FLIGHT SAFETY FOUNDATION

ALAR

APPROACH-AND-LANDING ACCIDENT REDUCTION

TOOL KIT

FSF ALAR BRIEFING NOTE 1.3

Golden Rules

"Golden rules" guide human activities in many areas.

In early aviation, golden rules defined the basic principles of airmanship.

With the development of technology in modern aircraft and with research on human-machine interface and crew coordination, the golden rules have been broadened to include the principles of interaction with automation and crew resource management (CRM).

The following golden rules are designed to assist trainees (but are useful for experienced pilots) in maintaining basic airmanship even as they progress to highly automated aircraft. These rules apply with little modification to all modern aircraft.

Statistical Data

The Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force, in a study of 76 approach-and-landing accidents and serious incidents worldwide in 1984 through 1997,[1] found that:

- Inadequate professional judgment/airmanship was a causal factor[2] in 74 percent of the accidents and serious incidents;
- Failure in CRM (crew coordination, cross-check and backup) was a causal factor in 63 percent of the events; and,
- Incorrect interaction with automation was a causal factor in 20 percent of the events.

Golden Rules

Automated Aircraft Can Be Flown Like Any Other Aircraft

To promote this rule, each trainee should be given the opportunity to hand fly the aircraft — that is, to fly "stick, rudder and throttles."

The flight director (FD), autopilot (AP), autothrottles (A/THR) and flight management system (FMS) should be introduced progressively in the training syllabus.

The progressive training will emphasize that the pilot flying (PF) always retains the authority and capability to revert:

- To a lower (more direct) level of automation; or,
- To hand flying — directly controlling the aircraft trajectory and energy condition.

Aviate (Fly), Navigate, Communicate and Manage — In That Order

During an abnormal condition or an emergency condition, PF-PNF/PM (pilot not flying/pilot monitoring) task sharing should be adapted to the situation (in accordance with the aircraft operating manual [AOM] or quick reference handbook [QRH]), and tasks should be accomplished with this four-step strategy:

Aviate. The PF must fly the aircraft (pitch attitude, thrust, sideslip, heading) to stabilize the aircraft's pitch attitude, bank angle, vertical flight path and horizontal flight path.

The PNF/PM must back up the PF (by monitoring and by making call-outs) until the aircraft is stabilized.

Navigate. Upon the PF's command, the PNF/PM should select or should restore the desired mode for lateral navigation and/or vertical navigation (selected mode or FMS lateral navigation [LNAV]/vertical navigation [VNAV]), being aware of terrain and minimum safe altitude.

Navigate can be summarized by the following:

- Know where you are;
- Know where you should be; and,
- Know where the terrain and obstacles are.

Communicate. After the aircraft is stabilized and the abnormal condition or emergency condition has been identified, the PF should inform air traffic control (ATC) of the situation and of his/her intentions.

If the flight is in a condition of *distress* or *urgency*, the PF should use standard phraseology:

- *"Pan Pan, Pan Pan, Pan Pan,"*[3] *or,*
- *"Mayday, Mayday, Mayday."*[4]

Manage. The next priority is management of the aircraft systems and performance of the applicable abnormal procedures or emergency procedures.

Table 1 shows that the design of highly automated aircraft fully supports the four-step strategy.

Display Use in Abnormal or Emergency Situations

Golden Rule	Display Unit
Aviate (fly)	Primary flight display
Navigate	Navigation display
Communicate	Audio control unit
Manage	Electronic centralized aircraft monitor or engine indication and crew alerting system

Source: FSF ALAR Task Force

Table 1

Implement Task Sharing and Backup

After the four-step strategy has been completed, the actions associated with the abnormal condition or emergency condition should be called by the PF.

Procedures should be performed as set forth in the AOM/QRH or in the following sequence:

- Emergency checklists;
- Normal checklists; and,
- Abnormal checklists.

These should be performed in accordance with the published task sharing, CRM and standard phraseology.

Critical actions or irreversible actions (e.g., selecting a fuel lever or a fuel-isolation valve to "OFF") should be accomplished by the PNF/PM after confirmation by the PF.

The PNF/PM should question any actions taken by the PF that are not understood or are considered inappropriate.

Although many airlines prefer the term *pilot monitoring* to reflect the primary responsibility of the PNF, it should be recognized that both the PNF/PM *and* the PF have a monitoring role.

