

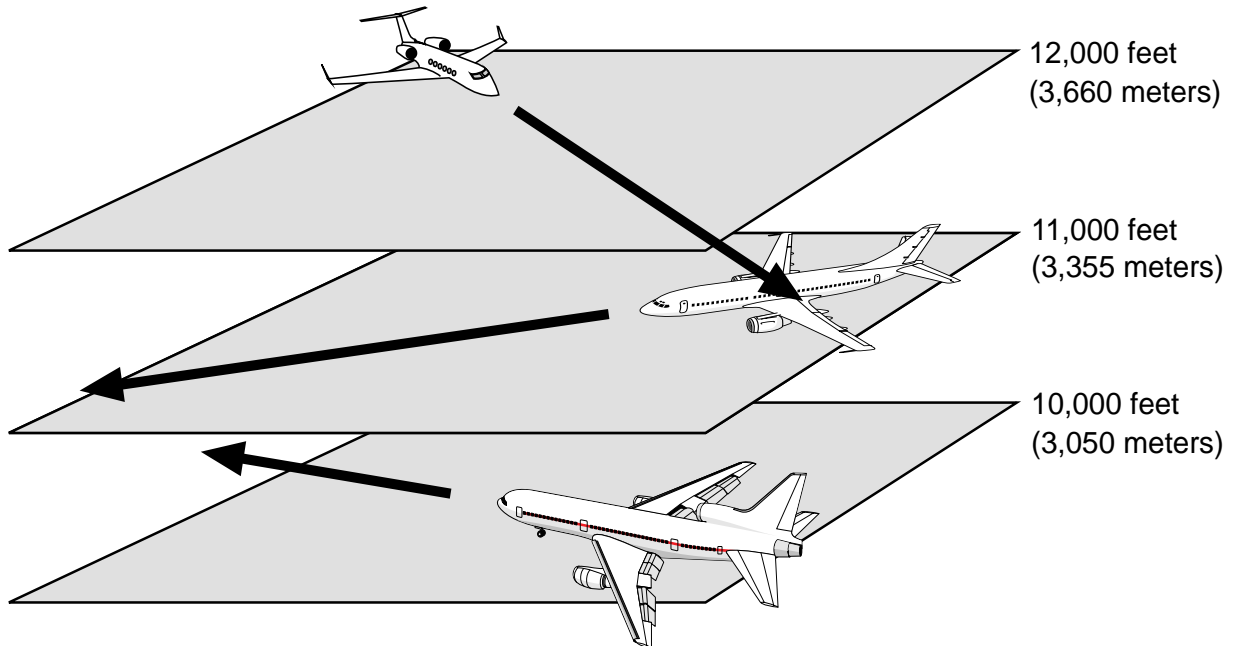
FLIGHT SAFETY FOUNDATION

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FLIGHT SAFETY

D I G E S T

Altitude Awareness Programs Can Reduce Altitude Deviations



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Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of flight safety. Nonprofit and independent, FSF was launched in 1945 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 660 member organizations in 77 countries.

Altitude Awareness Programs Can Reduce Altitude Deviations

Safety can be jeopardized when aircraft deviate from their assigned altitudes. Carefully implemented altitude awareness programs have been adopted by some airlines. These proven programs focus on improving communications, altitude alerter setting procedure, crew prioritization and task allocation, and ensuring correct altimeter settings.

*Capt. Robert L. Sumwalt III
President, Aviatrends*

On a cloudy winter morning, a Boeing 727 was being radar vectored for approach and landing at O'Hare International Airport, Chicago, Illinois, U.S. The crew acknowledged a descent clearance to 7,000 feet (2,134 meters), followed by the controller's immediate exclamation, "Maintain 8,000 feet [2,438 meters] — I have an altitude bust!"

All three flight crew members spotted another aircraft at their altitude, headed directly towards them. "It looked like he would be very close so I started a climb," recalled the captain. The first officer advised air traffic control (ATC) that the B-727 was climbing to avoid the traffic. The controller replied, "Do what you have to." The other aircraft slipped back into the clouds and the two aircraft passed vertically within 300 feet (91 meters).

Two airplanes are not supposed to be at the same place at the same time. An investigation revealed that the "intruding" aircraft, a departure from O'Hare, had been expected to level off at 5,000 feet (1,524 meters). Because of a "readback/hearback" communications error, the crew believed that they had been cleared to 8,000 feet (2,438 meters).

This incident was reported to the U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting

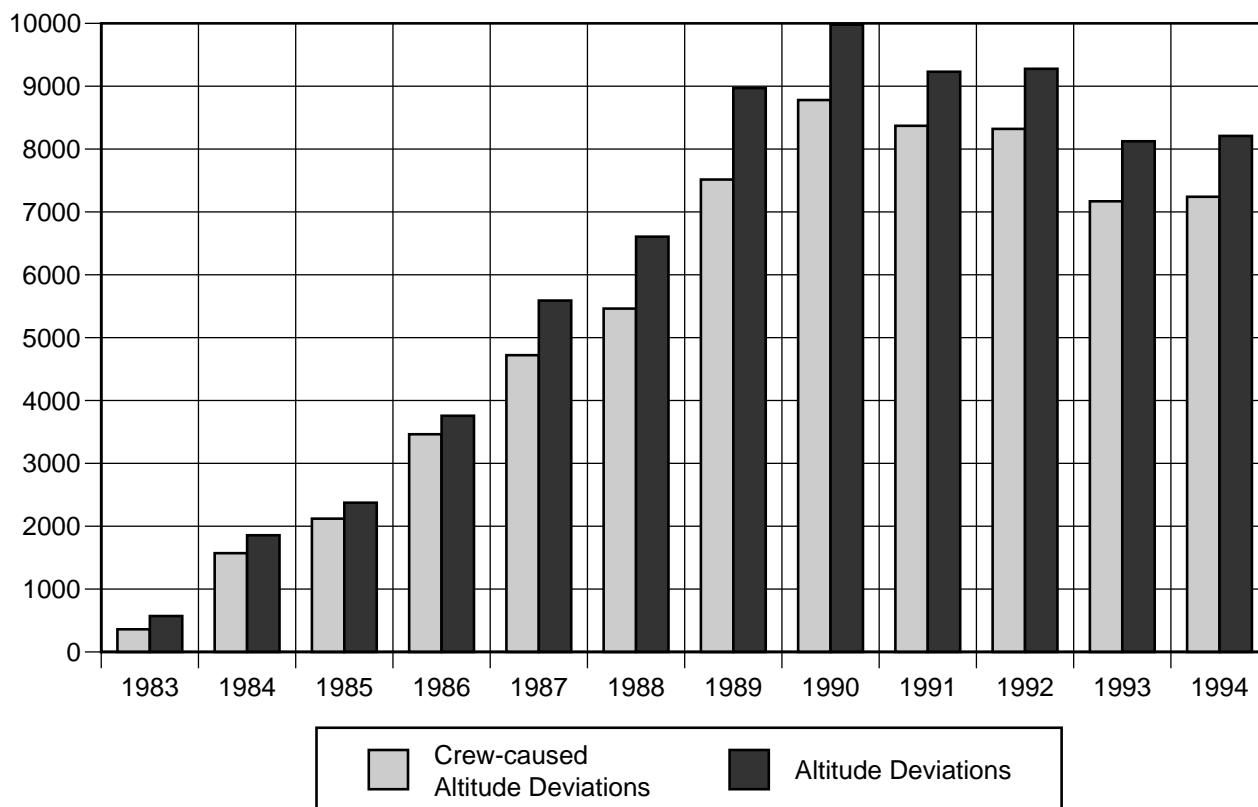
System (ASRS).¹ Known officially as a "pilot deviation from assigned altitude," among aviators such an incident is often called an "altitude bust." The consequences of altitude deviations range from accidents, near-midair collisions, federal violations for crew members, and passenger and crew injuries from rapid flight maneuvers while recovering from the altitude deviation.²

The types of altitude deviations are *failure to level* at the assigned altitude in either a climbing or descending mode; *failure to maintain* the assigned altitude, i.e., the aircraft strays from level flight; and *failure to attain* the assigned altitude, i.e., the aircraft does not reach level flight at the time or place prescribed by ATC.³

For the 12-year period January 1983 through December 1994, ASRS received 74,544 reports involving altitude deviations. Of those, 87 percent were categorized by ASRS analysts as having flight-crew causal factors. Figure 1 (page 2) shows an annual breakdown of these incident reports.

