Advisory Circular

Subject: Airport Obstacle Analysis | **Date:** 5/5/06 | **AC No:** 120-91
Initiated by: AFS-400

1. PURPOSE. This advisory circular (AC) describes acceptable methods and guidelines for developing takeoff and initial climb-out airport obstacle analyses and in-flight procedures to comply with the intent of the regulatory requirements of Title 14 of the Code of Federal Regulations (14 CFR) part 121, §§ 121.177, 121.189, and part 135, §§ 135.367, 135.379, and 135.398 and other associated one-engine-inoperative requirements relating to turbine engine powered airplanes operated under parts 121 and 135. The methods and guidelines presented in this AC are neither mandatory nor the only acceptable methods for ensuring compliance with the regulatory sections. Operators may use other methods if those methods are shown to provide the necessary level of safety and are acceptable to the Federal Aviation Administration (FAA). This AC need not serve as the sole basis for determining whether an obstacle analysis program meets the intent of the regulations. However, the methods and guidelines described in this AC have been derived from extensive FAA and industry experience and are considered acceptable to the FAA when appropriately used. Mandatory words such as "shall" or "must" apply only to those who seek to demonstrate compliance to a specific rule by use of a method set out in this AC without deviation.

2. RELATED REGULATIONS AND DOCUMENTS.

a. Regulations.

- 14 CFR part 1, § 1.1
- Part 25, §§ 25.105, 25.107, 25.111, 25.113, and 25.115
- Part 33
- Part 77
- Part 91, § 91.167
- Part 121, §§ 121.97, 121.141, 121.173, 121.177, 121.189, 121.191, 121.443, 121.445
- Part 135, §§ 135.367, 135.379, 135.381, 135.398
- Part 152, § 152.11

b. Related References.

(1) Additional information on airport obstacle analysis may be found in the documents listed below. The documents are available from:

New Orders, Superintendent of Documents
U.S. Government Printing Office
P.O. Box 371954
Pittsburgh, PA 15250-7954

(a) AC 150/5300-13, Airport Design.

(b) Order 8260.3, United States Standard for Terminal Instrument Procedures (TERPS).

(c) Order 8260.38, Civil Utilization of Global Positioning System (GPS).

(d) Order 8260.40, Flight Management System (FMS) Instrument Procedures Development.

(e) Order 8400.10, Air Transportation Operations Inspector's Handbook.

(2) Current editions of the International Civil Aviation Organization (ICAO) documents below may be purchased from:

ICAO Document Sales Unit
999 University St.
Montreal, Quebec
Canada H3C 5H7

(a) ICAO Annex 4, Chapters 3, 4, and 5.

(b) ICAO Annex 6, part 1.

(3) Airport/Facility Directory (A/FD). This document may be purchased from:

NOAA/National Ocean Service Distribution Division, N/ACC3
6501 Lafayette Ave.
Riverdale, MD 20737-1199.

3. FOCUS.

a. This AC applies to operations conducted under part 121 and operations of large transport and commuter category airplanes conducted under part 135, with particular emphasis on transport category turbine and reciprocating engine powered airplanes which meet the certification regulations applicable since August 29, 1959 (SR422B). Airplanes meeting earlier performance requirements or other types of airplanes may use criteria and methods equivalent to those described by this AC, provided they properly account for the performance specified by the airplane flight manual (AFM). Other operators (e.g., part 91 turbojet operators) may use the information in this AC as applicable to that operator's needs and requirements, as long as the resulting operations are otherwise consistent with applicable regulations.

b. If an operator adopts the suggestions contained in this AC, the operator must, when appropriate, replace discretionary language such as "should" and "may" with mandatory language in relevant manuals, operations specifications (OpSpecs), or management specifications (MSpecs).

4. BACKGROUND. Sections 121.177, 121.189, 135.367, 135.379, and 135.398 specify required takeoff and performance operating limitations. These limitations include determination of the takeoff flightpath that meets specified obstacle clearance requirements (both vertical and horizontal) in the event of an engine failure. Sections 121.189, 135.379, and 135.398 specify AFM compliance, and part 25 provides requirements for establishing the AFM performance data. While the AFM provides detailed instructions for determining the vertical clearance, it offers little guidance on the lateral clearance requirements. This AC provides information for determining safe clearance from obstacles for the actual flightpath, and for considering factors that may cause a divergence of the actual flightpath from the intended flightpath. This AC also provides guidance and acceptable lateral criteria to assist an operator in developing takeoff procedures and allowable weights for operational use.

5. IMPLEMENTATION. The FAA recommends that operators develop a plan to implement the guidance in this AC with performance gates to organize and schedule implementation. Service to a new airport location or the development of new or revised airport obstacle data presents an opportunity for implementation. The FAA expects operators to use the best available data for airport obstacle analysis and to continually review and use improved data as it becomes available. Airports listed in the Special Pilot-In-Command (PIC) Qualification Airports list at (http://www.opspecs.com/ops/SpecialPICAirports/), because of critical terrain or obstacles, should be given the highest priority. The FAA strongly recommends that operators review or reanalyze airports on this list in accordance with the guidance in this AC within two years of the date this AC is issued.