Know Your Available Guidance at All Times

The AP/FD-A/THR control panel(s) and the FMS control display unit (CDU) are the primary interfaces for the crew to communicate with the aircraft systems (to arm modes or select modes and to enter targets [e.g., airspeed, heading, altitude]).

The primary flight display (PFD), the navigation display (ND) and particularly the flight-mode annunciator (FMA) are the primary interfaces for the aircraft to communicate with the crew to confirm that the aircraft system has accepted correctly the crew's mode selections and target entries.

Any action on the AP/FD-A/THR control panel(s) or on the FMS CDU should be confirmed by cross-checking the corresponding FMA annunciation or data on the FMS display unit and on the PFD/ND.

At all times, the PF and the PNF/PM should be aware of the guidance modes that are armed or selected and of any mode changes.

Cross-Check the Accuracy of the FMS With Raw Data

When within navaid-coverage areas, the FMS navigation accuracy should be cross-checked with raw data.[5]

FMS navigation accuracy can be checked usually by:

- Entering a tuned very-high-frequency omnidirectional radio/distance-measuring equipment (VOR/DME) station in the bearing/distance ("BRG/DIST TO" or "DIST FR") field of the appropriate FMS page;
- Comparing the resulting FMS "BRG/DIST TO" (or "DIST FR") reading with the bearing/distance raw data on the radio magnetic indicator (RMI) or ND; and,
- Checking the difference between FMS and raw data against the criteria applicable for the flight phase (as required by standard operating procedures [SOPs]).

If the required accuracy criteria are not met, revert from LNAV to selected heading and raw data, with associated ND display.

One Head Up

Significant changes to the FMS flight plan should be performed by the PNF/PM. The changes then should be cross-checked by the other pilot after transfer of aircraft control *to maintain one head up at all times*.

When Things Do Not Go as Expected, Take Control

If the aircraft does not follow the desired horizontal flight path or vertical flight path and time does not permit analyzing and solving the anomaly, *revert without delay from FMS guidance to selected guidance or to hand flying.*

Use the Optimum Level of Automation for the Task

On highly automated and integrated aircraft, several levels of automation are available to perform a given task:

- FMS modes and guidance;
- Selected modes and guidance; or,
- Hand flying.

The optimum level of automation depends on:

- Task to be performed:
  - Short-term (tactical) task; or,
  - Long-term (strategic) task;
- Flight phase:
  - En route;
  - Terminal area; or,
  - Approach; and,
- Time available:
  - Normal selection or entry; or,
  - Last-minute change.

The optimum level of automation often is the one that the flight crew feels the most comfortable with, depending on their knowledge of and experience with the aircraft and systems.

Reversion to hand flying and manual thrust control may be the optimum level of automation for a specific condition.

Golden Rules for Abnormal Conditions and Emergency Conditions

The following golden rules may assist flight crews in their decision making in any abnormal condition or emergency condition, but particularly if encountering a condition not covered by the published procedures.

Understand the Prevailing Condition Before Acting

Incorrect decisions often are the result of incorrect recognition of the prevailing condition and/or incorrect identification of the prevailing condition.

Assess Risks and Time Pressures

Take time to make time when possible (e.g., request a holding pattern or radar vectors).

Evaluate the Available Options

Weather conditions, crew preparedness, type of operation, airport proximity and self-confidence should be considered in selecting the preferred option.

Include all flight crewmembers, cabin crewmembers, ATC and company maintenance technicians, as required, in this evaluation.

Match the Response to the Condition

An emergency condition requires immediate action (this does not mean rushed action), whereas an abnormal condition may tolerate a delayed action.

Consider All Implications, Plan for Contingencies

Consider all the aspects of continuing the flight through the landing.

Manage Workload

Adhere to the defined task sharing for abnormal/emergency conditions to reduce workload and to optimize crew resources.

Use the AP and A/THR to alleviate PF workload.

Use the proper level of automation for the prevailing condition.

Communicate

Communicate to all aircraft crewmembers the prevailing condition and planned actions so they all have a common reference as they work toward a common and well-understood objective.

Apply Procedures and Other Agreed Actions

Understand the reasons for any action and the implications of any action before acting and check the result(s) of each action before proceeding with the next action.

Beware of irreversible actions (cross-check before acting).

Summary

If only one golden rule were to be adopted, the following is suggested:

Ensure always that at least one pilot is controlling and is monitoring the flight path of the aircraft.