[ASRS warns, however, that certain caveats apply to the ASRS statistical data. "All ASRS reports are voluntarily submitted, and thus cannot be considered a measured random sample of the full population of like events ... This number may comprise

Altitude Deviations Reported to NASA Aviation Safety Reporting System for 1983–1994



Source: U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS)

Figure 1

over half of all the altitude deviations which occur, or it may be just a small fraction of total occurrences. We have no way of knowing which ... Only one thing can be known for sure from ASRS statistics — they represent the *lower measure* of the true number of such events which are occurring.”

[Notwithstanding these caveats, incident data such as those collected by ASRS are “ideally suited for providing the existence of a safety issue, understanding its possible causes, defining potential intervention strategies, and tracking the safety consequences once intervention has begun,” says Sheryl Chappell, NASA ASRS Research Director.^{4]}

In 1992, the U.S. Federal Aviation Administration (FAA) conducted a human factors study of altitude deviations.⁵ The study estimated that a typical air carrier flight presents 100 opportunities for an altitude deviation. That number was derived after researchers estimated that for each clearance that involves an altitude change, there are approximately 10 “altitude deviation opportunities.” That figure was then multiplied by 10, the approximate number of altitude

clearances that each flight is issued.⁶ “Considering that this number includes [deviation opportunities for] pilot[s] and controller[s] ... , this is probably a conservatively low figure,” the FAA study said. Some of the ways that human error can lead to an altitude deviation include:

- The controller determines and assigns the wrong altitude;
- The controller transmits the wrong altitude to the cockpit, but the pilot does not read back the altitude assignment and the controller does not request the readback;
- The pilot receives the correct altitude, reads back the correct altitude, but enters the incorrect altitude in the altitude alerter or mode control panel (MCP);
- The autopilot does not capture the MCP altitude setting; and,
- The pilot accepts an altitude clearance meant for another aircraft.

“Some of the examples cited have multiple sources of error,” according to the FAA study. “For instance, a pilot could enter the wrong altitude in the altitude alerter/MCP because of the confusion that results from similar digits in the speed, heading or [aircraft radio] call sign, or because he or she anticipated a certain altitude which was not assigned by ATC.”

The FAA study included an altitude deviation data-collection program, in which pilots and controllers were encouraged to report such events independently of ASRS and directly to the study’s researchers. One hundred sixty-two reports were filed by flight crews and 496 were filed by controllers. Of those reports having multiple sources of error, flight crews were determined to be the error source in 83 percent of the reports. This compares favorably to the ASRS figure (87 percent) of altitude deviations attributed to flight crews. The purpose of these figures is not to assign blame to crew members. Instead, the statistics have value in suggesting that to reduce altitude deviations, a logical starting point would be by developing a flight crew-centered program.

Several U.S. air carriers have developed altitude awareness programs to help prevent crew-caused altitude deviations. In 1986, Midwest Express Airlines became one of the first U.S. carriers to implement a formal altitude awareness program. The effectiveness of their program can be assessed by the carrier’s record: during the nine years that their altitude procedures have been in place, more than 200,000 jet flights have been flown with no altitude deviation violations. Another well-documented program was developed in 1990 jointly by USAir and the U.S. Air Line Pilots Association (ALPA). In the 14 months following the program’s implementation, USAir reduced its rate of altitude deviations by more than 50 percent, a value considered “statistically significant” by FAA researchers. Through program refinements, USAir’s altitude deviations were lowered by approximately 75 percent, as compared to preprogram figures.⁷ The program also provided a framework for the 1992 FAA altitude deviation study.

The success of these programs has led other carriers to adopt various aspects of them. In 1992, American Airlines implemented an altitude awareness program. Capt. Scott Griffith, managing director of Flight Operations Safety at American Airlines, said, “We have adopted the USAir program and have had positive effects with it in terms of reducing altitude deviations.” United Airlines noticed an almost immediate reduction in altitude deviations after implementing its program in early 1993. Figure 2 (page 4) depicts this improvement.

Alaska Airlines also inaugurated an altitude awareness program. “Even our small rate of altitude deviations was unacceptable,” explained Capt. David Smith, who said that

after adopting a USAir-type program, Alaska Airlines has “dramatically reduced altitude deviations.”

Figures demonstrate the benefits of altitude awareness programs. Nevertheless, figures alone cannot measure which carrier’s program is most effective. Each air carrier tracks and reports altitude deviations using different criteria. For example, some of these carriers track only altitude deviations that result in FAA violations. Other carriers, such as United, track altitude deviations from several sources, such as in-house incident reporting systems, FAA violations and other sources.

Prior to implementing its program, USAir reviewed 150 ASRS incident reports involving altitude deviations. The review revealed that although sometimes quite complex, the majority of the altitude busts could be placed into one of seven categories. Almost one quarter of those reviewed involved “hearback/readback” error, a predicament that arises when a pilot incorrectly reads back a clearance to ATC but the controller fails to recognize and correct the error. Other reasons included improperly set altitude alerters/MCPs; distractions

caused by passengers, other crewmembers or malfunctioning aircraft systems; failure of flight-deck automation to capture an altitude; improper altimeter settings; improper or lack of crew discipline and procedures; and ATC operational errors. By finding common denominators among many altitude deviations, a proactive plan to combat the problem was developed.

By comparing the benefits associated with a carefully developed altitude awareness program against the risks of altitude deviations, operators may find it desirable to implement their own program. “Don’t reinvent the wheel,” suggested Capt. Don

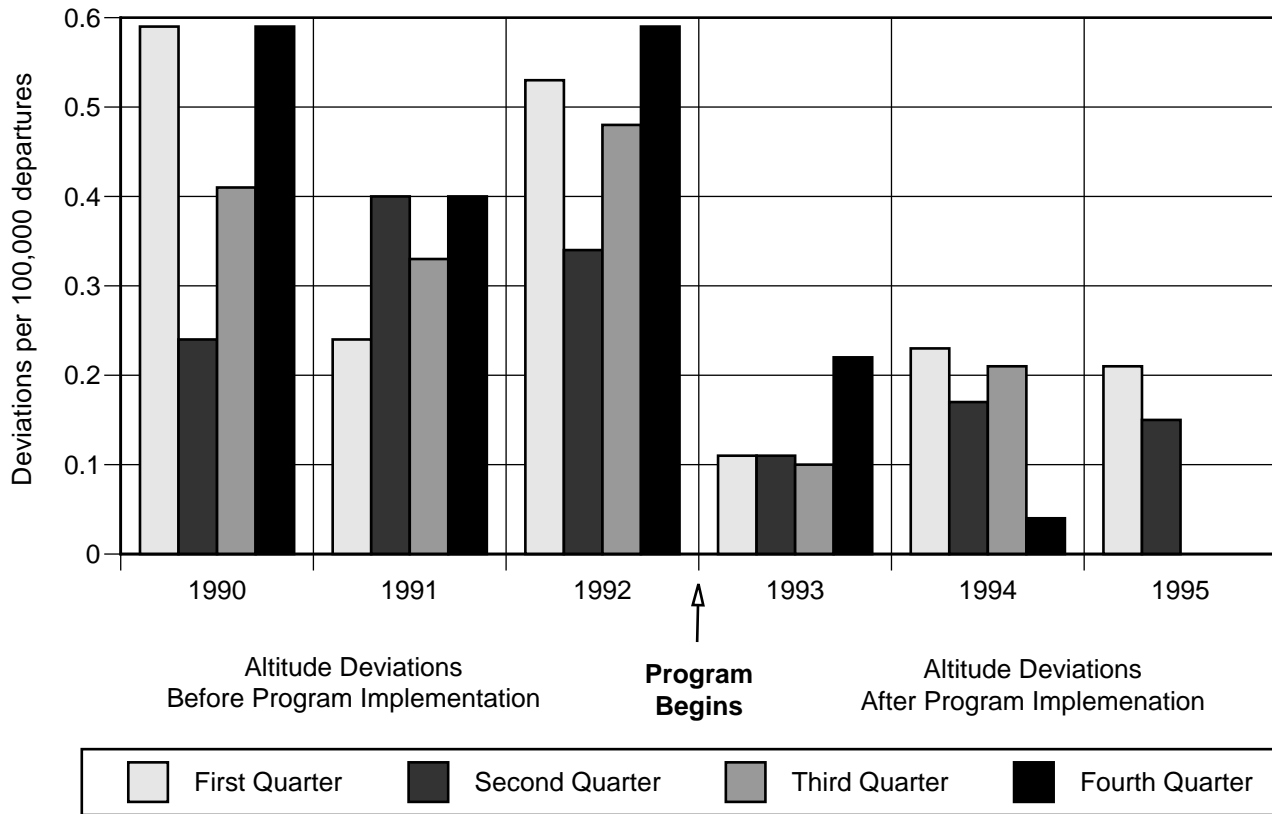
McClure, a leader in developing USAir’s program. “Look at what other carriers are doing and then tailor their programs to fit your operation.” Some key features in several effective altitude awareness programs are listed below:

Improving communications. A five-year review of ASRS data showed that problems with the transfer of information — primarily voice communications — occurred in more than 70 percent of the reports.⁸ A fundamental underpinning of an effective altitude awareness program must be emphasis on clear, unambiguous communications. This emphasis should include communications with ATC, as well as intracockpit communications.