6. SOURCES OF OBSTACLE DATA. Operators are expected to use the best and most accurate available obstacle data for a particular airport at the time of analysis. Data sources do not require specific FAA approval. Operators should be aware that an airport Obstruction Chart (OC), Type A chart, or any other single source may not include all the pertinent information necessary for doing a takeoff analysis.

7. TERPS CRITERIA VERSUS ONE-ENGINE-INOPERATIVE REQUIREMENTS.

a. Standard Instrument Departures (SID) or Departure Procedures (DP) based on TERPS or ICAO Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS) are based on normal (all engines operating) operations. Thus, one-engine-inoperative obstacle clearance requirements and the all-engines-operating TERPS requirements are independent, and one-engine-inoperative procedures do not need to meet TERPS requirements. Further, compliance with TERPS all-engines-operating climb gradient requirements does not necessarily assure that one-engine-inoperative obstacle clearance requirements are met. TERPS typically use specified all-engines-operating climb gradients to an altitude, rather than certificated one-engine-inoperative airplane performance. TERPS typically assume a climb gradient of 200 feet per nautical mile (NM) unless a greater gradient is specified. For the purposes of analyzing performance on procedures developed under TERPS or PANS-OPS, it is understood that any gradient requirement, specified or unspecified, will be treated as a plane which must not be penetrated from above until reaching the stated height, rather than as a gradient which must be exceeded at all points in the path. Operators must comply with 14 CFR requirements for the development of takeoff performance data and procedures. There are differences between TERPS and one-engine-inoperative criteria, including the lateral and vertical obstacle clearance requirements. An engine failure during takeoff is a non-normal condition, and therefore takes precedence over noise abatement, air traffic, SIDs, DPs, and other normal operating considerations.

b. In order for an operator to determine that a departure maintains the necessary obstacle clearance with an engine failure, the operator should consider that an engine failure may occur at any point on the departure flightpath.

(1) The most common procedure to maximize takeoff weight when significant obstacles are present along the normal departure route is to use a special one-engine-inoperative departure routing in the event of an engine failure on takeoff. If there is a separate one-engine-inoperative departure route, then the obstacles along this track are used to determine the maximum allowable takeoff weight for that runway.

(2) Consideration should be given to the possibility of an engine failure occurring after passing the point at which the one-engine-inoperative track diverges from the normal departure track. Judicious selection of this point would simplify the procedure and minimize the difficulty of this analysis. This is generally achieved by keeping the two tracks identical for as far as is practical.

(3) In some cases, two or more special one-engine-inoperative tracks may be required to accommodate all the potential engine failure scenarios.

(4) Analysis of an engine failure after takeoff may require the use of performance data in addition to that provided in the AFM. (Refer to paragraph 15a(1).)

c. When requested by the operators, the FAA may arrange a joint meeting with the operators and other interested parties for discussing all-engines-operating and one-engine-inoperative requirements at a particular problem airport. Interested parties should include representatives from the Regional Flight Standards Division (RFSD), the Regional Airspace Procedures Team (RAPT), certificate management office (CMO), local and regional Air Traffic Control specialists, Aviation System Standards, AJW-3 (Formerly AVN), and affected operators. The operators should bring to the initial meeting a specific departure proposal with alternatives that consider all-engines-operating and one-engine-inoperative requirements. The operators should attempt to agree on a standard one-engine-inoperative ground track and the FAA should make every effort to develop the SID and/or Instrument Flight Rules (IFR) departure procedure to match. The operators should understand that changes to the current SID or IFR departure may require a modification in takeoff weather minimums or variation in the length of the departure route. Because of the different performance characteristics of various airplanes and airline operational policy, this effort may not result in complete procedure standardization, but it is to the benefit of all parties that the number of unique procedures be minimized.

8. OBSTACLE CONSIDERATIONS.

a. Frangible structures fixed by function with an aeronautical purpose (such as antennas, approach lights, and signs) need not be considered in an obstacle analysis.

b. Operators shall take into account local temporary or transient obstacles such as ships, cranes, or trains. The clearance height allowances for vehicles above roads, railroads, etc., contained in part 77 and/or on the OC charts shall be used. If the operator has a means to determine the absence of a movable object at the time of takeoff, then it need not be accounted for in the analysis.

c. Operators should use reasonable judgment to account for the height of indeterminate objects (objects without recorded height) displayed on topographic maps. Indeterminate objects include such items as trees, buildings, flagpoles, chimneys, and transmission lines. The operator needs to use sound judgment in determining the best available data sources when conflicts occur between heights and locations of obstacles in the various sources.

d. If the operator cannot obtain adequate takeoff weights through the methods of analyses recommended by this AC or other acceptable methods, an obstacle removal program should be considered. Title 49 of the United States Code, Section 47107(a)(9) requires operators of obligated airports to take appropriate action to clear and protect terminal airspace required to protect instrument and visual operations to the airport (including operations at established minimum flight altitudes) by mitigating existing, and preventing future, airport hazards. One method of compliance is described in AC 150/5300-13, Airport Design, for obstacles within the airport's control. In general, these criteria provide for removal of obstacles that are not fixed by function nor required for airport operations safety, that are within the "Runway Object Free Area (OFA)" as defined in AC 150/5300-13. Operators should coordinate with the airport operator to determine whether it is feasible to have an obstacle removed.

e. Operators should establish an appropriate review cycle to periodically review the suitability of their performance data and procedures. In addition, operators should evaluate the effect of changes that occur outside of normal information or charting cycles. These changes may occur as a result of issuance of an operationally significant Notice to Airmen (NOTAM), temporary obstacle information, new construction, Automatic Terminal Information System (ATIS), procedural constraints, navigational aid (NAVAID) outages, etc. For both periodic reviews and temporary changes, the operator should consider at least the following:

(1) The need for an immediate change versus a routine periodic update.

