U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Mitigating the Risks of a Runway Overrun Upon Landing

Date: 9/17/14

Initiated by: AFS-800

AC No: 91-79A

Change:

1. PURPOSE. This advisory circular (AC) provides ways for pilots and airplane operators to identify, understand, and mitigate risks associated with runway overruns during the landing phase of flight. It also provides operators with detailed information that operators may use to develop company standard operating procedures (SOP) to mitigate those risks.

2. AUDIENCE. This document provides guidance to pilots and flightcrews, airplane operators, certificate holders, program managers, training providers, pilot examiners, and other support personnel. Pilots, airplane operators, certificate holders, program managers, training centers, and other support personnel should adopt the recommended procedures found in this AC to enhance awareness of the risks inherent during the landing phase of flight and the mitigations to employ to reduce the risk of a runway landing overrun.

3. APPLICABILITY. The focus of the content of this AC is primarily on operations not covered by Safety Alerts for Operators (SAFO) 06012, Landing Performance Assessments at Time of Arrival (Turbojets). Any values or examples provided in this AC are estimated values. Consult manufacturer information for specific guidance applicable to a given airplane model. However, in the absence of specific landing performance data provided by the airplane's manufacturer, the pilot/operator is encouraged to use the most conservative landing performance information presented in this AC. Further, the operator may consider these concepts as additional information in conjunction with an operator's specific operations specifications (OpSpecs) or management specifications (MSpecs) and the airplane's pilot's operating handbook (POH), or Airplane Flight Manual (AFM), as appropriate.

4. RELATED READING MATERIAL (current editions):

- AC 23-8, Flight Test Guide for Certification of Part 23 Airplanes;
- AC 25-7, Flight Test Guide for Certification of Transport Category Airplanes;
- AC 60-22, Aeronautical Decision Making;
- AC 120-71, Standard Operating Procedures for Flight Deck Crewmembers;
- AC 121.195(d)-1, Operational Landing Distances for Wet Runways; Transport Category Airplanes;
- Approach and Landing Accident Reduction (ALAR)/Runway Excursion Risk Reduction (RERR) Tool Kits;
- FAA-H-8083-25, Pilot's Handbook of Aeronautical Knowledge;
- FAA-H-8083-3, Airplane Flying Handbook;

- Flight Safety Foundation (FSF) ALAR Tool Kit; FSF ALAR Briefing Notes, 8.3, Landing Distances; 8.4, Braking Devices; 8.5, Wet or Contaminated Runways; 6.4, Bounce Recover-Rejected Landing; and 2.1, Human Factors.
- Reducing the Risk of Runway Excursions, FSF;
- Safety Targeted Awareness Report (STAR), Overruns on Landing, from the European Regions Airline Association (ERA) Air Safety Work Group;
- SAFO 06012, Landing Performance Assessments at Time of Arrival (Turbojets); and
- SAFO 10005, Go-Around Callout and Immediate Response.

5. BACKGROUND. According to Federal Aviation Administration (FAA) and National Transportation Safety Board (NTSB) information, runway overruns during the landing phase of flight account for approximately 10 incidents or accidents every year with varying degrees of severity, with many accidents resulting in fatalities. The NTSB also concludes that because of the dynamics of a tailwind approach and landing, particularly on wet or contaminated runways, the FAA should provide current and comprehensive guidance regarding the risks associated with tailwind landings and raise awareness of the reduced margins of safety during tailwind landing operations. Therefore, the NTSB recommended that the FAA revise AC 91-79, Runway Overrun Prevention, to include a discussion of the risks associated with tailwind landings and landings on wet or contaminated runways.

a. Strategy. Focused training and testing of pilots and flightcrews, combined with training-based scenarios, are the tools to preventing runway overrun events. Targeted emphasis on training and checking during initial pilot certification, recurrent training, and checking events must not merely be an academic event, but must be practical in order to increase a pilot's recognition of a higher-risk landing operation.

b. Necessity of Training. Focused training and testing of pilots and flightcrews, combined with training-based scenarios, are important tools for preventing runway overrun events.

c. Operator and Pilot Responsibility. Operators are responsible for developing training programs, SOPs, and complying with all of the regulatory requirements for the flight. All pilots are responsible for knowing the operational conditions they will be encountering and being able to assess the impact of environmental situations on the airplane's landing distance. This responsibility includes following company SOPs and/or industry best practices and exercising the highest level of aeronautical decision-making (ADM) to ensure the safety of the flight.

NOTE: This guidance pertains to the preflight planning requirements of Title 14 of the Code of Federal Regulations (14 CFR) part 91, §§ 91.103, 91.1037, and 91.605; part 121, § 121.195; and part 135, § 135.385.

6. DISCUSSION—HAZARDS ASSOCIATED WITH RUNWAY OVERRUNS. In order to develop risk mitigation strategies and tools, it is important to identify hazards associated with runway overruns. A study of FAA and NTSB data indicates that the following hazards increase the risk of a runway overrun:

- Unstabilized approach;
- High airport elevation or high-density altitude, resulting in increased groundspeed;
- Effect of excess airspeed over the runway threshold;
- Airplane landing weight;
- Landing beyond the touchdown point;
- Downhill runway slope;
- Excessive height over the runway threshold;
- Delayed use of deceleration devices;
- Landing with a tailwind; and
- A wet or contaminated runway.

a. What is an Unstabilized Approach? Safe landings begin long before touchdown. Adhering to the SOPs and best practices for stabilized approaches will always be the first line of defense in preventing a runway overrun. See Appendix 4, Unstabilized Approach Case Study, for an example of an unstabilized approach that led to a runway overrun.

b. High Airport Elevation. High airport elevation or high density altitude results in a higher true airspeed (TAS), ground speed, and a corresponding longer landing distance, compared to low airport elevation or low density altitude.

> **NOTE: For example, at 1,000-ft airport elevation, with a landing distance factor (see Appendix 1, Suggested Procedures and Training Information) of 1.05 to 1.10 (depending on runway condition), the crew should apply to the landing distance achieved at a sea-level airport elevation. The AFM/POH usually includes the adjustment for this factor.**

c. The Effect of Excess Airspeed. The pilot must be aware of airspeed during the approach and of the targeted reference landing airspeed (V_{REF})/airspeed, plus wind gust adjustments, over the runway threshold. An excessive approach speed may result in an excessive speed over the runway's threshold, which may result in landing beyond the intended touchdown point as well as a higher speed from which the pilot must bring the airplane to a stop. (Refer to the current editions of FSF ALAR Briefing Note 8.3—Landing Distances, and Boeing's Takeoff/Landing on Wet and Contaminated Runways.)

(1) FSF ALAR Briefing Note 8.3. A 10 percent increase in final approach speed results in a 20 percent increase in landing distance. This assumes a normal flare and touchdown (i.e., not allowing the airplane to float to bleed excess airspeed).

(2) Example. Runway length available is 5,000 ft and the airplane's AFM/POH certified landing distance may be up to 3,000 ft at the correct airspeed at the threshold crossing point. However, given a 10 percent increase in airspeed over the runway threshold, increasing the landing distance 20 percent, the resultant operational landing distance is now 3,600 ft (1.20×3,000).

d. Airplane Landing Weight. Any item that affects the landing speed or deceleration rate during the landing roll will affect the landing distance. The effect of gross weight on landing distance is one of the principal items determining the landing distance of an airplane. One effect of an increased gross weight is that the airplane will require a higher landing speed. When one considers minimum landing distances on a dry runway, braking friction is the main source of deceleration. The minimum landing distance will vary in direct proportion to the gross weight.

NOTE: For example, a 10 percent increase in gross weight at landing would result in a 5 percent increase in landing velocity and a 10 percent increase in landing distance. (Refer to the Pilot's Handbook of Aeronautical Knowledge for more information.)

e. Landing Beyond the Intended Touchdown Point. AFM/POH distances are based on a touchdown point determined through flight-testing procedures outlined in the current editions of AC 25-7 and AC 23-8. If the airplane does not touch down within the air distance included in the AFM or POH landing distance, it will not be possible to achieve the calculated landing distance.

f. Downhill Runway Slope. A negative runway slope of 1 percent (downhill) increases landing distance by 10 percent (a factor of 1.1). (Refer to FSF ALAR Briefing Note 8.3 and Appendix 1, Table 1-3, Sample Computation: Runway Length7,000 ft.)

g. Excessive Height Over the Runway Threshold – Threshold Crossing Height (TCH) Greater Than 50 ft (Excess TCH). The certified landing distances furnished in the AFM are based on the landing gear being at a height of 50 ft over the runway threshold. For every 10 ft above the standard 50 ft threshold height, landing air distance will increase 200 ft.

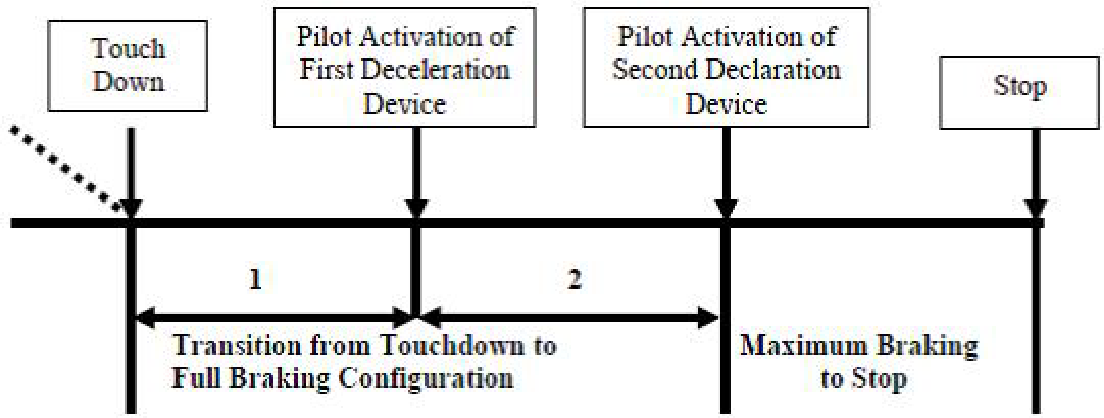
NOTE: For example, TCH of 100 ft increases the landing distance by about 1,000 ft (50 additional ft divided by 10 = 5 X 200 ft landing distance increase per each 10 ft above 50 ft TCH = 1,000 ft additional landing distance). (Refer to FSF ALAR Briefing Note 8.3.)

h. Delayed Use of Deceleration/Maximum Braking.

(1) For those airplanes so equipped, deceleration devices consist of spoilers, thrust reversers, and brakes. The touchdown point is important since the wheel brakes are much more effective in retarding the airplane than the air drag during the airborne part of the landing distance. The sooner the airplane touches down and starts braking, the shorter the total distance will be. The FSF ALAR Task Force found that delayed braking action during the landing rollout was involved in some of the accidents and serious incidents in which slow/delayed crew action was a causal factor. The FSF Runway Safety Initiative (RSI) team found that improper use and malfunction of speed brakes, wheel brakes, and reverse thrust were significant factors in a number of runway excursion landing accidents.

(2) Prompt and proper operation of all means of deceleration has a major influence on landing distances. Spoilers greatly decrease lift, dump the weight on the wheels, and thereby make the brakes effective. It should be noted that manual spoilers, operated by the pilot, involve a delay. Even 2 seconds at speeds of 200 ft/second (118 knots (kts)) can increase the stopping distance by almost 400 ft. Landing distance data in the AFM is typically based on a time increment of 1 second between successive actions to manually deploy/engage the deceleration devices (see Figure 1, Assumed Landing Time Delays in Deriving the Scheduled Landing Distance). *A conservative approach is to add 200 ft to the landing distance for every second in* *excess of 2 seconds to deploy the airplane's deceleration devices.* A prudent pilot will make a reasonable adjustment to the airplane's landing distance for any delay in employing the airplane's deceleration devices. Figure 2, Braking Devices on Stopping Energy and Stopping Distance, shows the relative effectiveness of each of the deceleration devices during the landing roll (refer to FSF ALAR Briefing Note 8.4).

FIGURE 1. ASSUMED LANDING TIME DELAYS IN DERIVING THE SCHEDULED LANDING DISTANCE



- Segment 1. This segment represents the flight test measured average time from touchdown to pilot activation of the first deceleration device. For AFM data expansion, use the longer of 1 second or the test time.
- Segment 2. This segment represents the flight test measured average test time from pilot activation of the first deceleration device to pilot activation of the second deceleration device. For AFM data expansion, use the longer of 1 second or the test time.
- Segment 2 is repeated until pilot activation of all deceleration devices has been completed and the airplane is in the full braking configuration.