For communications with ATC, proper radio phraseology is crucial. Consistent use of proper phraseology establishes a baseline for pilots and controllers, minimizing the chance that a radio transmission will be misunderstood, and increasing the likelihood that errors will be recognized. Included in this category must be an emphasis for pilots to

A fundamental underpinning of an effective altitude awareness program must be emphasis on clear, unambiguous communications.

One Air Carrier's Altitude Deviations Before and After Altitude Awareness Program Implementation



Source: United Airlines, Capt. Robert L. Sumwalt III

Figure 2

carefully read back to ATC all altitude assignments and the aircraft call sign.

The FAA's *Aeronautical Information Manual (AIM)* recommends that pilots report "when vacating any previously assigned altitude or flight level for a newly assigned altitude or flight level."⁹ This radio call brings to the controller's attention that a particular aircraft intends to change altitude, and provides a cross-check of the altitude to which the aircraft is proceeding. Although only a recommended call, the FAA altitude deviation study suggested that this should be a mandatory procedure for all air carriers.

The pilot's readback of an ATC clearance is a safety net within the ATC system. As a pilot reads back his or her understanding of a clearance, the controller is supposed to listen carefully for any inconsistencies or errors, then reconcile the differences. Nevertheless, in a 1986 ASRS study, *Human Factors in Aviation Operations: The Hearback Problem*, researcher William Monan documented that this does not always work

as designed.¹⁰ The study investigated 417 ASRS reports in which pilots erroneously read back clearances to ATC, but the errors were not caught by the controllers. "Readback/hearback error" is the term that researchers assigned to this problem.

Another study, looking at operational errors at one major airport, determined that 22 percent of the reports involved readback/hearback errors.¹¹ And in the 1992 FAA altitude deviation study, researchers examined 23 altitude busts that involved readback/hearback errors. "In all of these cases the altitude deviation would have been prevented if the controller had noticed and corrected the error," noted the 1992 altitude deviation study.

This excerpt from an ASRS report illustrates the hearback problem: "Crew read back clearance to climb to 14,000 feet [4,270 meters]. Passing 10,700 feet [3,264 meters] controller said, 'Maintain 10,000 feet [3,050 meters]'... . Controller insisted we were cleared to 10,000 feet Whether or not we were initially cleared to 14,000 feet is not the issue. We

read back a [possibly erroneous] clearance, we were not corrected and we proceeded on the assumption that we were cleared. I have been corrected by controllers for inaccurate readbacks many times. This time we were not . . .”

Readback/hearback error is a double-sided error. First, the pilot errs in the readback of a clearance; second, the controller fails to correct the error. Monan said that among the reasons that pilots make erroneous clearance readbacks are confusingly similar aircraft call signs; one pilot going off the ATC frequency for reasons such as listening to automatic terminal information service (ATIS), making public address (PA) announcements or making company-related radio calls; slips of mind and tongue (saying one thing and meaning another); and an expectation of a certain clearance.¹³ Reasons that controllers fail to detect erroneous clearance errors include radio transmissions from other aircraft or landlines [telephones] at inopportune times, similar sounding call signs, heavy workloads, blocked transmissions and the controller “hearing” what he or she expected to hear.^{13, 14}

Because of tendencies by pilots and controllers to make readback/hearback errors, an effective altitude awareness program must remind pilots that reading back a clearance does not guarantee clearance accuracy. As Donald R. Wilson wrote in *Accident Prevention*: “It is unreasonable to assume that a controller’s lack of response to a readback is tacit verification of its correctness. Although many controllers understand the importance of hearback, they may overlook it in a busy period. Pilots should not assume controller silence [as] verification, and they should ask the controller for a verbal confirmation.”¹⁵

Use of proper radio communication protocols and an understanding of readback/hearback errors can play a major role in eliminating altitude deviations. In 1989, a combination of language differences, nonstandard phraseology and a readback/hearback error became a lethal combination. A U.S.-based Boeing 747 cargo airliner was making a nonprecision instrument approach to a southeast Asian airport in marginal visual conditions at night. ATC cleared the airplane to descend “two four zero zero,” meaning for the aircraft to descend to 2,400 feet (732 meters) mean sea level (MSL). The crew read the clearance back as “O.K. Four zero zero” and descended to 400 feet (122 meters) MSL instead of the controller’s intended 2,400 feet MSL. The aircraft impacted terrain eight miles (14.8 kilometers) short of the runway.¹⁶

ASRS Directline reported that certain altitude clearances are more likely to be misinterpreted than others.¹² This finding emerged after analysts reviewed a sample set of 191 ASRS reports submitted between 1987 and 1990. Certain altitudes, according to the review, are more likely to be interpreted as another altitude. “I believe that it is very easy to confuse one-one thousand with one-zero thousand, and vice versa,” wrote a reporter. The reporter’s suspicions were borne out by the ASRS review, which found that 38 percent of the

studied reports involved misinterpretations of the 10,000 feet/11,000 feet altitude pair. The next largest category accounted for less than 5 percent of the total deviations in the data set. Figure 3 shows the altitude pairs that were confused with others and led to altitude deviations.

To minimize misunderstanding an altitude pair, when reading back a clearance to an often-confused altitude pilots should state the digits of the readback in two separate ways, e.g., “cleared to one-one thousand, eleven thousand.”

For intracockpit communications, it is essential that a crew cross-check and challenge each other when there is a doubt

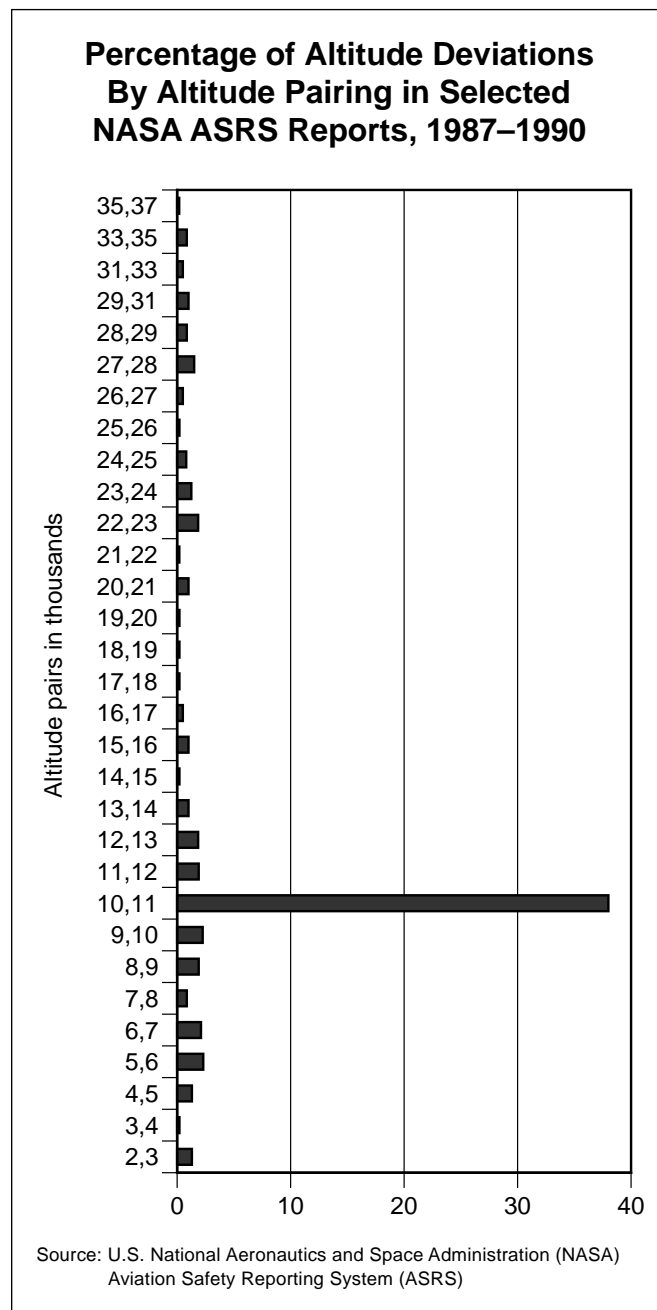


Figure 3

concerning the ATC clearance. If any cockpit crew member does not agree about the assigned altitude, ATC must be consulted for confirmation. “Never come to an agreement by cockpit consensus [alone],” Wilson said.