(2) Use of the best available information.

(3) Any significant vulnerability that may result from the continued use of data other than the most current data, until performance and/or procedures are updated through a routine revision cycle.

(4) Continued suitability of estimates or assumptions used for winds, temperatures, climb gradients, NAVAID performance, or other such factors that may affect airplane performance or the airplane's flightpath.

(5) The review cycles and response times should be keyed to the needs and characteristics of the operator's fleet, routes, airports, and operating environment. No specific time frame is established for an operator to conduct either periodic reviews or short-term temporary adjustments.

9. TERMINATION OF TAKEOFF SEGMENT.

a. For the purpose of the takeoff obstacle clearance analysis, the end of the takeoff flightpath is considered to occur when:

(1) The airplane has reached the minimum crossing altitude (MCA) at a fix or the minimum en route altitude (MEA) for a route to the intended destination;

(2) The airplane is able to comply with en route obstacle clearance requirements (§§ 121.191, 121.193, 135.381, and 135.383); or

(3) The airplane has reached the minimum vectoring altitude, or a fix and altitude from which an approach may be initiated, if the operator's emergency procedure calls for an immediate return to the departure airport or a diversion to the departure alternate in the event of an engine failure during takeoff.

b. When determining the limiting takeoff weight, the obstacle analysis should be carried out to the end of the takeoff segment as defined in paragraph 9a above. Operators should note that the end of the takeoff segment is determined by the airplane's gross flightpath, but the obstacle analyses must use the net flightpath data.

c. In the event that the airplane cannot return to and land at the departure airport, the takeoff flightpath should join a suitable en route path to the planned destination or to another suitable airport. It may be necessary to address extended times and alternate fuel requirements when climbing in a holding pattern with reduced climb gradients associated with one-engine-inoperative turns.

10. METHODS OF ANALYSIS. Sections 121.189, 135.379, and 135.398 require that the net takeoff flightpath clears all obstacles by either 35 feet vertically or 200 feet laterally inside the airport boundary, or 300 feet laterally outside the airport boundary. To operate at the required lateral clearance, the operator must account for factors that could cause a difference between the intended and actual flightpaths and between their corresponding ground tracks. For example, it cannot be assumed that the ground track coincides with the extended runway centerline without considering such factors as wind and available course guidance (reference paragraph 14). This AC will focus on two methods that may be used to identify and ensure clearance of critical obstacles: the Area Analysis Method and Flight Track Analysis Method. The two methods may be used in conjunction with each other on successive portions of the analysis. For example, an operator may choose to use an area analysis for the initial portion of the takeoff analysis, followed by a flight track analysis, and then another area analysis.

a. The Area Analysis Method defines an obstacle accountability area (OAA) within which all obstacles must be cleared vertically. The OAA is centered on the intended flight track and is acceptable for use without accounting for factors that may affect the actual flight track relative to the intended track, such as wind and available course guidance.

b. The Flight Track Analysis Method is an alternative means of defining an OAA based on the navigational capabilities of the aircraft. This methodology requires the operator to evaluate the effect of wind and available course guidance on the actual ground track. While this method is more complicated, it can result in an area smaller than the OAA produced by the Area Analysis Method.

11. AREA ANALYSIS METHOD.

a. During straight-out departures or when the intended track or airplane heading is within 15 degrees of the extended runway centerline heading, the following criteria apply:

(1) The width of the OAA is 0.0625D feet on each side of the intended track (where D is the distance along the intended flightpath from the end of the runway in feet), except when limited by the following minimum and maximum widths.

(2) The minimum width of the OAA is 200 feet on each side of the intended track within the airport boundaries, and 300 feet on each side of the intended track outside the airport boundaries.

(3) The maximum width of the OAA is 2,000 feet on each side of the intended track.. (See Appendix 1, Figure 1.)

b. During departures involving turns of the intended track or when the airplane heading is more than 15 degrees from the extended runway centerline heading, the following criteria apply:

(1) The initial straight segment, if any, has the same width as a straight-out departure.

(2) The width of the OAA at the beginning of the turning segment is the greater of:

(a) 300 feet on each side of the intended track.

(b) The width of the OAA at the end of the initial straight segment, if there is one.

(c) The width of the end of the immediately preceding segment, if there is one, analyzed by the Flight Track Analysis Method.

(3) Thereafter in straight or turning segments, the width of the OAA increases by 0.125D feet on each side of the intended track (where D is the distance along the intended flightpath from the beginning of the first turning segment in feet), except when limited by the following maximum width:

(4) The maximum width of the OAA is 3,000 feet on each side of the intended track. (See Appendix 1, Figure 2.)

c. The following apply to all departures analyzed with the Area Analysis Method:

(1) A single intended track may be used for analysis if it is representative of operational procedures. For turning departures, this implies the bank angle is varied to keep a constant turning radius with varying speeds.

