Flight Safety Foundation

ALAR

Approach-and-landing Accident Reduction

Tool Kit

FSF ALAR Briefing Note 1.1 — Operating Philosophy

Adherence to standard operating procedures (SOPs) is an effective method of preventing approach-and-landing accidents (ALAs), including those involving controlled flight into terrain (CFIT).

Crew resource management (CRM) is not effective without adherence to SOPs.

Statistical Data

The Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force found that "omission of action/ inappropriate action" (i.e., *inadvertent* deviation from SOPs) was a causal factor[1] in 72 percent of 76 approach-and-landing accidents and serious incidents worldwide in 1984 through 1997.[2]

The task force also found that "deliberate nonadherence to procedures" was a causal factor in 40 percent of the accidents and serious incidents.

Manufacturer's SOPs

SOPs published by an airframe manufacturer are designed to:

- Reflect the manufacturer's flight deck design philosophy and operating philosophy;
- Promote optimum use of aircraft design features; and,
- Apply to a broad range of company operations and environments.

The initial SOPs for a new aircraft model are based on the manufacturer's objectives and on the experience acquired during flight-testing programs and route-proving programs.

After they are introduced into service, SOPs are reviewed periodically and are improved based on feedback received from users (in training and in line operations).

Customized SOPs

An airframe manufacturer's SOPs can be adopted "as is" by a company or can be used to develop customized SOPs.

Changes to the airframe manufacturer's SOPs should be coordinated with the manufacturer and should be approved by the appropriate authority.

SOPs must be clear and concise; expanded information should reflect the company's operating philosophy and training philosophy.

U.S. Federal Aviation Administration (FAA) Advisory Circular 120-71, *Standard Operating Procedures for Flight Deck Crewmembers*, published Aug. 10, 2000, includes a list of generic topics that can be used for the development of company SOPs (see *Standard Operating Procedures Template*, page 6).

Company SOPs usually are developed to ensure standardization among different aircraft fleets operated by the company.

Company SOPs should be reassessed periodically, based on revisions of the airframe manufacturer's SOPs and on internal company feedback, to identify any need for change.

Flight crews and cabin crews should participate with flight standards personnel in the development and revision of company SOPs to:

- Promote constructive feedback; and,
- Ensure that the SOPs, as well as the reasons for their adoption, are understood fully by users.

Scope of SOPs

The primary purpose of SOPs is to identify and describe the standard tasks and duties of the flight crew for each flight phase.

SOPs generally are performed by recall, but tasks related to the selection of systems and to the aircraft configuration should be cross-checked with normal checklists.

SOPs are supplemented usually by information about specific operating techniques or by recommendations for specific types of operations (e.g., operation on wet runways or contaminated runways, extended-range twin-engine operations [ETOPS] and/or operation in reduced vertical separation minimums [RVSM] airspace).

SOPs assume that all aircraft systems are operating normally and that all automatic functions are used normally. (A system may be partially inoperative or totally inoperative without affecting the SOPs.)

SOPs should emphasize the following items:

- Operating philosophy;
- Task-sharing;
- Optimum use of automation;
- "Golden rules" (see FSF ALAR Briefing Note *1.3 — Golden Rules*);
- Standard calls;
- Normal checklists;
- Approach briefings;
- Altimeter-setting and cross-checking procedures;
- Descent profile management;
- Energy management;
- Terrain awareness;
- Approach hazards awareness;
- Radio altimeter;
- Elements of a stabilized approach (see Table 1) and approach gate[3];
- Approach procedures and techniques;
- Landing and braking techniques; and,
- Preparation and commitment to go around.

Table 1
Recommended Elements Of a Stabilized Approach

All flights must be stabilized by 1,000 feet above airport elevation in instrument meteorological conditions (IMC) and by 500 feet above airport elevation in visual meteorological conditions (VMC). *An approach is stabilized when all of the following criteria are met:*

1. The aircraft is on the correct flight path;
2. Only small changes in heading/pitch are required to maintain the correct flight path;
3. The aircraft speed is not more than V_{REF} + 20 knots indicated airspeed and not less than V_{REF};
4. The aircraft is in the correct landing configuration;
5. Sink rate is no greater than 1,000 feet per minute; if an approach requires a sink rate greater than 1,000 feet per minute, a special briefing should be conducted;
6. Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined by the aircraft operating manual;
7. All briefings and checklists have been conducted;
8. Specific types of approaches are stabilized if they also fulfill the following: instrument landing system (ILS) approaches must be flown within one dot of the glideslope and localizer; a Category II or Category III ILS approach must be flown within the expanded localizer band; during a circling approach, wings should be level on final when the aircraft reaches 300 feet above airport elevation; and,
9. Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing.

