and Part 25 Transport Category designs.

Manufacturer's Supplementary Operating Data

Much of what you will need to determine performance for Part 23 aircraft is not required by certification. That means that it is up to the manufacturer to determine if they will provide information on engine-out climb performance in the takeoff configuration and early stages of the climb.

When approved by the regulatory authorities, Supplementary Operating Data is okay to use, but it is important that you read, understand and abide by all conditions or restrictions that may appear with an unapproved supplement.

Notes:

1) *If the manufacturer does not provide the data you need, there may be a very good reason. The aircraft may not be able to clear obstacles at any practical takeoff weight. This is not an opportunity to improvise, and any procedure based on "homegrown" data will not gain regulatory approval.*

2) *Special use supplements may carry a warning that they operate outside the certified envelope of the aircraft. In these cases, contact the nearest Transport Canada regional office. You will need specific authorization to use a supplement that exceeds a certified limitation.*

WARNING: If your aircraft Flight Manual does not provide the data you need to complete this step and you are unable to obtain the required information from the manufacturer, **DO NOT** attempt to interpolate from other charts.

Commuter Category

(Includes FAR Part 23, sFAR 41 c), ICAO Annex 8 and Part 135 Appendix A)

and Transport Category

(Includes FAR Part 25 and CAR 4 (b))

These aircraft are certified for continued takeoff and climb at minimum gradients with an engine failure recognized at or after V_1. Part 25 standards are more stringent than the others in this group, but for our purposes all members of this group may be treated equally.

The AFM limitations section normally restricts maximum takeoff weight such that you can meet accelerate-stop, accelerate-go, single engine takeoff flight path (no obstacles) and landing limits, such as single-engine go-around and single-engine landing.

Performance may be expressed in terms of one gradient, which accounts for initial climb, cleanup, and enroute climb, or as segments. The segment concept is quite commonly used, and is explained further in Part 1 of this document.

Net Takeoff Flight Path data in the AFM is factored to account for less than perfect pilot technique or aircraft condition. For Part 25 and Part 23 Commuter, the impact of headwinds and tailwinds is also factored for conservatism. Headwind effects are credited at 50 percent, whereas tailwinds are credited at 150 percent. This pre-factoring fully complies with commercial operating rules, so you can apply reported headwinds to these charts without further adjustment. **If your aircraft is not certified to Part 25 or Part 23 Commuter, verify with the manufacturer whether or not the data is pre-factored for winds.**

You will get the published performance for an aircraft certified under Part 25, 23 Commuter, ICAO Annex 8, sFAR 41 c), or operated according to FAR 135 Appendix A, *provided you follow the manufacturer's procedures.* **If you do not fly the correct procedures, all performance guarantees are void.**

A manufacturer may provide a simplified takeoff planning chart that sets out for a range of takeoff conditions, maximum weights at which the aircraft meets certification guarantees, such as Accelerate-Stop, Accelerate-Go, and 2 to 2.4 percent (for twin-engined aeroplanes, depending on certification basis) during second segment climb, **over a flat, obstacle-free surface.**

The problem is, obstacles don't care how the aircraft was certified. You can fly into an unseen hill in cloud while holding a 2.4 percent gradient. What's important is the gradient you need to clear obstacles right now. Chances are it's more than 2.4 percent.

If our aim is to clear obstacles, we must always climb at the greater of the minimum certified gradient or whatever it takes to achieve obstacle clearance.

Part 3: Takeoff Planning: Accelerate-Stop and Accelerate-Go

Technically, the calculations for Accelerate-Stop and Accelerate-Go (or Engine-out takeoff distance) are two separate processes. They are however subject to many of the same considerations, which we will list below.

Takeoff planning is successful when you have determined the aircraft takeoff weight at the start of the takeoff roll (brake release weight) that produces the following results:

a) Accelerate-Stop Distance Required (ASDR) is less than Accelerate-Stop Distance Available (ASDA);

b) Engine-out Takeoff Run Required is less than Takeoff Run Available(TORA); and

c) Engine-out Takeoff Distance Required (to 35 feet) is less than Takeoff Distance Available (TODA).

General Considerations:

a) Runway slope, if applicable;

b) Ambient temperature, pressure altitude and wind components (headwind/tailwind and crosswind);

c) Runway condition (Is it bare and dry, wet, or contaminated?);

d) Aircraft condition (Anti-skid, brake energy limitations, brake cool-down limitations);

e) Fuel burn during taxi (Do you have a long taxi that will burn more fuel than planned, or a very short taxi that could leave you overweight at the start of takeoff?)

f) Specific procedures (V1 reduction, improved climb or other "unbalanced field" techniques);

g) Takeoff technique (How much runway will you use lining up? Will this be a rolling takeoff?); and

h) Surplus runway and stopway: consider what happens if you, the aircraft, or the runway are not working to 100 percent of expectations.

For specific guidance on how to calculate required accelerate/stop and accelerate/go distances, consult the Aircraft Flight Manual and your aircraft manufacturer.

The Go/NoGo decision

The key to understanding accelerate-stop distance is in understanding the dynamics of a rejected takeoff. By the time your aircraft reaches V_1 you have accumulated a considerable amount of energy. For a rejected takeoff to be successful your brakes must be able to convert all of that energy into heat without overheating themselves (brake failure or extreme fade-out) or the aircraft wheels (fire, burst wheel). And, of course they must do all of that before you run off the end of the runway (plus stopway, when available).

As you accelerate beyond V_1, your aircraft continues to gain energy at an astonishing rate, rapidly outstripping your ability to stop. Should you attempt an RTO past V_1, expect to run past the end of the accelerate-stop area... a long way past.

There is much debate about when a takeoff should continue and when it should not. The debate, of course, is only relevant if the aircraft can continue a takeoff with an engine failure. Aircraft that are not certified to continue takeoff in the event of an engine failure must reject the takeoff in the event of an engine failure up to, and sometimes beyond, V_R.

Many manufacturers and operators have divided the takeoff into two speed regimes, low and high. During the low-speed phase an RTO can be triggered by a relatively large number of causes, some minor. Once the aircraft enters the high-speed phase, the reasons for rejecting the takeoff reduce to a handful of major items such as engine failure, loss of directional control, etc. **After V_1 you are departing the runway.** Whether it's in the air or on the ground is up to you.

Is the low/high speed is philosophy right for you? Consider that a significant percentage of high-speed rejects occur as the result of a cockpit indication concerning a non-critical abnormality. An even higher percentage of runway overrun accidents result from a reject decision made at or above V_1. A very low percentage of accidents occur when the crew detects an abnormality in the high-speed phase of takeoff and elects to continue the takeoff.

If you haven't already done so, discuss the Go/NoGo decision with your aircraft manufacturer. Together you will arrive at a takeoff procedure that works for your company and the runways you operate from.

Normal Category considerations:

Part 23/sFAR 23 Normal Category aircraft treat takeoff planning a little differently, since technically they are not certified to continue takeoff in the event of an engine failure during the takeoff run, and may not be certified for engine-out climb in the takeoff configuration.

Accelerate-Stop must be to full stop for regulatory purposes. Where the manufacturer provides only Accelerate-Slow data for certification, they normally provide a distance factor to zero knots. This factor must be added to all Accelerate-Slow calculations.

The manufacturer may provide data to describe engine-out takeoff performance. If you elect to use this data, you need to determine what factors, if any, have been applied to the data. How has the manufacturer addressed headwinds and tailwinds? Is there a built-in degradation for line operation, or is the data for a perfect airplane and pilot?

Also, the data may be based on a different takeoff profile. The screen height for Normal Category aircraft is generally 50 feet, not 35. Where regulations require engine-out takeoff, you must use the certified screen height (in this case 50 feet) unless otherwise authorized.

Wet and Contaminated Runway considerations:

Manufacturers are traditionally required to certify their aircraft on **bare, dry runways**. In many cases you will also find factors for use during takeoff on wet or contaminated runways. For takeoff, these factors may take the form of weight penalties, distance factors, or a V_1 reduction, which considers both weight and distance requirements simultaneously.

Beware when applying factors, as some are mutually exclusive, and others result in an unreasonable penalty when mis-applied. Also determine whether the effects of engine or wing anti-ice systems has been included in contaminated runway factoring. In many cases you will find an additional factor required for anti-ice systems.

The aircraft manufacturer may provide Supplementary Operating Data for Contaminated Runway Operation. This is not certified data, but may be used subject to regulatory approval. In many cases this data permits the use of a 15 foot screen height for engine-out operations and allows credit for thrust reverse when calculating Accelerate-Stop Distance Required. There may be additional Minimum Equipment List (MEL) items associated with contaminated runway procedures.

Reduced Thrust:

Many aircraft permit reduced thrust takeoffs as a method of reducing operating costs and extending engine life. Various methods of thrust reduction exist. Some are based on the assumption of a higher than actual temperature, while others treat the engine as if it were a lower thrust variant, with complete certification data ("de-rate"). Which method is best depends on the aircraft and operational circumstances.

Despite the many operational benefits of using reduced thrust, there can be significant drawbacks when the operational environment becomes complex, for example limiting obstacles, runway contamination, or the presence of low level wind shear. In the event of an engine failure, many crews, no matter how well trained, feel compelled to advance power beyond the reduced setting used for takeoff, which, depending on the thrust reduction method, may result in engine damage or aircraft control problems.

Thrust reduction, regardless of the method used, may not be employed when operating from a contaminated runway. Many manufacturers may further restrict the conditions under which reduced thrust is allowed.

Remember: **Unless the manufacturer provides performance data for reduced thrust takeoffs, all takeoffs must be conducted at maximum design thrust for the ambient conditions, even on a bare, dry runway.**

Part 4: Net Takeoff Flight Path

Net Takeoff Flight Path (NTFP) planning generally addresses the phase of flight from Reference Zero to 1500 feet AGL, but may extend all the way to the Minimum Obstacle Clearance Altitude (MOCA).

This step is successful once you arrive at a weight at which the engine-out NTFP clears all obstacles by 35 feet vertically or 300 feet laterally.

General considerations:

1) Obstacle data

Whether the departure is VFR or IFR, it is impossible to demonstrate obstacle clearance without reliable information about obstacle height and distance. More than one aircraft has crashed into an obstacle that appeared to be much farther away or lower than it actually was. Seeing an obstacle is no guarantee you will clear it.

Regulations require that the pilot-in command use the best available data in determining the position and height of obstacles in the departure path. Which obstacles you need to consider depends largely on the method you will be using to analyze the departure (see Analysis methods, below). Depending on the area of operation, some sources of data may be:

a) an ICAO Type A Chart;

b) a private or public obstacle database;

c) local airport authorities;

d) topographical charts;

e) instrument departure criteria, such as those used in the *Canada Air Pilot*; or

f) a visual obstacle survey (see Visual departures, below).

2) Visual departures

It is not always possible to accurately determine an obstacle's height and bearing on departure. In some cases, the only method of gathering obstacle data is a visual airborne survey conducted during the arrival. This is often used in remote areas involving temporary or unprepared strips. This method clearly requires additional controls to be safe, and those controls are via specific authorizations.

Visual obstacle separation may be used, but there are several considerations:

a) All relevant parts of the obstacle must be clearly discernable. At night, obstacles and any relevant supporting structures (guywires, etc) must be sufficiently lit.

b) Visual contact with the obstacle must be established and maintained continuously from the start of the takeoff roll until it is no longer a factor;

c) The pilot must be able to maintain visual contact with the obstacle at the deck angle anticipated during an all-engines climb (this is because engines don't always fail on the runway);

d) The crew must be able to maintain visual contact at anticipated bank angles during departure (This permits assessment of the effectiveness of the turn with respect to the obstacle and winds); and

e) Where several obstacles exist, visual turns to avoid one obstacle should not lead toward another (any turn must be away from all obstacles). The reason for this final consideration is the fact that visual departures by definition are not subject to the degree of obstacle definition and performance analysis that IMC departures face. A pilot who is visually avoiding obstacles on both sides of the departure path will need to instantly assess obstacle clearance from multiple points, all the while correcting for wind, and coping with the aircraft emergency.

There are cases where an operator does have precise obstacle data and can calculate aircraft performance, but wishes to conduct a visual departure to reduce obstacle separation requirements. Under these circumstances consideration (e) above may not apply, since the flight path has already been determined for the wind and turn conditions.

3) The effects of wind

The regulations are very clear on the need to consider ambient wind conditions. They then go on to confuse the issue somewhat by requiring a 50 percent factor for headwinds and a 150 percent factor for tailwinds. What factor do you apply to crosswind? If you answered zero, consider this: A 10 knot crosswind will push an aircraft with a 150 knot groundspeed 333 feet off the intended track in 5000 feet, or about 20 seconds. If you look at obstacles only in the zero crosswind case (300 feet from the centreline), you are considering obstacles over which you will not fly, while ignoring obstacles that could become (tragically) relevant.

Wind can affect obstacle clearance differently as the departure proceeds. If the departure path contains turns from the runway heading, what was a headwind or crosswind at takeoff may now be a tailwind, producing a flatter than expected climb profile. Add to this the lateral effects of the wind on the flight path, and you could end up with an unhappy surprise, facing an obstacle sooner in the flight than you expected, with a tailwind-flattened climb that isn't enough to get you to safety.

If your departure varies from runway heading more than 15 degrees, you need to analyse the effects of wind on your turn.

4) Turns

Most aircraft can bank up to 15 degrees without a discernable effect on vertical climb performance. After that, the turn begins to exact a penalty in terms of loss of lift and an increase in drag. Climb performance is reduced during a turn. Stall speed increases, which may drive up any speed that is based on stall, such as V_2. A higher V_2 means a bigger turn radius. Depending on the aircraft, a departure that needs a sharp turn to avoid obstacles may prove expensive in terms of take-off weight penalties.

Turning departures requiring bank angles greater than 15 degrees and wind corrections create some of the most complex departure planning problems. Unless you have access to manufacturer's data concerning the effects of turns on the performance of your aircraft, this is a good occasion to obtain a commercially-prepared analysis.

Analysis Methods:

We will consider three methods: track analysis, the ICAO Area Analysis, and the Instrument Departure Criteria as presented in the Canada Air Pilot. See Figure 1 immediately following this part for a graphical comparison of the FAA, CAR and ICAO analysis methods.

1) Track Analysis:

This method establishes a corridor centred on the aircraft ground track during an engine-out departure. The width of the "corridor" is 400 feet (200 feet either side of centre) within airport boundaries and 600 feet wide thereafter. The aircraft must clear by 35 feet any obstacle that occurs inside the corridor.

The aircraft ground track for departure is based on expected conditions, including winds. In the interest of conservatism, only 50 percent of the headwind may be used, and tailwind is factored at 150 percent. For a given rate of climb, these factors make the climb gradient appear to be shallower than it is. Crosswind has no conservatism factor applied, but still must be considered at its full value. Any departure plan that is based on a constant heading after takeoff must consider the effects of crosswind when determining the ground track. Aircraft that have the ability (and ATC clearance) to hold a prescribed ground track in the event of an engine failure may centre the "corridor" on the prescribed track.

This method is the least limiting option for straight-out departures in zero crosswind situations. Aircraft with engine-out departure speeds above 120 knots may find this method beneficial in low to moderate (up to 15 knots) crosswinds. Crosswinds can significantly alter the obstacle area to be surveyed. Aircraft with a wide range of engine-out departure speeds may find obstacle planning complex.

Operators that have the capability to change the obstacle survey area based on crosswind will find the corridor method produces the minimum weight penalty, because only obstacles over which the aircraft will actually fly are considered. Also, certain cases make this method simple to use even without heavy computing power, such as departures where the prevailing winds normally move the flight path away from obstacles. In this case the operator can claim credit for the wind effects and not consider obstacles upwind of the departure path.