NOTE: For approved automatic deceleration devices (e.g., autobrakes or auto-spoilers, etc.) for which performance credit is sought for AFM data expansion, established times determined during certification testing may be used without the application of the 1-second minimum time delay described in the appropriate segment above.

FIGURE 2. BRAKING DEVICES ON STOPPING ENERGY AND STOPPING DISTANCE

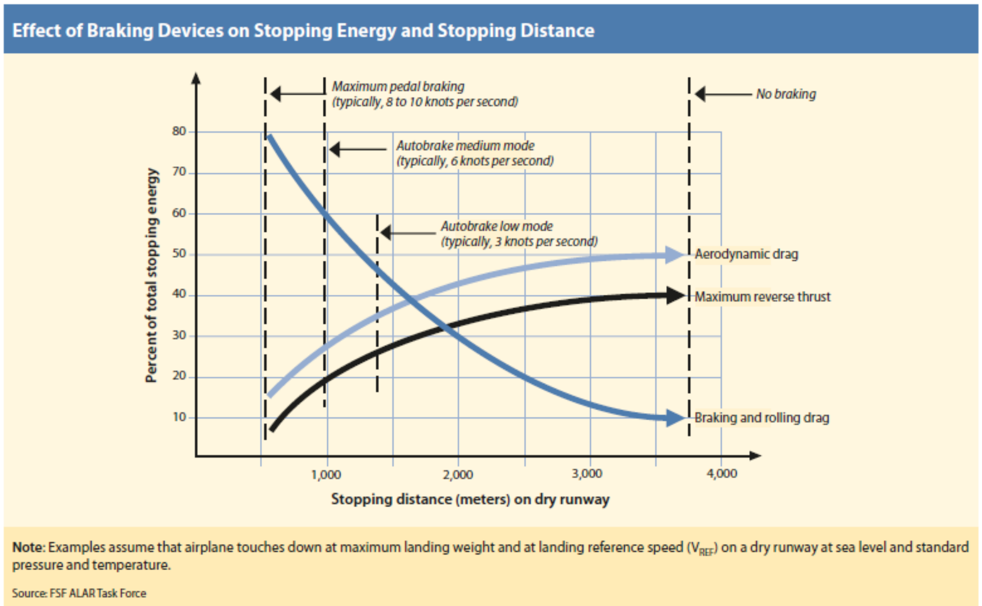
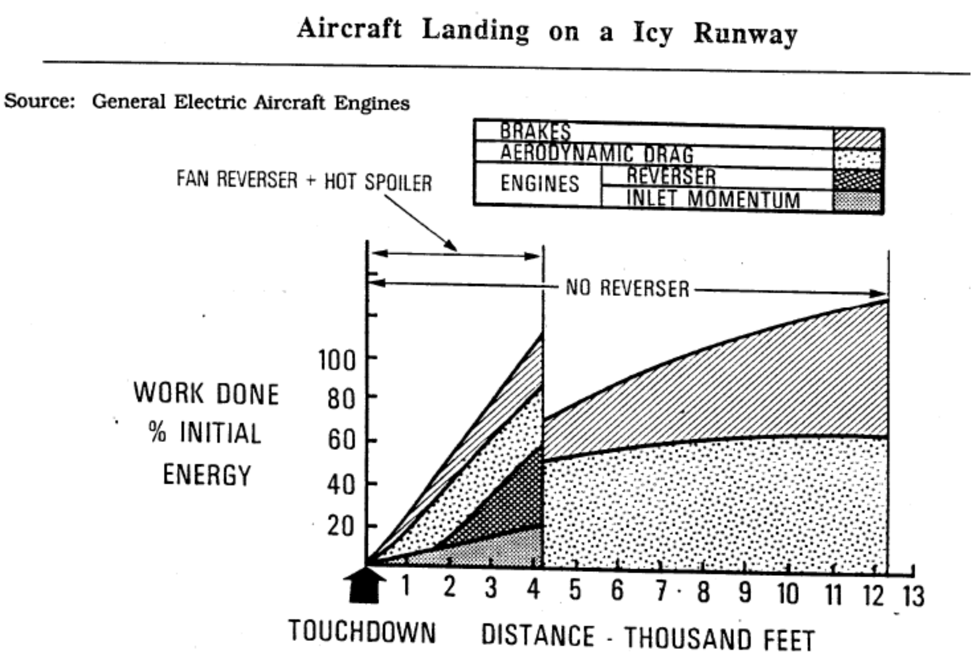
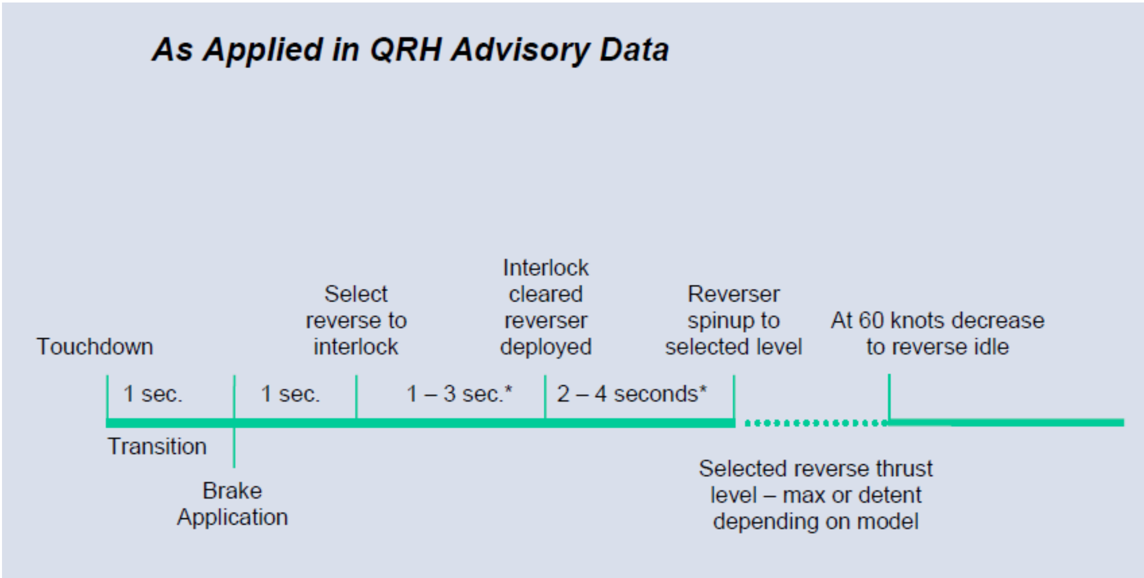


FIGURE 3. THRUST REVERSE EFFECTIVENESS



b. Icy runway.

FIGURE 4. SECONDS COUNT – REVERSE THRUST APPLICATION SEQUENCE (BOEING PERFORMANCE TAKEOFF/LANDING ON WET, CONTAMINATED, AND SLIPPERY RUNWAYS)



(3) Be conservative and add 20 percent to the rollout distance if the pilot does not maintain maximum braking until the airplane reaches a full stop. Otherwise, if available, use AFM data for less than maximum braking.

(4) For airplanes that do not have antiskid brakes, spoilers, or thrust reverse, caution should be exercised. Excessive braking can lead to causing a tire failure or cause a skidding condition, leading to a runway excursion. Therefore, flying a stabilized approach and timely application of deceleration devices are the keys to a safe landing.

NOTE: Example: Available runway 5, 000 feet (ft), AFM landing distance 3,000 ft, at correct speed, and at 50-ft TCH, a total of 3 seconds to deploy the airplane's deceleration devices, results in 1 second over the AFM landing distance assumed 2 seconds to deploy deceleration device will result in an additional 200 ft operational landing distance, for a total of 3,200 ft.

i. Landing with a Tailwind – Effect of a Tailwind on Landing Distance. The effect of a tailwind on landing distance is significant and is a factor in determining the landing distance required. Given the airplane will land at a particular airspeed, independent of the wind, the principal effect of a tailwind on operational landing distance is the change in the ground speed at which the airplane touches down.

(1) The effect of a tailwind will increase the landing distance by 21 percent for the first 10 kts of tailwind. (Refer to the Pilot's Handbook of Aeronautical Knowledge, and the aircraft's AFM/POH data to determine if tailwind landing data is available for the airplane.)

(2) Tailwind landings affect all types of airplanes. For transport category airplanes, the effect of tailwind is shown in the AFM landing distance information. For small airplanes, tailwind landing data may not be provided. The FAA Small Airplane Directorate provided the following tailwind performance information for a few small airplanes:

- *Cessna 150, 152*, note on the landing distance chart, "for operation with tailwinds up to 10 knots, increase distances by 10 percent for each 2 knots."
- *TMB 850*, note under landing distance table to "increase total distances of 30 percent for every 10 knots of tailwind."
- The *Cirrus* and *Columbia* are two very popular piston airplanes. The *Cirrus* uses the same note in the chart as *Cessna*. The *Columbia* is like the *Diamond* airplane and offers factors for grass but not tailwinds.

NOTE: Remember to account for the effect of a tailwind on landing distance, whether you are flying a large or small airplane.

(3) Tailwind example: Available runway 5,000 ft, AFM landing distance 3,000 ft, TCH at 50 ft and at the correct airspeed with a 10 kts tailwind results in an increase in the operational landing distance of 21 percent. This increase equates to an additional 630 ft which increases the operational landing distance to a total of 3,630 ft.

j. A Wet or Contaminated Runway. Landing distances in the manufacturer-supplied AFM provide performance in a flight test environment that is not necessarily representative of normal flight operations. For those operators conducting operations in accordance with specific FAA performance regulations, the operating regulations require the AFM landing distances to be factored to ensure compliance with the pre-departure landing distance regulations. These factors should account for pilot technique, wind and runway conditions, and other items stated above. Pilots and operators should also account for runway conditions at the time of arrival (TOA) to ensure the safety of the landing. *Though the intended audience of SAFO 06012 is turbojet airplanes, it is highly recommended that pilots of non-turbojet airplanes also follow the recommendations in SAFO 06012.*

(1) The SAFO urgently recommends that operators develop a procedure for flightcrews to assess landing performance based on conditions actually existing at the TOA, as distinct from conditions presumed at time of dispatch. Those conditions include weather, runway conditions, the airplane's landing weight, landing configuration, approach speed, and the flightcrew deploys deceleration devices in a timely manner.

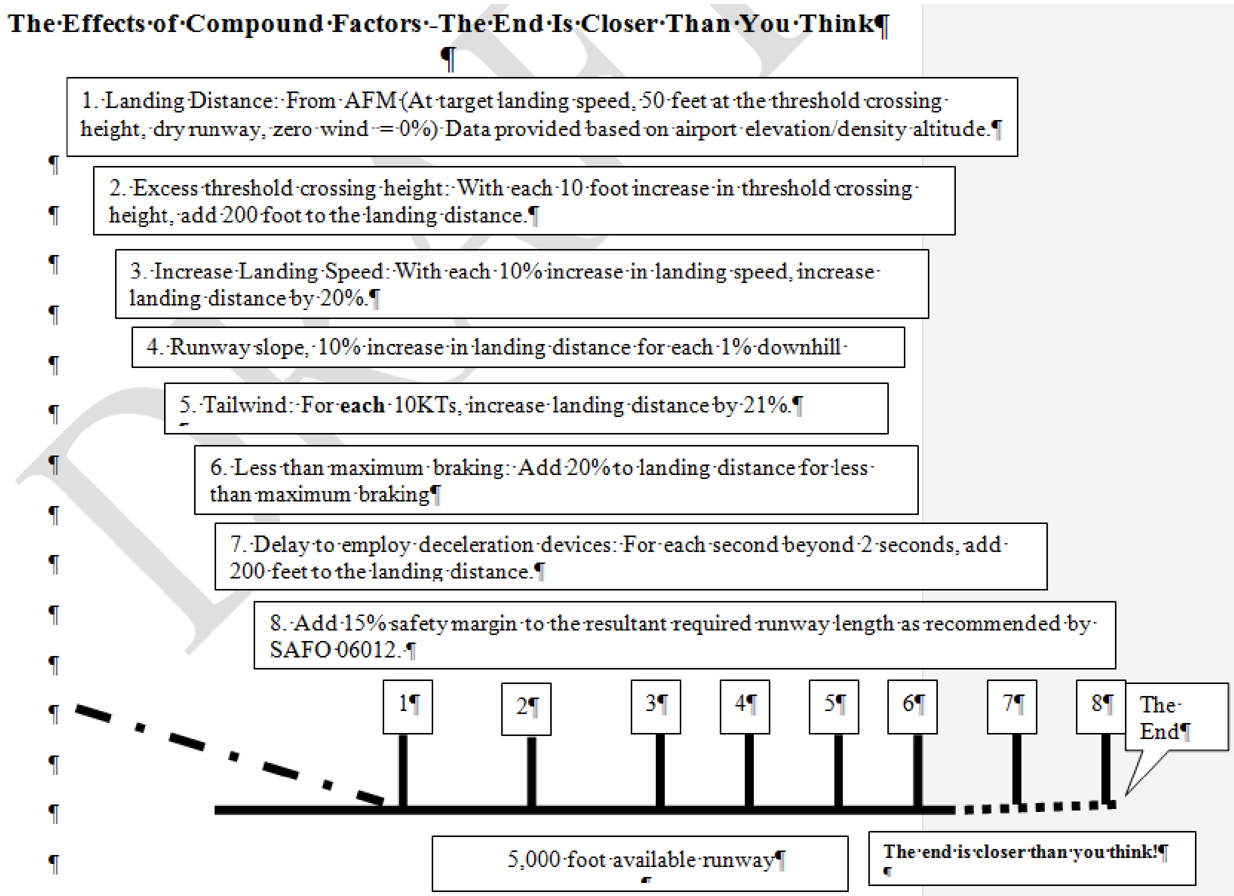
(2) Once the actual landing distance is determined, an additional safety margin of at least 15 percent should be added to that distance. Except under emergency conditions, flightcrews should not attempt to land on runways that do not meet the assessment criteria and safety margins as specified in SAFO 06012.