(2) Multiple intended tracks may be accommodated in one area analysis by increasing the OAA width accordingly. In a turn, the specified OAA half-widths (i.e., one-half of the OAA maximum width) should be applied to the inside of the minimum turn radius and the outside of the maximum turn radius. An average turn radius may be used to calculate distances along the track.

(3) The distance to an obstacle within the OAA should be measured along the intended track to a point abeam the obstacle.

(4) When an operator uses the Area Analysis Method, the operator does not need to separately account for crosswind, instrument error, or flight technical error within the OAA.

(5) Obstacles prior to the end of the runway need not be accounted for, unless a turn is made prior to the end of the runway.

(6) One or more turns of less than 15 degrees each, with an algebraic sum of not more than a 15 degree change in heading or track, may be analyzed as a straight-out departure.

(7) No accountability is needed for the radius of the turn or gradient loss in the turn for a turn with a 15 degree or less change in heading or track.

12. FLIGHT TRACK ANALYSIS METHOD. The Flight Track Analysis Method involves analyzing the ground track of the flightpath. This paragraph discusses factors that the operator must consider in performing a Flight Track Analysis.

a. Pilotage in Turns. The operator should consider the ability of a pilot to initiate and maintain a desired speed and bank angle in a turn. Assumptions used here should be consistent with pilot training and qualification programs.

b. Winds.

(1) When using the Flight Track Analysis Method while course guidance is not available, operators should take into account winds that may cause the airplane to drift off the intended track.

(2) The operator should take into account the effect of wind on the takeoff flightpath, in addition to making the headwind and tailwind component corrections to the takeoff gross weight used in a straight-out departure.

(3) When assessing the effect of wind on a turn, the wind may be held constant in velocity and direction throughout the analysis unless known local weather phenomena indicate otherwise.

(4) If wind gradient information is available near the airport and flightpath (e.g., wind reports in mountainous areas adjacent to the flightpath), the operator should take that information into account in the development of a procedure.

13. COURSE GUIDANCE. Operators may take credit for available course guidance when calculating the lateral location of the actual flight track relative to the intended track as part of a Flight Track Analysis.

a. Allowance for Ground-Based Course Guidance.

(1) When ground-based course guidance is available for Flight Track Analysis, the following nominal allowances may be used, unless the operator substantiates allowances for specific navigational aids at a particular airport:

(a) Localizer (LOC)—plus/minus 1.25 degree splay with minimum half-width of 300 feet. (Minimum width governs up to 2.25 nm from LOC.)

(b) Very High Frequency Omni-directional Range (VOR)—plus/minus 3.5 degree splay with minimum half-width of 600 feet. (Minimum width governs up to 1.6 nm from VOR.)

(c) Automatic Direction Finder (ADF)—plus/minus 5 degree splay with minimum half-width of 1,000 feet. (Minimum width governs up to 1.9 nm from ADF.)

(d) Distance Measuring Equipment (DME) Fix—plus/minus 1 minimum instrument display increment but not less than plus/minus 0.25 nm.

(e) DME Arc—plus/minus 2 minimum instrument display increments but not less than plus/minus 1 nm.

NOTE: The above splays originate from the navigation facility.

(2) These allowances account for crosswind, instrument error, flight technical error, and normal NAVAID signal inaccuracies. Further allowances should be made for known signal anomalies (see the A/FD).

(3) Ground-based course guidance may be used in combination with other forms of course guidance to construct a departure procedure.

b. Allowance for Airplane Performance-Based Area Navigation Capabilities.

(1) Airplane-based area navigation refers to a system (e.g., FMS, GPS, Area Navigation System (RNAV), required navigation performance (RNP), Inertial Reference System (IRS)) that permits airplane operations on any desired course, including a turn expansion for flyby or flyover waypoints, within the coverage of ground- or space-based station reference navigation signals or within the limits of self-contained system capabilities without direct course guidance from a ground-based NAVAID. The credit and consideration given to each system depends on its accuracy, redundancy, and usability under one-engine-inoperative conditions.

(2) The minimum allowance is the demonstrated accuracy of the airplane-based navigation equipment.

NOTE: Under no circumstances can the OAA half-width be reduced to less than the regulatory minimums of 200 feet within the airport boundaries and 300 feet after passing the boundaries.

NOTE: The demonstrated accuracy provided in the AFM may not be accurate for determining the OAA without further substantiation. For example, the AFM demonstrated accuracy has not considered "site specific" dependencies such as accuracy and availability of ground based NAVAIDs.

(3) Airplane-based course guidance may be used in combination with other navigational course guidance to construct a departure procedure.

c. Allowance for Visual Course Guidance.

(1) Visual ground reference navigation is another form of course guidance. However, to take advantage of visual course guidance, a Flight Track Analysis must be performed.

(2) The ability to laterally avoid obstacles by visual reference can be very precise, if the obstacles can be seen and are apparent. It is the operator's responsibility to operate in weather conditions, including ceiling and visibility at the time of the operation, that are consistent with the use of the visual ground reference points for the navigation upon which the obstacle analysis is based.

(3) To take advantage of visual course guidance, the flightcrew should be able to continuously determine and maintain the correct flightpath with respect to ground reference points so as to provide a safe clearance with respect to obstructions and terrain.