Planning for a variety of winds may lead to a splay based on the aircraft groundspeed and the highest anticipated crosswind from either side. If this is the case an operator may elect to simplify| their planning by using the ICAO area analysis method detailed below. The ICAO method provides similar obstacle protection to the wind adjusted corridor method in conditions up to a 15 knot crosswind for aircraft with a departure groundspeed of 120 knots or less. In addition, ICAO places maximum widths on the area to be surveyed for obstacles, and this may reap additional benefits. Please see 2) below for further.

2) ICAO Area Analysis:

The ICAO area analysis differs from the wind corrected corridor in that the lateral obstacle clearance requirements are based on the centreline of the departure track, and increase as the aircraft travels away from the end of the runway (or clearway, when available).

The net takeoff flight path must clear vertically by 35 feet all obstacles lying within a lateral distance defined by 90 metres + 0.125 x D where D is the distance travelled from the end of the takeoff distance available. There are maximum widths, defined as follows:

a) For straight-out departures (that is, with a heading change of 15 degrees or less), in day VMC or in any case when navaids, aircraft equipment and ATC authority permit the aircraft to follow the departure track irrespective of wind, obstacles greater than 300 meters either side of the departure track need not be considered.

Many modern aircraft possess the on board capability to generate and then fly a precise arc between fixes in all-engines or engine-out conditions. These aircraft need not consider obstacles more distant than 300 metres laterally from the FMS track, **provided ATC has authorized the proposed track in advance.**

b) For straight-out departures, where the aircraft is navigating solely by headings (for example, many SIDs) in night VMC or in IMC, obstacles greater than 600 metres either side of the departure track need not be considered.

c) For departures with heading changes of more than 15 degrees, where the aircraft is navigating solely by headings in night VMC or in IMC, obstacles greater than 900 metres either side of the departure track need not be considered.

Users of this method need not normally consider the effects of crosswinds on the flight path (see note below), but still need to consider headwind and tailwind effects, since these factors affect climb gradient, and the aircraft must still overfly all obstacles by 35 feet.

Note: Considering obstacles in the ICAO area provides adequate lateral obstacle clearance for most circumstances. Aircraft departing on a constant heading with departure ground speeds of less than 120 knots may come within 300 feet of the edge of the obstacle survey area when experiencing crosswinds of 15 knots or more.

3) *Canada Air Pilot* Instrument Departure Criteria

This method is also an area analysis method. Its main advantage over methods 1) and 2) is the availability of information. A pilot in the field can quickly determine a safe weight for departure without a complex obstacle analysis. The main disadvantage lies in the conservative obstacle area. In many cases, this method will include obstacles not considered in other methods, which may result in additional weight penalties.

While a comparison between ICAO and corridor obstacle survey areas is straightforward, instrument departure obstacle survey areas vary with the intended departure routes and location and type of navaids. A discussion of instrument departure design criteria is beyond the scope of this document. Consult TP 308, *Criteria for the Development of Instrument Procedures*, for further.

Although *Canada Air Pilot* Departure criteria are not designed for use in engine-out departures, most instrument departures are based on an obstacle survey, which can be used for engine-out planning, subject to certain limitations. The GEN section of the *Canada Air Pilot* describes the limitations of obstacle data reporting.

Supplements I and II provide methods for meeting CAR Net Takeoff Flight Path requirements using the *Canada Air Pilot*.

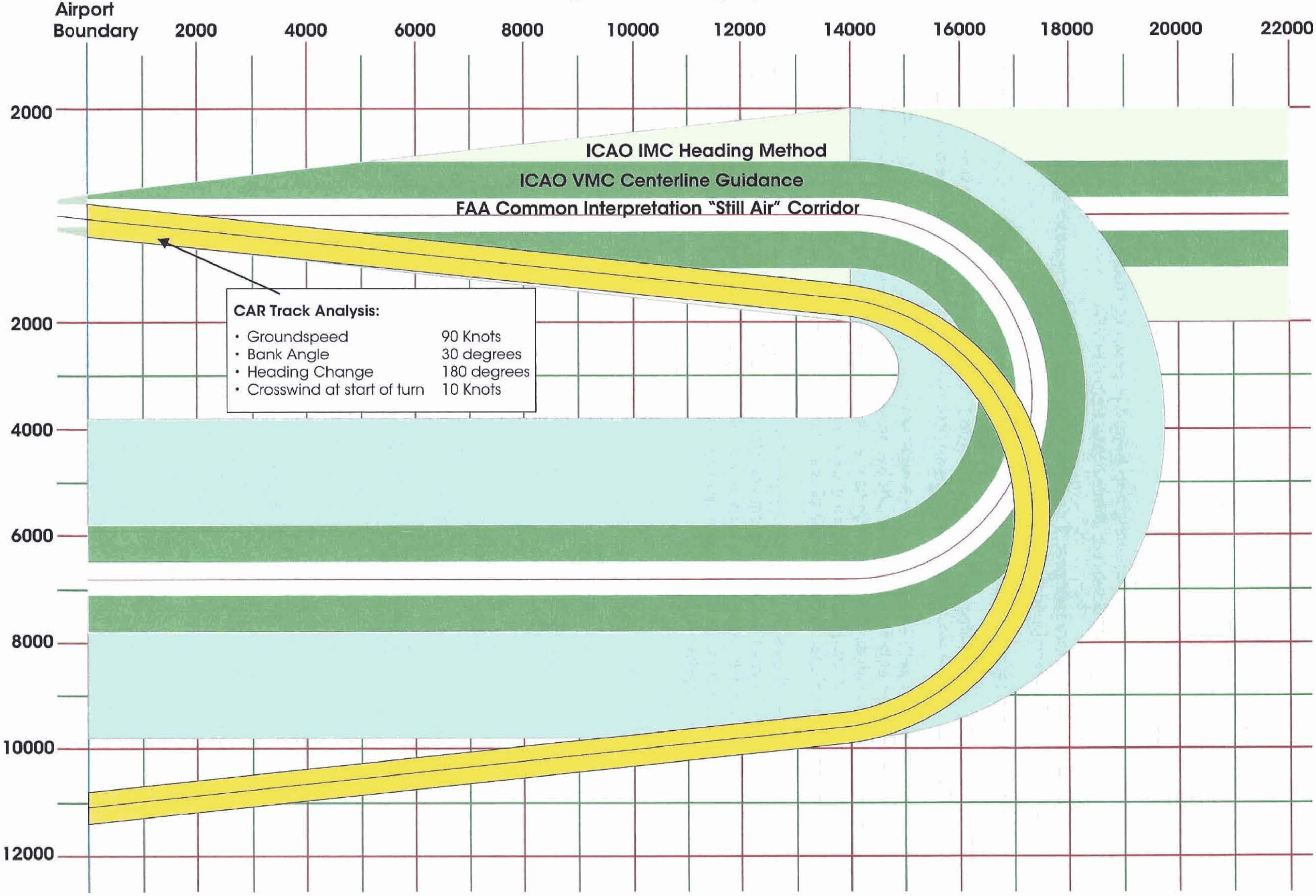
Weight reductions:

The process of determining an obstacle clearance limited takeoff weight may require repetitive calculations. Each weight reduction to improve obstacle clearance also reduces accelerate-stop and accelerate-go distances. A shorter takeoff distance in turn affords obstacle clearance with a shallower climb.

When payload is critical, one or two re-calculations may yield significant benefits. Be careful not to over-analyse the problem. If you leave yourself too little surplus runway you may not have enough of a margin for errors introduced during line-up, a rolling takeoff, less than perfect braking conditions or a less than perfectly performed RTO.

When the source of a takeoff weight restriction is an obstacle in the departure, you may be able to maximize your takeoff weight by using a reduced flap setting. Naturally, the selected flap setting and associated takeoff performance charts must be approved. Reduced takeoff flap settings normally improve engine-out climb capability, but at the cost of increased accelerate/stop and accelerate/go distance requirements. Be sure you can still meet all takeoff distance requirements at the selected flap setting.18

Figure 1
Net Takeoff Flight Path
Comparison of Obstacle Area Survey Methods
for Straight-out and Turning Departures



Part 5: En Route

En route performance is a requirement for all Commuter and Airline operations. The requirements differ by order as follows:

Commuter operations limit aircraft weight to permit engine-out cruise at the MOCA, if IFR or night VFR on an airway or company route, and 500 feet above obstacles if day VFR.

Airline operations are more stringent. Considering the ambient temperature and enroute winds (and the effects of fuel jettisoning, when applicable), the aircraft must be able to:

a) sustain a climb at an altitude that is 1,000 feet above any obstacle within 5 nm either side of track;

b) lose an engine and proceed to a suitable aerodrome while remaining 2,000 feet above all obstacles within 5 nm either side of track (driftdown is okay, provided the obstacle clearance is maintained).

Additionally, airline operations using aircraft with 3 or more engines, when more than 90 minutes from a suitable aerodrome, must be able to lose power on two engines and proceed to a suitable aerodrome while remaining 2,000 feet above any obstacle within 5 nm of the track, considering ambient temperature, winds and the effects of fuel jettisoning. Once again, driftdown is okay, but when considering jettisoned fuel, the aircraft must retain enough fuel to make it to the aerodrome plus 15 minutes at 1,500 feet AGL at cruise power.

All this means that, depending upon the type of aircraft and flight, you must determine how high you need to stay, and limit weight such that you can stay (or drift down to) the altitude you need. Most pilots already know the MEA and MOCA for the routes over which they fly. Meeting en route requirements can be based on those values, or more specific information if you wish. Just remember that obstacle data needs to be updated, and MOCA's can change with a map update or a NOTAM.

Part 6: Landing and Factoring

In this section we will cover the basic factors that apply prior to departure (Dispatch Limitations), and also some of the things to think about once the flight is in progress. Remember that nothing here waives any limitation found in the Approved Flight Manual. It's best to consider yourself bound by the most restrictive limitation, be it by Operating Rule or in the Flight Manual itself.

Dispatch Limitations

Dispatch limitations apply up to the start of takeoff. After that, they are irrelevant.

Do I need to consider Dispatch Limitations?

You will need to consider Dispatch Limitations if you operate a turbo-jet or any airplane with a MCTOW over 12,500 pounds.

What are the potential factors?

- For **propeller-driven** large aircraft, you can only dispatch or conduct a take-off if, based on the weather you expect on arrival at the destination and alternate, the flight manual landing distance is not more than 70 percent of the landing distance available. You need not provide additional factors for wet runways (unless, of course, the Flight Manual requires it).
- For **turbojet** aircraft, you can only dispatch or conduct a take-off if, based on the weather you expect on arrival at the destination and alternate, the flight manual landing distance is not more than 60 percent of the landing distance available. If you expect the runway to be wet when you arrive at your destination (not alternate), you need to increase the flight manual distance by 15 percent, and that new value must not exceed 60 percent of the landing distance available.

  Many manufacturers provide wet runway performance data that affords shorter landing distances than what you get after applying all of the regulatory factors. This data is okay to use, on one condition. The "wet runway" landing distance available must always meet or exceed the **longer** of:

  a) (bare and dry landing distance required) / 0.6; or

  b) wet runway distance required, where wet runway distance required equals:

    A. (bare and dry distance required x 1.15) / 0.6; or

    B. manufacturer's wet runway landing distance required.

Remember that a Dispatch Limitation applies up to the start of the take-off roll. After that, the 60 percent, 70 percent and 115 percent factors all become irrelevant. Once airborne, you can continue to the destination if you will land within 100 percent of the available landing distance. This will help you cope with a change in ambient weather, a runway change, or an equipment failure that increases the aircraft landing distance.

Are there any ways around this?

The regulation provides some leeway for ambient weather. It goes like this.

Let's say that under normal conditions (for example, dry runway with 5 knots of headwind, 10 degrees Celsius) you can meet the Dispatch limitations at your destination. Today it's dead calm and 30 degrees C. You're supposed to be stopped in 60 percent of the distance available, but today it looks like you'll need 80 percent at destination.

Provided you can meet all of the factors at your alternate, you can still go. Before you dispatch, you still need to verify that your actual landing distance required under the ambient conditions anticipated at time of landing will be within the actual landing distance available. **If the destination runway is forecast to be wet at the time of arrival, turbojets must apply full wet runway factoring.**

This provision is not intended to permit dispatch to an aerodrome where you could never reasonably expect to land in 60 percent (70 for props) of the available distance. For example, if it has to be -40 degrees C and a howling headwind for you to barely eek out a 60 percent landing distance, you have the wrong aeroplane for that strip. Go somewhere else or use something else. If in doubt as to what's reasonable for your operation, contact a Transport Canada regional office.

Wet and Contaminated Runways

Apart from any discussion of Dispatch factors, you need to understand how your aircraft handles wet or contaminated runways, and build this understanding into procedures for coping with less than ideal takeoff and landing surfaces. There are a number of sources for information, starting with the manufacturer. Many aircraft provide approved or advisory information addressing the effects of water, snow, slush or ice on the runway. Take the time to read and understand this material before you need it. Poor runway conditions are often associated with other problems that increase workload. More than one crew has miscalculated the effects of weather in their haste.

The James Brake Index

The James Brake Index (JBI) is a common method for measuring and reporting on runway friction. The basis for the use of JBI information is contained in TP 2300, <u>*A.I.P. Canada*</u>, and will not be repeated here.

JBI information is useful **<u>advisory material</u>** in that it provides the pilot with a general picture of the runway braking characteristics. The operative word here is <u>general</u>. JBI describes the friction as seen by the measuring device, and <u>not your airplane</u>. Depending on the size, approach speed and landing gear configuration of your aircraft, you may experience better or worse braking than predicted by the JBI tables.

When the manufacturer provides data for wet or contaminated runways, you may not be able to establish a direct correlation between the runway conditions in the manufacturer's document and JBI. In these cases it's best to stick with the manufacturer's data, and classify JBI values into approximate ranges (for example, "fair", "good", "poor") **for your aircraft.** If all you have is bare, dry runway data, the JBI tables do provide adjusted distances. Table "A" is a basic table, whereas Table "B" is intended for aircraft that have landing distance factors. These tables are useful, provided you keep the following in mind:

a) Use Table "A" for the bare and dry distances from your Flight Manual, and apply your own Dispatch Limitation factors (60 percent, 70 percent or 115 percent as applicable) to the JBI-corrected distances you obtain. This way you can determine roughly how much runway you will actually need, and effects of additional factors are clear. Your calculations using this method will also make any errors easier to detect.

   This raises a point of interpretation in the CARs. Do you need to consider reduced braking other than wet runways when calculating Dispatch factors? The CARs are silent on this, so unless your Flight Manual addresses this area, it's up to you. But consider this - how much will it cost you to consider the reduced braking prior to departure and account for it? Is it more than you will spend if you slide off the end of the runway on landing?

b) Remember that JBI provides a rough measurement at best. If your calculations based on the JBI correction say you'll need 7,950 feet, please don't bet your life on an 8,000 foot landing surface. Even if you calculated everything perfectly, runway conditions can change rapidly, and you can run out of room. Always leave yourself an out.

c) How much margin should you leave? When using JBI tables, it's a judgement call. The JBI gives you an idea of what you can expect on landing, but that's only part of the picture. In order to make the right decision, you need to know the capabilities (and limitations!) of both you and your airplane.

Supplement I: Takeoff Performance Calculation Using the

Canada Air Pilot

Aircraft with Certified Engine-out Climb Capability

The basic question that these performance calculations should answer for the pilot is "how much weight can I carry?". To answer this simple question the pilot needs to know the following:

a) How much distance do I need for Accelerate/Stop and Accelerate/Go? (Part 3);
What obstacles do I need to clear after takeoff? (Part 4); and

b) How do enroute or landing performance requirements for this trip affect my weight? (Parts 5 and 6)

c) In this Supplement, we will focus on takeoff planning (Parts 3, 4 and 5) using the Canada Air Pilot as a data source. We will discuss the limitations to this method, and how they affect a particular phase of flight planning.