(3) A safety margin of 15 percent should be added, and the resulting distance should be within the runway length available. *The FAA considers a 15 percent margin to be the minimum acceptable safety margin.*

NOTE: The flightcrew should not apply this 15 percent safety margin to the landing distance determined for compliance with any other OpSpec/MSpec requirement.

(4) Know you can stop within the landing distance available. The cumulative effect of the conditions that extend the airplane's landing distance, plus the 15 percent safety margin, can be a substantial increase to the AFM/POH data, unless the pilot is aware of the items presented, and possesses the knowledge and flying discipline to mitigate the risk of a runway overrun. See below Table 1, The Effects of Compound Factors—The End is Closer Than You Think.

TABLE 1. THE EFFECTS OF COMPOUND FACTORS—THE END IS CLOSER THAN YOU THINK



7. RISK MITIGATION.

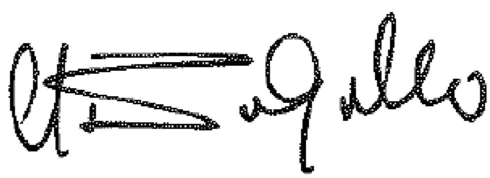
a. SOP. Specific SOPs to prevent a runway overrun are a primary risk mitigation tool. Once SOPs are developed, it is imperative that the pilot/flightcrew execute them faithfully to mitigate a runway overrun. As a minimum, the SOPs should contain the factors presented in this AC.

b. Runway Overrun Mitigation Training Curriculum. An effective training program is the next tool that provides academic knowledge and skill to increase the pilot's awareness of the factors that can cause a runway overrun. At a minimum, the operator's training program should include the same elements contained in their SOP. Also, the go-around maneuver and the reasons to initiate a go-around maneuver must be part of their training. (Refer to SAFO 10005.)

NOTE: Operators should also incorporate this training into their pilot and dispatcher training for operations conducted in accordance with 14 CFR parts 121, 135, 125, 91, 91K, 141, and 142. Further, all independent certificated flight instructors (CFI) should also provide this training to the pilots they train.

c. Flight Checking and Recurrent Training. Checking, testing, and recurrent training that emphasizes airplane landing performance are essential tools to mitigate runway overruns. Designated Pilot Examiners (DPE), flight and ground instructors, check airman, and dispatch examiners should specifically stress ADM, runway overrun risk management scenarios, and the elements within this AC as they qualify, train pilots, flightcrews, and dispatchers to exercise the privileges of their certificate. Trainers and examiners must include runway overrun mitigation strategies during training and checking to ensure the pilot/applicant can apply the principles in a real-world environment.

NOTE: The following appendices provide additional information for operators and pilots to develop SOPs, training programs, pilot techniques, and case study.



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APPENDIX 1. SUGGESTED PROCEDURES AND TRAINING INFORMATION

1. ORGANIZATION. This appendix divides the discussion of runway overruns during the landing phase of flight into the following broad categories:

- Definitions;
- The necessity to fly a stabilized approach to the touchdown aiming point;
- A discussion of landing performance data; and
- Landing and braking techniques.

2. DEFINITIONS. The following, though not all inclusive, are definitions of landing elements that form the foundation for a successful landing.

a. Declared Runway Distance. Declared distances for a runway represent the maximum distances available and suitable for meeting takeoff and landing distance performance requirements. All Title 14 of the Code of Federal Regulations (14 CFR) part 139 airports report declared distances for each runway. For runways without published declared distances, the declared distances may be assumed to be equal to the physical length of the runway unless there is a displaced landing threshold. (Refer to the Aeronautical Information Manual (AIM) for more information.)

b. Landing Distance Available (LDA). The length of the runway declared available for landing. This distance may be shorter than the full length of the runway due to a threshold displacement.

c. Actual Landing Distance. The landing distance for the reported meteorological and runway surface conditions, runway slope, airplane weight, airplane configuration, approach speed, use of autoland or a Head-Up-Guidance System (HGS), and ground deceleration devices planned to be used for the landing. It does not include any safety margin and represents the best performance the airplane is capable of for the conditions. (Refer to SAFO 06012, Landing Performance Assessments at Time of Arrival (Turbojets), for more information.)

d. Braking Action Reports. When available, air traffic control (ATC) furnishes pilots the quality of braking action received from pilots or airport management. The quality of braking action is described by the terms "good," "fair (medium)" (see note below), "poor," and "nil," or a combination of these. When pilots report the quality of braking action by using the terms noted above, *pilots should use descriptive terms that are easily understood, such as "braking action is poor the first/last half of the runway," and include the type of airplane.* When tower controllers have received runway braking action reports, which include the terms fair (medium) (see note below), poor, or nil, or whenever weather conditions are conducive to deteriorating or rapidly changing runway braking conditions, the tower will include on the automated terminal information service (ATIS) broadcast the statement, "Braking Action Advisories are in Effect." (Refer to the AIM for more information.) See Table 1-1, Operational Runway Condition Assessment Matrix (RCAM) Braking Action Codes and Definitions, below. (See the notes below for the RCAM for clarification and information of terms and addition of codes.)

NOTE: The braking action term "FAIR" is in the process of being changed to "MEDIUM" throughout the Federal Aviation Administration (FAA). Until an official language change is published, the current guidance of the term "FAIR" is used.

TABLE 1-1. OPERATIONAL RUNWAY CONDITION ASSESSMENT MATRIX (RCAM) BRAKING ACTION CODES AND DEFINITIONS

Airport Operator Assessment Criteria		Control/Braking Assessment Criteria	
Runway Condition Description	**Code**	**Deceleration or Directional Control Observation**	**Pilot Reported Braking Action**
• Dry	**6**	---	---
• Frost • Wet (Includes damp and less than 1/8 inch depth of water) ***Less than 1/8 inch (3mm) depth of:*** • Slush • Dry Snow • Wet Snow	**5**	Braking deceleration is normal for the wheel braking effort applied AND directional control is normal.	Good
-15ºC and Colder outside air temperature: • Compacted Snow	**4**	Braking deceleration OR directional control is between Good and Medium.	Good to Medium
• Slippery When Wet (wet runway) • Dry Snow or Wet Snow (any depth) over Compacted Snow ***1/8 inch depth or greater of:*** • Dry Snow • Wet Snow ***Warmer than -15ºC outside air temperature:*** • Compacted Snow	**3**	Braking deceleration is noticeably reduced for the wheel braking effort applied OR directional control is noticeably reduced.	Medium
1/8 inch depth or greater of: • Water • Slush	**2**	Braking deceleration OR directional control is between Medium and Poor.	Medium to Poor
• Ice	**1**	Braking deceleration is significantly reduced for the wheel braking effort applied OR directional control is significantly reduced.	Poor
• Wet Ice • Water on top of Compacted Snow • Dry Snow or Wet Snow over Ice	**0**	Braking deceleration is minimal to non-existent for the wheel braking effort applied OR directional control is uncertain.	Nil

Operational RCAM Version 2014.1

Note: The unshaded portion of the RCAM is associated with how an airport operator conducts a runway condition assessment.
Note: The shaded portion of the RCAM is associated with the pilot's experience with braking action.
Note: The Operational RCAM illustration will differ from the RCAM illustration used by Airport Operators.
Note: Runway condition codes, one for each third of the landing surface, for example 4/3/3, represent the runway condition description as reported by the airport operator. The reporting of codes by runway thirds is expected to begin in October of 2016.

e. Aiming Point. The aiming point is the point on the ground at which, if the airplane maintains a constant glidepath and does not execute the round out (flare) maneuver for landing, it would touch the ground.

f. Maximum Braking Effort. Maximum braking effort is defined as maximum brake application by the pilot.

g. Adjusted Landing Distance. Is the actual landing distance adjusted for a landing safety margin in accordance with the operator's standard operating procedures (SOP). This should not be confused with the landing distance associated with the dispatch requirements.

h. Target Touchdown Point. As discussed in the current edition of FAA-H-8083-3, Airplane Flying Handbook, the target touchdown point is defined as a touchdown point approximately 1,000 feet (ft) down the runway. Additionally, the operator may define the desired target touchdown point in their SOP.

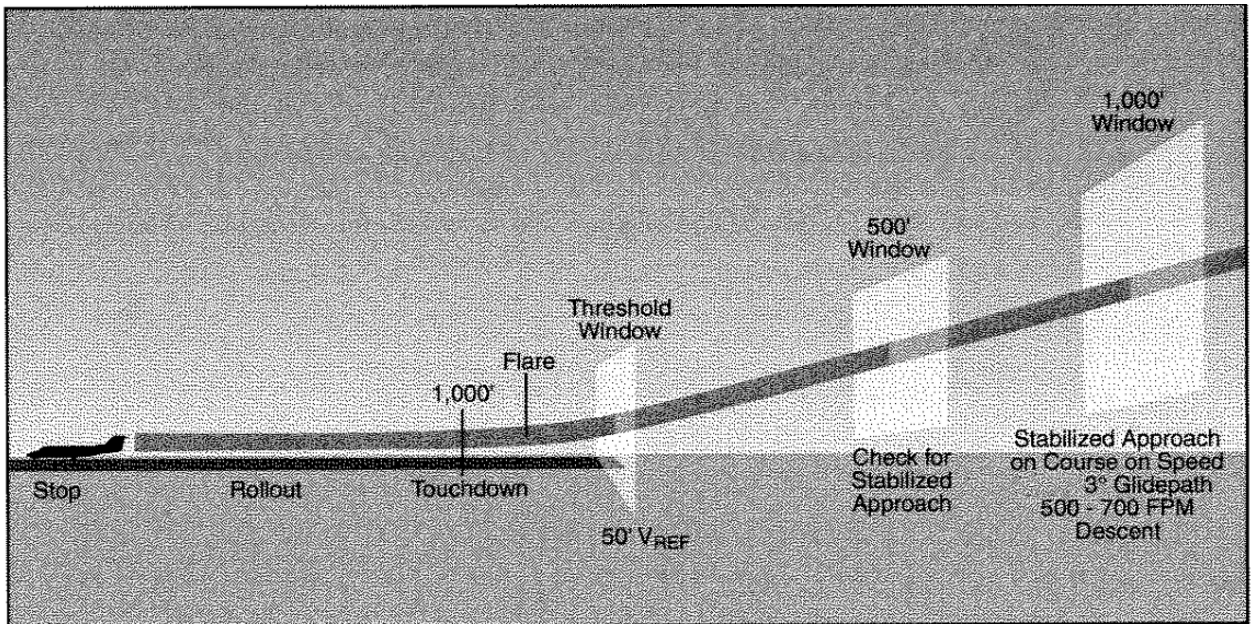
i. Touchdown Zone (TDZ). As referenced in the current edition of Airline Transport Pilot (ATP) Practical Test Standards (PTS) FAA-S-8081-5, Airline Transport Pilot and Aircraft Type Rating Practical Test Standards for Airplane, the TDZ is referred to as a point 500-3,000 ft beyond the runway threshold not to exceed the first one-third of the runway. This reference is not used in landing distance performance calculations.

j. Unfactored or Certified Landing Distance. The landing distance determined during certification as required by 14 CFR part 23, § 23.75 and 14 CFR part 25, § 25.125. The unfactored landing distance is not adjusted for any safety margin additives. The unfactored certified landing distance may be different from the actual landing distance because not all factors affecting landing distance are required to be accounted for by certification regulations. For example, the unfactored certified landing distances are based on a dry, level (zero slope) runway at standard day temperatures, and do not normally take into account the use of autobrakes, autoland systems, HGS, or thrust reversers. This is considered the baseline landing distance from which all subsequent user calculations emanate.

k. Factored Landing Distance. For applicable operations, the dispatch landing distance allows the airplane to land and stop within 60 percent of the available runway when the runway is dry. The factored landing distance is the certified landing distance multiplied by 1.67, which can then be compared directly to the available landing distance. When the runway is wet, the certified distance is multiplied by 1.97 to account for the 15 percent additional runway requirement.