(a) The procedure should be well defined with respect to ground reference points so that the track to be flown can be analyzed for obstacle clearance requirements.

(b) An unambiguous written and/or pictorial description of the procedure must be provided for crew use.

(c) The limiting environmental conditions (wind, ceiling, visibility, day/night, ambient lighting, obstruction lighting, etc.) must be specified for the use of the procedure so that the flightcrew is able to visually acquire ground reference navigation points and navigate with respect to those points.

(d) The procedure must be within the one-engine-inoperative capabilities of the airplane with respect to turn radius, bank angles, climb gradients, effects of winds, cockpit visibility, etc.

(4) When visual course guidance is used for Flight Track Analysis, the following minimum allowances (in addition to turn radius) apply:

(a) If the obstacle itself is the reference point being used for visual course guidance, the minimum allowance is 300 feet for lateral clearance from that obstacle.

(b) When following a road, railroad, river, valley, etc., for course guidance, the minimum allowance is 1,000 feet on each side of the width of the navigation feature. This width should include the meandering and/or curves of the navigation feature being used or the definable center of the valley or river.

(c) When using a lateral visual reference point to initiate a turn, the minimum allowance is plus/minus 0.25 nm along the track at the turn point.

(d) When initiating a turn directly over a visual reference point, the minimum allowance is plus/minus 0.50 nm along the track at the turn point.

(e) When initiating a turn to avoid overflight of a visual reference point, the minimum allowance is plus/minus 1 nm along the track at the turn point.

(5) Visual course guidance may be used as part of an IFR procedure (e.g., SID, DP) or in conjunction with IFR flight during that portion of the operation which is in visual meteorological conditions (VMC). The visual course guidance may be used in combination with other forms of course guidance to construct a one-engine-inoperative departure procedure.

14. ANALYSIS OF TURNS.

a. Temperature Effects on Turns. Temperature usually has a very large effect on turn radius. First, the turn radius is a function of true airspeed (plus wind), which varies with temperature at the same indicated airspeed. Second, the one-engine-inoperative indicated airspeed (V_2 or V_2 plus an increment) varies considerably with weight, and limit weight is strongly affected by temperature. The temperature effect on both the maximum and minimum turn radii must be taken into account. However, it is acceptable to do a turn analysis based on a single critical temperature if that temperature produces results which are conservative for all other temperatures.

b. Bank Angle. Sections 121.189, 135.379, and 135.398 assume that the airplane is not banked before reaching a height of 50 feet, and that thereafter, the maximum bank is not more than 15 degrees. Obstacle clearance at certain airports can be enhanced by the use of bank angles greater than 15 degrees. The following bank angles and heights may be used with operation specification (OpSpec) authorizations (in accordance with section 121.173 (f)). Any bank angles greater than the values shown below require additional specific FAA authorization.

MAXIMUM BANK ANGLES

Height (above Departure End of Runway - feet)	**Maximum Bank Angle (degrees)**
h>400	25
400>h>100	20
100>h>50*	15

* = Or 1/2 of wingspan, whichever is higher

(1) The AFM generally provides a climb gradient decrement for a 15 degree bank. For bank angles less than 15 degrees, a proportionate amount of the 15 degree value may be applied, unless the manufacturer or AFM has provided other data. Bank angles over 15 degrees require additional gradient decrements.

(2) If bank angles of more than 15 degrees are used, V_2 speeds may have to be increased to provide an equivalent level of stall margin protection and adequate controllability (i.e., V_{MCA} (minimum control speed, air)). Unless otherwise specified in the AFM or other performance or operations manuals from the manufacturer, acceptable adjustments to ensure adequate stall margins and gradient decrements are provided by the following table:

BANK ANGLE ADJUSTMENTS

Bank Angle	Speed	'G' Load	Gradient Loss
15°	V_2	1.035	AFM 15° Gradient Loss
20°	V_2+XX/2	1.064	Double 15° Gradient Loss
25°	V_2+XX	1.103	Triple 15° Gradient Loss

Where 'XX' = the all-engines-operating operating speed increment (usually 10 or 15 knots)

NOTE: On some airplanes, the AFM standard V-speeds may already provide sufficient stall margin protection without additional adjustments.

(3) Bank angles over 25 degrees may be appropriate in certain circumstances but require specific evaluation and FAA certificate-holding district office (CHDO) approval.

(4) Accountability for speed increase for bank angle protection may be accomplished by increasing V-speeds by the required increment shown above or by accelerating to the increment above V_2 after liftoff. The following are examples of acceptable methods:

(a) If available, AFM data for "improved climb" or "overspeed" performance may be used to determine weight decrements for the desired increase to V_1, V_R, and V_2.

(b) Calculate a weight decrement from the weight/V-speed relationship in the AFM for the desired increase in V_1, V_R, and V_2.

(c) Account for the acceleration above V_2 by trading the climb gradient for speed increase. Integrate this climb gradient loss over the distance required to accelerate to determine an equivalent height increment to be added to all subsequent obstacles.

(5) Gradient loss in turns may be accounted for by increasing the obstacle height by the gradient loss multiplied by the flightpath distance in the turn. This will result in an equivalent obstacle height that can be analyzed as a "straight-out" obstacle in the operator's airport analysis programs.