Takeoff Distance:

<u>Accelerate-Go</u>

In order to use the CAP gradient for obstacle clearance, we must meet Accelerate-Go requirements within the published Takeoff <u>Run</u> Available, not Takeoff <u>Distance</u> Available. The surveyed obstacle surface in the CAP starts at 35 feet over the departure end of the runway. If we used Clearway or Stopway we would reach 35 feet well past the end of the runway and lose our separation from obstacles.

Obstacle Clearance in the Climb: Net Takeoff Flight Path:

If the airport has an instrument approach, and departure minima other than "Not Assessed" (for CAP users), you can correlate the required climb gradient to the performance data in the Aeroplane Flight Manual (AFM). We will cover this method in detail, complete with a sample worksheet, below.

Note: The annotation "Not Assessed" indicates that no obstacle survey has been done to validate the minimum departure gradient. *This means that you are responsible for determining a safe obstacle-clear departure path, and the CAP cannot be used to meet Net Take-off Flight Path requirements.*

Regardless of the source of a takeoff analysis, remember that you are responsible for obstacle clearance, and need to ensure that the obstacle data used in your method is current. NOTAMs may indicate the presence of a new obstacle, or the airport manager may have new information. Your planning system needs to be able to absorb new information and produce a new analysis quickly.

To use the CAP as a data source, you will need the following:

a) The CAP Aerodrome and SID chart (if applicable) for your airport;

b) The Takeoff Planning Worksheet - Aircraft Certified For Engine-out Performance (Appendix C); and

c) The performance section(s) of your Flight Manual.

Remember: **These steps are for obstacle clearance calculations only. Conduct all takeoffs in accordance with the Flight Manual.**

We will progress through the form step-by step. (For an illustrated chart, see Appendix B)

Step 1: Basic Data

In this step we record the aircraft type, the airport and runway in use, and information about the departure that does not change with ambient conditions.

Runway Data is available on the Airport Diagram. Copy the TORA, ASDA and Runway Slope figures into their respective blocks for use in Step 3, later.

Remember that we cannot use TODA for this method, since the published climb gradient starts at the end of the runway, and we must stay on or above the surface defined by that gradient.

Required Climb Gradient in feet per nautical mile for the runway will appear on the Airport Diagram or SID chart. If no figure is published, the gradient is 200 feet per nautical mile. Move to the graph side of the worksheet and note the line which corresponds to the published gradient. Unless there is a close-in obstacle, this line defines your required performance after takeoff.

> **WARNING:** The published gradient may not account for certain close-in obstacles, but may instead state their height and distance from the Departure End of the Runway (DER). If you find an obstacle notation in the Airport Diagram or SID chart, note its height and distance from DER in the "Close-in" column in Step 4

Step 2: Ambient Conditions

Record Temperature, Pressure Altitude and reported wind. Resolve the wind into a Headwind or Tailwind component. Also record what aircraft weight and configuration you expect to use for this trip. Note the presence of runway contamination as a reminder for Step 3.

Step 3: Takeoff Distance Calculations (Accelerate-Stop and Accelerate-Go)

Enter your Flight Manual Accelerate-Stop Chart(s) for the Weight, configuration and ambient conditions and determine the Accelerate-Stop Distance Required (to zero knots) and Engine-out Takeoff Distance Required (also known as Accelerate-Go Distance or as Single-Engine Takeoff Distance).

Subtract these figures from ASDA and TORA, respectively. The results are **Stopping Margin and Surplus Runway,** respectively. You cannot continue your calculations until you arrive at a combination of weight and flap that results in positive margins. (Technically, a zero margin is legal, but is it a good idea? Ask yourself what happens if the wind shifts or the temperature rises just a little during your taxi out.)

If you have Surplus Runway, record the value in the box for plotting. Move over to the Graph portion of the Worksheet and find the intersection of the Departure End of Runway (DER) vertical line and the 35 foot AGL horizontal line. Move left along the 35 foot line by the amount of surplus runway (up to 5000 feet). This is the **Starting Point** at which you will base your aircraft Takeoff Flight Path planning (Step 5).

Step 4: Close-in Obstacle Data

If you find an obstacle notation in the Airport Diagram or SID chart, note its height (+ 35 feet for clearance) and distance from the DER under the "CLOSE-IN OBSTACLE" heading. You can then plot these values directly on the Graph portion of the worksheet.

A close-in obstacle may demand a higher than published departure gradient. The required gradient is the higher of the published gradient, or the nearest line at or above the plotted position of the obstacle on the Performance Graph.

Step 5: Plotting your performance

Here's where it all comes together. You know about any Close in Obstacles, and you know the required climb gradient, 200 ft/nm or greater. You also know where you are starting on the Performance Chart. Now it's time to see if your aircraft can achieve the performance you need.

From your Aircraft Flight Manual, determine, for the aircraft configuration and ambient conditions the climb gradient or height and distance to the end of each segment. Plot these points relative to your **Starting Point** on the Performance Graph, up to the point you reach 1500 feet AGL.

If your aircraft provides departure data in terms of gradients you will need to convert the gradients into height and distance. Appendix E provides a conversion chart for this purpose.

> **WARNING:** The Takeoff Planning Worksheet – Aircraft Certified for Engine-out Performance is not valid above 1500 feet AGL. Upon reaching 1500 feet AGL you must be able to sustain an engine-out climb at or above the published CAP Required Climb Gradient.

Step 6: Determine Maximum Takeoff Weight

If the line representing your aircraft stays at or above the required gradient line, you can meet obstacle clearance requirements at your selected weight and configuration under today's conditions. Record the weight at which the aircraft performance meets requirements.

If your actual performance goes below the required gradient line, all is not lost. Complete the flight path planning to 1500 feet, then see where your performance problem is. This is normally in the third, or level segment. You need to lose weight or change your flap setting, but how much of a change should you make?

The graph can help here. Let's say at the end of the third segment you are at 400 feet, but 1000 feet past the line horizontally. You need to adjust your weight and/or flap setting to find 1000 feet worth of distance. A small weight reduction might net you 500 feet of takeoff distance and a steeper second segment climb such that you start the third segment 750 feet earlier, and shorten the segment itself by 250 feet. Voila! You now know the weight and flap setting you need for today's departure.

Once you have determined a weight that will give you adequate performance, verify the appropriate takeoff and climb speeds from your AFM. With that information, you're done.

Developing a quick-reference chart

Our method is intended to be straightforward, but you can simplify cockpit workload further by preparing several "what if" combinations of temperature, altitude and wind and summarizing your takeoff weights into a table. Depending on how you choose your examples, you should be able to define a weight limit that works across a wide spectrum of conditions. A sample table might look like the following:

[Aircraft Type] Maximum Takeoff Weight (pounds) Limited by Performance					
Published Gradient **200 ft/nm**		Pressure Altitude **S/L to 2000**		Runway length **5000+**	
Temperature --->		-25 to 15	15 to 25	25 to 35	35-50
Headwind	-10	14800	14000	13800	12800
	0	16000	15500	14000	13500
	10	16000	16000	15000	14000
	20	16000	16000	16000	15000

Notes:

Supplement II:
Takeoff Performance
Calculation Using the

Canada Air Pilot

Aircraft Without Certified Engine-out Climb Capability

Introduction:

Aircraft without certified engine-out performance face the same obstacles as aircraft with certified climb, but the calculation exercise is often hampered by lack of data.

"Non-certified" aircraft differ from their "certified" cousins in two major ways:

1) The data provided in the Flight Manual represents optimum, not degraded figures. It is unlikely that a line pilot experiencing a surprise engine failure will actually achieve the performance in these tables; and

2) There is normally no data provided for the third segment, or cleanup phase. Without this data it is impossible to predict the flight path once the aircraft levels off to reduce power, retract flaps, and accelerate to enroute climb speed.

We asked several manufacturers of Part 23 turbine aircraft about the possibility of obtaining third segment charts for their aircraft, for use in 10 passenger operation. Their response was that, although these charts could be made available, it would generally be more economical to carry only nine passengers than to take the weight penalty necessary for 10 passenger operation.

Certain Part 23 aircraft have adequate engine-out performance to climb directly from 50 feet to 1500 feet at takeoff power without exceeding engine limitations and with the flaps in the takeoff configuration. This 'straight climb' procedure is permitted provided the gradient exceeds that published in the Canada Air Pilot, and engine limits are respected.

Takeoff Distance:

Accelerate/Stop

This calculation is the same as for aircraft with certified engine-out climb, with one difference:

sFAR 23 aircraft operators may only have Accelerate-Slow data. In order to complete this calculation you will need to correct the Accelerate-Slow figure to a full-stop situation. Most manufacturers supply a correction figure or supplemental Accelerate-Stop charts.

Accelerate-Go

Accelerate-go for the Part 23 aircraft includes a climb to 50 feet, not 35 feet. Remember, in order to use the CAP gradient for obstacle clearance, we must meet Accelerate-Go requirements within the published Takeoff Run Available, not Takeoff Distance Available. The surveyed obstacle surface in the CAP starts at 35 feet over the departure end of the runway. If we used Clearway or Stopway we would reach 50 feet well past the end of the runway, would likely pass through 35 feet below the published gradient or "surface", and lose our separation from obstacles.

Obstacle Clearance in the Climb:
Net Takeoff Flight Path:

Aircraft not certified for engine-out climb typically do not build in any degradation to the data they provide. In order to ensure obstacle clearance, the Takeoff Planning Worksheet for these aircraft builds in a 0.8 percent safety margin.

> **WARNING:** Use of the incorrect takeoff planning worksheet may lead to collision with obstacles on departure. Ensure that the worksheet used is appropriate to the certification basis of the aircraft.

As stated in the introduction, to do this step your aircraft must provide one of two things:

a) The ability to climb directly from 50 to 1500 feet (your engines must permit takeoff power for 10 minutes or more to use this option); or

b) Data for cleanup and acceleration (third segment).

If the airport has an instrument approach, and departure minima other than "Not Assessed" (for CAP users), you can correlate the required climb gradient to the performance data in the Aeroplane Flight Manual (AFM). We will cover this method in detail, complete with a sample worksheet, below.

Note: The annotation "Not Assessed" indicates that no obstacle survey has been done to validate the minimum departure gradient. *This means that you are responsible for determining a safe obstacle-clear departure path, and the CAP cannot be used to meet Net Take-off Flight Path requirements.*

Regardless of the source of a takeoff analysis, remember that you are responsible for obstacle clearance and need to ensure that the obstacle data used in your method is current. NOTAMs may indicate the presence of a new obstacle or the airport manager may have new information. Your planning system needs to be able to absorb new information and produce a new analysis quickly.

To use the CAP as a data source, you will need the following:

a) The CAP Aerodrome and SID chart (if applicable) for your airport;

b) The Takeoff Planning Worksheet - Aircraft NOT Certified For Engine-out Performance (Appendix D); and

c) The performance section(s) of your Flight Manual.

Remember: **These steps are for obstacle clearance calculations only. Takeoff and climb procedures are not affected by speeds or rates of climb de termined here.**

We will progress through the form step-by step. (For an illustrated chart, see Appendix B)

Step 1: Basic Data

In this step we record the aircraft type, the airport and runway in use, and information about the departure that does not change with ambient conditions.

Runway Data is available on the Airport Diagram. Copy the TORA, ASDA and Runway Slope figures into their respective blocks for use in Step 3, later.

Remember that we cannot use TODA for this method, since the published climb gradient starts at the end of the runway, and we must stay on or above the surface defined by that gradient.

Required Climb Gradient in feet per nautical mile for the runway will appear on the Airport Diagram or SID chart. If no figure is published, the gradient is 200 feet per nautical mile. Move to the graph side of the worksheet and note the line which corresponds to the published gradient. Unless there is a close-in obstacle, this line defines your required performance after takeoff.

WARNING: The published gradient may not account for certain close-in obstacles, but may instead state their height and distance from the Departure End of the Runway (DER). If you find an obstacle notation in the Airport Diagram or SID chart, note its height and distance from DER in the "Close-in" column in Step 4

Step 2: Ambient Conditions

Record Temperature, Pressure Altitude and reported wind. Resolve the wind into a Headwind or Tailwind component. Also record what aircraft weight and configuration you expect to use for this trip. Note the presence of runway contamination as a reminder for Step 3.

Step 3: Takeoff Distance Calculations (Accelerate-Stop and Accelerate-Go)

Enter your Flight Manual Accelerate-Stop Chart(s) for the weight, configuration and ambient conditions and determine the Accelerate-Stop Distance Required (to zero knots) and Engine-out Takeoff Distance Required (also known as Accelerate-Go Distance or as Single-Engine Takeoff Distance).

Subtract these figures from ASDA and TORA, respectively. The results are **Stopping Margin** and **Surplus Runway**, respectively. You cannot continue your calculations until you arrive at a combination of weight and flap that results in positive margins. (Technically, a zero margin is legal, but is it a good idea? Ask yourself what happens if the wind shifts or the temperature rises just a little during your taxi out.)

If you have Surplus Runway, record the value in the box for plotting. Move over to the Graph portion of the Worksheet and find the intersection of the Departure End of Runway(DER) vertical line and the 50 foot AGL horizontal line. Move left along the 50 foot line by the amount of surplus runway (up to 5000 feet). This is the **Starting Point** at which you will base your aircraft Takeoff Flight Path planning (Step 5).

Step 4: Close-in Obstacle Data

If you find an obstacle notation in the Airport Diagram or SID chart, note its height (+ 35 feet for clearance) and distance from the DER under the "CLOSE-IN OBSTACLE" heading. You can then plot these values directly on the Graph portion of the worksheet.

A close-in obstacle may demand a higher than published departure gradient. The required gradient is the higher of the published gradient, or the nearest line at or above the plotted position of the obstacle on the Performance Graph.

Step 5: Plotting your performance

Here's where it all comes together. You know about any Close in Obstacles, and you know the required climb gradient, 200 ft/nm or greater. You also know where you are starting on the Performance Chart. Now it's time to see if your aircraft can achieve the performance you need.

From your Aircraft Flight Manual, determine, for the aircraft configuration and ambient conditions the climb gradient or height and distance to the end of each segment. Plot these points relative to your **Starting Point** on the Performance Graph, up to the point you reach 1500 feet AGL.

If your aircraft provides departure data in terms of gradients you will need to convert the gradient into height and distance. Appendix E provides a conversion chart for this purpose.

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If the line representing your aircraft stays at or above the required gradient line, you can meet obstacle clearance requirements at your selected weight and configuration under today's conditions. Record the weight at which the aircraft performance meets requirements.

If your actual performance goes below the required gradient line, all is not lost. Complete the flight path planning to 1500 feet, then see where your performance problem is. This is normally in the third, or level segment. You need to lose weight or change your flap setting, but how much of a change should you make?

The graph can help here. Let's say at the end of the third segment you are at 400 feet, but 1000 feet past the line horizontally. You need to adjust your weight and/or flap setting to find 1000 feet worth of distance. A small weight reduction might net you 500 feet of takeoff distance and a steeper second segment climb such that you start the third segment 750 feet earlier, and shorten the segment itself by 250 feet. Voila! You now know the weight and flap setting you need for today's departure.