3. STABILIZED APPROACH TO THE TOUCHDOWN AIM POINT. A stabilized approach is the safest profile, and it is one of the most critical elements to ensure a safe approach to a landing operation.

FIGURE 1-1. STABILIZED APPROACH



NOTE: The approach descent rate will vary given the airplane's ground speed as a result of the required approach speed per Airplane Flight Manual (AFM), weight, and wind additives.

a. Landing Configuration. The airplane should be in the landing configuration early in the approach. The landing gear should be down, landing flaps selected, trim set, and fuel balanced per the AFM or pilot's operating handbook (POH). Landing checklist items should be completed. Ensuring that these tasks are completed will help keep the number of variables to a minimum during the final approach.

b. Stabilized on Profile. The airplane should be stabilized on profile before descending through the 1,000-ft window or through the 500 ft above TDZ elevation (TDZE) window in visual meteorological conditions (VMC). Configuration, trim, speed, and glidepath should be at or near the optimum parameters early in the approach to avoid distractions and conflicts as the airplane nears the threshold window. The electronic or visual glidepath or an optimum glidepath angle of 3 degrees should be established and maintained. For the purposes of this AC, approaches that require a glidepath angle greater than 3 degrees are a "special case." The airplane must be in the proper landing configuration, on the correct lateral track, the correct vertical track and at the proper airspeed. It should be noted, as it applies to stabilized approaches, that following lateral and vertical tracks should require only normal bracketing corrections.

NOTE: An approach that requires abnormal bracketing does not meet the stabilized approach concept, and a go-around should be initiated.

c. Descent Rate. The optimum descent rate for a 3 degree approach path is based upon the airplane's ground speed. A pilot must exercise discipline and situational awareness to maintain the airplane's target approach speed. The following is a method to estimate the appropriate descent rate for a 3 degree descent path: Multiplying the ground speed in knots (kts) by 5 provides a usable target 3 degree descent rate in ft per minute. Combined with disciplined airspeed control, slight adjustments in the rate of descent to maintain the glidepath will ensure flying the descent/instrument landing system (ILS) glidepath. For example, see Table 1-2, Rates of Descent Estimate Concept for a Three-Degree Glidepath vs. Ground Speed, and refer to the ILS approach chart.

TABLE 1-2. RATES OF DESCENT ESTIMATE CONCEPT FOR THREE-DEGREE GLIDEPATH VS. GROUND SPEED

Ground speed kts	70	90	100	120	140	160
Published 3^0 GS fpm	372	478	531	637	743	849
5×GS estimated fpm	350	450	500	600	700	800

d. Indicated Airspeed. Indicated airspeed should be not more than V_{REF} + 5 or the POH published approach airspeed, with appropriate adjustments for wind or other factors, and never less than V_{REF} or the appropriate airspeed in order to avoid the loss of aircraft control. There is a strong relationship between trim, speed, and power, and it is important to stabilize the speed in order to minimize those variables.

e. Turbojet Engine Speed. The engine speed should be at a setting that allows best response when and if a rapid power increase is needed. The stabilized approach parameters should be confirmed at 500 ft (VMC) or 1,000 ft instrument meteorological conditions (IMC) above airport TDZE. This is approximately 1-2 minutes from touchdown. If the approach is not stabilized at that altitude, a go-around/balked landing should be executed.

f. Touchdown Point. Extended flare and runway slope are two factors that affect pilot control of the touchdown point. Turbine airplanes should be flown onto the runway rather than being held off the surface as speed dissipates. A firm landing is both normal and desirable. The typical operational touchdown point is in the first third of the runway, and it may be farther down the runway than the 1,000 ft point. This additional distance should be accounted for in the landing distance assessment at time of arrival (TOA).

g. Downhill Runway Slope. Additionally, a negative runway slope affects the touchdown point. According to the Flight Safety Foundation (FSF) Approach and Landing Accident Reduction (ALAR) Briefing Note 8.3—Landing Distances, each 1 percent of runway down slope increases the landing distance by 10 percent. Depending upon the airplane's manufacturer, runway slope may be included in the AFM/POH landing performance data.

TABLE 1-3. SAMPLE COMPUTATION: RUNWAY LENGTH 7,000 FT

Elevation of Approach end of runway	1,310’
Elevation of Roll out end of runway	1,100’
	210’ down hill difference
210’/7000 X 100% = 3% downhill gradient	
3% downhill gradient = 30% increase in effective runway length required.	
Adjusted effective runway length (7000’ X 1.3) = **9,100 feet. An increase of 2,100 feet**	

NOTE: When computing runway gradient, every 1.0 percent grade equals approximately 10 percent change in effective runway length. Also, for shorter runways, it does not take as large an elevation difference between runway ends to result in a 3 percent gradient. For example: for a 3 percent gradient for a 3,000-ft runway, the elevation difference between the runway ends would only be 90 ft.

h. Factors that Contribute to an Unstabilized Approach.

(1) An ATC clearance that requests an airspeed in excess of those airspeeds normally flown in the terminal area, and/or clearances that require an airplane to remain at altitude to a point where intercepting the normal glidepath is difficult to achieve, pilots should be aware that if they cannot achieve a stabilized approach profile, to advise ATC.

NOTE: A stabilized approach to landing is key to mitigating the risk of a runway overrun. If the pilot determines that a stabilized approach cannot be flown, the approach should not be accepted and a go-around should be initiated.

(2) It is paramount that the airplane arrives at the approach threshold window on speed. If the pilot has planned to carry additional airspeed beyond the threshold due to gusty surface wind conditions, then the effect of this additional airspeed/ground speed should be included in the actual landing distance. A balked landing maneuver should be executed if the airplane does not cross the runway threshold at the planned airspeed.

NOTE: A 10 percent excess landing speed causes at least a 21 percent increase in landing distance. The excess speed places a greater working load on the brakes because of the additional kinetic energy to be dissipated. Also, the additional speed causes increased drag and lift in the normal ground attitude, and the increased lift reduces the normal force on the braking surfaces. The deceleration may suffer during this range of speed immediately after touchdown, and it is more probable for a tire to be blown out from braking at this point.

4. DISCUSSION OF LANDING DATA.

a. Landing Performance Assessment. Landing performance assessment is influenced by a multitude of variables. Airplane weight and configuration, use of deceleration devices, airport elevation, atmospheric temperature, wind, runway length, runway slope, and runway surface condition (i.e., dry, wet, contaminated, improved, unimproved, grass, etc.) are all factors in determining landing performance. The condition of airplane tires, brakes, and systems installed/operative/inoperative (e.g., antiskid braking, propeller reversing, thrust reversers, etc.), and pilot abilities/technique all have a direct impact on the airplane's ability to come to a full stop after touchdown. However, there is no one standard format in which airplane manufacturers are required to provide this additional data. The pilot must be aware of the airplane's landing data/performance. The pilot must also obtain the most current runway condition information within a reasonable time before initiating the approach phase of flight in order to assess the airplane operational landing distance to ensure that it does not exceed the landing distance available. To begin the assessment process of landing performance, we need to first address some basic principles of landing performance.

b. Data Provided. The data provided in the AFM/POH may only provide unfactored landing data, which does not reflect operational landing distances. The AFM landing data for most large airplanes operated in accordance with 14 CFR part 121 provide factored landing distances. Some manufacturers provide advisory or supplemental performance data in the AFM/POH which may account for conditions such as a dry runway, a wet runway, ground spoilers operative/inoperative, thrust reversers operative/inoperative, antiskid operative/inoperative, propeller reverse, tailwind, and/or headwind. Also, it is very important to understand that the factors that affect the stopping ability of an airplane are cumulative.

c. AFM Performance Section. The following includes general examples of aircraft performance factors required for certification, and inclusion in the airplane's AFM. Landing performance is of primary interest in operating an airplane because it is a factor in defining the runway length requirements. In addition to the importance of proper piloting technique, any factor that affects the landing velocity or deceleration during the landing roll will affect landing distance.

(1) Factors Required to be Included in the Performance Charts:

- Pressure altitude,
- Standard Temperature,
- Gross weight,
- Wind, and
- Airplane configuration.

(2) For Small Airplanes Operation on Unpaved Runway Information. For airplanes less than 6,000 pounds (2730 kg) maximum weight, the factors given below may be quoted in the flight manual as an alternative to the scheduling of data derived from testing or calculation. It should be noted that these factors are intended to cover the range of airplane types in this category and are necessarily conservative (refer to the current edition of AC 23-8, Flight Test Guide for Certification of Part 23 Airplanes).

TABLE 1-4. SMOOTH, FLAT RUNWAY

	Takeoff	**Landing**
Dry Grass	1.2	1.2
Wet Grass	1.3	1.6

NOTE: If the runway is not smooth, the grass is very long or very short, higher factors may be warranted. Very short grass = golf course length. Very long grass = un-mowed field or high interstate highway median grass length.

(3) Landing Distances for Large Transport Airplanes. Landing distances for large transport airplanes determined during certification tests are aimed at demonstrating the shortest performance distances for a given airplane weight with a *test pilot at the controls*. In addition, they are established with full awareness that operational rules for normal operations require the addition of factors to determine minimum operational field lengths. Therefore, the landing distances determined for large airplanes, under § 25.125, are much shorter than the landing distances achieved in normal operations. For small airplanes, under § 23.75 (reference AC 23-8), prescribes the requirements to certify a small airplane landing performance, though the factors of weight, speed, and pressure altitude are considered, the factors that extend the landing distance are not included. Therefore, given the factors that increase the airplane's required landing distance, the pilot/operator should seriously consider the consequence of not assessing the landing distance required.

(4) Air Carriers and 14 CFR Part 91K Operators. To mitigate the risk of a runway overrun, air carriers and part 91K operators are required by regulation to multiply the airplane's actual landing distance by a specified factor associated with a destination or alternate airport. All operations must mitigate the risk of a runway overrun by considering all the elements that affect the unfactored landing distance provided in the AFM/POH. This is to ensure that at the time arrival, the landing distance required will not exceed the landing distance available. (For the purpose of example, refer to the applicable part 91K, § 91.1037; part 121, § 121.195; and 14 CFR part 135, § 135.385 for more information.)

NOTE: Notwithstanding that non-air carriers/operators are not required by regulation to use a factored landing distance, they are strongly encouraged to adopt a factored landing distance methodology to mitigate the risk of a runway overrun.

d. Minimum Landing Distance Prediction. In the prediction of minimum landing distance from the AFM/POH data, the following should be addressed (see paragraph 4 above and the sample cumulative landing distance worksheet in Appendix 3 for more information):

- High airport elevation or high density altitude, resulting in increased groundspeed;
- Landing weight;
- Excess airspeed over the runway threshold;
- Landing beyond the intended touchdown point;
- Runway slope;

- Excessive height over the runway threshold;
- Delayed use of deceleration devices;
- Tailwind landing; and
- A wet or contaminated runway.

e. The Effect of Wind on Landing Performance. Figure 1-2, Effect of Wind on Landing Performance, illustrates the general effect of wind by showing the percent change in takeoff or landing distance as a function of the ratio of wind velocity to takeoff or landing speed. For example, a tailwind velocity that is 10 percent of the landing airspeed produces a general effect of a 21 percent increase in the landing distance. (Refer to the current editing of the Pilot's Handbook of Aeronautical Knowledge, FAA-H-8083-25, Aircraft Performance.)

NOTE: If the wind direction is variable (VRB) and a range is given, the value that provides to most negative condition must be used in performance calculations. If no range is given, the full value of the wind velocity must be considered a tailwind, since the possibility of this exists on landing.