(6) For bank angles greater than 15 degrees, the 35-foot obstacle clearance relative to the net takeoff flightpath should be determined from the lowest part of the banked airplane.

15. ADDITIONAL CONSIDERATIONS.

a. AFM Data.

(1) Unless otherwise authorized, AFM data must be used for one-engine-inoperative takeoff analysis. It is recognized that many AFMs generally contain only the one-engine-inoperative performance for loss of an engine at V_1 on takeoff. All-engines-operating performance must also be considered to determine the airplane's flightpath in the event of an engine failure at a point on the flightpath after V_1. The best available all-engines-operating data should be used consistent with best engineering practices. Operator's may find appropriate acceptable data in various sources, such as: community noise documents, performance engineer's handbooks, flight characteristics manuals, and manufacturers' computer programs.

(2) Certain airports may present situations outside the boundaries covered by the AFM. AFM data may not be extrapolated without an authorized deviation specified in §§ 121.173(f) and 135.363(h). Application for such deviation, with supporting data, should be forwarded to Flight Standards Service (AFS-1) through the principal operations inspector (POI) at the Flight Standards District Office (FSDO) or CMO.

b. Acceleration and Cleanup Altitudes.

(1) For standardization of operating procedures, many operators select a standard cleanup altitude that is higher than that required for obstacle clearance at most airports. With the standard cleanup altitudes, the acceleration and cleanup may be accomplished within the takeoff thrust time limit established in the AFM. The obstacle analysis is usually based on a level-off for cleanup, but there is no operational requirement to level off except in the rare case of a distant obstacle, which must be cleared in the final segment. Obstacle clearance margins usually are improved by continuing the climb during cleanup.

(2) The terrain and obstacles at certain airports may require a higher-than-standard cleanup altitude to be used and may still allow acceleration and cleanup to be accomplished within the takeoff thrust time limit.

c. Validation Flights.

(1) Consideration should be given to conducting a flight to confirm flightcrews' ability to fly actual, special one-engine-inoperative departures and to uncover any potential problems associated with those procedures, particularly if they differ significantly from the all-engines-operating procedures, or if terrain makes course guidance questionable at the one-engine-inoperative altitudes. It should be emphasized that the purpose of this flight is not to prove the validity of the performance data or to demonstrate obstacle clearance. In addition, cockpit workload considerations and minimum control speed characteristics are best evaluated in a simulator. Under NO circumstances will the validation flights be conducted with paying passengers on board. If it is possible to perform the validation or part of the validation in a simulator, presuming that the simulator is appropriately modeled and qualified, it is recommended that the simulator be used for this purpose. If an actual validation flight in an airplane is required, it is recommended that a pre-validation flight be conducted in the simulator to simulate actual evaluation/validation conditions and procedures. It may also be possible that prior experience gained by another airplane type and/or operator may provide sufficient confirmation of the procedure.

(2) A confirmation flight with a simulated engine failure at V_1 is not recommended. Acceptable techniques used for these flights include:

(a) Initiating the procedure from a low pass over the runway at configurations, speeds, and altitudes that represent takeoff conditions.

(b) Using a power setting on all engines calculated to give a thrust/weight ratio representative of one-engine-inoperative conditions.

(c) Setting one engine to flight idle to give a thrust/weight ratio representative of one-engine-inoperative conditions.

16. PILOT INFORMATION.

a. The development and implementation of unique departure and go-around procedures should be coordinated with the flight operations department. Flightcrews must receive instructions through an appropriate means regarding these procedures. Based on the complexity, this instruction could be done through flight operations bulletins, revisions to selected flightcrew manuals, takeoff charts, NOTAMs, or special ground or simulator training.

b. The operator should advise flightcrews of the following (this may be accomplished as a general policy for all airports with exceptions stated as applicable, or specified for each airport):

(1) How to obtain V-speeds consistent with the allowable weights, with particular attention given to the effects of wind, slope, improved climb performance, and contaminants.

(2) The intended track in case of an engine failure. (Some operators have a standard policy of flying runway heading after an engine failure; others routinely assume the all-engines-operating ground track unless specifically stated otherwise.) In any case, the intended track should be apparent to the flightcrew, and failure at any point along the track should be taken into account.

(3) Speeds (relative to V_2) and bank angles to be flown—all-engines-operating and one-engine-inoperative.

(4) The points along the flightpath at which the flap retraction sequence and thrust reduction are to be initiated.

(5) Initial turns should be well defined. ("Immediate" turns should be specified with a minimum altitude for initiation of the turn or a readily identifiable location relative to the runway or navigational fix.)

> **NOTE: Current performance information may be provided to flightcrews by dispatch centers that is relevant to each flight operation. Such information may be passed to flightcrews as a result of a dispatch conference, using radio communications, ACARS, Electronic Flight Bags (EFB), on-board printers, etc.**

17. MISSED APPROACHES, REJECTED LANDINGS, AND BALKED LANDINGS.

a. General.

(1) Parts 121 and 135 do not specifically require an obstacle clearance analysis for one-engine-inoperative missed approaches or rejected landings. While it is not necessary to perform such an analysis for each flight, dispatch, or landing weight limitation, it is appropriate to provide information to the flightcrews on the safest way to perform such a maneuver should it be required. The intent is to identify the best option or options for a safe lateral ground track and flightpath to follow in the event that a missed approach, balked landing, rejected landing, or go-around is necessary. To accomplish this, the operator may develop the methods and criteria for the analysis of one-engine-inoperative procedures which best reflect that operator's operational procedures.