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Developing a quick-reference chart

Our method is intended to be straightforward, but you can simplify cockpit workload further by preparing several "what-if" combinations of temperature, altitude and wind and summarizing your takeoff weights into a table. Depending on how you choose your examples, you should be able to define a weight limit that works across a wide spectrum of conditions. A sample table might look like the following

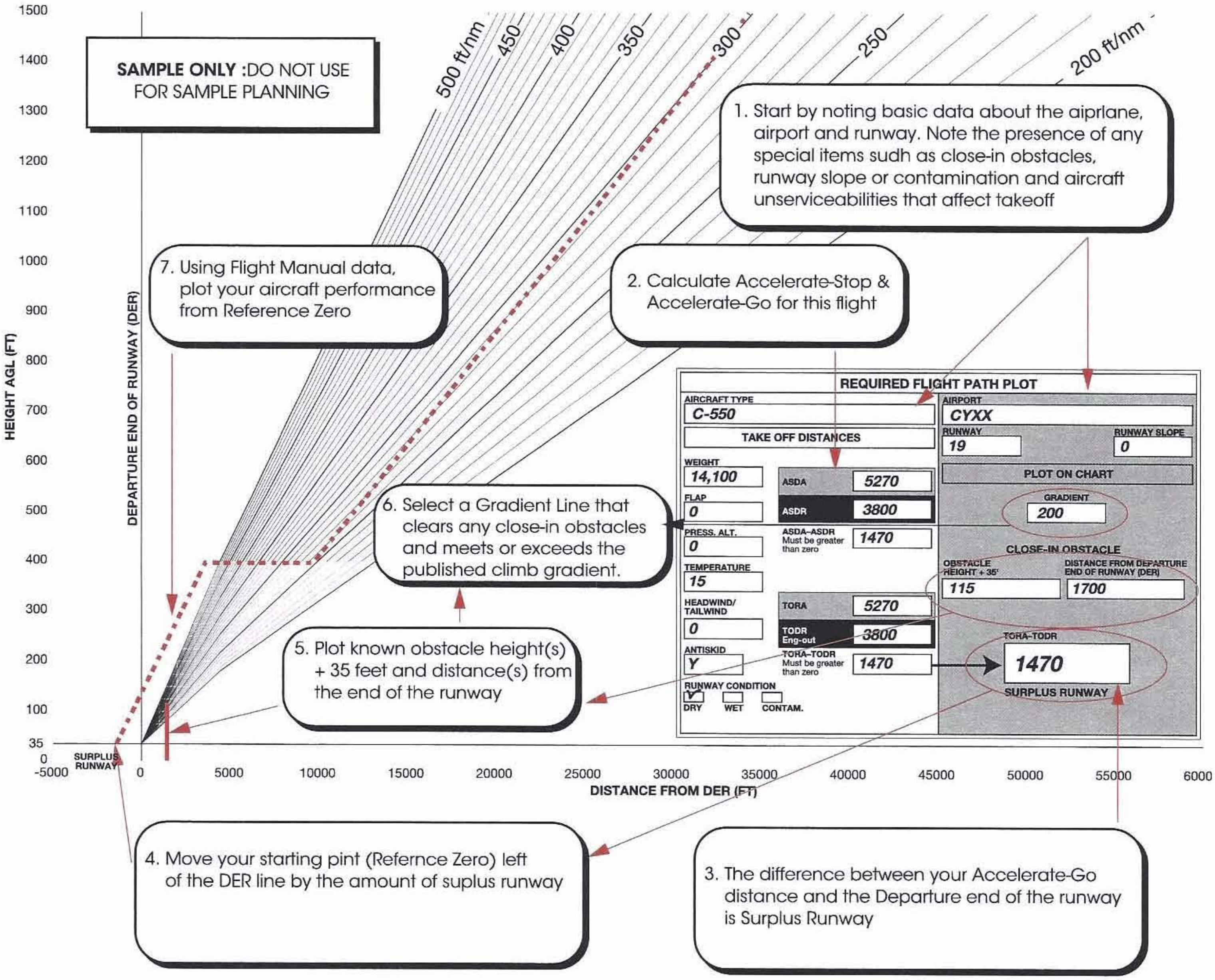
[Aircraft Type] Maximum Takeoff Weight (pounds) Limited by Performance					
Published Gradient **200 ft/nm**		Pressure Altitude **S/L to 2000**		Runway length **5000+**	
Temperature --->		-25 to 15	15 to 25	25 to 35	35-50
Headwind	-10	11000	10500	10000	9500
	0	12500	12000	11000	10000
	10	12500	12500	12000	11000
	20	12500	12500	12500	15000

Appendix A: CAR Performance requirements versus Aircraft Certification

June 3, 1996	CAR 703 CASS 723 Air Taxi	CAR 704 CASS 724 Commuter	CAR 705 CASS 725 Airline	Aircraft Certification Requirements All requirements based on ambient temp, press alt and winds unless otherwise stated				
				FAR 23 Normal Category	sFAR 23	Pt 135 Appx A	FAR 23 Commuter sFAR 41 (c) Ann 8	FAR 25 Transport Category
Accelerate-Stop Distance	1200 RVR : sustain a positive rate of climb engine-out in the takeoff configuration. This requirement may be satisfied by meeting engine-out Takeoff Distance to 50 (35) feet	required, 724 standards provide relief	required, 725 standards provide relief for 9 or less pax reciprocating	to 35 knots**	to 35 knots**	required		
Takeoff Distance (all engines)		required		to 50 feet			to 35 feet, 115% of actual distance required.	
Takeoff Distance (engine out)		small: requ'd for 1200 RVR large/jet: required	required	none*	none*		35 ft screen (bare, dry).	
First Segment positive rate of climb					required.		2 eng +ve 3 eng 0.3% 4 eng 0.5%	
Net Takeoff Flight Path	Not required	small: req'd for 1200 RVR large/jet: required but 724 provides relief	required, 725 provides relief for reciprocating powered aircraft		none*	2.0% - 400' 1.2% -1000' No Degradation	Engines - 400 -1000 2 2.0% 1.2% 3 2.3% 1.5% 4 2.6% 1.7% Data presented in AFM is degraded -0.8% - 2-eng -0.9% 3-eng -1.0 % 4-eng	Eng -400 -1500 2 2.4 % 1.2% 3 2.7 % 1.5% 4 3.0 % 1.7%
Enroute Net Flight Path		carrying pax maintain MOCA or MEA engine-out	2-eng a/c: climb at 1000' above and drift down 2000' above obsts with 1 eng out 3+eng a/c 90 mins away from airport: drift 2000' above obsts. with 2 engs out	TOW limit eng-out turbine and >6000# recip 1.5% @5000' ISA others + ve rate @5000'ISA	TOW limit eng-out 1.2 % @ 5000' at ISA		Canada: WAT limit to permit 50'/min ROC enroute	Required: AFM data degraded 2-eng 1.1% 3-eng 1.4 % 4-eng 1.6 %
Landing Weight	Not required	required		amndmnt 21, all engs balked landing climb 3.3% @ S.L. ISA	Landing Climb all-engines, 3.3% gradient		Eng. out Approach Climb 2-eng 2.1% 3-eng 2.4% 4-eng 2.7% Landing Climb all engines, 3.3%	Landing Climb all engines, 3.2%
Landing Distance Dispatch Factor (Destination)	Not required	.6 jet .7 large prop .8 by Ops Spec	.6 jet .7 prop	actual landing distance only provided*			Factored "field length" data is presented (but not usually limiting) in the AFM by Canadian airworthiness rules. Unfactored data is included at manufacturer's option.	
Landing Distance Dispatch Factor (Alternate)								
Wind Factoring	Not required	50 percent of headwind, 150 percent of tailwind, 100 percent of crosswind					headwind and tailwind factors built into AFM data	
Wet Runway	Req'd where limited by AFM	Jet: Additional 15 percent factor required					AFM or supplement may have related factors.	
Contaminated Runway	AFM may have limits	Standards for 15 foot screen height and credit for use of reverse thrust						

Notes: * - Data may be found in Supplements to the AFM ** - Manufacturer may provide distance factor to full stop **Shaded areas** indicate flight path data is over an obstacle-free surface

Appendix B: TAKE OFF PLANNING WORKSHEET – Sample



SAMPLE ONLY :DO NOT USE FOR SAMPLE PLANNING

1. Start by noting basic data about the aiprlane, airport and runway. Note the presence of any special items sudh as close-in obstacles, runway slope or contamination and aircraft unserviceabilities that affect takeoff

2. Calculate Accelerate-Stop & Accelerate-Go for this flight

3. The difference between your Accelerate-Go distance and the Departure end of the runway is Surplus Runway

4. Move your starting pint (Refernce Zero) left of the DER line by the amount of suplus runway

5. Plot known obstacle height(s) + 35 feet and distance(s) from the end of the runway

6. Select a Gradient Line that clears any close-in obstacles and meets or exceeds the published climb gradient.

7. Using Flight Manual data, plot your aircraft performance from Reference Zero

REQUIRED FLIGHT PATH PLOT

AIRCRAFT TYPE *C-550*

TAKE OFF DISTANCES

WEIGHT *14,100*

FLAP *0*

PRESS. ALT. *0*

TEMPERATURE *15*

HEADWIND/ TAILWIND *0*

ANTISKID *Y*

RUNWAY CONDITION
☑ DRY ☐ WET ☐ CONTAM.

ASDA *5270*

ASDR *3800*

ASDA–ASDR Must be greater than zero *1470*

TORA *5270*

TODR Eng-out *3800*

TORA–TODR Must be greater than zero *1470*

AIRPORT *CYXX*

RUNWAY *19*

RUNWAY SLOPE *0*

PLOT ON CHART

GRADIENT *200*

CLOSE-IN OBSTACLE

OBSTACLE HEIGHT + 35' *115*

DISTANCE FROM DEPARTURE END OF RUNWAY (DER) *1700*

TORA–TODR *1470*

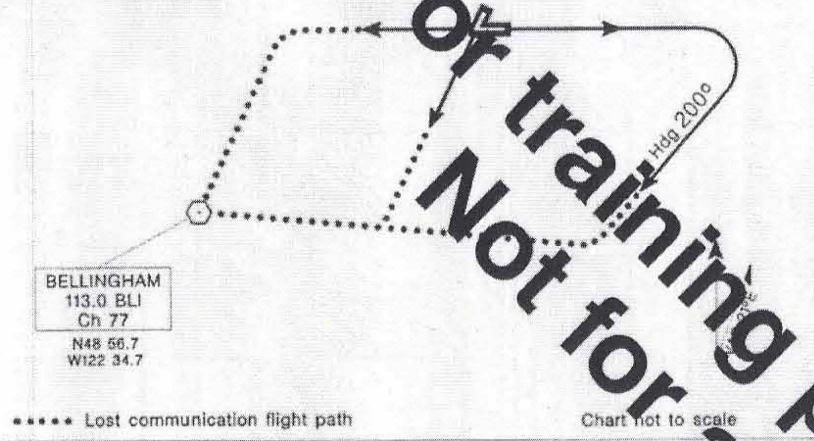
SURPLUS RUNWAY

SID(VECTOR) 8 Geomatics Canada ABBOTSFORD

ABBOTSFORD ONE DEP(CYXX 1.)

ABBOTSFORD BRITISH COLUMBIA

VOT 115.7
ATIS 119.8
GND 121.8
TWR 119.4 295.0
O/T RADIO 119.4 (MF CZ)
DEP VICTORIA TML 132.7 252.5



••••• Lost communication flight path

Chart not to scale

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DEPARTURE ROUTE DESCRIPTION

Runway 07: Category A and B – Climbing right turn to 200° for vectors to assigned route. Maintain 3000 or as assigned.

Category C and D – Requires minimum climb gradient of 390 ft/NM to 4000. Climb runway heading to 1800. Climbing right turn to 200° for vectors to assigned route. Maintain 5000 or as assigned.

Runway 19: Climb runway heading for vectors to assigned route. Maintain 3000 or as assigned.

Note: 80' trees 1700' from departure end of runway.

Runway 25: Requires minimum climb gradient of 240 ft/NM to 500. Climb runway heading for vectors to assigned route. Maintain 3000 or as assigned.

Lost Communication: If no radio contact with Departure Control by published/assigned altitude continue to BLI VOR then via filed/assigned route. Continue climb to flight planned/assigned altitude/flight level 5 minutes after departure.

Note: Refer to Noise Abatement Procedures for additional requirements.

ABBOTSFORD ONE DEP(CYXX 1.) ABBOTSFORD BRITISH COLUMBIA ABBOTSFORD

EFF 14 SEP 95 CHANGE: Comm box 8

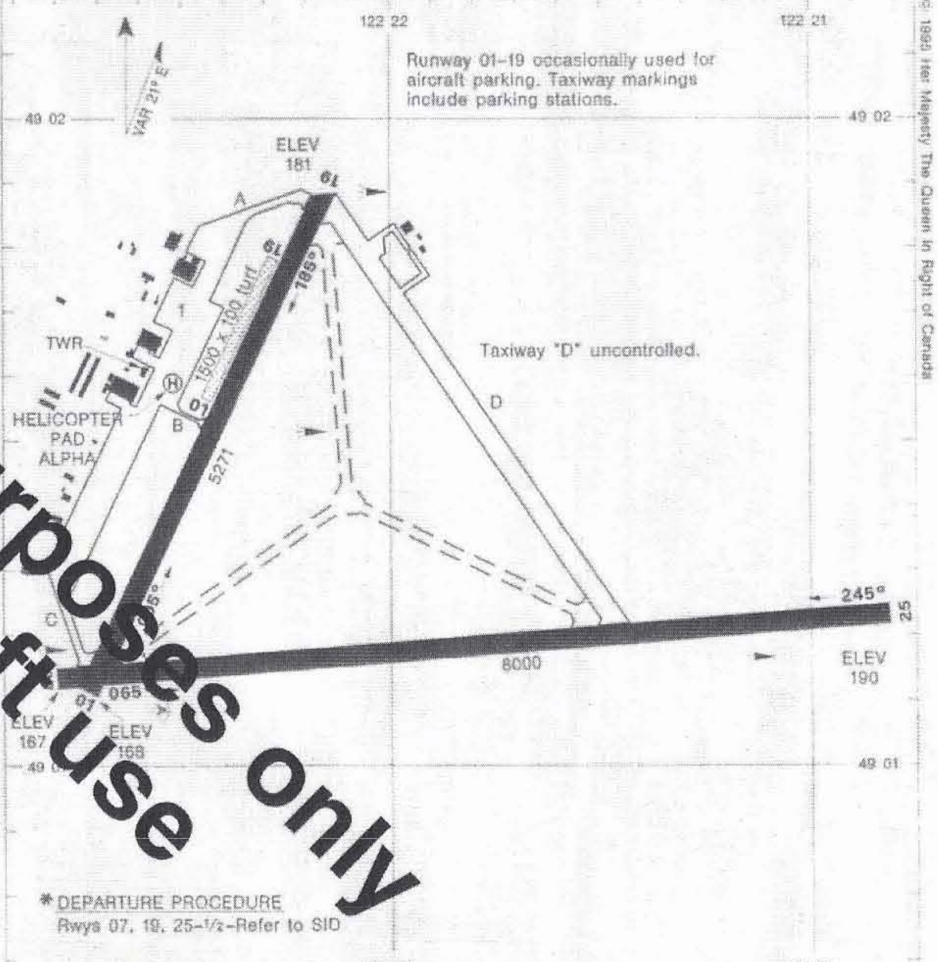
10

AERODROME CHART

Geomatics Canada ABBOTSFORD ABBOTSFORD BRITISH COLUMBIA

VOT	ATIS	GND	TWR	DEP
115.7	119.8	121.8	119.4 295.0 O/T RADIO 119.4 (MF CZ)	VICTORIA TERMINAL 132.7 252.5

DECLARED DISTANCES	07	25	01	19				
TORA	8000	8000	5271	5271				
TODA	9000	9000	6271	6271				
ASDA	8000	8000	5271	5271				
LDA	8000	8000	5271	5271				



Runway 01–19 occasionally used for aircraft parking. Taxiway markings include parking stations.

Taxiway "D" uncontrolled.