An approach that becomes unstabilized below 1,000 feet above airport elevation in IMC or below 500 feet above airport elevation in VMC requires an immediate go-around.

Source: Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force (V1.1 November 2000)

General Principles

SOPs should contain safeguards to minimize the potential for inadvertent deviations from SOPs, particularly when operating under abnormal conditions or emergency conditions, or when interruptions/distractions occur.

Safeguards include:

- Action blocks — groups of actions being accomplished in sequence;
- Triggers — events that initiate action blocks;
- Action patterns — instrument panel scanning sequences or patterns supporting the flow and sequence of action blocks; and,

- Standard calls — standard phraseology and terms used for effective crew communication.

Standardization

SOPs are the reference for crew standardization and establish the working environment required for CRM.

Task-sharing

The following guidelines apply to any flight phase but are particularly important to the high-workload approach-and-landing phases.

The pilot flying (PF) is responsible for controlling the horizontal flight path and the vertical flight path, and for energy management, by:

- Supervising autopilot operation and autothrottle operation (maintaining awareness of the modes armed or selected, and of mode changes); or,
- Hand-flying the aircraft, with or without flight director (FD) guidance, and with an appropriate navigation display (e.g., horizontal situation indicator [HSI]).

The pilot not flying (PNF) is responsible for monitoring tasks and for performing the actions requested by the PF; this includes:

- Performing the standard PNF tasks:
  - SOP actions; and,
  - FD and flight management system (FMS) mode selections and target entries (e.g., altitude, airspeed, heading, vertical speed, etc.), when the PF is hand-flying the aircraft;
- Monitoring systems and aircraft configuration; and,
- Cross-checking the PF to provide backup as required (this includes both flight operations and ground operations).

Automation

With higher levels of automation, flight crews have more options and strategies from which to select for the task to be accomplished.

Company SOPs should define accurately the options and strategies available for the various phases of flight and for the various types of approaches.

Training

Disciplined use of SOPs and normal checklists should begin during transition training, because habits and routines acquired during transition training have a lasting effect.

Transition training and recurrent training provide a unique opportunity to discuss the reasons for SOPs and to discuss the consequences of failing to adhere to them.

Conversely, allowing deviations from SOPs and/or normal checklists during initial training or recurrent training may encourage deviations during line operations.

Deviations From SOPs

To ensure adherence to published SOPs, it is important to understand why pilots intentionally or inadvertently deviate from SOPs.

In some intentional deviations from SOPs, the procedure that was followed in place of the SOP seemed to be appropriate for the prevailing situation.

The following factors and conditions are cited often in discussing deviations from SOPs:

- Inadequate knowledge or failure to understand the procedure (e.g., wording or phrasing was not clear, or the procedure was perceived as inappropriate);
- Insufficient emphasis during transition training and recurrent training on adherence to SOPs;
- Inadequate vigilance (e.g., fatigue);
- Interruptions (e.g., communication with air traffic control);
- Distractions (e.g., flight deck activity);
- Task saturation;
- Incorrect management of priorities (e.g., lack of a decision-making model for time-critical situations);
- Reduced attention (tunnel vision) in abnormal conditions or high-workload conditions;
- Inadequate CRM (e.g., inadequate crew coordination, cross-check and backup);
- Company policies (e.g., schedules, costs, go-arounds and diversions);
- Other policies (e.g., crew duty time);
- Personal desires or constraints (e.g., schedule, mission completion);
- Complacency; and,
- Overconfidence.

These factors may be used to assess company exposure to deviations and/or personal exposure to deviations, and to develop corresponding methods to help prevent deviations from SOPs.

