

The Concept of the "Sterile Cockpit"

Original story by L. Sumwalt

In 1981, additional U.S. Federal Aviation Administration Regulations were enacted to reduce accidents by prohibiting non-essential crew activities during critical phases of flight. A recent review of anonymous reports suggests that non-compliance remains a problem.

Six minutes before touchdown, Eastern Air Lines Flight 212, a McDonnell Douglas DC9 with 78 passengers and four crew members on board, was descending toward runway 36 at Charlotte, North Carolina, U.S.A. Because patchy dense fog hid the runway from view, a very high frequency omnidirectional radio range (VOR) distance measuring equipment (DME) non-precision instrument approach was being flown. During the approach, the flight crew discussed politics, used cars and the nation's economic uncertainty.

Two minutes prior to touchdown, the conversation switched to trying to identify a local amusement park that the aircraft had just passed. Shortly after receiving landing clearance, the captain remarked to his first officer, *"Yeah, we're all ready. All we got to do is find the airport"*. Three seconds later the aircraft impacted terrain 3.3 miles (5.3 kilometers) short of the runway. Seventy two people were killed in the 1974 accident.

Fourteen years later, in 1988, the flight crew of Delta Air Lines Flight 1141, a Boeing 727, spent 17 minutes chatting with a flight attendant in the cockpit while taxiing for departure at the Dallas-Fort Worth (Texas, U.S.) International Airport. During the two minutes between the flight attendant's departure from the cockpit and the initiation of take-off roll, the flight crew started the Nr. 3 engine and conducted the before-take-off checklist. In their haste to prepare for departure, the crew apparently failed to set the flaps for take-off, an omission that was not identified during the crew's checklist recital. Seven seconds after take-off rotation, the aircraft's stall warning system activated. Seconds later the aircraft plunged to the ground. There were 15 fatalities and 26 serious injuries.

The U.S. National Transportation Safety Board (NTSB) determined that poor cockpit discipline played a role in each of these accidents. In its investigation of the DC 9 accident at Charlotte, the NTSB stated that the crew's non-pertinent conversations *"were distracting and reflected a casual mood and lax cockpit atmosphere which continued throughout the remainder of the approach and which contributed to the accident"*. In the Dallas-Fort Worth accident, the NTSB said that *"had the captain exercised his responsibility and asked the flight attendant to leave the cockpit or, as a minimum, stopped the non-pertinent conversations, the 25-minute taxi time could have been used more constructively and the flap position discrepancy might have been discovered"*.

The cockpit of an aircraft during taxi-out or approach is neither the time nor the place for non-flight-related conversations. Numerous accidents and serious incidents have occurred when flight crews diverted their attention from the tasks at hand and engaged in activities unrelated to flying.

In 1981, the U.S. Federal Aviation Administration (FAA) enacted Federal Aviation Regulations (FARS) Part 171.542 for air carriers and Part 135.100 for air taxi operators. *"Flight Crew member Duties"*, also known in the industry as the *"sterile cockpit rule"*, are the subject of these two parts of the FARS. These regulations prohibit crew members from performing non-essential duties or activities while the aircraft is in a *"critical phase of flight"*. The FARs define *"critical phase of flight"* as all ground operations involving taxiing, take-off and landing and all other flight operations conducted below 10,000 feet (3050 meters) mean sea level (MSL), except cruise flight.

The Federal Register explains the FAA's rationale for the rule making:

"Critical phases of flight ... are the phases of a flight in which the flight crew is busiest, such as during take-off and landing and instrument approaches. When many complex tasks are performed in a short time interval, distracting events could cause errors and significant reductions in the quality of work performed.

The performance of a non-safety related duty or activity when flight crew workload is heavy could be the critical event which precludes a flight crew member from performing an essential task such as extending the landing gear prior to touchdown."

There are situations where 10,000 feet MSL might be an insufficient boundary for defining the critical phase of flight. At high-altitude airports, 10,000 feet above ground level (AGL) may be a more appropriate boundary. For flights with cruise altitudes below 10,000 feet MSL, crews can use a specific distance from the airport or the beginning of descent as a signal to begin sterile cockpit procedures.

The FARs never intended to prohibit functions that are necessary for flight safety. Items that must never be stifled include: accomplishment of checklists, crew callouts, procedural discussions, voicing safety concerns and crew interactions such as acknowledgements and commands. Conversely, because they are not related to the safe operation of aircraft the regulations specifically prohibit the following during critical phases of flight:

"non-safety related [radio calls] as ordering galley supplies and confirming passenger connections, announcements made to passengers promoting the air carrier or pointing out sights of interest and filling out company payroll and related records, ... eating meals, engaging in non-essential conversations within the cockpit and non-essential communications between the cabin and cockpit crews, and reading publications not related to the proper conduct of the flight..."