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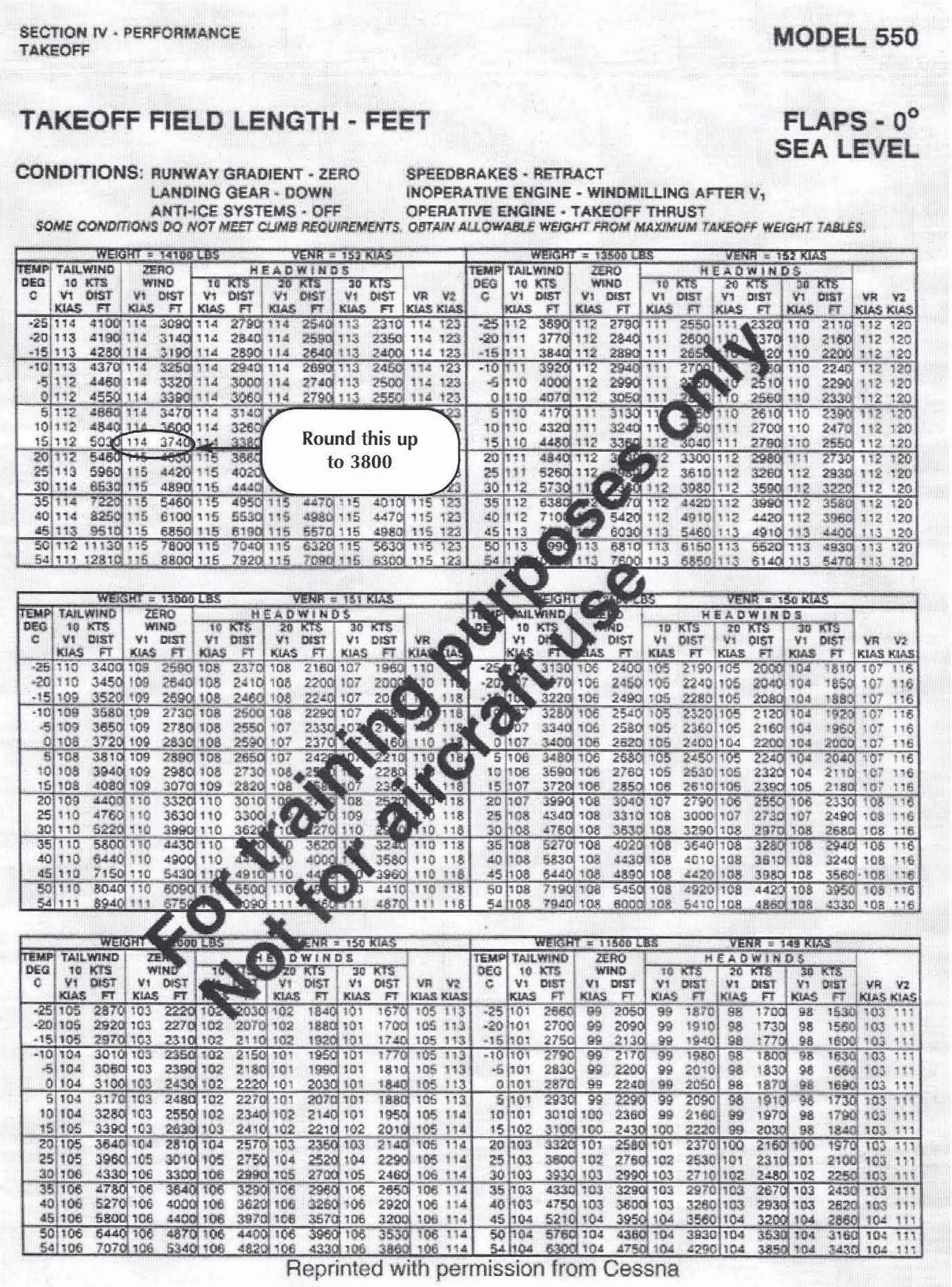
* DEPARTURE PROCEDURE
Rwys 07, 19, 25–½–Refer to SID

TAKE-OFF MINIMA	SCALE IN FEET
Rwys 07; 19; 25: *	1000 0 1000 2000 3000

AERODROME CHART ABBOTSFORD BRITISH COLUMBIA ABBOTSFORD NAD63

EFF 14 SEP 95 CHANGE: Altn minima deleted. Comm box 10

For training purposes only
Not for aircraft use



SECTION IV - PERFORMANCE
TAKEOFF

MODEL 550

TAKEOFF FIELD LENGTH - FEET

FLAPS - 0°
SEA LEVEL

CONDITIONS: RUNWAY GRADIENT - ZERO
LANDING GEAR - DOWN
ANTI-ICE SYSTEMS - OFF
SPEEDBRAKES - RETRACT
INOPERATIVE ENGINE - WINDMILLING AFTER V_1
OPERATIVE ENGINE - TAKEOFF THRUST

SOME CONDITIONS DO NOT MEET CLIMB REQUIREMENTS. OBTAIN ALLOWABLE WEIGHT FROM MAXIMUM TAKEOFF WEIGHT TABLES.

WEIGHT = 14100 LBS VENR = 153 KIAS

TEMP DEG C	TAILWIND 10 KTS V1 KIAS	TAILWIND 10 KTS DIST FT	ZERO WIND V1 KIAS	ZERO WIND DIST FT	HEADWINDS 10 KTS V1 KIAS	HEADWINDS 10 KTS DIST FT	HEADWINDS 20 KTS V1 KIAS	HEADWINDS 20 KTS DIST FT	HEADWINDS 30 KTS V1 KIAS	HEADWINDS 30 KTS DIST FT	VR KIAS	V2 KIAS
-25	114	4100	114	3090	114	2790	114	2540	113	2310	114	123
-20	113	4190	114	3140	114	2840	114	2590	113	2350	114	123
-15	113	4280	114	3190	114	2890	114	2640	113	2400	114	123
-10	113	4370	114	3250	114	2940	114	2690	113	2450	114	123
-5	112	4460	114	3320	114	3000	114	2740	113	2500	114	123
0	112	4550	114	3390	114	3060	114	2790	113	2550	114	123
5	112	4860	114	3470	114	3140	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	112	4840	114	3600	114	3260	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	112	5030	114	3740	114	3380	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	112	5460	115	4030	115	3660	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	113	5960	115	4420	115	4020	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	114	6530	115	4890	115	4440	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	114	7220	115	5460	115	4950	115	4470	115	4010	115	123
40	114	8250	115	6100	115	5530	115	4980	115	4470	115	123
45	113	9510	115	6850	115	6190	115	5570	115	4980	115	123
50	112	11130	115	7800	115	7040	115	6320	115	5630	115	123
54	111	12810	115	8800	115	7920	115	7090	115	6300	115	123

Round this up to 3800

WEIGHT = 13500 LBS VENR = 152 KIAS

TEMP DEG C	TAILWIND 10 KTS V1 KIAS	TAILWIND 10 KTS DIST FT	ZERO WIND V1 KIAS	ZERO WIND DIST FT	HEADWINDS 10 KTS V1 KIAS	HEADWINDS 10 KTS DIST FT	HEADWINDS 20 KTS V1 KIAS	HEADWINDS 20 KTS DIST FT	HEADWINDS 30 KTS V1 KIAS	HEADWINDS 30 KTS DIST FT	VR KIAS	V2 KIAS
-25	112	3690	112	2790	111	2550	111	2320	110	2110	112	120
-20	111	3770	112	2840	111	2600	110	[illegible]	110	2160	112	120
-15	111	3840	112	2890	111	[illegible]	[illegible]	[illegible]	110	2200	112	120
-10	111	3920	112	2940	111	[illegible]	[illegible]	[illegible]	110	2240	112	120
-5	110	4000	112	2990	111	[illegible]	[illegible]	2510	110	2290	112	120
0	110	4070	112	3050	111	[illegible]	110	2560	110	2330	112	120
5	110	4170	111	3130	[illegible]	[illegible]	110	2610	110	2390	112	120
10	110	4320	111	3240	[illegible]	[illegible]	111	2700	110	2470	112	120
15	110	4480	112	[illegible]	112	3040	111	2790	110	2550	112	120
20	111	4840	112	[illegible]	[illegible]	3300	112	2980	111	2730	112	120
25	111	5260	112	[illegible]	[illegible]	3610	112	3260	112	2930	112	120
30	112	5730	[illegible]	[illegible]	112	3980	112	3590	112	3220	112	120
35	112	6380	[illegible]	[illegible]	112	4420	112	3990	112	3580	112	120
40	112	[illegible]	[illegible]	5420	112	4910	112	4420	112	3960	112	120
45	113	[illegible]	[illegible]	6030	113	5460	113	4910	113	4400	113	120
50	113	[illegible]	113	6810	113	6150	113	5520	113	4930	113	120
54	[illegible]	[illegible]	113	7600	113	6850	113	6140	113	5470	113	120

WEIGHT = 13000 LBS VENR = 151 KIAS

TEMP DEG C	TAILWIND 10 KTS V1 KIAS	TAILWIND 10 KTS DIST FT	ZERO WIND V1 KIAS	ZERO WIND DIST FT	HEADWINDS 10 KTS V1 KIAS	HEADWINDS 10 KTS DIST FT	HEADWINDS 20 KTS V1 KIAS	HEADWINDS 20 KTS DIST FT	HEADWINDS 30 KTS V1 KIAS	HEADWINDS 30 KTS DIST FT	VR KIAS	V2 KIAS
-25	110	3400	109	2590	108	2370	108	2160	107	1960	110	[illegible]
-20	110	3450	109	2640	108	2410	108	2200	107	[illegible]	[illegible]	[illegible]
-15	109	3520	109	2690	108	2460	108	2240	107	[illegible]	[illegible]	118
-10	109	3580	109	2730	108	2500	108	2290	107	[illegible]	[illegible]	118
-5	109	3650	109	2780	108	2550	107	2330	[illegible]	[illegible]	[illegible]	[illegible]
0	108	3720	109	2830	108	2590	107	2370	[illegible]	[illegible]	110	[illegible]
5	108	3810	109	2890	108	2650	107	[illegible]	[illegible]	2210	110	[illegible]
10	108	3940	109	2980	108	2730	108	[illegible]	[illegible]	2280	[illegible]	[illegible]
15	108	4080	109	3070	109	2820	108	[illegible]	107	[illegible]	[illegible]	118
20	109	4400	110	3320	110	3010	[illegible]	[illegible]	108	[illegible]	[illegible]	118
25	110	4760	110	3630	110	3300	[illegible]	[illegible]	109	[illegible]	[illegible]	118
30	110	5220	110	3990	110	[illegible]	[illegible]	[illegible]	110	[illegible]	[illegible]	118
35	110	5800	110	4430	110	[illegible]	[illegible]	3620	[illegible]	3240	110	118
40	110	6440	110	4900	110	[illegible]	[illegible]	4000	[illegible]	3580	110	118
45	110	7150	110	5430	[illegible]	4910	110	[illegible]	[illegible]	3960	110	118
50	110	8040	110	6090	[illegible]	5500	[illegible]	[illegible]	[illegible]	4410	110	118
54	111	8940	111	[illegible]	[illegible]	[illegible]	111	[illegible]	111	4870	111	118

WEIGHT = [illegible] LBS VENR = 150 KIAS

TEMP DEG C	TAILWIND 10 KTS V1 KIAS	TAILWIND 10 KTS DIST FT	ZERO WIND V1 KIAS	ZERO WIND DIST FT	HEADWINDS 10 KTS V1 KIAS	HEADWINDS 10 KTS DIST FT	HEADWINDS 20 KTS V1 KIAS	HEADWINDS 20 KTS DIST FT	HEADWINDS 30 KTS V1 KIAS	HEADWINDS 30 KTS DIST FT	VR KIAS	V2 KIAS
-25	[illegible]	3130	106	2400	105	2190	105	2000	104	1810	107	116
-20	[illegible]	[illegible]	106	2450	105	2240	105	2040	104	1850	107	116
[illegible]	[illegible]	3220	106	2490	105	2280	105	2080	104	1880	107	116
[illegible]	[illegible]	3280	106	2540	105	2320	105	2120	104	1920	107	116
[illegible]	[illegible]	3340	106	2580	105	2360	105	2160	104	1960	107	116
0	107	3400	106	2620	105	2400	104	2200	104	2000	107	116
5	106	3480	106	2680	105	2450	105	2240	104	2040	107	116
10	106	3590	106	2760	105	2530	105	2320	104	2110	107	116
15	107	3720	106	2850	106	2610	105	2390	105	2180	107	116
20	107	3990	108	3040	107	2790	106	2550	106	2330	108	116
25	108	4340	108	3310	108	3000	107	2730	107	2490	108	116
30	108	4760	108	3630	108	3290	108	2970	108	2680	108	116
35	108	5270	108	4020	108	3640	108	3280	108	2940	108	116
40	108	5830	108	4430	108	4010	108	3610	108	3240	108	116
45	108	6440	108	4890	108	4420	108	3980	108	3560	108	116
50	108	7190	108	5450	108	4920	108	4420	108	3950	108	116
54	108	7940	108	6000	108	5410	108	4860	108	4330	108	116

WEIGHT = [illegible] LBS VENR = 150 KIAS

TEMP DEG C	TAILWIND 10 KTS V1 KIAS	TAILWIND 10 KTS DIST FT	ZERO WIND V1 KIAS	ZERO WIND DIST FT	HEADWINDS 10 KTS V1 KIAS	HEADWINDS 10 KTS DIST FT	HEADWINDS 20 KTS V1 KIAS	HEADWINDS 20 KTS DIST FT	HEADWINDS 30 KTS V1 KIAS	HEADWINDS 30 KTS DIST FT	VR KIAS	V2 KIAS
-25	105	2870	103	2220	102	2030	102	1840	101	1670	105	113
-20	105	2920	103	2270	102	2070	102	1880	101	1700	105	113
-15	105	2970	103	2310	102	2110	102	1920	101	1740	105	113
-10	104	3010	103	2350	102	2150	101	1950	101	1770	105	113
-5	104	3060	103	2390	102	2180	101	1990	101	1810	105	113
0	104	3100	103	2430	102	2220	101	2030	101	1840	105	113
5	104	3170	103	2480	102	2270	101	2070	101	1880	105	113
10	104	3280	103	2550	102	2340	102	2140	101	1950	105	114
15	105	3390	103	2630	103	2410	102	2210	102	2010	105	114
20	105	3640	104	2810	104	2570	103	2350	103	2140	105	114
25	105	3960	105	3010	105	2750	104	2520	104	2290	105	114
30	106	4330	106	3300	106	2990	105	2700	105	2460	106	114
35	106	4780	106	3640	106	3290	106	2960	106	2650	106	114
40	106	5270	106	4000	106	3620	106	3260	106	2920	106	114
45	106	5800	106	4400	106	3970	106	3570	106	3200	106	114
50	106	6440	106	4870	106	4400	106	3960	106	3530	106	114
54	106	7070	106	5340	106	4820	106	4330	106	3860	106	114

WEIGHT = 11500 LBS VENR = 149 KIAS

TEMP DEG C	TAILWIND 10 KTS V1 KIAS	TAILWIND 10 KTS DIST FT	ZERO WIND V1 KIAS	ZERO WIND DIST FT	HEADWINDS 10 KTS V1 KIAS	HEADWINDS 10 KTS DIST FT	HEADWINDS 20 KTS V1 KIAS	HEADWINDS 20 KTS DIST FT	HEADWINDS 30 KTS V1 KIAS	HEADWINDS 30 KTS DIST FT	VR KIAS	V2 KIAS
-25	101	2660	99	2050	99	1870	98	1700	98	1530	103	111
-20	101	2700	99	2090	99	1910	98	1730	98	1560	103	111
-15	101	2750	99	2130	99	1940	98	1770	98	1600	103	111
-10	101	2790	99	2170	99	1980	98	1800	98	1630	103	111
-5	101	2830	99	2200	99	2010	98	1830	98	1660	103	111
0	101	2870	99	2240	99	2050	98	1870	98	1690	103	111
5	101	2930	99	2290	99	2090	98	1910	98	1730	103	111
10	101	3010	100	2360	99	2160	99	1970	98	1790	103	111
15	102	3100	100	2430	100	2220	99	2030	98	1840	103	111
20	103	3320	101	2580	101	2370	100	2160	100	1970	103	111
25	103	3600	102	2760	102	2530	101	2310	101	2100	103	111
30	103	3930	103	2990	103	2710	102	2480	102	2250	103	111
35	103	4330	103	3290	103	2970	103	2670	103	2430	103	111
40	103	4750	103	3600	103	3260	103	2930	103	2620	103	111
45	104	5210	104	3950	104	3560	104	3200	104	2860	104	111
50	104	5760	104	4360	104	3930	104	3530	104	3160	104	111
54	104	6300	104	4750	104	4290	104	3850	104	3430	104	111