(2) Generally, published missed approach procedures provide adequate terrain clearance. However, further analysis may be required in the following circumstances:

(a) Published missed approach has a climb gradient requirement;

(b) Departure procedure for the runway has a published minimum climb gradient;

(c) A special one-engine-inoperative takeoff procedure is required; or

(d) There are runways that are used for landing but not for takeoff.

NOTE: Operators should incorporate procedures for converting required climb gradients to required climb rates in pilot and dispatcher airplane performance sections of their approved training programs.

(3) A distinction needs to be made between a missed approach and a rejected landing. A one-engine-inoperative missed approach from the minimum descent altitude (height) (MDA (H)), decision altitude (height) (DA (H)), or above can frequently be flown following the published missed approach procedure. A rejected landing from a lower altitude may require some other procedure (e.g., following the same one-engine-inoperative procedure as used for takeoff). In any case, the pilot should be advised of the appropriate course of action when the published missed approach procedure cannot be safely executed.

b. Assessment Considerations.

(1) Operators may accomplish such assessments generically for a particular runway, procedure, aircraft type, and expected performance, and need not perform this assessment for each specific flight. Operators may use simplifying assumptions to account for the transition, reconfiguration, and acceleration distances following go-around (e.g., use expected landing weights, anticipated landing flap settings).

(2) The operator should use the best available information or methods from applicable AFMs or supplementary information from aircraft or engine manufacturers. If performance or flightpath data are not otherwise available to support the necessary analysis from the above sources, the operator may develop, compute, demonstrate, or determine such information to the extent necessary to provide for safe obstacle clearance.

(3) The operational considerations should include:

(a) Go-around configuration transitions from approach to missed approach configuration, including expected flap settings and flap retraction procedures.

(b) Expected speed changes.

(c) Appropriate engine failure and shutdown (feathering if applicable) provisions, if the approach was assumed to be initiated with all engines operative.

(d) Any lateral differences of the missed approach flightpath from the corresponding takeoff flightpath.

(e) Suitable balked landing obstacle clearance until reaching instrument approach, missed approach, or en route procedurally protected airspace.

(f) Any performance or gradient loss during turning flight.

(g) Methods used for takeoff analysis (such as improved climb), one-engine-inoperative maximum angle climb, or other such techniques may be used.

(h) Operators may make obstacle clearance assumptions similar to those applied to corresponding takeoff flightpaths in the determination of net vertical flightpath clearance or lateral track obstacle clearance.

c. Assessment Conditions for Balked Landing.

(1) A "balked landing" starts at the end of the touchdown zone (TDZ). A TDZ typically is considered to be the first one-third of the available landing distance or 3,000 feet, whichever is less. When appropriate for the purposes of this provision, operators may propose to use a different designation for a TDZ. For example, alternate consideration of a TDZ may be appropriate for runways:

(a) That are less than 6,000 feet in length and which do not have standard TDZ markings;

(b) That are short and require special aircraft performance information or procedures for landing;

(c) That are for Short Takeoff and Landing (STOL) aircraft; or

(d) Where markings or lighting dictate that a different TDZ designation would be more appropriate.

(2) An engine failure occurs at the initiation of the balked landing from an all-engines-operating configuration.

(3) Balked landing initiation speed > V_{REF} or V_{GA} (as applicable).

(4) Balked landing initiation height is equal to the specified elevation of the TDZ.

(5) Balked landing initiation configuration is normal landing flaps and gear down.

(6) At the initiation of the maneuver, all engines are at least in a spooled configuration.

d. "One-Way" Airports or Other Special Situations.

(1) Where obstacle clearance is determined by the operator to be critical, such as for:

(a) Airports in mountainous terrain that have runways that are used predominantly for landing in one direction and takeoff in the opposite direction ("one way in" and "opposite way out"); or

(b) Runways at which the planned landing weight is greater than the allowed takeoff weight.

(2) The operator should provide the following guidance to the flightcrew:

(a) The flightpath that provides the best ground track for obstacle clearance, and

(b) The maximum weight(s) at which a missed approach or rejected landing can safely be accomplished under various conditions of temperature, wind, and aircraft configuration.

18. ALTERNATE MEANS. The methods and guidelines presented in this AC are not the only acceptable methods. An operator who desires to use an alternate means should submit an application to the CHDO. The application should describe the alternate assumptions, methods, and criteria to be used along with any other supporting documentation. The CHDO will forward the application through the FSDO (CMO/certificate management unit (CMU)) to the Director, Flight Standards Service, AFS-1, for review and approval, if appropriate.