Summary

Deviations from SOPs occur for a variety of reasons; intentional deviations and inadvertent deviations from SOPs have been identified as causal factors in many ALAs.

CRM is not effective without adherence to SOPs, because SOPs provide a standard reference for the crew's tasks on the flight deck. SOPs are effective only if they are clear and concise.

Transition training provides the opportunity to establish the disciplined use of SOPs, and recurrent training offers the opportunity to reinforce that behavior.

The following FSF ALAR Briefing Notes provide information to supplement this discussion:

- *1.2 — Automation*;
- *1.3 — Golden Rules*;
- *1.4 — Standard Calls*;
- *1.5 — Normal Checklists*;
- *1.6 — Approach Briefing*;
- *2.1 — Human Factors*; and,
- *2.2 — Crew Resource Management*.♦

References

1. The Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force defines *causal factor* as "an event or item judged to be directly instrumental in the causal chain of events leading to the accident [or incident]." Each accident and incident in the study sample involved several causal factors.

2. Flight Safety Foundation. "Killers in Aviation: FSF Task Force Presents Facts About Approach-and-landing and Controlled-flight-into-terrain Accidents." *Flight Safety Digest* Volume 17 (November–December 1998) and Volume 18 (January–February 1999): 1–121. The facts presented by the FSF ALAR Task Force were based on analyses of 287 fatal approach-and-landing accidents (ALAs) that occurred in 1980 through 1996 involving turbine aircraft weighing more than 12,500 pounds/5,700 kilograms, detailed studies of 76 ALAs and serious incidents in 1984 through 1997 and audits of about 3,300 flights.

3. The FSF ALAR Task Force defines *approach gate* as "a point in space (1,000 feet above airport elevation in instrument meteorological conditions or 500 feet above airport elevation in visual meteorological conditions) at which a go-around is required if the aircraft does not meet defined stabilized approach criteria."

Related Reading From FSF Publications

Flight Safety Foundation (FSF) Editorial Staff. "ATR 42 Strikes Mountain on Approach in Poor Visibility to Pristina, Kosovo." *Accident Prevention* Volume 57 (October 2000).

FSF Editorial Staff. "Crew Fails to Compute Crosswind Component, Boeing 757 Nosewheel Collapses on Landing." *Accident Prevention* Volume 57 (March 2000).

FSF Editorial Staff. "Ice Ingestion Causes Both Engines to Flame Out During Air-taxi Turboprop's Final Approach." *Accident Prevention* Volume 56 (February 1999).

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Simmon, David A. "Boeing 757 CFIT Accident at Cali, Colombia, Becomes Focus of Lessons Learned." *Flight Safety Digest* Volume 17 (May–June 1998).

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FSF Editorial Staff. "Captain's Inadequate Use of Flight Controls During Single-engine Approach and Go-around Results in Loss of Control and Crash of Commuter." *Accident Prevention* Volume 52 (November 1995).

Pope, John A. "Developing a Corporate Aviation Department Operations Manual Reinforces Standard — and Safe — Operating Procedures." *Flight Safety Digest* Volume 14 (April 1995).

Overall, Michael. "New Pressures on Aviation Safety Challenge Safety Management Systems." *Flight Safety Digest* Volume 14 (March 1995).

Lawton, Russell. "Breakdown in Coordination by Commuter Crew During Unstabilized Approach Results in Controlled-flight-into-terrain Accident." *Accident Prevention* Volume 51 (September 1994).

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Arbon, E. R.; Mouden, L. Homer; Feeler, Robert A. "The Practice of Aviation Safety: Observations from Flight Safety Foundation Safety Audits." *Flight Safety Digest* Volume 9 (August 1990).

Pope, John A. "Manuals, Management and Coordination." *Flight Safety Digest* Volume 7 (September 1988).

Regulatory Resources

International Civil Aviation Organization (ICAO). *International Standards and Recommended Practices, Annex 6 to the Convention of International Civil Aviation, Operation of Aircraft*. Part I, *International Commercial Air Transport – Aeroplanes*. Appendix 2, "Contents of an Operations Manual," 5.9. Seventh edition – July 1998, incorporating Amendments 1–25.