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SINGLE ENGINE TAKEOFF FLIGHT PATH DISTANCES

FLAPS - 0°
SEA LEVEL

CONDITIONS: REFER TO FIGURE 4-18

WT LBS	TEMP DEG C	TAILWIND 10 KTS			ZERO WIND			HEADWIND 10 KTS			HEADWIND 20 KTS			HEADWIND 30 KTS		
		F&S FT	THIRD FT	FINAL FT	F&S FT	THIRD FT	FINAL FT	F&S FT	THIRD FT	FINAL FT	F&S FT	THIRD FT	FINAL FT	F&S FT	THIRD FT	FINAL FT
14100	5	6182	12346	35211	5401	10246	30603	5146	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4644	8344	26294
	10	6413	12933	37774	5607	10740	32840	5343	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4825	8752	28229
	15	6663	13570	41402	5828	11273	35994	5556	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5020	9194	30951
	20	7461	15296	48013	6521	[illegible]	41665	6215	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5614	10354	35775
	25	8478	17488	56986	7399	14502	49304	7049	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6363	11815	42227
	30	9767	20266	69098	8506	16776	59508	8099	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7303	13649	50762
	35	11508	23996	87949	9988	19809	75135	9500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8551	16079	63640
	40	13756	28789	118604	11882	23671	99847	11285	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19148	83513
13500	5	5623	11481	32216	4907	9499	27983	4672	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7704	24019
	10	5821	12005	34423	5083	9938	29911	4842	9294	28474	4603	8670	[illegible]	[illegible]	8068	25693
	15	6035	12571	37512	5273	10412	32606	5024	9739	31044	4777	9088	[illegible]	[illegible]	8459	28024
	20	6713	14080	43078	5862	11658	37397	5585	10904	35592	5311	10175	[illegible]	5039	9471	32111
	25	7564	15969	50453	6599	13212	43705	6285	12355	41570	5975	11528	[illegible]	5669	10730	37462
	30	8630	18338	60101	7517	15153	51891	7156	14164	49305	6801	13212	[illegible]	6450	12295	44352
	35	10036	21449	74393	8721	17688	63873	8296	16524	60587	7879	15405	[illegible]	7468	14328	54327
	40	11777	25302	95813	10198	20805	81496	9692	19420	77084	9195	[illegible]	72839	8708	16813	68753
	45	14022	30237	135813	12082	24764	113223	11465	23087	106456	10862	[illegible]	100028	10272	19943	93916
13000	5	5198	10814	29953	4530	8921	25997	4311	8330	24734	[illegible]	[illegible]	[illegible]	3879	7208	22291
	10	5373	11290	31907	4686	9321	27709	4461	8706	26369	[illegible]	[illegible]	[illegible]	4017	7539	23779
	15	5561	11804	34624	4853	9751	30084	4621	9110	28637	[illegible]	8492	[illegible]	4164	7893	25838
	20	6156	13162	39485	5370	10870	34276	5114	10156	[illegible]	[illegible]	[illegible]	[illegible]	4609	8802	29422
	25	6893	14838	45809	6010	12249	39703	5722	11444	[illegible]	5437	[illegible]	[illegible]	5156	9917	34038
	30	7810	16926	53909	6801	13960	46607	6473	13039	[illegible]	6149	[illegible]	42055	5830	11296	39873
	35	9000	19628	65525	7823	16163	56414	7442	15091	[illegible]	[illegible]	[illegible]	50780	6696	13063	48088
	40	10431	22884	82062	9043	18803	70182	8596	[illegible]	[illegible]	[illegible]	[illegible]	62925	7724	15171	59479
	45	12203	26917	110222	10541	22052	93047	10010	[illegible]	[illegible]	[illegible]	19123	82791	8977	17748	77983
	50	14725	32571	171879	12644	26559	140319	11984	[illegible]	[illegible]	[illegible]	22966	122523	10712	21288	114429
12500	5	4806	10186	27866	4182	8378	24164	3977	[illegible]	[illegible]	[illegible]	7268	21825	3573	6742	20694
	10	4960	10622	29606	4320	8743	25690	[illegible]	[illegible]	[illegible]	3901	7590	23218	3695	7043	22022
	15	5126	11091	32007	4467	9134	27793	4251	[illegible]	[illegible]	4037	7935	25134	3825	7366	23849
	20	5649	12312	36272	4922	10140	31476	[illegible]	[illegible]	[illegible]	4449	8811	28460	4216	8181	27003
	25	6291	13807	41738	5479	11369	36180	[illegible]	[illegible]	[illegible]	4952	9879	32693	4693	9174	31013
	30	7083	15655	48612	6164	12882	[illegible]	[illegible]	[illegible]	[illegible]	5569	11191	37984	5277	10392	35997
	35	8100	18021	58212	7039	14812	[illegible]	[illegible]	[illegible]	47687	6354	12859	45237	6019	11938	42856
	40	9290	20806	71329	8057	17073	[illegible]	7658	[illegible]	58069	7266	14811	55010	6880	13745	52047
	45	10716	24154	92181	9269	[illegible]	[illegible]	[illegible]	18429	74192	8347	17135	70107	7898	15893	66172
	50	12668	28695	132022	10913	[illegible]	[illegible]	[illegible]	21798	103548	9803	20247	97299	9265	18763	91355
12000	5	4443	9595	25869	3859	[illegible]	[illegible]	[illegible]	7325	21291	3477	6804	20207	3289	6302	19148
	10	4579	9992	27405	3981	[illegible]	[illegible]	[illegible]	7638	22581	3590	7097	21439	3397	6576	20323
	15	4725	10420	29516	[illegible]	[illegible]	[illegible]	[illegible]	7973	24350	3710	7411	23127	3512	6870	21933
	20	5186	11522	33247	[illegible]	9462	[illegible]	4292	8820	27419	4074	8201	26043	3857	7603	24698
	25	5747	12860	37961	[illegible]	10559	[illegible]	4755	9844	31276	4513	9154	29702	4273	8488	28165
	30	6435	14505	[illegible]	[illegible]	[illegible]	[illegible]	5321	11098	36012	5050	10320	34187	4782	9571	32410
	35	7309	16588	[illegible]	6347	[illegible]	[illegible]	6035	12679	42412	5726	11788	40238	5421	10930	38122
	40	8308	18987	[illegible]	7204	[illegible]	53484	6847	14490	50755	6494	13468	48107	6146	12486	45536
	45	9471	21798	[illegible]	8197	[illegible]	66566	7786	16602	63059	7381	15425	59668	6983	14295	56390
	50	11019	[illegible]	[illegible]	9509	20816	88571	9024	19372	83597	8548	17987	78828	8080	16658	74251
	54	12907	29996	155528	11091	24387	127863	10512	22672	119724	9946	21031	112052	9391	19460	104809
11500	5	4105	9035	24081	3559	7380	20825	3380	6865	19787	3201	6366	18769	3025	5886	17775
	10	4226	9401	25458	3667	7685	22035	3484	7151	20943	3301	6634	19873	3121	6138	18830
	15	4355	9791	27335	3782	8010	23683	3594	7455	22518	3408	6921	21379	3222	6404	20265
	20	4762	10788	30638	4137	8830	26544	3932	8220	25239	3728	7631	23962	3527	7065	22717
	25	5253	11989	34763	4563	9813	30102	4337	9137	28621	4113	8484	27172	3891	7856	25760
	30	5854	13459	39793	5083	11015	34425	4831	10256	32722	4582	9525	31060	4335	8820	29439
	35	6608	15301	46516	5733	12515	40173	5448	11652	38167	5167	10821	36213	4888	10020	34309
	40	7453	17386	55130	6459	14208	47495	6137	13226	45091	5818	12280	42753	5503	11371	40481
	45	8412	19772	67506	7280	16140	57923	6914	15019	54924	6553	13942	52018	6197	12907	49201
	50	9660	22859	87461	8343	18627	74443	7918	17325	70417	7500	16075	66537	7089	14876	62797
	54	11141	26491	120541	9593	21535	100950	9096	20014	95029	8609	18557	89383	8130	17162	83995

Plot these values on the chart relative to Reference Zero which is the DER minus surplus runway.

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SECTION IV - PERFORMANCE
TAKEOFF

MODEL 550

FIRST SEGMENT TAKEOFF NET CLIMB GRADIENT - PERCENT

FLAPS - 0°

CONDITIONS: ANTI-ICE SYSTEMS - OFF *
LANDING GEAR - DOWN
AIRSPEED - V_2
SPEEDBRAKES - RETRACT
INOPERATIVE ENGINE - WINDMILLING
OPERATIVE ENGINE - TAKEOFF THRUST

As a final check, note that first segment climb is steep enough

ALT FT	TEMP DEG C	WEIGHT - POUNDS																																							
		14100					13500					13000					12500					11500					10500					9500					8500				
		WIND KNOTS					WIND KNOTS					WIND KNOTS					WIND KNOTS					WIND KNOTS					WIND KNOTS					WIND KNOTS					WIND KNOTS				
		-10	0	10	20	30	-10	0	10	20	30	-10	0	10	20	30	-10	0	10	20	30	-10	0	10	20	30	-10	0	10	20	30	-10	0	10	20	30	-10	0	10	20	30
0	-25	4	5	5	6	6	5	6	6	6	7	5	6	7	7	8	6	7	7	8	8	7	9	9	10	10	9	11	11	12	13	11	13	14	15	16	13	16	17	18	19
	-20	4	5	5	6	6	5	6	6	6	7	5	6	7	7	8	6	7	7	8	8	7	9	9	10	10	9	11	11	12	13	11	13	14	15	16	13	16	17	18	19
	-15	4	5	5	6	6	5	6	6	6	7	5	6	7	7	8	6	7	7	8	8	7	9	9	10	10	9	11	11	12	13	11	13	14	15	16	13	16	17	18	19
	-10	4	5	5	6	6	5	6	6	6	7	5	6	7	7	8	6	7	7	8	8	7	9	9	10	10	9	11	11	12	13	11	13	14	14	15	13	16	17	18	19
	-5	4	5	5	6	6	5	6	6	6	7	5	6	7	7	8	6	7	7	8	8	7	9	9	10	10	9	11	11	12	13	11	13	14	14	15	13	16	17	18	19
	0	4	5	5	6	6	5	6	6	6	7	5	6	7	7	8	6	7	7	8	8	7	9	9	10	10	9	11	11	12	13	11	13	14	14	15	13	16	17	18	19
	5	4	5	5	6	6	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	7	7	8	8	7	9	9	10	10	9	10	11	12	12	11	13	14	14	15	13	16	17	18	19
	10	4	5	5	5	6	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	7	7	8	8	7	8	9	9	10	9	10	11	11	12	11	12	13	14	15	13	15	16	17	18
	15	4	4	5	5	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	6	7	7	8	7	8	8	9	9	8	10	10	11	12	10	[illegible]	[illegible]	[illegible]	14	13	15	16	17	18
	20	3	4	4	4	5	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	6	6	6	7	6	7	8	8	8	8	9	9	10	11	9	11	[illegible]	12	[illegible]	12	14	15	15	17
	25	3	3	3	3	4	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4	5	5	5	6	5	6	7	7	7	7	8	8	9	9	[illegible]	[illegible]	[illegible]	11	12	11	12	13	14	15
	30	2	2	3	3	3	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3	4	4	5	5	5	5	6	6	6	6	7	7	8	8	[illegible]	9	[illegible]	10	11	10	11	12	13	14
	35	1	2	2	2	2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3	3	4	4	4	4	5	5	5	5	5	6	6	7	[illegible]	[illegible]	[illegible]	8	9	9	9	10	11	11	12
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	50	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	4	[illegible]	[illegible]	5	4	5	6	6	6	6	7	8	8	9
	54	-1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	3	[illegible]	[illegible]	[illegible]	4	4	[illegible]	5	5	6	5	6	7	7	8
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	15	3	4	4	4	5	4	5	5	5	5	4	5	5	6	6	5	6	6	6	7	[illegible]	[illegible]	8	8	9	[illegible]	9	10	10	11	10	11	12	13	13	12	14	15	16	17
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	25	2	3	3	3	3	3	3	3	4	4	3	4	4	4	4	4	4	[illegible]	[illegible]	[illegible]	5	6	6	[illegible]	[illegible]	6	7	8	8	9	8	9	10	10	11	10	12	12	13	14
	30	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	3	4	[illegible]	[illegible]	[illegible]	4	5	[illegible]	[illegible]	[illegible]	5	6	7	7	8	7	8	9	9	10	9	10	11	12	13
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	50	0	0	0	0	0	0	0	0	0	0	0	1	1	[illegible]	[illegible]	[illegible]	[illegible]	1	1	[illegible]	[illegible]	[illegible]	2	2	2	3	3	3	4	4	4	5	5	5	6	6	7	7	7	8
	52	-1	-1	-1	-1	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	0	1	1	1	1	[illegible]	2	2	2	2	2	3	3	3	4	4	4	5	5	5	5	6	7	7	7
2000	-25	4	5	5	6	6	5	6	6	6	7	5	6	[illegible]	7	[illegible]	6	7	7	8	8	7	9	9	10	10	9	10	11	12	13	11	13	14	14	15	13	16	17	18	19
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	-15	4	5	5	6	6	5	6	6	6	7	5	[illegible]	[illegible]	7	7	[illegible]	[illegible]	7	8	8	7	9	9	10	10	9	10	11	12	13	11	13	14	14	15	13	16	17	18	19
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	-5	4	5	5	6	6	5	6	6	6	[illegible]	[illegible]	[illegible]	7	7	7	6	[illegible]	7	8	8	7	9	9	10	10	9	10	11	12	12	11	13	14	14	15	13	16	17	18	19
	0	4	5	5	6	6	5	6	6	[illegible]	[illegible]	[illegible]	6	7	7	[illegible]	6	7	7	8	8	7	9	9	10	10	9	10	11	12	12	11	13	13	14	15	13	16	17	18	19
	5	4	4	5	5	5	4	5	5	[illegible]	6	5	6	6	[illegible]	[illegible]	[illegible]	6	7	7	8	7	8	8	9	9	8	10	10	11	12	10	12	13	13	14	13	15	16	17	18
	10	3	4	4	4	5	4	5	5	5	[illegible]	4	[illegible]	5	6	[illegible]	5	6	6	7	7	6	7	8	8	9	8	9	10	10	11	10	11	12	13	13	12	14	15	16	17
	15	3	3	4	4	4	3	[illegible]	4	4	5	4	5	[illegible]	[illegible]	5	4	5	5	6	6	6	7	7	7	8	7	8	9	9	10	9	10	11	12	12	11	13	14	15	16
	20	2	3	3	3	3	[illegible]	[illegible]	[illegible]	4	4	[illegible]	[illegible]	[illegible]	4	5	4	4	5	5	5	5	6	6	7	7	6	7	8	8	9	8	9	10	11	11	10	12	13	13	14
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* FOR ANTI-ICE SYSTEMS ON, SUBTRACT 3 FROM ABOVE CLIMB GRADIENTS.