Altitude alerter setting procedure. Virtually all transport aircraft have an altitude alerter installed to notify pilots (usually through an aural warning tone) that they are approaching their assigned altitude. Each time a new altitude assignment is received the new altitude is dialed into the alerter’s window or the altitude window of the MCP.

It is crucial that the correct altitude be set into the altitude alerter/MCP. One airline’s study, for instance, revealed that roughly one-third of its altitude deviations involved mis-set altitude alerters.¹⁸

The ASRS hearback study determined that after the altitude alerter was set, it tended to become the “sole authority for what the aircraft’s altitude should be.” It also noted that pilot reliance on the alerter “appeared to blot out pilot consciousness or awareness of the numbers as heard from the controller. Time and time again, although both airmen ‘knew’ the correct altitude assigned to them, a mis-set altitude selector was allowed to take the aircraft to an erroneous flight level.”

This ASRS report illustrates the problem: “Center [cleared us to cross XYZ at] FL [flight level] 290 [29,000 feet (8,845 meters)]. I wrote that down on my pad [but] the Captain set FL 240 [24,000 feet (7,320 meters)] in the altitude alerter. I started down to cross at FL 290, then noticed FL 240 [set into the alerter’s window] Passing FL 250 [25,000 feet (7,625 meters)] controller called asking our cleared altitude. We replied FL 240 and he issued an immediate left turn with similar instructions to another aircraft.”

Part of the altitude awareness program that Midwest Express pioneered in 1986 involves a procedure to ensure that the correct altitude is set into the alerter. Said Capt. David Phipps, one of the program’s architects: “As the pilot not flying [PNF] accepts an altitude assignment from ATC, he or she inserts that altitude into the alerter, points to it and verbally repeats the altitude. This is a challenge, in effect asking the pilot flying [PF] to verify that the repeated altitude is correct, and that the number inserted into the alerter is also correct.” The PF then responds to the challenge by repeating the altitude that he or she heard and understood. If there is a difference in the understanding of the clearance this is the time to resolve it with ATC. The PF then looks at and points to the altitude alerter to confirm that the proper altitude has been set.¹⁹

Phipps said common errors to avoid are:

- The PF responds prematurely by pointing to the alerter before it has been set;

- The PNF discontinues pointing to the alerter before getting a response from the PF;
- The PF fails to point to the alerter, and may not look at the inserted altitude; and,
- The alerter is incorrectly set on departure or during arrival to a clearance limit rather than to the appropriate intermediate altitude constraint.²⁰

The 1992 FAA altitude deviation study collected positive and negative comments regarding this procedure. “Although the concept is great, it is sometimes awkward and confusing to have arms crossing on the forward panels while one pilot [the PNF] is trying to set the altitude, while the other pilot is trying to fly the aircraft,” said one pilot. While the procedure may seem cumbersome at first, it should be kept in mind that without cross-cockpit confirmation it is possible for an unauthorized altitude to be set and go undetected. Another pilot commented: “Leaving your finger there makes the other pilot look, and helps you to listen.”

When a pilot receives an ATC clearance, that information is placed into the brain’s “working memory.”²¹ Information in the working memory is forgotten with passage of time and with the inflow of additional information. For this reason, the altitude alerter/MCP should be set immediately upon receipt of clearance — even before the clearance is read back to ATC. The altitude readback can then be made by looking at numerals set in the alerter. This serves as an additional cross-check that the alerter’s setting matches the numbers that are read back.

Altitude callouts. Air carriers typically require the PNF to make an altitude callout when 1,000 feet (305 meters) above or below the assigned altitude when descending and climbing, respectively. As part of its altitude awareness program, USAir took a novel approach with these callouts, changing *who* makes the callout, *when* it is done and specifically *what* the callout will be. The carrier is convinced that this shift contributed to its program’s success.

The PF now makes the altitude callout at USAir. The airline’s rationale is that the pilot physically at the controls is the one who must actually level the airplane at the desired altitude, so it is critical that this crew member be keenly aware of altitude. USAir felt that requiring the PF to make the altitude callout strengthens this crew member’s altitude awareness. The role of the PNF is to back up and challenge the PF if the callout is not made.

USAir discovered in its research that a pilot’s own altitude vigilance could become diminished by relying unconsciously on the altitude alerter’s aural warning to remind him or her of approaching level-off altitude.^{22,23} To combat this conditioning, USAir stated that the altitude callout should be made *prior* to the sounding of the altitude alerter’s “1,000 feet to level-off” tone.²⁴

Also changed was the way that the altitude callout was actually made. USAir's previous altitude callout was "one to go," meaning 1,000 feet to level-off. Now the PF announces the altitude passing and then states the intended level-off altitude, for example, "six thousand for seven thousand." The carrier believes that this method verbally brings attention to the altitude at which the PF intends to level. It may also raise a question from another crew member such as, "Seven thousand? I thought we were cleared to seventeen thousand."²⁵

From a human factors perspective, USAir believes that these callout modifications help form a multilevel defense against altitude deviations. The first level of defense is that the PF will detect that he or she is nearing the desired level-off altitude. If the PF fails to make the callout, then the PNF will make the callout, forming the next defense level. If both human defense levels should fail to detect the nearing level-off altitude, then the third defense level, the aural alerter, will remind the crew.²⁶

Crew prioritization and task allocation. Said one reporter to ASRS, "... we were cleared from 5,000 feet [1,524 meters] to 6,000 feet [1,829 meters]. I read back the clearance and proceeded to do the paperwork (filling out the aircraft logbook). After the logbook was completed, I looked up and noticed that we were at 8,500 feet [2,591 meters] ... We just weren't paying attention."

One-quarter of the pilot-reported altitude deviations in the FAA study were categorized as task prioritization/allocation errors. An effective altitude awareness program should encourage crews to refrain from doing extraneous tasks (such as paperwork, eating and searching for the next destination's approach charts) while the aircraft is climbing and descending. Many of these tasks can wait until the aircraft is level. On short hops it may be difficult to delay some tasks until level-off, but the more time devoted to looking at the flight instruments during altitude changes, the greater the chances of preventing an altitude overshoot.

Capt. Griffith of American Airlines also suggested that pilots consider the last 1,000 feet of altitude change as a "miniature sterile period" where they focus their attention on two primary tasks — instrument scan and visual monitoring for outside traffic. [Griffith was referring to the "sterile cockpit rule," FAA-mandated in the U.S., that prohibits nonessential activities during critical phases of flight.]

American also warns crew members that highly automated aircraft may create a "complacency surrounding the level-off." The problem, according to Chidester and Martin in American Airlines' *Flight Deck*, is that as the aircraft approaches the level-

off point there may be a change in the rate of climb or descent, which can be perceived by the crew as positive confirmation that the aircraft will level at the desired altitude. This may allow unsuspecting pilots to divert their attention from the altitude capture. "Monitoring needs to continue all the way to level-off," said Chidester and Martin.²⁷

As noted in the ASRS hearback study, miscommunication can arise when one pilot is off ATC frequency. Pilots can minimize this by carefully timing these off-frequency excursions, according to Capt. Gary Drska, director of flight standards and training at Midwest Express Airlines. "For example, if a pilot is anticipating a clearance for lower altitude, delay making the 'in-range' call to company until after the new clearance has been received," said Drska.

Wrote an ASRS reporter following a altitude deviation, "In the future I will not make PA announcements while changing altitudes." Along the same lines, crews should copy the ATIS prior to beginning the descent.