FIGURE 1-2. EFFECT OF WIND ON LANDING PERFORMANCE

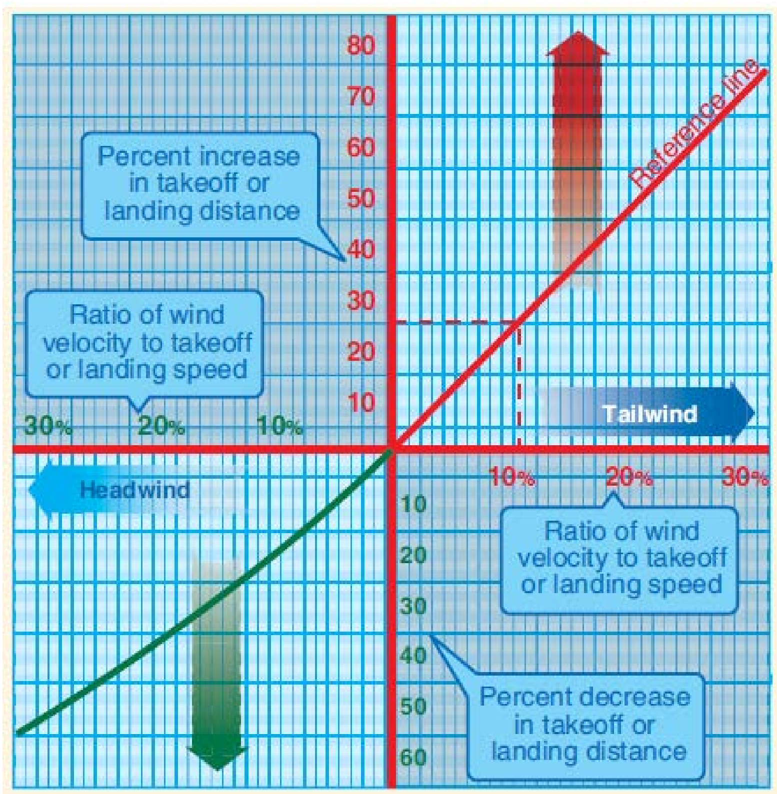
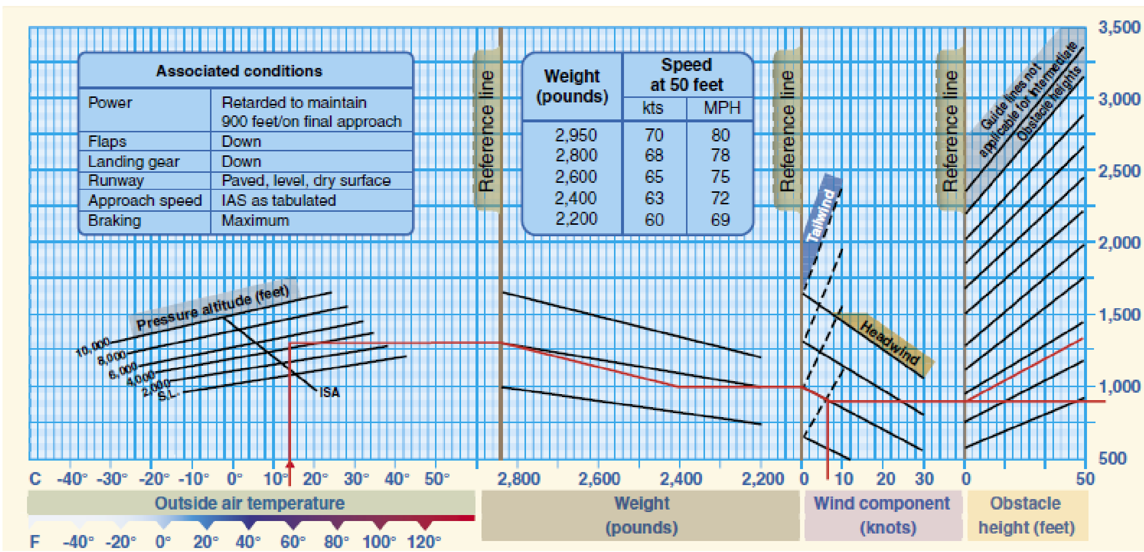


FIGURE 1-3. BASIC LANDING DISTANCE CHART

Conditions		LANDING DISTANCE							
Flaps lowered to 40° Power off Hard surface runway Zero wind									
Gross weight lb	Approach speed IAS, MPH	At sea level & 59 °F		At 2,500 ft & 59 °F		At 5,000 ft & 41 °F		At 7,500 ft & 32 °F	
		Ground roll	Total to clear 50 ft OBS	Ground roll	Total to clear 50 ft OBS	Ground roll	Total to clear 50 ft OBS	Ground roll	Total to clear 50 ft OBS
1,600	60	445	1,075	470	1,135	495	1,195	520	1,255

Note
1. Decrease the distances shown by 10% for each 4 knots of headwind.
2. Increase the distance by 10% for each 60 °F temperature increase above standard.
3. For operation on a dry, grass runway, increase distances (both "ground roll" and "total to clear 50 ft obstacle") by 20% of the "total to clear 50 ft obstacle" figure.

FIGURE 1-4. CUMULATIVE TYPE OF LANDING CHART PLOTTING DENSITY ALTITUDE, LANDING WEIGHT, HEADWIND/TAILWIND, AND OBSTACLE CLEARANCE



f. Stabilized Approach. Without the benefit on an AFM/POH performance chart that accounts for the variables this AC is discussing, the concept in Figure 1-1, Stabilized Approach, provides an appreciation of the factors that increase the airplane's landing distance, and it keeps the pilot engaged in landing distance assessment.

(1) Figure 1-2, Effect of Wind on Landing Performance, illustrates the general effect of wind by showing the percent change in takeoff or landing distance as a function of the ratio of wind velocity to takeoff or landing speed.

(2) Figure 1-4, Cumulative Type of Landing Chart Plotting Density Altitude, Landing Weight, Headwind/Tailwind, and Obstacle Clearance, provides the manufacturer's airplane performance data accounting for density altitude, landing weight, wind, and obstacle clearance height. It also illustrates a performance chart which plots the cumulative effect of each condition as the pilot progresses to obtain the landing distance.

g. Airplane Landing Weight. Calculate the anticipated landing weight by starting with the airplane gross takeoff weight at departure and subtracting the anticipated normal consumption of fuel required to arrive at the destination airport. If the en route fuel burn is less than planned, the airplane will arrive at its destination at a weight heavier than expected. Therefore, relative to the airplane's actual landing weight, a recalculation of the airplane's landing performance is essential prior to attempting a landing maneuver to validate the dispatched landing distance available.

h. Extended Flaps. Flaps may be fully extended to give the airplane a lower stalling speed during the approach to landing. This also allows the airplane to land in a shorter distance. The higher lift and drag associated with fully extended flaps produces greater drag permitting a steeper approach. The greater lift permits a lower landing speed to the landing site but imposes handling difficulties in airplanes with very low wing loading (the ratio between the wing area and the weight of the airplane). Winds across the line of flight, known as crosswind, causes the windward side of the airplane to generate more lift and drag, causing the airplane to roll, yaw, and pitch off its intended flight path. As a result, many light airplanes have limits on how strong the crosswind can be while using flaps. Furthermore, once the airplane is on the ground, the flaps may decrease the effectiveness of the brakes since the wing is still generating lift and preventing the entire weight of the airplane from resting on the tires, thus increasing stopping distance, particularly in wet or icy conditions. Thereby, usually the pilot will raise the flaps as soon as possible for airplanes without spoilers to prevent this from occurring under wet or icy conditions, and done with caution. Notwithstanding the possible effect of a full flap landing, achieving the target airspeed over the threshold, and flying the slowest approach speed for the wind conditions, selecting the maximum flap setting approved by the airplane manufacturer will provide the shortest operational landing distance.

i. Threshold Crossing Height and Airspeed. As previously discussed, the correct threshold crossing airspeed is specifically defined. Therefore it is essential to understand the impact of deviations in threshold crossing airspeeds.

j. Critical Condition Combinations. The most critical conditions of landing performance are combinations of:

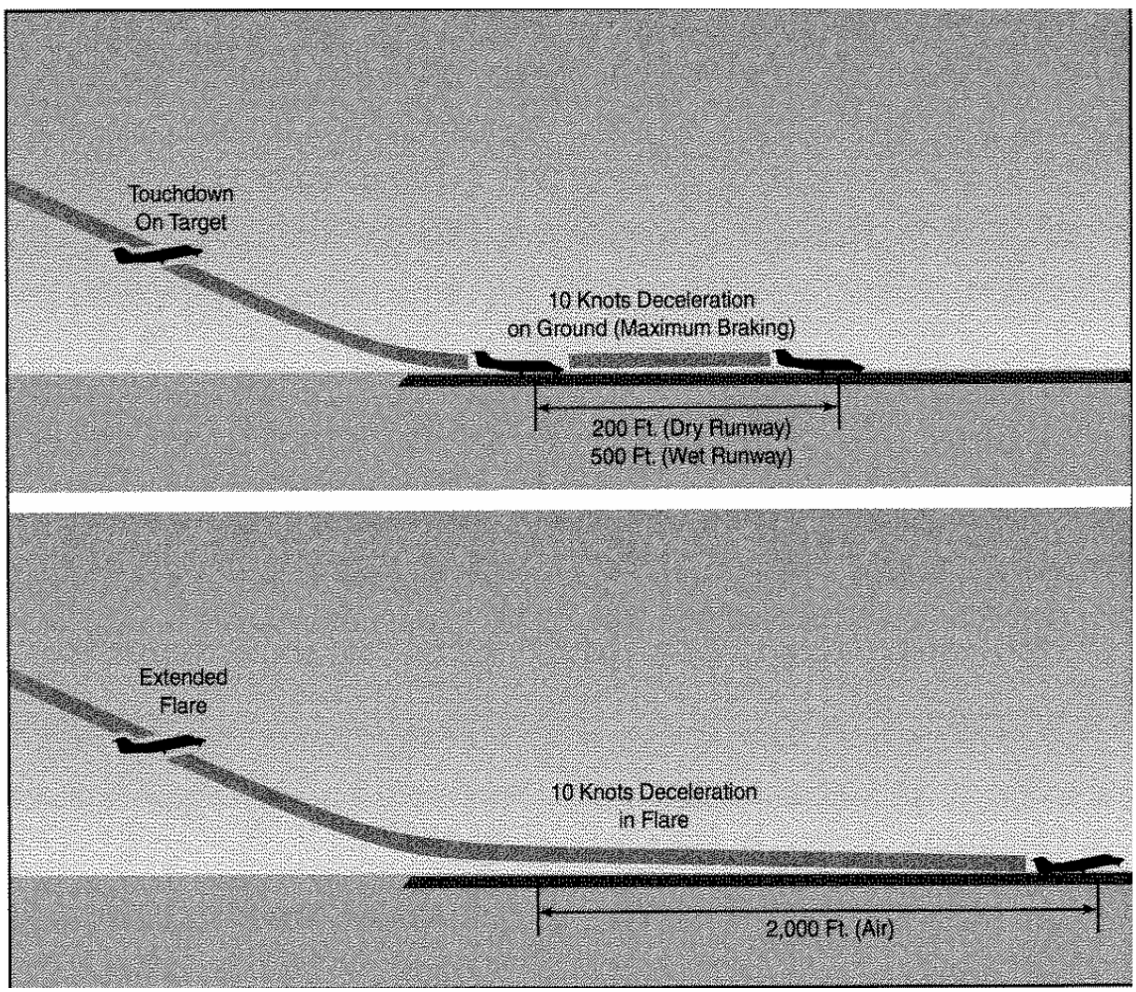
- High gross weight, high density altitude,
- Wet/contaminated runway,
- Tailwind landing,
- Downhill slope,
- Less than maximum landing flap, and
- Short runway.

NOTE: In all cases, it is necessary to make an accurate prediction of minimum landing distance to compare with the available runway.

5. LANDING AND BRAKING TECHNIQUE. The flare, touchdown, and the braking technique, are also critical factors in completing a successful approach and landing maneuver. Landing and braking techniques are discussed below from a point at the beginning of the approach flare through a point at which the airplane decelerates to normal taxi speed or has been brought to a full stop.

a. The Flare. The flare reduces the approach rate of descent to a more acceptable rate for touchdown. If the flare is extended while additional speed is bled off, additional runway will be used. An extended flare may also result in an increase in pitch attitude which may lead to a tail strike. A firm landing does not mean a hard landing, but rather a deliberate or positive touchdown at the desired touchdown point. A landing executed solely for passenger comfort considerations, which extends the touchdown point beyond the TDZ, is not impressive, desirable, or consistent with safety or regulations. It is essential to fly the airplane onto the runway at the target touchdown point. See Figure 1-5, Effects of an Extended Flare, as an example of the results of an extended flare.