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

- 1.1 — Operating Philosophy;
- 1.2 — Automation;
- 1.5 — Normal Checklists; and,
- 2.2 — Crew Resource Management.

Notes

1. 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.
2. 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]."
3. The International Civil Aviation Organization (ICAO) says that the words "Pan Pan" (pronounced "Pahn, Pahn") at the beginning of a communication identifies *urgency* — i.e., "a condition concerning the

safety of an aircraft … or of some person on board or within sight, but which does not require immediate assistance." ICAO says that "Pan Pan" should be spoken three times at the beginning of an urgency call.

4. ICAO says that the word "Mayday" at the beginning of a communication identifies *distress* — i.e., "a condition of being threatened by serious and/or imminent danger and of requiring immediate assistance." ICAO says that "Mayday" should be spoken three times at the beginning of a distress call.

5. The FSF ALAR Task Force defines *raw data* as "data received directly (not via the flight director or flight management computer) from basic navigation aids (e.g., ADF, VOR, DME, barometric altimeter)."

Related Reading From FSF Publications

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Lacagnina, Mark. "Glideslope Unusable." *AeroSafety World* Volume 3 (November 2008).

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Lacagnina, Mark. "Automation Revisited." *AeroSafety World* Volume 1 (October 2006).

Flight Safety Foundation (FSF) Editorial Staff. "Improper Control Inputs Cited in ATR 72 Bounced Landing." *Accident Prevention* Volume 62 (November 2005).

FSF Editorial Staff. "Crew's Failure to Maintain Airspeed Cited in King Air Loss of Control." *Accident Prevention* Volume 61 (October 2004).

FSF Editorial Staff. "Nonadherence to Approach Procedure Cited in Falcon 20 CFIT in Greenland." *Accident Prevention* Volume 61 (November 2004).

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FSF Editorial Staff. "MD-82 Overruns Runway While Landing in Proximity of Severe Thunderstorms." *Accident Prevention* Volume 59 (February 2002).

FSF Editorial Staff. "Descent Below Minimum Altitude Results in Tree Strike During Night, Nonprecision Approach." *Accident Prevention* Volume 58 (December 2001).

FSF Editorial Staff. "Crew Loses Control of Boeing 737 While Maneuvering to Land." *Accident Prevention* Volume 58 (August 2001).

FSF Editorial Staff. "Runway Overrun Occurs After Captain Cancels Go-around." *Accident Prevention* Volume 58 (June 2001).

Wiener, Earl L.; Chute, Rebecca D.; Moses, John H. "Transition to Glass: Pilot Training for High-technology Transport Aircraft." *Flight Safety Digest* Volume 18 (June–August 1999).

FSF Editorial Staff. "Poorly Flown Approach in Fog Results in Collision With Terrain Short of Runway." *Accident Prevention* Volume 52 (August 1995).

Lawton, Russell. "Steep Turn by Captain During Approach Results in Stall and Crash of DC-8 Freighter." *Accident Prevention* Volume 51 (October 1994).

Rosenthal, Loren J.; Chamberlin, Roy W.; Matchette, Robert D. "Flight Deck Confusion Cited in Many Aviation Incident Reports." *Human Factors & Aviation Medicine* Volume 41 (July–August 1994).

King, Jack L. "Coping with High-tech Cockpit Complacency." *Accident Prevention* Volume 49 (January 1992).

Notice

The Flight Safety Foundation (FSF) Approach-and-Landing Accident Reduction (ALAR) Task Force produced this briefing note to help prevent approach-and-landing accidents, 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's Joint Safety Analysis Team and the European Joint Aviation Authorities Safety Strategy Initiative.

This briefing note is one of 33 briefing notes that comprise a fundamental part of the FSF *ALAR Tool Kit,* which includes a variety of other safety products that also have been developed to help prevent approach-and-landing accidents.

The briefing notes have been prepared primarily for operators and pilots of turbine-powered airplanes with underwing-mounted engines, but they can be adapted for those who operate airplanes with fuselage-mounted turbine engines, turboprop power plants or piston engines. The briefing notes also address operations with the following: electronic flight instrument systems; integrated autopilots, flight directors and autothrottle systems; flight management systems; automatic ground spoilers; autobrakes; thrust reversers; manufacturers'/operators' standard operating procedures; and, two-person flight crews.

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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