Wilson suggested developing a "pilot-off-frequency" procedure. "In multipilot environments, when one pilot is off-frequency, the pilot handling ATC should:

- "Test radio volume and ensure good reception;
- "Be sure that communication is understood, and ask for clarification if information is not clear;
- "Always read back; and,
- "Brief the other pilot when he returns to the frequency as to what information was received, especially any changes in clearances."²⁸

Transition altitude. According to the FAA study, "Numerous incidents occurred when the pilots either (a) failed to reset the barometric pressure setting on altimeters at the [transition altitude], or (b) checked only the last two digits of the altimeter, leading to incorrectly set altimeters and an altitude deviation. In addition, several of the ATC tapes reviewed indicated that controllers sometimes communicate only the last two digits of altimeter settings, which could potentially result in altitude deviations." The study recommended that pilots announce all four digits when resetting their altimeters at transition altitude in descent. "If a crew receives fewer than four digits from ATC for the pressure setting [QNH],²⁹ they should call ATC and ask for all digits," the study recommended.

To illustrate the importance of properly set altimeters, consider a U.S. carrier operating overseas that almost became a

One-quarter of the pilot-reported altitude deviations collected and analyzed in the FAA study were categorized as task prioritization/allocation errors.

controlled-flight-into-terrain (CFIT) accident. The second officer heard incorrectly the altimeter setting from ATIS as being 29.91 inches of mercury. The correct setting was 991 millibars.³⁰ When issuing descent clearance, ATC gave the altimeter setting as, “QNH 991.”

Because the altimeters were incorrectly set, the aircraft was actually 640 feet (195 meters) lower during the approach than indicated on the altimeters. As explained by a crewmember in a report to ASRS, “At 1,000 feet [3,048 meters] above MDA [minimum descent altitude] captain called out ‘1,000 feet’ and shortly thereafter the second officer monitoring the approach ... called out ‘300 feet [91 meters] radio altitude — go around!’ ... After the missed approach captain questioned tower about altimeter setting level 29.91 and received confirmation. A second voice, however, corrected that statement to 991 millibars”

The crew later computed that they were within 160 feet [49 meters] of striking terrain. Considering their descent rate of 1,500 feet [457 meters] per minute, they were within seconds of becoming another accident statistic. Figure 4 illustrates the altimeter difference.

ASRS *Directline* suggested that to prevent such incidents, approach charts should be reviewed prior to beginning descent, approach and landing phase. “Each flight crew member should pay particular attention to whether altimeter setting will be given in inches [of mercury] (Hg), millibars (mb) or hectopascals (hPa).”³¹

Flexibility Needed

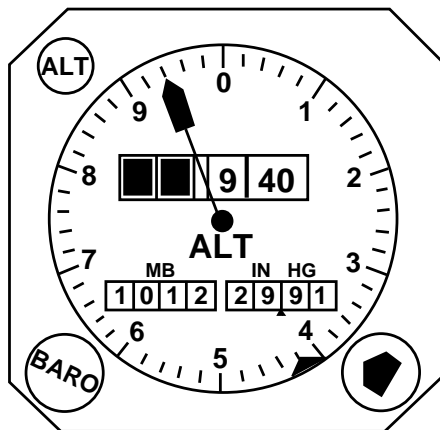
As with any flight program implementation, heeding responses from line pilots is imperative to validate procedural design. For instance, USAir initially adopted Midwest Express’s altitude alerter setting procedure verbatim. Nevertheless, feedback from line pilots caused USAir to modify certain aspects of the procedure. On highly automated aircraft, for example, USAir pilots felt there were too many hands reaching for knobs and buttons on the MCP. On another aircraft type, the alerter was located too far from the captain.

McClure said that a program will be most effective if it is simple and compatible with the operating environment. “Find what works for your operation, then strive for 100 percent standardization,” said McClure. Drska added: “Like the success of any program, it is imperative for check airmen to be onboard with it. It must be constantly reinforced during line checks and simulator training.” Both McClure and Drska agreed that in the beginning, certain procedures, especially pointing to the altitude alerter, will seem awkward and burdensome for crew members. “Patience is needed when implementing such a program, but the benefits are well-worth while,” Drska said.

It is believed that other safety-enhancing spin-offs can result from altitude awareness programs. Through the greater emphasis on precise radio communications, cross-cockpit verification and enhanced crew coordination, pilots may be involved in fewer runway transgressions, en route course deviations, and other aviation safety incidents.♦

Consequences of Incorrectly Set Altimeter in One NASA ASRS Report

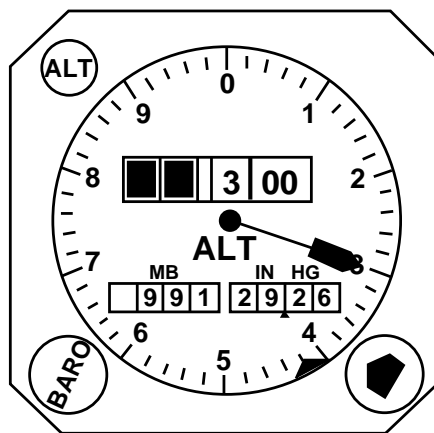
What the flight crew saw with the altimeter incorrectly set to 29.91 inches of mercury (Hg).



The nonprecision approach had a minimum descent altitude (MDA) of 420 feet (128 meters). The graphic on the left is what the flight crew saw with an incorrectly set altimeter.

The graphic on the right shows that they were actually 120 feet below MDA at the point of the go-around. When executing a nonprecision approach, it is common practice to use a higher rate of descent than for an ILS. Thus by the time that the aircraft’s descent rate was arrested, they had descended as low as 160 feet (49 meters) above the surface.

At a setting of 991 hectopascals (hPa), they were 120 feet (37 meters) below the minimum descent altitude.



Source: U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS)

Figure 4

About the Author

Capt. Robert L. Sumwalt III is president of Aviatrends, a company that specializes in aviation safety research and consulting. Sumwalt is also a captain for a major U.S. air carrier, where he has served as an airline check airman and instructor pilot. He is a regular contributor to *Professional Pilot* magazine, and co-wrote "ASRS Incident Data Reveal Details of Flight-crew Performance During Aircraft Malfunctions," in the October 1995 Flight Safety Digest.

References

1. U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) is a confidential incident reporting system. The data base includes approximately 300,000 reports, increasing by about 2,500 reports monthly. The majority of these reports are submitted by air carrier pilots. These reports are often rich with information, as many reporters describe in detail their perspective of the circumstances surrounding an incident. It is touted as "the most comprehensive source of information about human operator error in existence."

The numbers and proportions of various incident types in the ASRS data base cannot be assumed to reflect all incidents, reported or not. The only reasonable inference is that the number of incidents of a particular type reported to ASRS is the minimum number that have actually occurred.

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FAA Forecasts Highest U.S. Air Traffic Growth in Regional/Commuter Airlines, International Routes

FAA workload increases are expected to be moderate.

Editorial Staff Report

U.S. domestic air carrier passenger traffic is expected to grow at an average 4 percent annually through fiscal year (FY) 2006, but the regional/commuter segment of that traffic will climb more steeply, at a projected 6.6 percent average annual increase. U.S. international air carrier traffic is forecast to increase at 5.8 percent annually over the 12-year period of FY 1994–2006.

U.S. Federal Aviation Administration (FAA) operations at airport towers are foreseen growing at a moderate 1.5 percent annually averaged through FY 2006, when calculated to include the planned conversion of 50 FAA-controlled airports to contract towers. The workload at the FAA's air route traffic control centers (ARTCCs) is expected to grow at an average 1.9 percent through the 12-year period.

Those were among the forecasts in *FAA Aviation Forecasts: Fiscal Years 1995–2006*, one of an annual series of reports predicting the economics and traffic demands of U.S. nonmilitary aviation, and predicting workload measures for FAA towers, centers and flight service stations. The report also includes statistics for recent years.

The FAA reported that in FY 1994, the 10 major U.S.-registered airlines' domestic traffic grew by 4.0 percent, but national/regional traffic increased 50.7 percent. The FAA defines major airlines as air carriers with annual operating revenues of more than US\$1 billion. Nationals have annual operating revenues between \$100 million and \$1 billion, and regionals have annual operating revenues of less than \$100 million. A commuter air carrier is one that is certified under U.S. Federal

Aviation Regulations (FARs) Part 135 or Part 121, operates aircraft with a maximum of 60 seats and operates at least five scheduled round trips per week.