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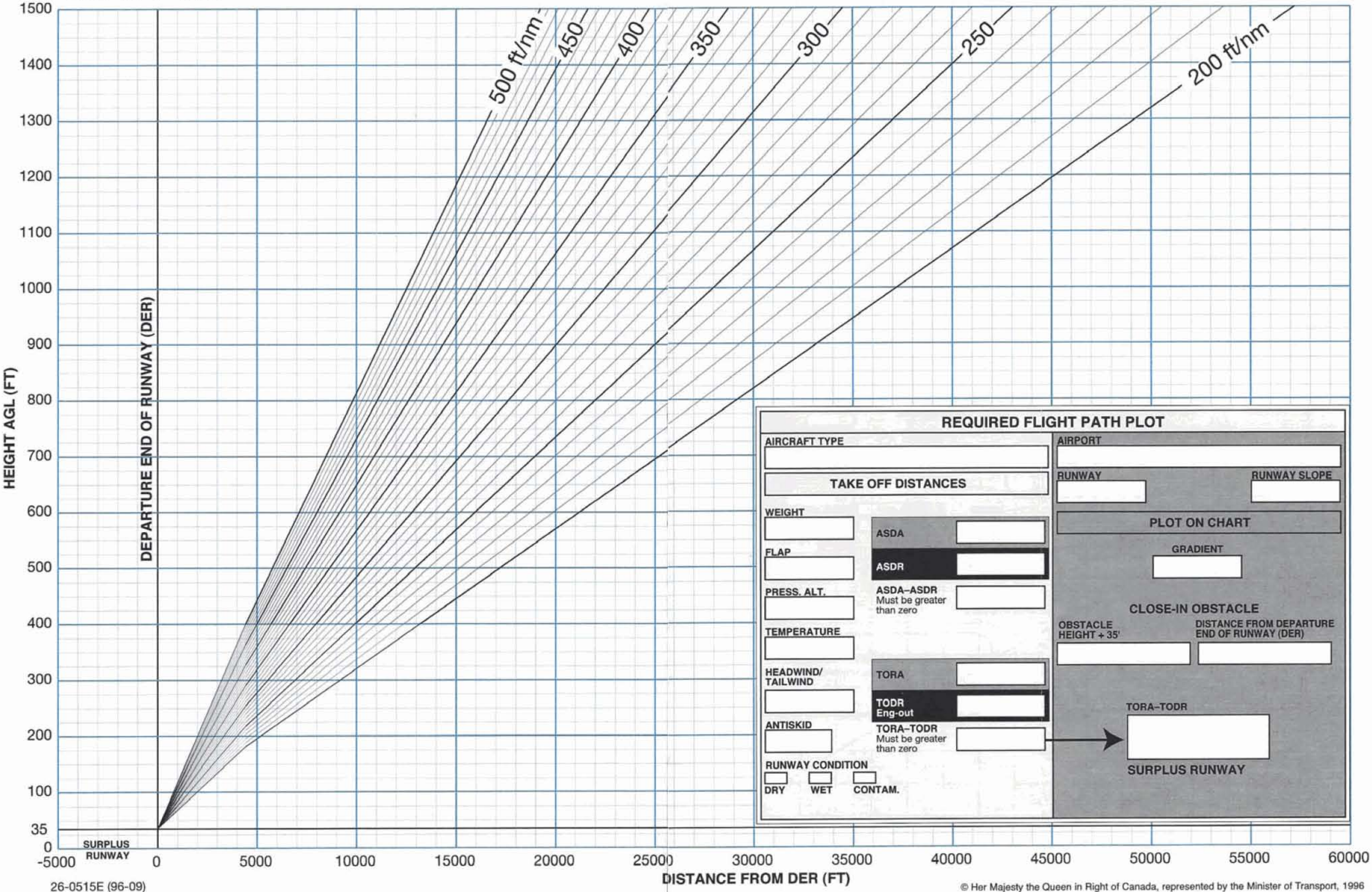
Transport Canada Transports Canada

Takeoff Planning Worksheet: Aircraft Certifiied for Engine-out Performance

Canada



REQUIRED FLIGHT PATH PLOT

AIRCRAFT TYPE

TAKE OFF DISTANCES

WEIGHT

FLAP

PRESS. ALT.

TEMPERATURE

HEADWIND/ TAILWIND

ANTISKID

RUNWAY CONDITION

☐ DRY ☐ WET ☐ CONTAM.

ASDA

ASDR

ASDA–ASDR Must be greater than zero

TORA

TODR Eng-out

TORA–TODR Must be greater than zero

AIRPORT

RUNWAY

RUNWAY SLOPE

PLOT ON CHART

GRADIENT

CLOSE-IN OBSTACLE

OBSTACLE HEIGHT + 35'

DISTANCE FROM DEPARTURE END OF RUNWAY (DER)

TORA–TODR

SURPLUS RUNWAY

26-0515E (96-09)

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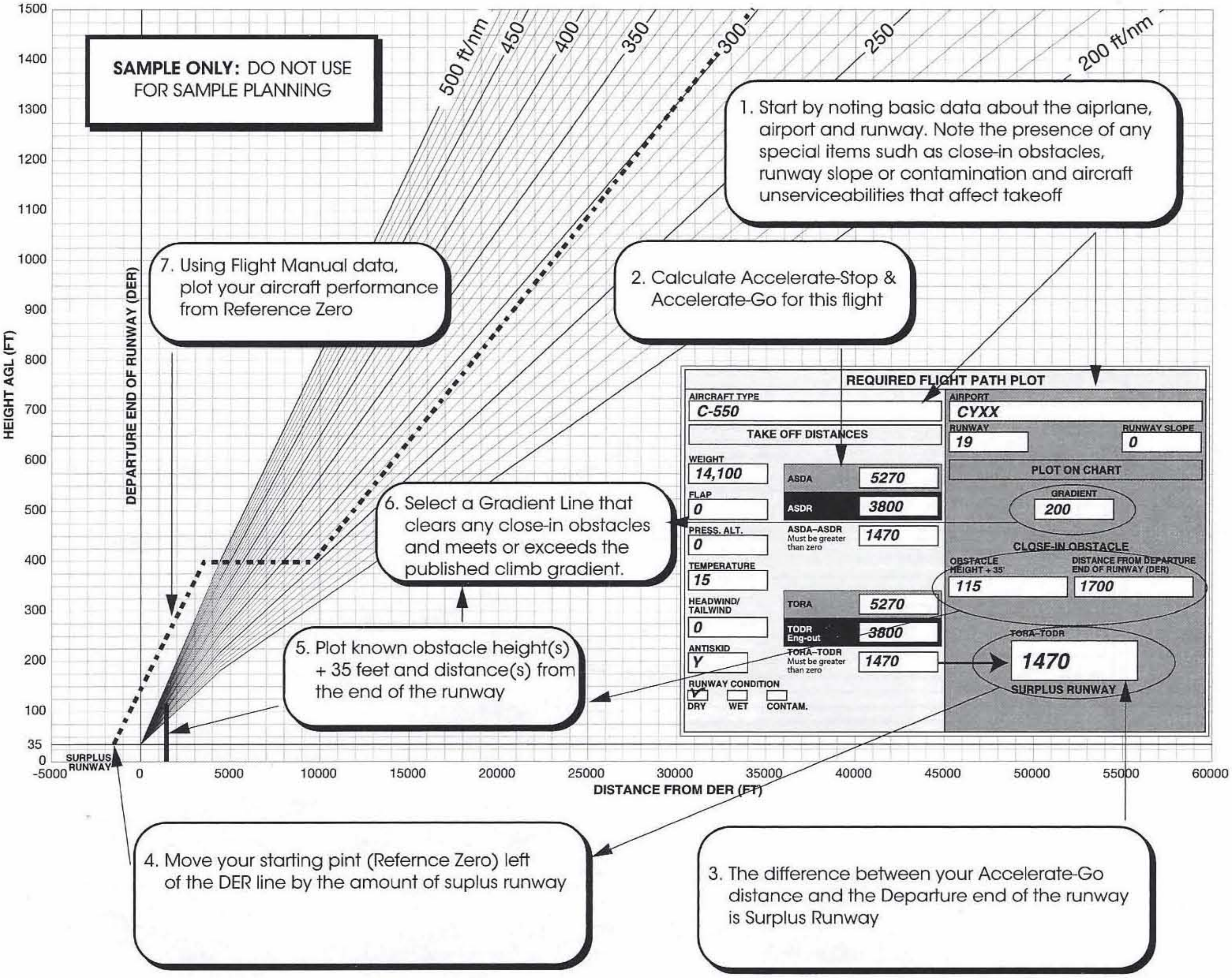
TAKE OFF PLANNING



SAMPLE ONLY: DO NOT USE FOR SAMPLE PLANNING

1. Start by noting basic data about the aiprlane, airport and runway. Note the presence of any special items sudh as close-in obstacles, runway slope or contamination and aircraft unserviceabilities that affect takeoff

2. Calculate Accelerate-Stop & Accelerate-Go for this flight

3. The difference between your Accelerate-Go distance and the Departure end of the runway is Surplus Runway

4. Move your starting pint (Refernce Zero) left of the DER line by the amount of suplus runway

5. Plot known obstacle height(s) + 35 feet and distance(s) from the end of the runway

6. Select a Gradient Line that clears any close-in obstacles and meets or exceeds the published climb gradient.

7. Using Flight Manual data, plot your aircraft performance from Reference Zero

REQUIRED FLIGHT PATH PLOT

AIRCRAFT TYPE: C-550

TAKE OFF DISTANCES

WEIGHT: 14,100

FLAP: 0

PRESS. ALT.: 0

TEMPERATURE: 15

HEADWIND/ TAILWIND: 0

ANTISKID: Y

ASDA: 5270

ASDR: 3800

ASDA–ASDR Must be greater than zero: 1470

TORA: 5270

TODR Eng-out: 3800

TORA–TODR Must be greater than zero: 1470

RUNWAY CONDITION: ☑ DRY ☐ WET ☐ CONTAM.