FIGURE 1-5. EFFECTS OF AN EXTENDED FLARE



b. Touchdown. A proper approach and flare positions the airplane to touch down at the target touchdown point. Once the main wheels have contacted the runway, the pilot must maintain directional control and initiate the stopping process. The runway distance available to stop is longest if the touchdown was on target. Once the airplane is on the ground, ground spoilers, wheel brakes, and reversers (depending on airplane equipage) are much more effective in slowing the airplane than the aerodynamic drag produced in the flare maneuver.

NOTE: General aviation airplane technique is to slowly apply backpressure to the yoke to assist braking and to avoid damage to the nose gear or propeller.

c. Braking. A distinction should be made between the procedures for minimum landing distance and an ordinary landing roll with considerable excess runway available. Minimum landing distance will be obtained by creating a continuous peak deceleration of the airplane; that is, extensive use of the brakes for maximum deceleration. On the other hand, an ordinary landing roll with considerable excess runway may allow extensive use of aerodynamic drag to minimize wear and tear on the tires and brakes. If aerodynamic drag is sufficient to cause deceleration, it can be used in deference to the brakes in the early stages of the landing roll. For instance, brakes and tires suffer from continuous hard use, but airplane aerodynamic drag is free and does not wear out with use. The use of aerodynamic drag is applicable only for deceleration to 60 or 70 percent of the touchdown speed. At speeds less than 60 to 70 percent of the touchdown speed, aerodynamic drag is so slight as to be of little use, and braking must be utilized to produce continued deceleration. Since the objective during the landing roll is to decelerate, the powerplant thrust should be the smallest possible positive value (or largest possible negative value in the case of thrust reversers).

NOTE: In addition to proper procedures, many other variables affect the landing performance. Any item that alters the landing speed or deceleration rate during the landing roll will affect the landing distance.

(1) There are three primary forces available for deceleration during the rollout process: wheel braking, aerodynamic drag, and reverse thrust/propeller reversing, if available. The deployment of ground spoilers, if installed, immediately upon touchdown on the runway has the effect of dumping the lift generated by the wings and placing the airplane's weight on the wheels, which enhances the effects of wheel braking after touchdown. Deployment of drag devices are most effective at higher speeds and are not affected by runway surface conditions. In all cases, the pilot must ensure the automatic deployment of the deceleration devices occurs. If not, the pilot must immediately manually employ the devices to minimize the time lost to achieve as close as possible the assessed landing distance.

(2) Timely deployment of spoilers will increase drag by 50 to 60 percent, but more importantly, deployment of the spoilers increases wheel loading by as much as 200 percent in the landing flap configuration. This increases the tire-to-ground friction force making the maximum tire braking forces available. Many airplanes with auto-spoilers installed require weight on wheels to deploy the spoilers, which reinforces the requirement for a positive touchdown as a soft touchdown can delay the automatic deployment. Spoiler deployment immediately after touchdown provides the greatest benefit.

(3) When minimum landing distances are considered, braking friction forces predominate during the landing roll and, for the majority of airplane configurations, braking friction is the main source of deceleration when the runway is dry.

d. Wet and Contaminated Runway Surface. When the runway is wet or slippery, reverse thrust (if the airplane is equipped), may be the dominant deceleration force just after touchdown, and throughout the deceleration if the runway has poor or worse braking conditions. As the airplane slows down, the wheel brakes become the dominate deceleration force. When the runway length is limited, for airplanes equipped with an antiskid system, maximum wheel braking should be applied immediately after touchdown. For airplanes without an antiskid system slow back pressure should be applied to the yoke such that it will not raise the nose of a nose gear airplane for aerodynamic braking while maximum braking that will not cause skidding is applied. In all situations, braking should be maintained until the airplane slows to a safe taxi speed for the conditions.

e. Autobrakes. If the airplane is equipped with autobrakes, manufacturers recommend the use of the autobrakes for all landings on contaminated runways. Autobrakes are applied earlier in the landing roll, and to the level selected by the pilot for the anticipated landing condition, runway available, and provide the most efficient and timely use of braking action. However, the pilot must ensure that if the autobrakes do not engage upon touchdown, then manual braking must be applied.

f. Antiskid. Application of brakes is different for airplanes equipped with a functioning antiskid braking system than for airplanes without such a system.

(1) For airplanes without an antiskid system, brakes should be applied progressively throughout the deceleration process, and the pilot must recognize the point that wheel skid occurs. Maximum braking effectiveness occurs just prior to the point where wheel skidding occurs. However, should a skid occur, releasing brake pressure can stop skidding and then maximum braking can be reestablished until the deceleration process is completed. Pilots should be aware that a skid is most likely at higher speeds and at that point may not be perceptible.

(2) For airplanes with antiskid system, to achieve the benefits of antiskid, the brakes must be applied firmly throughout the deceleration process. When maximum braking is required, it is accomplished by holding maximum brake application pressure and allowing the antiskid system to operate. Letting up on the brakes (unless required to regain directional control) defeats the purpose of the antiskid system. The pulsation caused by the modulation of the brake pressure by the antiskid system indicates that the antiskid system is operating normally although the pulsation may be disconcerting to the pilot.

g. Touchdown Technique. A firm touchdown at the target touchdown point, followed by, for those airplanes so equipped, the deployment of ground spoilers, the timely selection of thrust reverse (if installed), and the application of max/progressively applied firm braking will result in the shortest landing distance ground roll, particularly on wet or contaminated runway surfaces.

h. Directional Control. The nosewheel should be lowered onto the runway immediately after touchdown. Placing the nosewheel on the runway will assist in maintaining directional control. It also decreases the wing angle of attack, thereby decreasing lift and placing more load onto the tires, which increases tire-to-ground friction.

i. Thrust Reversers. In the event of an asymmetric deployment, the nosewheel on the ground will aid in directional control. If the thrust reversers deploy asymmetrically, or if the airplane begins to drift due to a crosswind, close the thrust reversers and reestablish directional control. Once the airplane's track down the runway is reestablished, redeploy the thrust reversers. Use airplane steering in accordance with the AFM procedures.

6. SUMMARY. A stabilized approach terminating with a landing in the TDZ, timely deployment of airplane deceleration devices, and braking technique are critical elements to mitigating the landing runway-overrun risk. It is a responsibility of operators to consider the factors presented, and incorporate these items, as well as the extensive research and safety information available regarding avoiding a runway overrun into training programs and operations manuals. It is the pilot's responsibility to apply the landing assessment process, exercise conservative aeronautical decision-making (ADM), be proficient in the landing techniques for the conditions to be encountered, and that a go-around or diversion are mitigations to prevent a runway overrun.

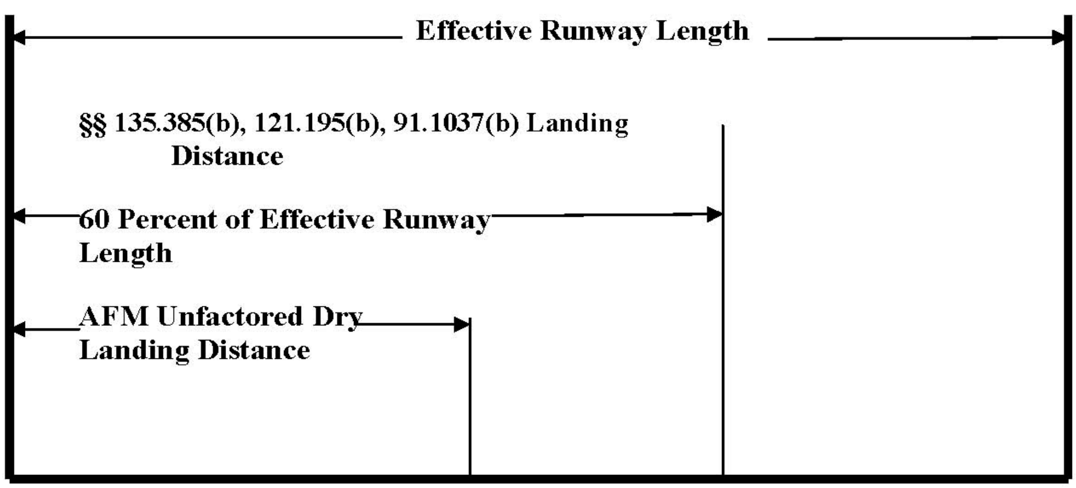
APPENDIX 2. REGULATORY CONSIDERATIONS AND RECOMMENDED OPERATIONAL PRACTICES

1. REGULATORY REQUIREMENTS FOR LANDING FOCUS ON PREDEPARTURE FLIGHT PLANNING. The intent is to ensure that a flight operation does not begin that cannot reasonably be safely concluded upon reaching the destination or alternate airport, as applicable. Regarding regulations, there are differences in the various operating regulations concerning landing performance. Compliance with these regulations is shown using approved data from the Airplane Flight Manual (AFM).

> **NOTE: Some manufacturers supply advisory or supplemental data that provides landing performance data based on landing weight, airport elevation and temperature, corrected for wind (headwind, tailwind), and slope. Manufacturers may also supply advisory or supplemental data that accounts for runway condition (wet, dry, and contaminated) and braking degradation (i.e., antiskid is inoperative, thrust reversers are inoperative, etc.). Pilots and operators should be familiar with the data presented in their AFM, and they should be capable of applying both the approved data and advisory or supplemental data to make operational decisions.**

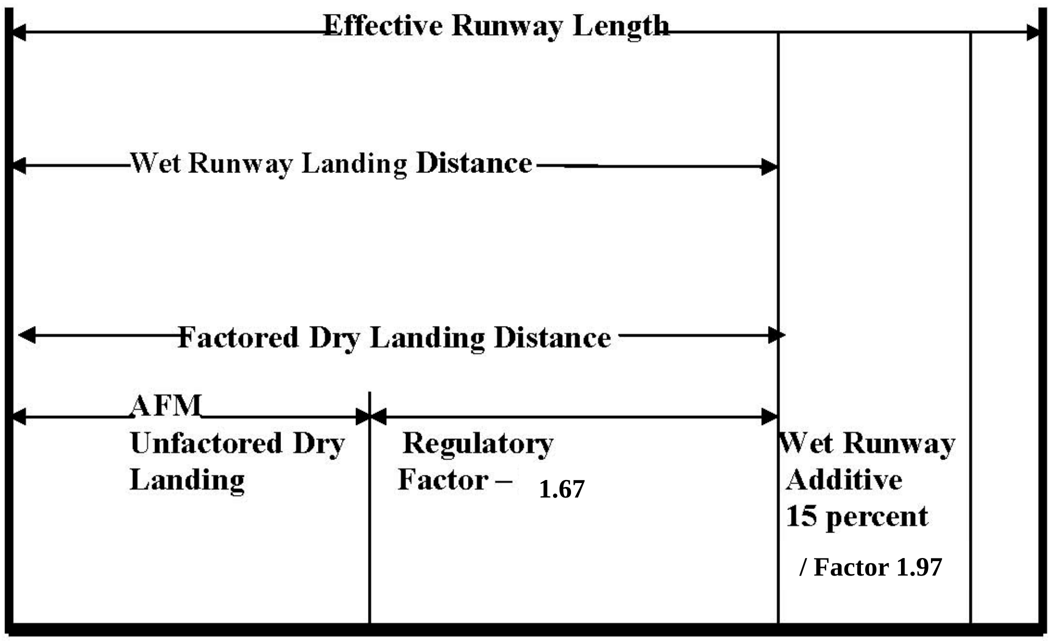
2. REGULATORY CONSIDERATIONS. It is not the intent of this advisory circular (AC) to provide the regulatory requirements. However, operators and pilots must be knowledgeable of the operational regulations applicable to their type of operation. Figure 2-1, Sections 121.195(b), 135.385(b), and 91.1037(b) 60-Percent Rule; Figure 2-2, Sections 121.195(d), 135.385(d), and 91.1037 Wet Runway 115-Percent Rule; and Table 2-1, Regulatory Planned Landing Distance Calculations Overview, provide a regulatory overview of airplane landing performance requirements applicable to flight operations conducted in accordance with Title 14 of the Code of Federal Regulations (14 CFR) parts 91K, 121, and 135.

FIGURE 2-1. SECTIONS 121.195(B), 135.385(B), AND 91.1037(B) 60-PERCENT RULE



NOTE: Part 91, § 91.1037 states, in part: "(e) Unless, based on a showing of actual operating landing techniques on wet runways, a shorter landing distance (but never less than that required by paragraph (b) or (c) of this section) has been approved for a specific type and model airplane and included in the Airplane Flight Manual, no person may take off a turbojet airplane when the appropriate weather reports or forecasts, or any combination of them, indicate that the runways at the destination or alternate airport may be wet or slippery at the estimated time of arrival unless the effective runway length at the destination airport is at least 115 percent of the runway length required under paragraph (b) or (c) of this section."