U.S. air carriers' international traffic grew 2.8 percent, and trans-Pacific traffic — which had increased at an average 17.5 percent annually between FY 1986 and FY 1992 — declined 0.2 percent in FY 1994. That decrease was offset by increases of 6.0 percent to and from Latin America and of 4.2 percent over North Atlantic routes.

The regional/commuter industry expanded rapidly in 1994. Growth was 14.8 percent measured by passenger boardings and 18.1 percent measured by revenue passenger miles (RPMs).

Looking ahead, the FAA projected U.S. air carrier domestic growth of passenger boardings at 6.1 percent higher in FY 1995 than FY 1994, with another increase of 5.9 percent in FY 1996 (Table 1, page 12). A leveling-off was expected after that, with growth over the 12-year forecast period averaging 4.0 percent per year.

But the FAA also calculated that the domestic growth in passenger traffic would increase load factors (the percentages of airplane seats filled) more than it would increase operational volume. Air carrier operations were forecast to increase at an average 1.9 percent annually.

U.S. air carriers' international traffic is anticipated to grow at an annual average of 5.8 percent over the forecast period,

Table 1
U.S. Aviation Activity Forecasts, Fiscal Years 1995–2006

Aviation Activity	Historical				Forecast		Percent Average Annual Growth (actual and forecast)				
	1985	1993	1994	1995	1996	2006	85–94	93–94	94–95	95–96	94–06
Air Carrier											
Enplanements (millions)											
Domestic	350.4	434.0	472.0	501.0	530.3	754.3	3.4	8.7	6.1	5.9	4.0
International	24.3	45.2	46.3	48.6	51.6	90.6	7.4	2.4	5.0	6.2	5.8
Atlantic	11.4	15.7	16.5	17.4	18.5	30.4	4.2	4.9	5.4	6.3	5.2
Latin America	7.9	15.8	16.4	17.3	18.4	33.2	8.5	3.7	5.3	6.4	6.0
Pacific	5.0	13.6	13.4	13.9	14.7	27.0	11.6	(1.9)	4.0	5.8	6.0
System	374.6	479.2	518.3	549.6	581.9	844.9	3.7	8.2	6.0	5.9	4.2
RPMs* (billions)											
Domestic	265.8	348.6	371.4	391.5	412.2	596.2	3.8	6.5	5.4	5.3	4.0
International	64.4	134.8	138.5	145.5	154.7	273.1	8.9	2.8	5.0	6.3	5.8
Atlantic	36.1	61.5	64.1	67.6	72.0	119.6	6.6	4.2	5.5	6.5	5.3
Latin America	9.7	20.8	22.1	23.4	24.9	46.1	9.6	6.0	6.2	6.4	6.3
Pacific	18.6	52.4	52.4	54.4	57.7	107.4	12.2	(0.2)	4.0	6.0	6.2
System	330.2	483.4	509.9	537.0	566.9	869.3	4.9	5.5	5.3	5.6	4.5
Regionals/Commuters											
Enplanements (millions)	24.4	46.7	53.6	58.4	62.6	115.1	9.1	14.8	9.0	7.2	6.6
RPMs (billions)	3.6	9.4	11.1	12.4	13.6	28.2	13.3	18.1	11.7	9.7	8.1
Fleet											
Air Carrier	2,938	4,263	4,426	4,474	4,582	6,531	4.7	3.8	1.1	2.4	3.3
Regional/Commuters	1,551	2,054	2,179	2,284	2,396	3,250	3.9	6.1	4.8	4.9	3.4
General Aviation (thousands)	219.6	183.6	176.0	173.8	171.7	174.6	(2.5)	(4.1)	(1.3)	(1.2)	(0.6)
Hours Flown (millions)											
Air Carrier	7.7	11.0	11.2	11.4	11.7	17.8	4.3	1.4	1.5	2.5	3.9
Regional/Commuters	N.A.	2.9	3.0	3.1	3.2	4.5	N.A.	1.7	4.0	3.8	3.5
General Aviation	30.9	24.4	24.1	24.3	24.5	27.0	(2.8)	(1.2)	0.8	0.8	1.0

* RPM: revenue passenger miles

Air Carrier: Certified under U.S. Federal Aviation Regulations (FARs) Part 121 and Part 127.
 Commuter/Air taxi: Certified under FARs Part 135.
 General Aviation: All civil aviation activity except that of air carriers certified under FARs Parts 121, 123, 127 and 135.
 Source: U.S. Federal Aviation Administration

Table 2
U.S. Federal Aviation Administration (FAA) Workload Measures, Fiscal Years 1995–2006

Workload Measures (in millions)	Historical			Forecast			Percent Average Annual Growth (actual and forecast)				
	1985	1993	1994	1995	1996	2006	85–94	93–94	94–95	95–96	94–06
Aircraft Operations											
Air Carrier	11.3	12.6	13.2	13.6	14.0	16.6	1.7	4.8	3.0	2.9	1.9
Commuter/Air Taxi	6.9	9.7	10.0 (9.5)	9.9	10.1	13.1	4.2	3.1	4.2	2.0	2.7
General Aviation	37.2	35.2	34.7 (31.8)	33.9	32.4	36.4	(0.8)	(1.4)	6.6	(4.4)	1.1
Military	2.5	2.6	2.4 (2.3)	2.2	1.9	1.9	(0.5)	(7.7)	(4.4)	(13.6)	(1.6)
Total	57.9	60.1	60.3 (56.8)	58.6	58.4	68.0	0.5	0.3	3.2	(0.3)	1.5
Instrument Operations											
Air Carrier	11.8	13.6	14.3	14.7	15.1	18.1	2.1	4.4	2.8	2.7	2.0
Commuter/Air Taxi	6.4	10.4	10.8	11.1	11.4	14.4	6.0	3.9	2.8	2.7	2.4
General Aviation	16.4	17.7	18.0	18.3	18.6	21.0	1.0	1.7	1.7	1.6	1.3
Military	4.1	3.9	3.7	3.6	3.5	3.5	(1.1)	(5.1)	(2.7)	(2.8)	(0.5)
Total	38.7	45.7	46.7	47.7	48.6	57.0	2.1	2.1	2.1	1.9	1.7
IFR Aircraft Handled											
Air Carrier	14.6	19.0	20.0	20.6	21.2	26.3	3.6	5.3	3.0	2.9	2.3
Commuter/Air Taxi	4.8	6.2	6.5	6.8	7.0	9.1	3.4	4.8	4.6	2.9	2.8
General Aviation	8.3	7.4	7.7	7.9	8.1	9.1	(0.8)	4.1	2.6	2.5	1.4
Military	5.0	4.8	4.6	4.5	4.4	4.4	(0.9)	(4.2)	(2.2)	(2.1)	(0.4)
Total	32.7	37.5	38.8	39.8	40.7	48.9	1.9	3.5	2.6	2.3	1.9
Flight Services											
Pilot Briefs	15.0	10.0	9.4	9.2	8.9	8.1	(5.1)	(6.0)	(2.1)	(3.3)	(1.2)
Flight Plans Originated	8.4	6.2	6.2	6.1	6.0	5.7	(3.3)	0.0	(1.6)	(1.6)	(0.7)
Aircraft Contacted	8.2	4.9	4.6	4.3	4.2	4.0	(6.2)	(6.1)	(6.5)	(2.3)	(1.2)
Total (without DUATS*)	55.0	37.2	35.8	34.9	34.0	31.6	(4.7)	(3.8)	(2.5)	(2.6)	(1.0)
DUATS	N.A.	12.3	16.2	13.2	14.4	20.2	N.A.	31.7	(18.6)	9.1	1.9
Total (with DUATS)	55.0	49.5	52.0	48.1	48.4	51.8	(0.6)	5.1	(7.5)	0.6	0.0

Note: Two activity levels are shown for 1994 towered operations, (1) for the current 402 towered airports and (2) for 352 airports — the new base that removes the 50 airports converted to contract towers during 1995.
 Source: U.S. Federal Aviation Administration
 *DUATS — Direct User Access Terminal System

measured by RPMs or boardings. "International travel is, to a large extent, being driven by the strong demand projected in Latin American (6.3 percent annually in RPMs) and trans-Pacific (6.2 percent) markets," the report said. "North Atlantic markets are expected to grow by 5.3 percent over the forecast period."

U.S. regional/commuter airlines accounted for 10.5 percent of scheduled domestic passenger service in FY 1994. By FY 2006, these carriers are expected to board 13.7 percent of domestic passengers.