ICAO. *Procedures for Air Navigation Services – Aircraft Operations*. Volume I, *Flight Procedures*. Fourth edition, 1993. Reprinted May 2000, incorporating Amendments 1–10.

ICAO. *Manual of All-Weather Operations*. Second edition – 1991.

ICAO. *Preparation of an Operations Manual*. Second edition – 1997.

U.S. Federal Aviation Administration (FAA). *Federal Aviation Regulations*. 91.3 "Responsibility and authority of the pilot in command," 121.133 "Preparation," 121.141 "Airplane Flight Manual," 121.401 "Training program: General," 125.287 "Initial and recurrent pilot testing requirements," 135.293 "Initial and recurrent pilot testing requirements." January 1, 2000.

FAA. Advisory Circular (AC) 120-71, *Standard Operating Procedures for Flight Deck Crewmembers*. August 10, 2000.

FAA. AC 120-48, *Communication and Coordination Between Flight Crewmembers and Flight Attendants*. July 13, 1988.

FAA. AC 120-51C, *Crew Resource Management Training*. October 30, 1998.

FAA. AC 120-54, *Advanced Qualification Program*. August 9, 1991.

FAA. AC 121-32, *Dispatch Resource Management Training*. February 7, 1995.

Joint Aviation Authorities (JAA). *Joint Aviation Requirements – Operations (JAR-OPS 1), Commercial Air Transportation (Aeroplanes)*. 1.1040 "General Rules for Operations Manuals." March 1, 1998.

JAA. *JAR-OPS 1*. 1.1045 "Operations Manual – structure and contents." March 1, 1998.

Notice

The Flight Safety Foundation (FSF) Approach-and-landing Accident Reduction (ALAR) Task Force has produced this briefing note to help prevent ALAs, including those involving controlled flight into terrain. The briefing note is based on the task force's data-driven conclusions and recommendations, as well as data from the U.S. Commercial Aviation Safety Team (CAST) Joint Safety Analysis Team (JSAT) and the European Joint Aviation Authorities Safety Strategy Initiative (JSSI).

The briefing note has been prepared primarily for operators and pilots of turbine-powered airplanes with underwing-mounted engines (but can be adapted for fuselage-mounted turbine engines, turboprop-powered aircraft and piston-powered aircraft) and with the following:

- Glass flight deck (i.e., an electronic flight instrument system with a primary flight display and a navigation display);
- Integrated autopilot, flight director and autothrottle systems;
- Flight management system;
- Automatic ground spoilers;
- Autobrakes;
- Thrust reversers;
- Manufacturers'/operators' standard operating procedures; and,
- Two-person flight crew.

This briefing note is one of 34 briefing notes that comprise a fundamental part of the FSF *ALAR Tool Kit,* which includes a variety of other safety products that have been developed to help prevent ALAs.

This information is not intended to supersede operators' or manufacturers' policies, practices or requirements, and is not intended to supersede government regulations.

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Standard Operating Procedures Template

[The following template is adapted from U.S. Federal Aviation Administration (FAA) Advisory Circular 120-71, *Standard Operating Procedures for Flight Deck Crewmembers*.]

A manual or a section in a manual serving as the flight crew's guide to standard operating procedures (SOPs) may serve also as a training guide. The content should be clear and comprehensive, without necessarily being lengthy. No template could include every topic that might apply unless it were constantly revised. Many topics involving special operating authority or new technology are absent from this template, among them extended-range twin-engine operations (ETOPS), precision runway monitor (PRM), surface movement guidance system (SMGS), required navigation performance (RNP) and many others.