FIGURE 2-2. SECTIONS 121.195(D), 135.385(D), AND 91.1037 WET RUNWAY 115-PERCENT RULE



NOTE: Calculations depicted in Table 2-1 are preflight planning calculations. When the flight arrives at the destination, 100 percent of the effective runway length is available for landing. It should be noted that operators with operations specifications (OpSpecs) and management specifications (MSpecs) must complete these calculations in accordance with those directives.

TABLE 2-1. REGULATORY PLANNED LANDING DISTANCE CALCULATIONS OVERVIEW

Regulation	Type of Airplane	Runway Condition	Percentage of Effective Runway Length
§ 121.195(b) § 135.385(b) § 91.1037(a)	Large turbine powered	Dry	60 percent
§ 121.195(c) § 135.385(c)	Turbopropeller alternate airport	Dry	70 percent
§ 121.195(d) § 135.385(d) § 91.1037(e)	Turbojet without an approved AFM wet runway landing technique	Wet/Slippery	115 percent of § 121.195(b) or § 135.385(b), or § 91.1037(e) AFM factored dry landing distance
§ 135.385(f) § 91.1037(c)(2)	Large turbine powered, eligible on demand	OpSpecs/MSpecs Authorized	80 percent
§ 121.197 § 135.387(a)	Large turbine powered alternate airport	Dry	60 percent
§ 121.197 § 135.387(a)	Turbopropeller alternate airport	Dry	70 percent
§ 135.387(b) § 91.1037(3)(d)	Large turbine powered, eligible on demand alternate airport	OpSpecs/MSpecs Authorized	80 percent

NOTE: For part 125 operators, it is highly recommended that they adopt the stated regulatory requirements contained in Table 2-1 above.

a. Part 91 Operational Recommendations.

(1) Preflight planning requirements for part 91 operators are governed by §§ 91.103 and 91.605. It is highly recommended that part 91 operators, and pilots calculate predeparture landing distance performance requirements based on the guidance contained in their AFM, and employ the landing assessment process before initiating the approach landing phase of the flight, and consider the factors presented in this AC to avoid a runway overrun.

(2) To ensure that an acceptable landing distance safety margin exists at TOA, the FAA recommends a 15 percent safety margin be applied to the actual airplane landing distance. The 15 percent safety margin is a minimum safety margin to be applied after accounting for all known variables, such as the meteorological, runway surface conditions, landing with a tailwind, airplane configuration and weight, runway slope, threshold crossing height and airspeed, and the timely utilization of ground deceleration devices. Be prepared, know the landing conditions, divert to an alternate, or go around, but do not risk a runway overrun.

APPENDIX 3. OPERATIONAL AWARENESS OF WET AND CONTAMINATED RUNWAYS LANDING DISTANCE DATA

1. MANUFACTURERS AND AIRPLANE FLIGHT MANUAL (AFM) DATA. In accordance with Federal Aviation Administration (FAA) certification rules, the FAA-approved AFM data are determined only for dry runway conditions. Some manufacturers provide supplemental FAA-approved AFM data for operation on wet grooved runways. Manufacturers may also provide supplemental advisory landing distance data for conditions beyond those required by regulation; however, they are not used in lieu of the advised 15 percent safety margin. The data contained in these supplements, although not FAA approved, are based on the same flight test data used to generate the FAA-approved dry runway takeoff and landing performance presented in the AFM. Performance is calculated using analytical corrections to dry runway performance utilizing methods appropriate for aircraft certification outside the United States. Again, at least a 15 percent safety margin should be applied to these data.

2. METHODS USED TO ADJUST DRY RUNWAY PERFORMANCE. The analytical methods employed to adjust the dry runway performance to account for conditions encountered on wet and contaminated runways are complex and comprehensive. The methods utilized include adjustments for changes in the braking coefficient, precipitation drag, and hydroplaning, as applicable.

3. BRAKING COEFFICIENT. The braking coefficient is a measure of the braking efficiency at the contact point between the airplane main tires and the runway. The braking coefficient is the ratio of braking force divided by the weight on the tire. A tire supporting 5,000 pounds with a braking coefficient of 0.5 would be capable of producing 2,500 pounds of stopping force. As contaminants are introduced onto the runway, the braking coefficient is reduced, decreasing the stopping capability of the airplane.

> **NOTE: For example, a wet runway typically will reduce the braking coefficient by about 50 percent. Runways contaminated with dry snow typically can reduce the braking coefficient down to about 0.10, or only 20-25 percent of the braking capability of a dry runway. In other words, the 2,500-pound stopping force on a dry runway may now be only 500-600 pounds on dry snow.**

4. PRECIPITATION DRAG. Precipitation drag comprises two components: precipitation impingement drag and precipitation displacement drag.

a. Precipitation Impingement Drag. Precipitation impingement drag is the force created as contaminant spray from the tires impacts parts of the airframe, such as the flaps behind the main gear. Impingement drag assists in slowing the airplane and resists acceleration.

b. Precipitation Displacement Drag. Precipitation displacement drag is a resistance force created as the tires push runway contaminant out of the way while moving along the runway.

c. Example. It is the force you feel when trying to move your hand rapidly through water. As your hand moves the water is forced out of the way, and the faster you try to move your hand, the stronger the resistance. Runway contaminants act much the same way. The resultant resistance force assists in slowing the airplane during landing or a rejected takeoff, and also resists acceleration during takeoff.

> **NOTE: Some manufacturers do not include the effects of precipitation drag on landing distances. However, if the effect of precipitation drag is included in the landing distance performance for the airplane, it has the non-intuitive characteristic. This means that given a conservative approach to assessing the airplane's landing distance due to precipitation drag, if a deeper contaminant level is selected with the intention of being conservative, the result will be the opposite—it will be non-conservative. If less contaminant is actually there, it will result in a longer distance than calculated.**

5. DETERMINE THE RUNWAY SURFACE CONDITION. Appropriate determination of the runway surface condition is basic to the mitigation of a runway overrun. Once the surface condition is determined, it is a pilot's responsibility to decide whether the standard AFM dry runway performance charts are appropriate or whether the wet and contaminated performance data needs to be consulted. In preparing for takeoff, this decision is considerably easier since the pilot can visually survey the runway. The standard dry runway charts are for a totally dry runway.

> **NOTE: For example, if the ramp is too damp to sit on due to morning dew, the runway is probably the same. The pilot should use the wet or contaminated performance data.**

6. DATA REVIEW. When reviewing takeoff and landing data, the pilot should pay attention to the details, and select the correct chart. In many cases this is obvious, but there may be conditions, or combinations of conditions, that can make the selection problematic. Careful review of Aviation Routine Weather Report (METAR) or other airport reports may provide sufficient information to make the proper selection. At airports where automated terminal information service (ATIS) is available, surface contamination reports may be included that can be used as a guide. At other airports, no information may be available. Regardless of the source, it is prudent to utilize the information that yields the most conservative performance. If reports indicate mixed runway conditions such as snow and slush, <u>use the chart for the contaminant that results in the longest distance</u>. If no reliable information is available, use the chart for the reasonably likely condition that provides the longest distance.

> **NOTE: If you choose to land with a tailwind, a tailwind is a significant factor that increases an airplane's landing distance. Selection of a runway condition that renders a shorter distance should only be based on factual information. The pilot should resist the temptation to use a less severe runway contamination condition simply because it produces a landing distance that is equal to or less than the available runway length.**

> **NOTE: Runway overrun mitigation implies, if the landing assessment reveals that the runway length available is not long enough to safely land and stop the airplane, change to a longer runway, or even divert to a different airport.**

7. RUNWAY SURFACE CONDITIONS BEYOND DATA COVERAGE. There are runway surface conditions, such as wet ice, that are worse than the wet and contaminated data provided in the airplane's landing performance AFM. Even the most effective braking systems are ineffective in the presence of a near zero braking coefficient.

> **NOTE: For example, with a zero or near zero braking coefficient, the rolling friction coefficient of all the tires is near zero. Nosewheel steering will be ineffective, and the pilot will not be able to correct for any side force on the airplane, such as a crosswind. Given this reported runway condition, the flight should divert to an airport where the better landing conditions are reported.**

8. OPERATIONS AT NON-TOWERED AIRPORTS. Operations at non-towered airports require pilots to gather available information on expected runway conditions prior to initiating an approach.

> **NOTE: For example, if there is no clear report of runway condition(s), but the pilot knows rain has been in the area, that pilot should assume the runway is wet. Also, if there is rain actively falling on the runway, standing water should be assumed. If there is any doubt as to the amount of water on the runway, assume the most conservative condition that requires the longest landing distance.**

9. DECELERATION. Once committed to an operation on a wet or contaminated runway, the pilot should expect a lower level of deceleration than experienced on a dry runway.

> **NOTE: For example, consider the landing distances for wet and contaminated surfaces, assuming zero wind and a zero runway gradient. Then add the distance effect of a tailwind, downhill runway gradient, additional speed, and delayed use of deceleration devices. Under these conditions, a wet runway increases the landing distance over a dry runway by approximately 26 percent. If standing water is present, the landing distance increases approximately 52 percent.**

> **NOTE: The contaminant only affects the ground roll and braking. It has no impact on the air distance from 50 feet (ft) to touchdown, which is included in the landing distance. In the presence of standing water, for the total landing distance to increase 52 percent, the ground braking distance increases 100 percent. This situation will surprise a pilot the first time it is encountered because the deceleration rate on this surface will be only one-half of what the pilot has experienced on a dry runway.**

10. CONTAMINANT PROCEDURES. For any contaminant, the pilot should expect a relatively low deceleration rate in the initial phase of braking. A wet runway may be less severe than other contaminants, but the pilot must remember that any increase in total landing distance will occur entirely in the landing ground roll braking segment.

NOTE: Under some conditions, wet runways have exhibited significantly worse than expected braking, and the reason for this is not yet understood.

11. HYDROPLANING. Hydroplaning is defined as a condition that exists when the tires ride on the surface of the contaminant, much like a water ski. When the tires are hydroplaning, directional control and braking action are virtually impossible. An effective antiskid system can minimize the effects of hydroplaning. See Figure 3-1, Hydroplaning.

FIGURE 3-1. HYDROPLANING

a. Hydroplaning. Hydroplaning is a significant factor that should be considered in determining stopping capability on a contaminated runway. Hydroplaning depends on wheel speed and tire pressure. The key item to remember when the airplane is hydroplaning is that the tires are no longer in contact with the runway, although the airplane is not airborne. Though at high speeds, aerodynamic drag can provide a significant decelerating force. Reverse thrust/propeller reversing, if installed, provides nearly all the decelerating force when hydroplaning since the brakes are essentially ineffective. These characteristics are included in the distances presented in the contaminated runway supplemental data when provided by the airplane manufacturer.

b. Directional Control. It is very important to realize that directional control has not been demonstrated on these surfaces. The pilot should expect significant degradation in directional controllability on a contaminated runway, depending on the level of available runway friction, especially with an engine shut down or with a crosswind. Some manufacturers provide maximum crosswind values, derived through simulation and calculation, for landing on contaminated runways.

NOTE: Runway surface conditions are rarely consistent over the full length of the runway. Even dry runways will present different friction coefficients due to heavy rubber deposits in the touchdown zone (TDZ) and large paint markings such as the 1,000-foot markers or centerline stripes. The degree of runway surface contamination due to ice, packed snow, or standing water varies along the length of the runway. The pilot will sense changes in the deceleration rate as the airplane transitions from one contaminant condition to another.

12. BRAKE FAILURE VERSUS REDUCED BRAKING. How does the pilot differentiate between reduced braking capability and a brake failure with reduced, and occasionally very low, deceleration rates due to runway contamination? The best answer is for the pilot to be thoroughly familiar with all operating characteristics of the airplane. Experience is the best tool, and until the pilot has the experience, training and knowledge of aircraft performance is the best tool. All pilots should take advantage of the opportunity to experience braking capability in the simulator on different contaminants when possible. While decelerating, scan the airspeed display in order to relate the change in speed to the kinesthetic perceptions. During the period of maximum brake application after touchdown, the antiskid system is working to keep the tires on the verge of a skid. The pilot may perceive small, abrupt pulses as the tires occasionally get a solid grip prior to skidding, followed by a short release of brakes to allow the tires to spin up again. As the surface condition becomes more challenging, the antiskid system will command longer brake releases to maintain a proper level of friction between the tire and the runway. As the airplane decelerates, the braking effectiveness will increase but may never attain dry runway levels. As long as the pilot senses the cycling of the antiskid system, the pilot knows the brakes are performing to the maximum extent permitted by the runway surface condition.