In forecasting its own workload, the FAA noted that demand for its operational services at towered airports increased marginally in FY 1994 after three declining years. Through FY 2006, activity at FAA towered airports was forecast to grow 1 percent annually on average compared with FY 1994 figures. But because the 402 airports at which the agency provides tower services directly will be reduced to 352, activity at those remaining was predicted to increase by an annual average of 1.5 percent (Table 2, page 13).

"The increased use of avionics by regional/commuter airlines and general aviation aircraft, combined with the implementation of additional airport radar service areas, is

expected to result in instrument operations at FAA towered airports increasing at a somewhat faster rate than total aircraft operations," the report said. It predicted an average annual growth of 1.7 percent in instrument operations.

ARTCCs are expected to be an average 1.9 percent busier annually during the 12-year forecast period. "The higher growth rate at en route centers, relative to activity at towered airports, results from the fact that commercial activity accounts for a significantly larger percentage of center activity ...," the report said. "Therefore, the projected increases in commercial aircraft activity, especially during the first three years of the forecast period, will have a much greater impact on total center traffic."

Aviation activity at FAA facilities, the report said, is expected to expand at a slower rate than the general U.S. economy. The difference was attributed to the expected decrease in military flying, slower growth in general aviation and "higher load factors, larger aircraft and longer trip distances flown by commercial airlines."♦

Editorial note: This article is based on *FAA Aviation Forecasts: Fiscal Years 1995–2006*. Report no. FAA-APO-95-1. March 1995. Available from the National Technical Information Service (NTIS), Springfield, Virginia, U.S.

Publications Received at FSF Jerry Lederer Aviation Safety Library

FAA Evacuation Study Pinpoints Physical Characteristics That Affect Egress

*Books: The Naked Pilot reviews human error accidents
in the light of biological and physiological traits.*

Editorial Staff

Reports

Aircraft Evacuations Through Type-III Exits II: Effects of Individual Subject Differences. McLean, G.A.; George, M.H. A special report prepared for the U.S. Federal Aviation Administration (FAA) Office of Aviation Medicine. Report No. DOT/FAA/AM-95/25. August 1995. 18 pp. Figures, references. Available through NTIS.*

Keywords:

1. Aircraft Evacuations
2. Egress
3. Human Factors
4. Ergonomics

This report continues the study conducted for the U.S. Federal Aviation Administration's Office of Aviation Medicine on the effect of aircraft passageway width on passenger exit during an emergency evacuation. (See also Report No. DOT/FAA/AM-95/22, *Aircraft Evacuations Through Type-III Exits I: Effects of Seat Placement at the Exit*). The second phase of this study examined the effects of the width of the aircraft cabin center aisle on the egress of individual subjects.

Two subject groups, one consisting of persons between ages 18 and 40, the other between ages 40 and 62, enacted a series of simulated emergency evacuations of an aircraft through Type III overwing exits. The exits were approached via passageways of 6-inch (15.24-centimeter), 10-inch (25.4-centimeter), 13-inch (33.02-centimeter), 15-inch (38.1-centimeter), and 20-inch (50.8-centimeter) widths.

Evacuation times for each simulation were extracted from videotape recordings. The variable factors considered in the

simulations were an individual subject's age, weight, height, gender and waist size. The factors most notably affected were age, weight and gender: Increased subject age and weight were related to increased egress times, and male subjects exited much more quickly than females. Unexpectedly, passage width did not affect any of the variables significantly. The report also notes that egress times increased among older subjects as they developed better strategies for emergency evacuation during the repeated simulations.

The report concludes that studies of emergency aircraft evacuation should account for the personal characteristics of the individual subjects involved in the research. Physical characteristics such as age, weight and gender can affect research results significantly. In addition, the results of research studies employing repeated activities can be affected as the subjects gain experience.

HINCOF-I: A Code for Hail Ingestion in Engine Inlets. Interim Report. U.S. Federal Aviation Administration (FAA) Technical Center. Report No. DOT/FAA/CT-94-80. August 1995. 72 pp. Figures, tables, appendices. Available through NTIS.*

Keywords:

1. Water Ingestion
2. Hail Ingestion
3. Turbo Fan

Hail ingestion into an aircraft's engine is a major hazard during flight. Hailstones entering an engine inlet can affect all parts of the engine. Friction, collision and melting, heat, fragmentation and the accretion of dirt and oil alter the shape, size and structure of the hailstones to cause mechanical damage and changes in engine performance. Power loss, compression system surges or the occasional flameout can result from

hailstorm damage. The development of a means of determining the occurrence of such effects in relation to atmospheric and flight conditions is therefore extremely important to future engine design and operational procedures.

This report describes HINCOF-I, a code developed to predict the motion of hailstones from the atmosphere, through an inlet, up to the engine face. The code is divided into two parts — one to predict air flow, and the other to predict hail motion. The second part considers the changes that may occur in the physical characteristics of hailstones because of the altering factors described above. Inlet geometry and engine operation characteristics are also included in the code so that any desired set of conditions can be included in a specific calculation. HINCOF-I can be used to relate the spinner geometry — conical or elliptical — to the possible diversion of hail at the engine face into the bypass stream. The code may also be used to assess the influence of various hail characteristics on the distribution of hailstones over the engine face.

Appendix A contains the methodology for determining the air flowfield of engine inlets. Appendix B lists the variables considered in the code.

Books

The Naked Pilot: The Human Factors in Aircraft Accidents. Beaty, David. Shrewsbury, England: Airlife Publishing Ltd., 1995. 310 pp. Figures, references, index.

David Beaty writes that approximately 70 percent of aircraft accidents in the last 25 years have been attributed to pilot or human error. This book, the newly revised and updated edition of *Human Factors in Aircraft Accidents*, considers aspects of human nature — biological and psychological responses that have been with us for millions of years — and addresses how these fundamental human failings have led to the loss of hundreds of lives.

The chapter headings outline each aspect of human nature under scrutiny: “Communication”; “To See and Not to See”; “The Male Ego,” “Learning and Regression”; “The Clockwork Captain, or Deus in Machina”; “Boredom and Absence of Mind”; “Conformity: The Three-Head Hydra” and “Fatigue and Stress.” Each chapter illustrates the results of these all-too-human failings with horrific examples. This book contains detailed accounts of the circumstances in several major air carrier accidents.

In addition to considering why accidents occur, Beaty discusses human factors education and human factors in management. The latter section provides further examples of how cost-cutting measures and commercial pressure on airline employees adversely affect aviation safety, emphasizing that pilots are not alone in vulnerability to human error.

Pilot Judgment and Crew Resource Management. Jensen, Richard S. Brookfield, Vermont, U.S.: Ashgate Publishing Co., 1995. 349 pp. Figures, tables, references, index.

This book not only examines how decision making can be applied to the improvement of aviation safety, but also addresses the principles required to learn, teach and evaluate judgment. For pilots, this book provides foundations for learning how to make better and safer decisions. For flight instructors, it discusses how to teach and evaluate professional judgment in their students.

Pilot Judgment examines the kinds of errors that pilots make. The book divides errors into instrument and control errors, procedural errors, and errors in decision making. The last are examined most closely. Decision-making errors include continued flight with an instrument malfunction or illness, failure to ask for help during severe problems and failure to adhere to approved procedures and making decisions in haste or with inadequate or incorrect information.

Human factors that influence judgment are divided into categories: mental, moral, emotional, physiological, social, philosophical, and individual personalities and attitudes; each is discussed in turn. The author includes personal accounts of his own flight experience to illustrate the factors involved in the decision-making process.

Chapter titles include “Introduction to Judgment Error,” “Judgment Models,” “Rational Judgment,” “Can Judgment be Taught?,” “Stress, Fatigue, and Nutrition,” “The Assessment of Pilot Judgment,” “Complacency” and “Risk Management in Aviation.” One chapter addresses the special decision-making factors to be considering when piloting balloons and gliders. Each chapter concludes with its own list of references.♦

* U.S. Department of Commerce
National Technical Information Service (NTIS)
Springfield, VA 221612 U.S.
Telephone: (703) 487-4780

Updated U.S. Federal Aviation Administration (FAA) Regulations Reference Materials

U.S. Federal Aviation Regulations (FARs)

Part	Date	Subject
71	9/15/95	<i>Designation of Class A, Class B, Class C, Class D and Class E Airspace Areas; Airways; Routes; and Reporting Points</i> (incorporates Amendment 71-25, "Amendment to the South Florida Low Offshore Airspace Area," adopted 10/28/95 and Amendment 71-26, "Airspace Designation, Incorporation by Reference," adopted 8/23/95).