The following are nevertheless viewed by industry and FAA alike as examples of topics that constitute a useful template for developing comprehensive, effective SOPs:

- Captain's authority;
- Use of automation, including:
  - The company's automation philosophy;
  - Specific guidance in selection of appropriate levels of automation;
  - Autopilot/flight director mode selections; and,
  - Flight management system (FMS) target entries (e.g., airspeed, heading, altitude);
- Checklist philosophy, including:
  - Policies and procedures (who calls for; who reads; who does);
  - Format and terminology; and,
  - Type of checklist (challenge-do-verify, or do-verify);
- Walk-arounds;
- Checklists, including:
  - Safety check prior to power on;
  - Originating/receiving;
  - Before start;
  - After start;
  - Before taxi;
  - Before takeoff;
  - After takeoff;
  - Climb check;
  - Cruise check;
  - Approach;
  - Landing;
  - After landing;
  - Parking and securing;
  - Emergency procedures; and,
  - Abnormal procedures;
- Communication, including:
  - Who handles radios;
  - Primary language used with air traffic control (ATC) and on the flight deck;
  - Keeping both pilots "in the loop";
  - Company radio procedures;
  - Flight deck signals to cabin; and,
  - Cabin signals to flight deck;

- Briefings, including:
  - Controlled-flight-into-terrain (CFIT) risk considered;
  - Special airport qualifications considered;
  - Temperature corrections considered;
  - Before takeoff; and,
  - Descent/approach/missed approach;
- Flight deck access, including:
  - On ground/in flight;
  - Jump seat; and,
  - Access signals, keys;
- Flight deck discipline, including:
  - "Sterile cockpit"[1];
  - Maintaining outside vigilance;
  - Transfer of control;
  - Additional duties;
  - Flight kits;
  - Headsets/speakers;
  - Boom mikes/handsets;
  - Maps/approach charts; and,
  - Meals;
- Altitude awareness, including:
  - Altimeter settings;
  - Transition altitude/flight level;
  - Standard calls (verification of);
  - Minimum safe altitudes (MSAs); and,
  - Temperature corrections;
- Report times; including:
  - Check in/show up;
  - On flight deck; and,
  - Checklist accomplishment;
- Maintenance procedures, including:
  - Logbooks/previous write-ups;
  - Open write-ups;
  - Notification to maintenance of write-ups;
  - Minimum equipment list (MEL)/dispatch deviation guide (DDG);
  - Where MEL/DDG is accessible;
  - Configuration deviation list (CDL); and,
  - Crew coordination in ground deicing;
- Flight plans/dispatch procedures, including:
  - Visual flight rules/instrument flight rules (VFR/IFR);
  - Icing considerations;
  - Fuel loads;
  - Weather-information package;
  - Where weather-information package is available; and,
  - Departure procedure climb gradient analysis;
- Boarding passengers/cargo, including:
  - Carry-on baggage;
  - Exit-row seating;
  - Hazardous materials;
  - Prisoners/escorted persons;
  - Firearms onboard; and,
  - Count/load;
- Pushback/powerback;
- Taxiing, including:
  - Single-engine;
  - All-engines;
  - On ice or snow; and,
  - Prevention of runway incursion;
- Crew resource management (CRM), including crew briefings (cabin crew and flight crew);
- Weight and balance/cargo loading, including:
  - Who is responsible for loading cargo and securing cargo; and,
  - Who prepares the weight-and-balance data form; who checks the form; and how a copy of the form is provided to the crew;
- Flight deck/cabin crew interchange, including:
  - Boarding;
  - Ready to taxi;
  - Cabin emergency; and,
  - Prior to takeoff/landing;
- Takeoff, including:

  - Who conducts the takeoff;
  - Briefing, VFR/IFR;
  - Reduced-power procedures;
  - Tail wind, runway clutter;
  - Intersections/land and hold short operations (LAHSO) procedures;
  - Noise-abatement procedures;
  - Special departure procedures;
  - Use/nonuse of flight directors;
  - Standard calls;
  - Cleanup;
  - Loss of engine, including rejected takeoff after V_1 (actions/standard calls);
  - Flap settings, including:
    - Normal;
    - Nonstandard and reason for; and,
    - Crosswind; and,
  - Close-in turns;
- Climb, including:
  - Speeds;
  - Configuration;
  - Confirm compliance with climb gradient required in departure procedure; and,
  - Confirm appropriate cold-temperature corrections made;
- Cruise altitude selection (speeds/weights);
- Position reports to ATC and to company;
- Emergency descents;
- Holding procedures;
- Procedures for diversion to alternate airport;
- Normal descents, including:
  - Planning top-of-descent point;
  - Risk assessment and briefing;
  - Use/nonuse of speedbrakes;
  - Use of flaps/gear;
  - Icing considerations; and,
  - Convective activity;
- Ground-proximity warning system (GPWS) or terrain awareness and warning system (TAWS)[2] recovery ("pull-up") maneuver;
- Traffic-alert and collision avoidance system (TCAS)/ airborne collision avoidance system (ACAS);
- Wind shear, including:
  - Avoidance of likely encounters;
  - Recognition; and,
  - Recovery/escape maneuver;
- Approach philosophy, including:
  - Precision approaches preferred;
  - Stabilized approaches standard;
  - Use of navigation aids;
  - FMS/autopilot use and when to discontinue use;
  - Approach gate[3] and limits for stabilized approaches, (Table 1);
  - Use of radio altimeter; and,
  - Go-arounds (plan to go around; change plan to land when visual, if stabilized);
- Individual approach type (all types, including engine-out approaches);
- For each type of approach:
  - Profile;
  - Flap/gear extension;
  - Standard calls; and,
  - Procedures;
- Go-around/missed approach, including:
  - Initiation when an approach gate is missed;
  - Procedure;
  - Standard calls; and,
  - Cleanup profile; and,
- Landing, including:
  - Actions and standard calls;
  - Configuration for conditions, including:
    - Visual approach;
    - Low visibility; and,
    - Wet or contaminated runway;
  - Close-in turns;
  - Crosswind landing;
  - Rejected landing; and,
  - Transfer of control after first officer's landing.

Table 1
Recommended Elements of a Stabilized Approach

All flights must be stabilized by 1,000 feet above airport elevation in instrument meteorological conditions (IMC) and by 500 feet above airport elevation in visual meteorological conditions (VMC). *An approach is stabilized when all of the following criteria are met:*

1. The aircraft is on the correct flight path;
2. Only small changes in heading/pitch are required to maintain the correct flight path;
3. The aircraft speed is not more than V_{REF} + 20 knots indicated airspeed and not less than V_{REF};
4. The aircraft is in the correct landing configuration;
5. Sink rate is no greater than 1,000 feet per minute; if an approach requires a sink rate greater than 1,000 feet per minute, a special briefing should be conducted;
6. Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined by the aircraft operating manual;
7. All briefings and checklists have been conducted;
8. Specific types of approaches are stabilized if they also fulfill the following: instrument landing system (ILS) approaches must be flown within one dot of the glideslope and localizer; a Category II or Category III ILS approach must be flown within the expanded localizer band; during a circling approach, wings should be level on final when the aircraft reaches 300 feet above airport elevation; and,
9. Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing.

An approach that becomes unstabilized below 1,000 feet above airport elevation in IMC or below 500 feet above airport elevation in VMC requires an immediate go-around.

Source: Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force (V1.1, November 2000)

References

1. The *sterile cockpit rule* refers to U.S. Federal Aviation Regulations Part 121.542, which states: "No flight crewmember may engage in, nor may any pilot-in-command permit, any activity during a critical phase of flight which could distract any flight crewmember from the performance of his or her duties or which could interfere in any way with the proper conduct of those duties. Activities such as eating meals, engaging in nonessential conversations within the cockpit and nonessential communications between the cabin and cockpit crews, and reading publications not related to the proper conduct of the flight are not required for the safe operation of the aircraft. For the purposes of this section, critical phases of flight include all ground operations involving taxi, takeoff and landing, and all other flight operations below 10,000 feet, except cruise flight." [The FSF ALAR Task Force says that "10,000 feet" should be height above ground level during flight operations over high terrain.]
2. Terrain awareness and warning system (TAWS) is the term used by the European Joint Aviation Authorities and the U.S. Federal Aviation Administration to describe equipment meeting International Civil Aviation Organization standards and recommendations for ground-proximity warning system (GPWS) equipment that provides predictive terrain-hazard warnings. "Enhanced GPWS" and "ground collision avoidance system" are other terms used to describe TAWS equipment.
3. The Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force defines *approach gate* as "a point in space (1,000 feet above airport elevation in instrument meteorological conditions or 500 feet above airport elevation in visual meteorological conditions) at which a go-around is required if the aircraft does not meet defined stabilized approach criteria."

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