AIRPORT: CYXX

RUNWAY: 19

RUNWAY SLOPE: 0

PLOT ON CHART

GRADIENT: 200

CLOSE-IN OBSTACLE

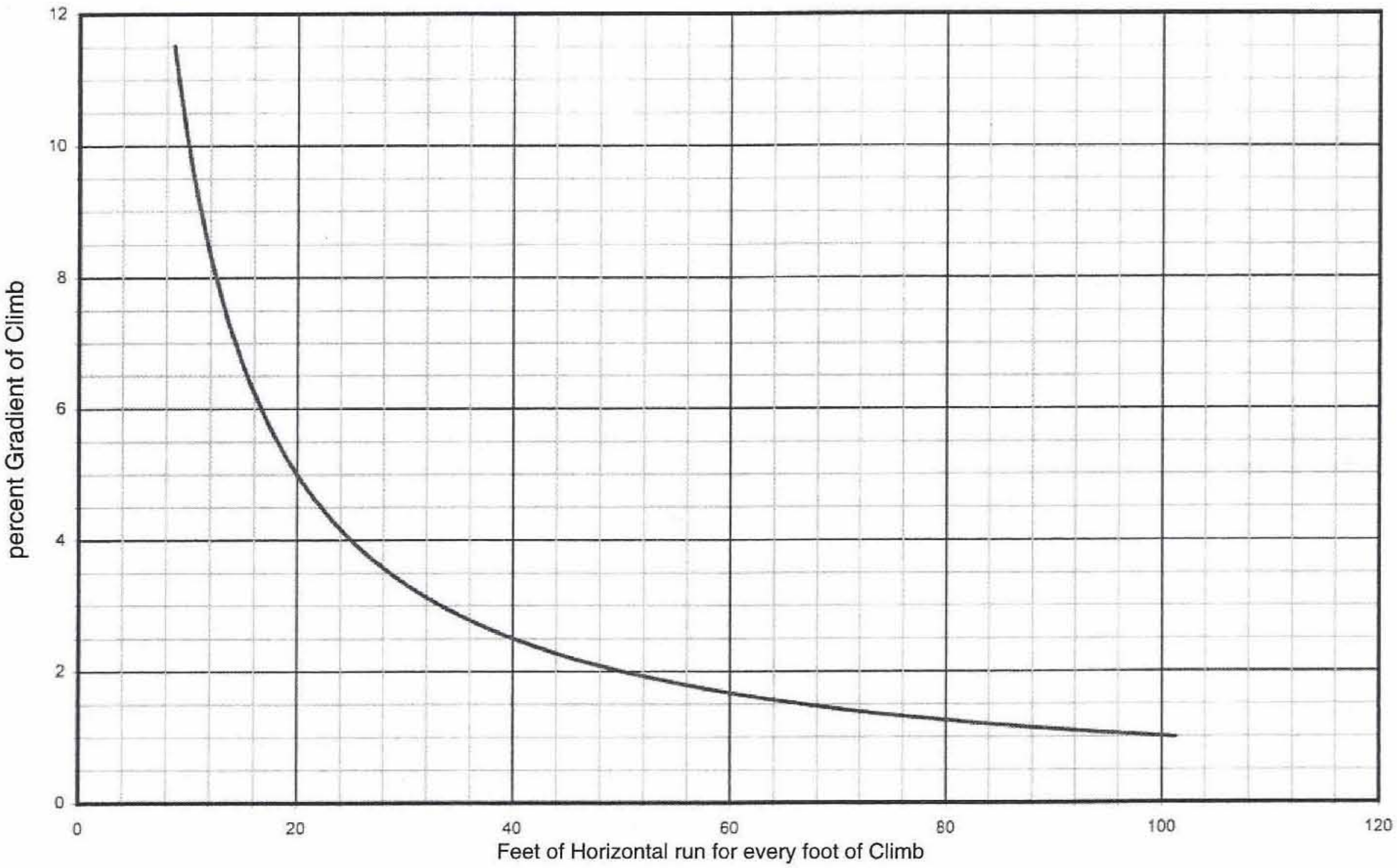
OBSTACLE HEIGHT + 35': 115

DISTANCE FROM DEPARTURE END OF RUNWAY (DER): 1700

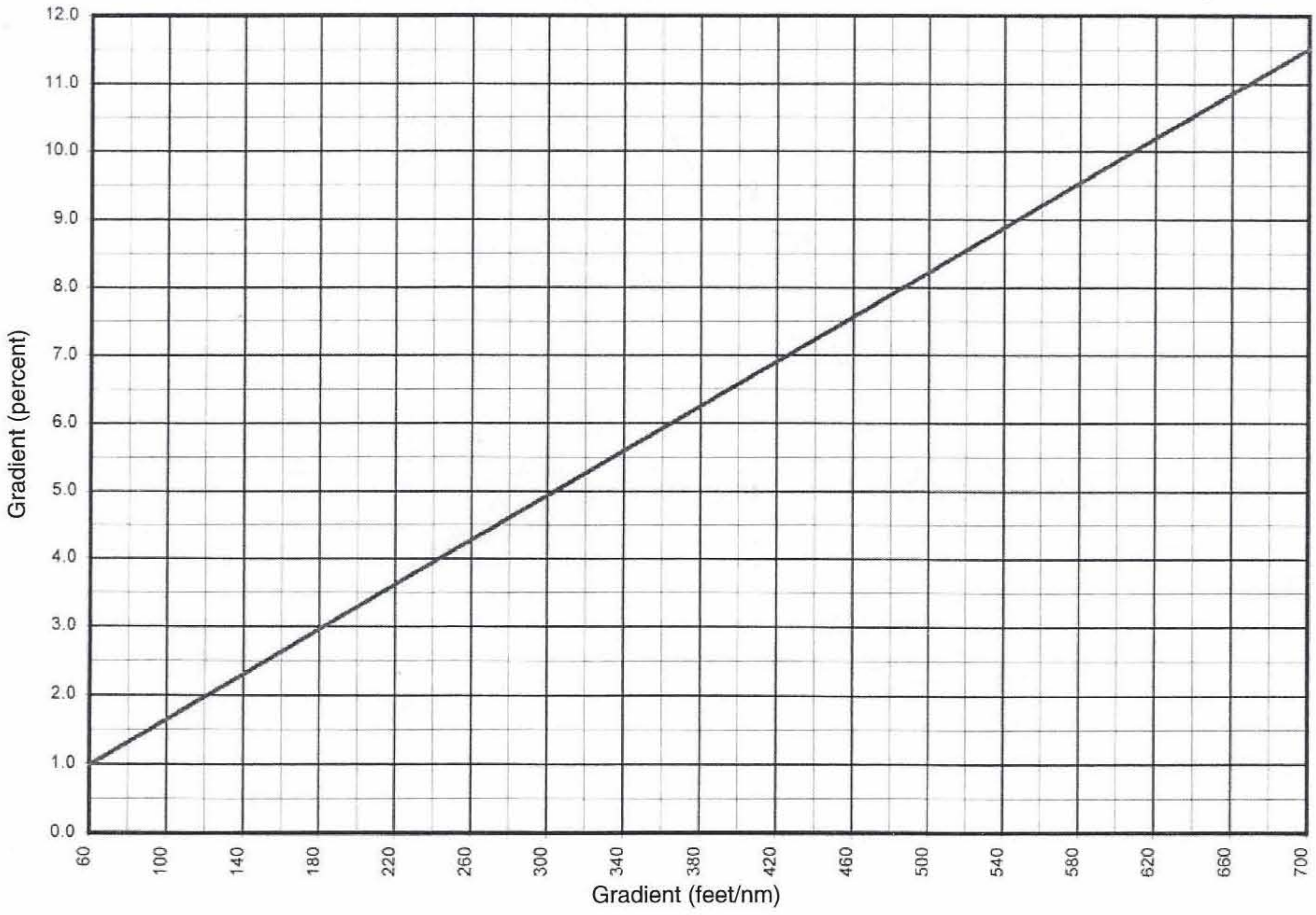
TORA–TODR: 1470

SURPLUS RUNWAY

Climb Gradient Conversion to Height and Distance



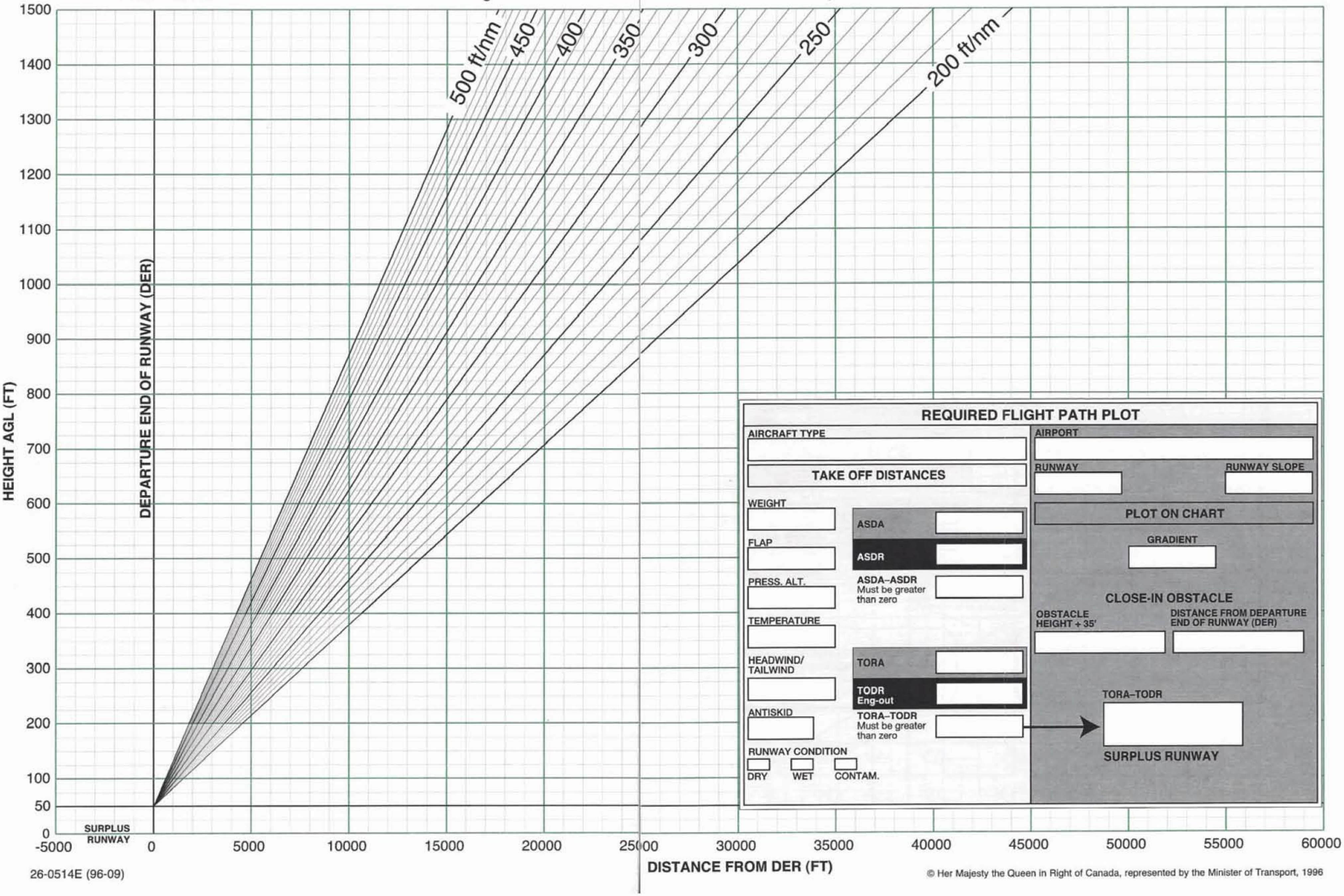
Gradient Conversion from Percent to Feet per Nautical Mile



Transport Canada Transports Canada

Takeoff Planning Worksheet: Aircraft NOT Certified for Engine-out Performance

Canada



REQUIRED FLIGHT PATH PLOT

AIRCRAFT TYPE ☐

TAKE OFF DISTANCES

WEIGHT ☐

FLAP ☐

PRESS. ALT. ☐

TEMPERATURE ☐

HEADWIND/TAILWIND ☐

ANTISKID ☐

RUNWAY CONDITION

☐ DRY ☐ WET ☐ CONTAM.

ASDA ☐

ASDR ☐

ASDA–ASDR Must be greater than zero ☐

TORA ☐

TODR Eng-out ☐

TORA–TODR Must be greater than zero ☐ →

AIRPORT ☐

RUNWAY ☐

RUNWAY SLOPE ☐

PLOT ON CHART

GRADIENT ☐

CLOSE-IN OBSTACLE

OBSTACLE HEIGHT + 35′ ☐

DISTANCE FROM DEPARTURE END OF RUNWAY (DER) ☐

TORA–TODR ☐

SURPLUS RUNWAY

26-0514E (96-09)

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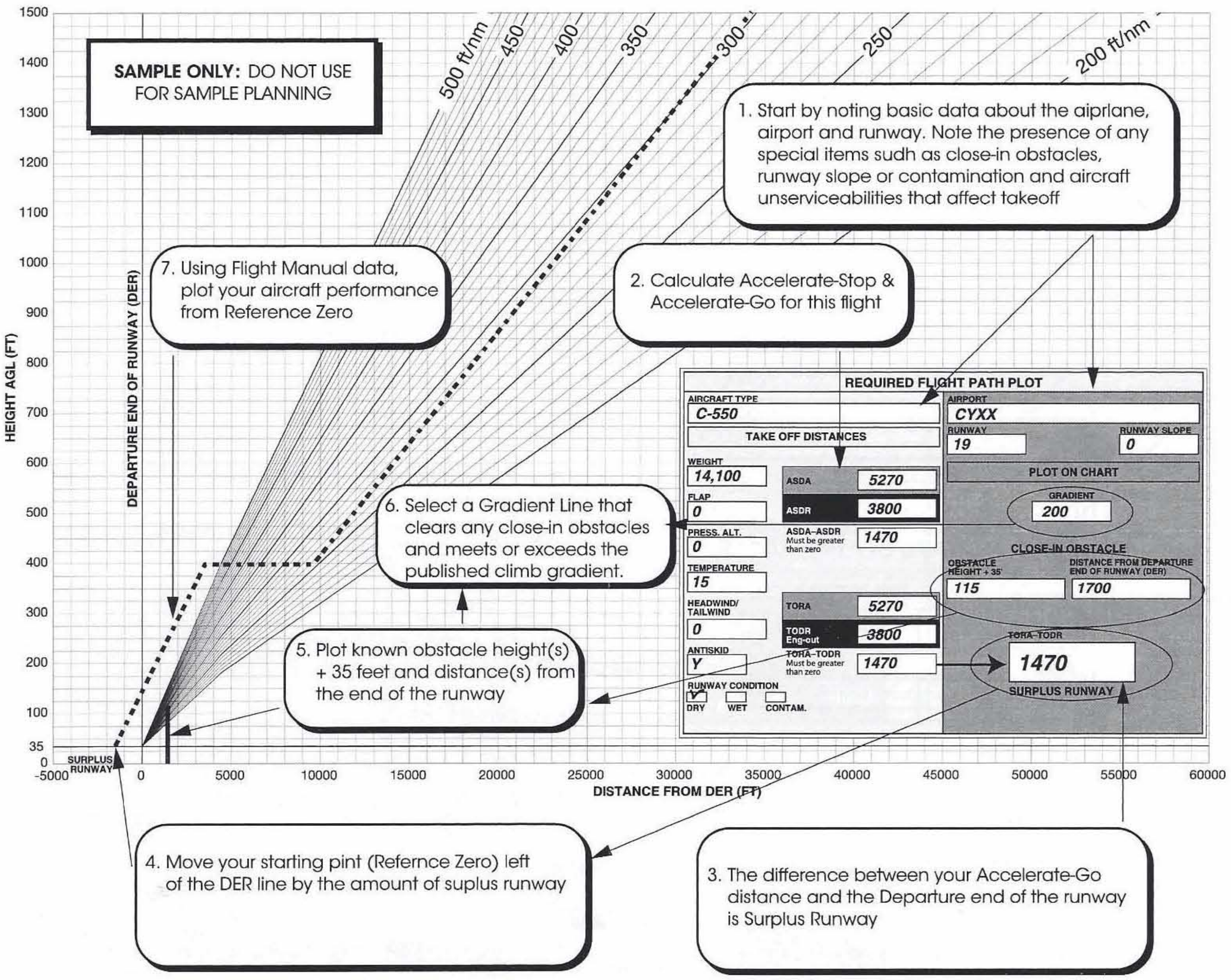
TAKE OFF PLANNING



SAMPLE ONLY: DO NOT USE FOR SAMPLE PLANNING

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6. Select a Gradient Line that clears any close-in obstacles and meets or exceeds the published climb gradient.

7. Using Flight Manual data, plot your aircraft performance from Reference Zero

REQUIRED FLIGHT PATH PLOT

AIRCRAFT TYPE: C-550

AIRPORT: CYXX

TAKE OFF DISTANCES

RUNWAY: 19

RUNWAY SLOPE: 0

WEIGHT: 14,100

ASDA: 5270

FLAP: 0

ASDR: 3800

PRESS. ALT.: 0

ASDA–ASDR Must be greater than zero: 1470

TEMPERATURE: 15

HEADWIND/ TAILWIND: 0

TORA: 5270

TODR Eng-out: 3800

ANTISKID: Y

TORA–TODR Must be greater than zero: 1470

RUNWAY CONDITION: ☑ DRY ☐ WET ☐ CONTAM.

PLOT ON CHART

GRADIENT: 200

CLOSE-IN OBSTACLE

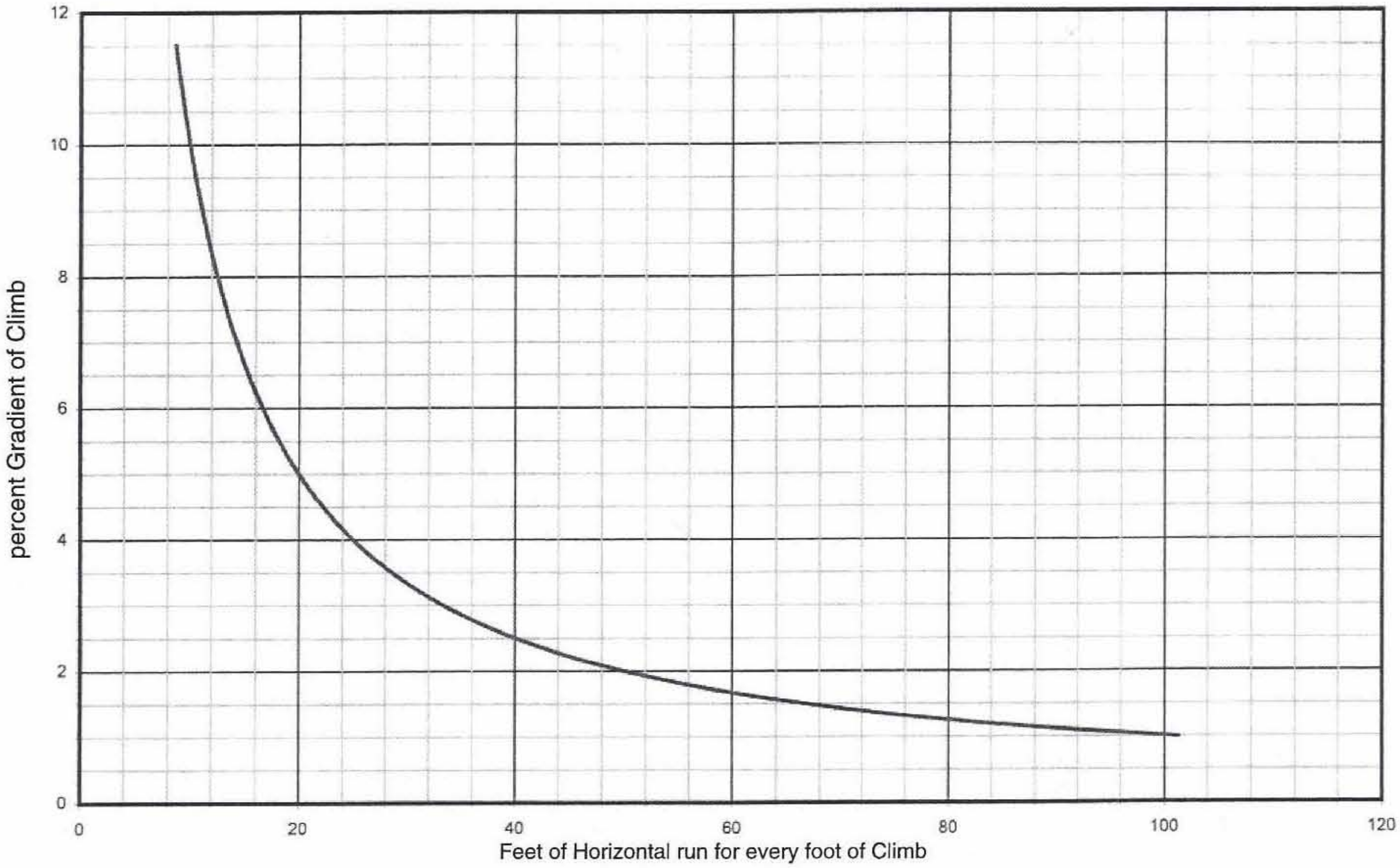
OBSTACLE HEIGHT + 35': 115

DISTANCE FROM DEPARTURE END OF RUNWAY (DER): 1700

TORA–TODR: 1470

SURPLUS RUNWAY

Climb Gradient Conversion to Height and Distance



Gradient Conversion from Percent to Feet per Nautical Mile