Advisory Circulars (ACs)

AC No.	Date	Title
00-2.9	8/15/95	<i>Advisory Circular Checklist</i> (cancels AC 00-2.8, <i>Advisory Circular Checklist</i> , dated 6/15/94).
00-44GG	July 1995	<i>Status of Federal Aviation Regulations</i> (cancels AC 00-44FF, <i>Status of Federal Aviation Regulations</i> , dated July 1994).
23.1309-1B	7/28/95	<i>Equipment, Systems, and Installations in Part 23 Airplanes</i> (cancels AC 23.1309-1A, <i>Equipment, Systems, and Installations in Part 23 Airplanes</i> , dated 6/3/92 and Change 1 to AC 23.1309-1A, dated 8/5/92).
150/5210-14A	7/13/95	<i>Airport Fire and Rescue Personnel Protective Clothing</i> (cancels AC 150/5210-14, <i>Airport Fire and Rescue Personnel Protective Clothing</i> , dated 3/12/86).

Accident/Incident Briefs

Complacent Crew's DC-10 Landing Ends in Overrun Area

Incorrect fuel-tank selection results in fuel shortage during climb for Beech 55 Baron.

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Editorial Staff

The following information provides an awareness of problems through which such occurrences may be prevented in the future. Accident/incident briefs are based on preliminary information from government agencies, aviation organizations, press information and other sources. This information may not be entirely accurate.



Unstabilized Approach Ends with Runway Excursion

McDonnell Douglas DC-10. Minor damage. No injuries.

The DC-10 was on a coupled approach for Runway 04R in visual meteorological conditions at night, but the aircraft landed long. After leaving the runway and after entering a hard-surfaced overrun area, the aircraft was stopped.

The flight crew initiated a right 270-degree turn to exit the overrun area and reach a cargo taxiway. During the turn, the nose wheel departed the hard surface, runway threshold lights were damaged and a small grass fire was started near the overrun area. At the gate, ground personnel determined that the aircraft had suffered minor damage to the nose wheel and main-gear tires.

An investigation determined that the flight crew had positioned for a straight-in approach more than 40 nautical miles (56 kilometers) from the airport at an altitude of 8,000 feet (2,440 meters). As the flight passed through 2,240 feet (683 meters), airspeed was 215 knots, leading edge slats were extended, engines were at idle thrust and the descent rate was 1,260 feet (384 meters) per minute. At 1,000 feet (305 meters) above field elevation, airspeed was 213 knots with no change in configuration or descent rate.

The flight data recorder indicated that the throttles were advanced to slightly above idle during the landing phase for about 10 seconds as the airplane was held off the ground until the landing gear extended. The landing gear was extended at about 205 knots. Final landing flap configuration of flaps 35 occurred at about 40 feet (12.2 meters) above airport elevation and the flare was initiated at about 190 knots, with touchdown at 185 knots. Reverse thrust was selected on all three engines, but only engines no. 1 and no. 2 developed full reverse thrust.

The flight crew reported that they heard a ground-proximity warning system (GPWS) callout of “Too low, gear” during the approach, at which time they extended the gear. In addition, a review of air traffic control conversations indicated that the flight crew did not advise the tower controller or ground controller that the aircraft had left the runway. Controllers said that the distance from the tower made it difficult to determine whether the aircraft had left the runway. Landings on the runway continued normally because controllers were not advised of the problem.

The investigation found that the landing gear and flaps were not extended in normal sequence, that the Final Descent Checklist was not accomplished, that the captain did not follow standard procedures by initiating a go-around after receiving the GPWS alert and that the flight crew was complacent. The incident is being used by the company for training in all fleets.



Handrail Accident Seriously Injures Passenger

Fokker F28. No damage. One serious injury.

The F28 had arrived in the United Kingdom after a flight from a European city. When the flight arrived at its assigned gate, no ramp agent was present to maneuver the passenger loading bridge.

A short time later, a ramp agent arrived but determined that the loading bridge was set too high for the F28 and recommended that passengers deplane from the aircraft’s integral stairs. The stairs were deployed, but the flight attendant needed assistance from the ramp agent to reach and secure the left handrail. Passenger deplaning proceeded normally until an elderly woman passenger leaned on the left handrail and it collapsed. The passenger fell two meters (6.6 feet) to the ramp and suffered severe chest, neck and head injuries.

Three days later, the injured passenger and her husband were to be flown home on the same aircraft. Prior to boarding, the captain checked the left handrail during his preflight inspection, and it collapsed.

An engineering inspection of the handrail and latch found no irregularities to account for its collapse. The operator said it was considering adding alignment stripes to the handrail to help crews determine that the handrails are locked. Inspection procedures for correct locking have also been added to crew information.

Freighter Crashes Following Engine Failure

Douglas DC-3. Aircraft destroyed. One fatality. Two serious injuries.

The twin-engine DC-3 had taken off from a Canadian airport when the pilot declared an emergency and attempted to return to the airport.

During a turn to the runway, the aircraft descended and struck a dike wall along a river. The DC-3 burst into flames and was destroyed by the impact and fire. Witnesses to the accident reported that the no. 2 engine was not running at the time of the accident. Weather was reported as clear with unlimited visibility.



Twin Damaged After Botched NDB Approach

Beech 100 King Air. Substantial damage. No injuries.

The twin-turboprop King Air with two crew members and seven passengers on board was making a daylight nondirectional beacon (NDB) approach in instrument meteorological conditions. The pilot did not establish visual contact with the runway until he was over the threshold.

Although the first officer recommended a go-around, the captain elected to continue the landing. Before touchdown, a propeller struck the ground about 1,600 feet (488 meters) past the runway threshold. The landing gear contacted the runway 2,486 feet (758 meters) from the threshold of the 5,235-foot (1,597-meter) runway. The nose gear and propeller were substantially damaged but no one on the aircraft was injured.



Fuel Tank Selection Cuts Flight Short

Beech 55 Baron. Substantial damage. Two serious injuries.

After a normal takeoff in daylight visual meteorological conditions, both engines stopped during initial climb and an emergency landing was executed.

The pilot and a passenger were seriously injured when the aircraft struck a tree.

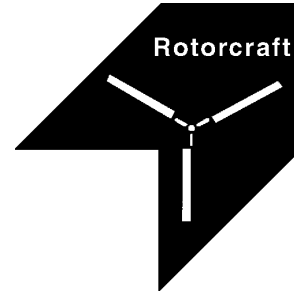
An investigation determined that the fuel tank selectors were set in the auxiliary position and that the engines had stopped because of fuel starvation. The pilot's operating handbook states that the main fuel tanks should be selected for takeoff. The pilot had 30 hours flight time in the aircraft.

Crosswind Snags Single on Touchdown

Cessna 172. Substantial damage. No injuries.

The pilot of the Cessna was attempting to land in a crosswind reported to be gusting to 30 knots. Control of the aircraft was lost at touchdown and it departed the runway toward a nearby line of hangars.

The aircraft collided with several 45-U.S. gallon (170-liter) drums, tearing off the nose gear and the right main landing gear. The 172 then struck an embankment, skidded across a parking lot and came to rest nearly a mile from the touchdown point.



Emergency Mountain Slope Landing Executed After Engine Failure

Bell 206. Substantial damage. No injuries.

Shortly after takeoff from a mountain top, the helicopter's engine lost power. The aircraft had been stranded on the mountain for five days because of poor weather and heavy snowfall.

Before takeoff, the pilot cleared the snow from the aircraft and from one engine inlet and ran the engine for about 20 minutes. The engine quit about one minute after takeoff. The pilot executed a 180-degree autorotation and the helicopter landed hard on slightly sloping terrain. The aircraft sustained substantial damage. The pilot and one passenger were not injured. Weather at the time of the accident was reported to be visual meteorological conditions.

Loss of Control Follows Preflight Oversight

Hiller UH-12E. Substantial damage. One serious injury.

The helicopter had been towed to the work area with a shipping block attached to the main rotor head. At the work site, the pilot and ground crew attached the main rotor blades, but forgot to remove the shipping block.

When the aircraft lifted off from a trailer, the pilot was unable to maintain control and the helicopter impacted terrain. The pilot was seriously injured and the helicopter sustained substantial damage. Weather at the time of the accident was report as visual meteorological conditions with clear skies.♦



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