> **NOTE: The pilot cannot modulate the brakes better than the antiskid system. Pilot response time to the changing conditions is measured in seconds, and the antiskid system can adjust in milliseconds. The best braking performance will occur when the pilot presses hard on the brake pedals and maintains a constant pressure. Let the antiskid do all the modulation but be sensitive to that same antiskid operation. Be perceptive and make note of the antiskid pulses. That is the pilot’s firsthand knowledge of proper brake operation.**

13. PERFORMANCE DATA NOTES. Every pilot should read and understand the information presented in the contaminated runway supplemental data before using the information to calculate performance. When the pilot thoroughly understands the operation of the antiskid system, becomes familiar with the runway condition at the destination, and completes and applies conservative landing distance calculations, the pilot will mitigate the risk of a runway overrun.

14. TABLES FOR RUNWAY MITIGATION. These tables are included to assist the pilot in the application of the concepts presented to mitigate the risks associated with the hazard of a runway overrun. Table 3-1, Memory Jogger: Can You Stop?; Table 3-2, All Factors Present Cumulative Landing Distance Example; and Table 3-3, All Factors Cumulative Landing Distance Example Stabilized Approach and Timely Deceleration, provide guides to be considered in order to mitigate a runway overrun. Table 3-1 provides a memory jogger for the concepts pilots must exercise to mitigate the risk of a runway overrun. Table 3-2 provides a sample of what can occur if all the runway factors to consider are present in a landing. Table 3-3 demonstrates the benefits of a stabilized approach, choosing to land with favorable winds, and timely deceleration.

> **NOTE: These items cannot replace the information contained in the AFM. They are provided to help the flightcrew member recognize the possible increase in risk associated with certain conditions. The information**

presented in this AC must not be used to replace or supplant AFM landing performance or associated contaminated runway performance information provided by the manufacturer.

TABLE 3-1. MEMORY JOGGER: CAN U STOP?

CAN U STOP?	
C–Calculate	Use the manufacturer's or company data to determine the landing distance required prior to departure and again prior to landing based on company SOPs. Be sure to consider factors as dry/wet runways and associated contamination, planned touchdown point, speed and height over the landing threshold, runway slope, tailwind/wind speed and direction, inoperative equipment, and any special cases.
U–Understand	The manufacturer's AFM landing data and it is derived based on flight test data. Factors to be applied to the data to adjust it for the current conditions. If data is not available, employ the information contained in SAFO 06012.
S–Stabilized	Ensure that you understand all the requirements of a stabilized approach and you are able to fly one given the actual conditions. If not, go around!
P-Professional	Land like a professional using the airplane's capabilities as described in the AFM and SOPs. *A professional puts safety ahead of style.*

TABLE 3-2. ALL FACTORS PRESENT CUMULATIVE LANDING DISTANCE EXAMPLE

1. Available runway length.	**5,000 ft**
2. Per AFM, Dry runway Un-factored AFM landing distance for density altitude & lightest landing gross weight.	**3,000 ft**
3. Runway Slope -1%: Add 10% of landing distance per 1% downhill slope, i.e., 1% downhill slope adds 10% to the landing distance.	**300 (3,300’)**
4. Excessive airspeed at 50 foot landing threshold, landing distance increase: For each 10% increase in landing speed greater than the AFM, add 20% landing distance or: Example: 10 % fast (3,300 × .20 = 660 ft).	**660 ft (3,960’)**
5. Tailwind Condition: Add 21% to landing distance for each 10 kts in tailwind. Example: 10-kt Tailwind .21 × 3,960 = 832 ft.	**832 ft (4,792’)**
6. Extended Flare Add 200 ft per second flare time: Results in a 200 ft/sec additive (2 × 200 = 400 ft).	**400 ft (5,192’)**
7. Excess 50-ft height: Add 200 ft to the landing distance for each 10 ft above 50 ft. Example: 10-ft excess.	**200 ft (5,392’)**
8. MEL/CDL additions: Any additions caused by minimum equipment list (MEL)/Configuration Deviation List (CDL) requirements No MEL/CDL additive 0 ft.	**0**
9. Sum of before landing items 2 through 8 added 2,392 ft = 80% greater than 3,000 ft.	**5,392 ft**
10. Deceleration devices, 3 second deployment time. (1 second more than the 2 second max) add 200 ft per each second greater than 2 seconds. Add 200 ft or use AFM data if available.	**200 ft (5,592’)**
11. Less than maximum braking add 20% or use AFM data if available.	**1,118 ft (6,710’)**
12. Wet Runway SAFO Safety Margin. If wet, add 15 percent of line 9 or use AFM data if available .15 × 5,392 = 809 ft.	**1,107 ft (7,717’)**
13. After landing factors, Lines 10 - 13 added 2,425 ft, 45% greater than 5,392 ft. Required landing distance 7,717 ft 2,717 ft longer than available. Cumulative Landing Distance Increase: 157%	**7,717 ft**

TABLE 3-3. ALL FACTORS CUMULATIVE LANDING DISTANCE EXAMPLE STABILIZED APPROACH AND TIMELY DECELERATION

1. Available runway length.	**5,000 ft**
2. Per AFM, Dry runway Unfactored AFM landing distance for density altitude & lightest landing gross weight.	**3,000 ft**
3. Runway Slope -1%: Add 10% of landing distance per 1% downhill slope, i.e., 1% downhill slope adds 10% to the landing distance.	**300**
4. Excessive airspeed at 50-ft landing threshold, landing distance increase: For each 10% increase in landing speed greater than the AFM, add 20% landing distance or: Example: 10% fast (3,300 × .20 = 660 ft).	**0**
5. Tailwind Condition: Add 21% to landing distance for each 10 kts in tailwind. Example: 10 kt Tailwind .21 × 3,960 = 832 ft.	**0**
6. Extended Flare Add 200 ft/sec flare time: Results in a 200 ft/sec additive (2 × 200 = 400 ft).	**0**
7. Excess 50-ft height – Add 200 ft to the landing distance for each 10 ft above 50 ft. Example: 10-ft excess.	**0**
8. MEL/CDL additions: Any additions caused by minimum equipment list (MEL)/Configuration Deviation List (CDL) requirements No MEL/CDL additive 0 ft.	**0**
9. Sum of before landing items 2 through 8 added 2,392 ft equals 80% greater than 3,000 ft.	**3,300 ft**
10. Deceleration devices, 3 second deployment time. (1 second more than the 2 second max) add 200 ft per each second greater than 2 seconds. Add 200 ft or use AFM data if available.	**0**
11. Less than maximum braking add 20% or use AFM data if available.	**0**
12. Wet Runway SAFO Safety Margin. If wet, add 15% of line 9 or use AFM data if available .15 × 5,392 = 809 ft.	**495 ft**
13. After Landing factors Lines 10 - 13 added 495 ft, leaving 1,210 ft runway remaining after the 15% safety margin. Reduced landing distance: 3,927 ft. Cumulative landing distance within 66% of available runway.	**3,790 ft**

NOTE: In a stabilized approach, the proficient pilot receives an accurate runway condition report, chooses to land on a runway with a favorable wind for landing, and adds a safety margin, which results in stopping within the landing distance available.

APPENDIX 4. UNSTABILIZED APPROACH CASE STUDY

You, the first officer, obtained automated terminal information service (ATIS) information during the descent that indicated strong westerly winds on the ground and field elevation of approximately 800 feet (ft) mean sea level (MSL). Because of terrain, the most common approach to the landing runway is via the instrument landing system (ILS) approach to another runway, and then to perform a circle-to-land maneuver to the landing runway.

(a) Air traffic control (ATC) then advises you of updates to the ATIS and also to expect a straight-in approach. You have approximately 5 minutes to prepare for landing on the new runway. Without performing a completely new approach briefing, you prepare for the change in runway by confirming your previously planned flap setting of 40 degrees, with a reference landing airspeed (V_{REF}) of 138 knots (kts). Given that the airplane is flying the ATC assigned, heading and descending steadily with the autopilot engaged, routine communications with ATC almost entirely consume the short time available to prepare the approach.

(b) The newly assigned runway is relatively short and will have a tailwind; however, the landing distance is adequate, but provides little margin for error. While you are obtaining the new ATIS (indicating a tailwind for landing, but within the airplane's tailwind limit), the captain receives and acknowledges an ATC instruction to maintain 230 kts or more until advised, with vectors to a base leg, and to follow another airplane to intercept the final approach path. Then, when ATC clears your airplane for a visual approach to the runway, the airplane is at 230 kts, at 5,000 ft MSL, and almost 10 miles away from the runway. Noting that the airport's elevation is approximately 800 ft MSL, the captain must both slow the airplane and descend relatively quickly to make the landing, while configuring the airplane for landing.

(1) Do You Continue With the Approach? ATC positions the airplane high and fast close to the runway, and now you face the difficult task of establishing a stabilized approach. Alternative options include either extending the approach path in cooperation with ATC or abandoning the approach. However, 1 minute after ATC clears the airplane for the approach, you perform the first configuration change to get the airplane below 225 kts (the maximum speed to extend flaps to 5 degrees). The airplane is now descending to 3,000 ft, slowing through 225 kts, and slightly overshooting the final approach course on autopilot.

(2) What Would Your Landing Strategy Be? The captain then disconnects the autopilot and brings the airplane back on course, ordering gear extension and successive flap extensions, while maintaining 3,000 ft until 3 miles from the threshold. The captain then commands flaps 40 while the airplane is above 180 kts. (Maximum speed for flaps 40 is well below this speed.) The airplane then slows to 180 kts, and the captain is flying the approach at more than twice the normal 3-degree gradient to the runway in his or her efforts to touch down just beyond the runway threshold. When the airplane passes below 1,200 ft above ground level (AGL), and its descent rate increases through 2,900 ft/minute, the ground proximity warning system (GPWS) "sink rate" warning starts to sound continuously, later followed by the more stringent "whoop, whoop, pull up" warning.

(3) What is Your Reaction? When the airplane reaches 1,000 ft above airport elevation, its airspeed has increased to almost 200 kts with a 14-knot tailwind, and it is descending at more than 2,600 ft/minute. When descending through 500 ft, 16 seconds from touchdown, speed is unchanged and descent rate is almost 2,000 ft/minute. You miss the 500 ft required callout as you are also concerned about the airplane that has landed ahead and has not yet cleared the runway. Despite all of this, the airplane continues at a steep gradient greater than 3 degrees until the captain begins the flare for landing at approximately 150 ft AGL. Although he manages to land the airplane within the normal TDZ, he has not been able to slow the airplane while descending at that angle. Despite the engines remaining at idle, the airplane is flying on average some 45 kts faster than the target speed throughout the final approach and landing. The airplane touches down at a speed of 182 kts, with a 6-knot tailwind, some 2,150 ft beyond the runway threshold with approximately 3,900 ft of runway remaining. The captain does not apply and hold maximum brake pressure (as it was the airline's policy to use manual braking rather than autobraking during landing rollouts), and uses reverse thrust. However, he is unable to stop the airplane on the runway, and the airplane overruns the runway.

(4) Lesson Learned. The lesson learned is that flying a stabilized approach is critical for safety, regardless of whether one is flying an airliner or a light airplane. Always fly per company procedures, use the manufacturer's AFM/POH landing performance for the current landing conditions, exercise sound aeronautical decision-making (ADM), and ensure the following:

(a) The airplane is on the correct flight path.

(b) Only small changes in heading/pitch are necessary to maintain the correct flight path.

(c) For large airplanes, the airspeed is not faster than V_{REF} (threshold crossing speed) plus 5 kts indicated speed, or as stated in the SOP for windy conditions. Do not fly slower than V_{REF}. For small airplanes, after aligning with the runway, fly the AFM/POH recommended approach airspeed, and adjust airspeed for windy conditions. In the absence of a manufacturer's recommended approach airspeed, use $1.3 \times V_{SO}$ (stall speed or minimum stead flight speed at which the airplane is controllable in the landing configuration), and use flaps per the wind conditions, or as recommended by the manufacturer to ensure positive lateral airplane control during the flare to touch down. (Refer to the current edition of FAA-H-8083-3, Airplane Flying Handbook, for more information.)

(d) The airplane is in the correct landing configuration.

(e) Power setting is appropriate for the airplane configuration and is not below the minimum power for the approach as defined by the operating manual; and the crew has conducted all briefings and checklists.