ORIGINAL SIGNED by
Carol Giles for

James J. Ballough
Director, Flight Standards Service

APPENDIX 1. OBSTACLE ACCOUNTABILITY AREA

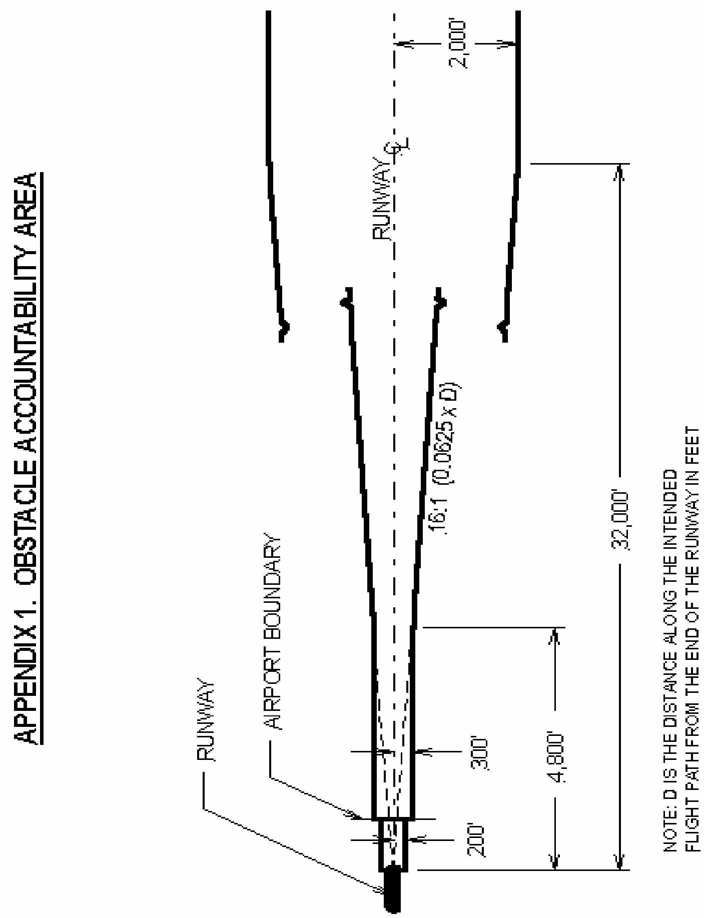
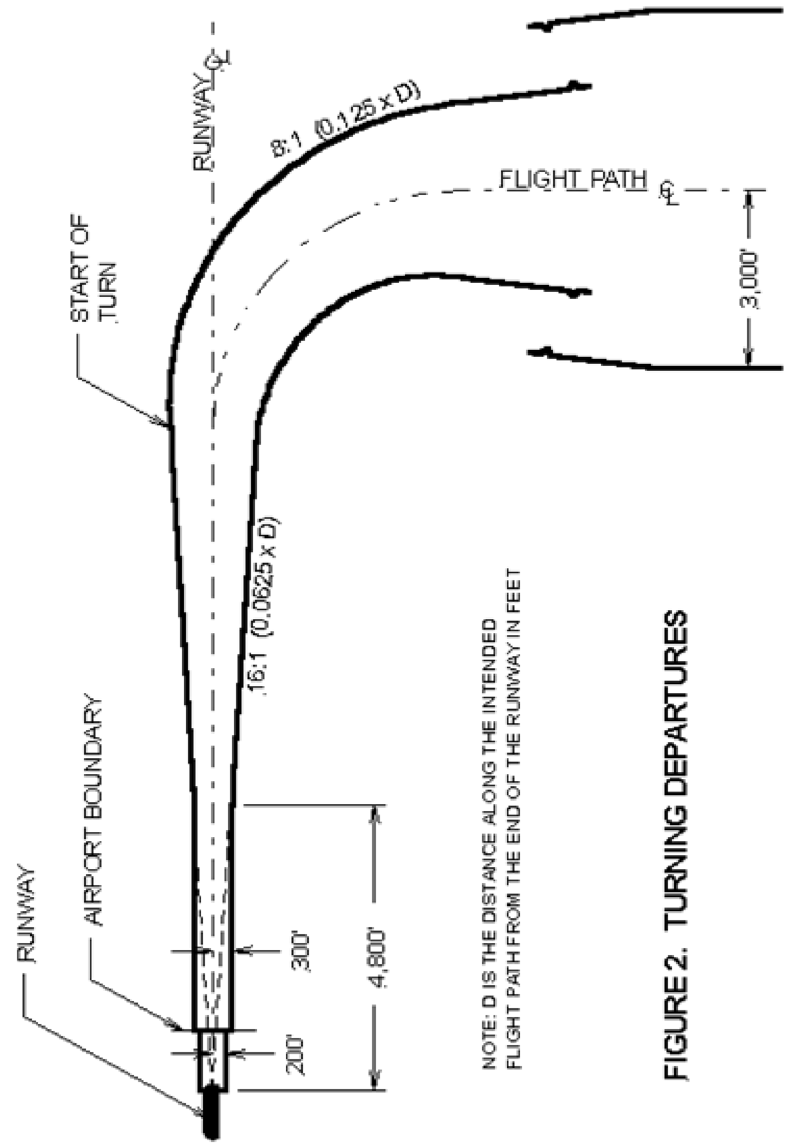


FIGURE 1. STRAIGHT-OUT DEPARTURES

APPENDIX 1. OBSTACLE ACCOUNTABILITY AREA (Continued)

APPENDIX 1. OBSTACLE ACCOUNTABILITY AREA



NOTE: D IS THE DISTANCE ALONG THE INTENDED FLIGHT PATH FROM THE END OF THE RUNWAY IN FEET

FIGURE 2. TURNING DEPARTURES