RESPONSIBILITY TO MAINTAIN STERILE COCKPIT SHARED BY CREW MEMBERS

The regulations are carefully worded to apportion the responsibility of keeping the cockpit "sterile": "Regarding crew member involvement with non-essential activities: No flight crew member may engage in, nor may any pilot in command permit... nor may any flight crew member perform..... Responsibility for maintaining the sterile cockpit is on each crew member. If any duties except those duties required are conducted during the critical phase of flight, the pilot in command must not permit them to continue.

The FAA also places the regulatory responsibility in the hands of companies: "No certificate holder shall require ... any flight crew member [to] perform any duties during a critical phase of flight except those duties required for the safe operation of the aircraft".

The following report was submitted to the U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS). The report illustrates how poorly designed company procedures can contribute to unsafe conditions.

"Distracted by flight attendant with passenger count. (We) took off, and to this moment, I do not remember being cleared for take-off. This had the potential for a 'Canary Islands' take-off accident. (in history's worst aviation accident, 583 persons were killed after the runway collision of a KLM Boeing 747 and a Pan American Airways 747. The 1977 collision was blamed on failure of the KLM pilot in command to follow approved procedures and directives and on his failure to abort the take-off.) Company procedure for flight attendant cockpit visit while taxiing contributed ..."

Aircraft operators would be prudent to survey their operational practices and eliminate those that could create cockpit distractions.

NON-COMPLIANCE LEADS TO ACCIDENTS AND SERIOUS INCIDENTS

Although the sterile cockpit has enhanced aviation safety, it is difficult to estimate the number of accidents and serious incidents that it has prevented. Where non-compliance has led to accidents and incidents, the unfortunate results are obvious. Delta Flight 1141 is one such example. Each year the ASRS receives scores of incident reports that illustrate deviations from the sterile cockpit. Typical are remarks such as *"If we [had] adhered to the sterile cockpit this situation probably would not have occurred"*.

ASRS Directline in 1993 published a review of 63 incident reports involving sterile cockpit deviations. Researchers noted that the following problems were attributed to sterile cockpit violations:

- 48 percent were altitude deviations;
- 14 percent were course deviations;
- 14 percent were runway transgressions;
- 14 percent were general distractions with no specific adverse consequences;
- 8 percent involved take-offs or landings without clearance; and
- 2 percent involved near-mid-air collisions.

In analyzing each report, ASRS researchers tabulated reported violations of the sterile cockpit; multiple violations were noted in some reports. Below are the five most frequent violations:

- **Extraneous conversation**

As in the cited accidents in Charlotte and Dallas-Fort Worth, the ASRS review noted that 35 of the 63 reports mentioned extraneous cockpit conversations when describing incidents. As explained in one report, *"Both the FO [first officer] and I became distracted because of a conversation that was started before the level-off. At 4300 feet [1310 meters] our altitude alert system went off Our sterile cockpit procedures should have eliminated this problem if properly followed"*.

- **Distractions by flight attendants**

Fifteen of the 63 reports mentioned distractions created when flight attendants entered or called the cockpit during a critical phase of flight. One reporter said that a flight attendant entered the cockpit during taxi with coffee for the crew. *"Crew attention momentarily diverted"*, said the reporter. Then the aircraft inadvertently encroached on an active runway, forcing another aircraft on final approach to go around.

- **Non-pertinent radio calls**

Non safety-related radio calls below 10,000 feet, such as ordering galley supplies and confirming passenger connections, were found in 12 of the 63 reports.

Although it occurred prior to the 1981 FARs implementation, a September 1978 mid-air collision illustrated the potential safety implications of conducting non-safety-related radio calls during a critical phase of flight. In that accident, a Pacific Southwest Airlines (PSA) Boeing 727 collided with a Cessna 172 over San Diego, California, U.S. The NTSB noted that while air traffic control (ATC) was providing traffic advisories to the PSA crew and issuing visual separation instructions, the 727's flight engineer was off the ATC frequency discussing catering needs on the company radio frequency. The NTSB did not find a causal link between the flight engineer's company radio conversation and the accident's occurrence, but did state that *"it does point out the dangers inherent in this type of cockpit environment during descent and approach to landing"*.

- **Public address (PA) announcements**

"Beautiful day making approach into familiar station, captain elects to make a PA announcement to passengers while flying the aircraft", reported one pilot. "Resulting distraction of the passenger announcement [caused us to overshoot] altitude [by] 500 feet [152 meters]." An additional nine similar reports were among the 63 in the ASRS review.

- **Sightseeing**

"Nowhere does Webster's [Dictionary] define 'sightseeing' as an activity that is essential to the safe operation of aircraft", said the ASRS researchers who found three such reports in its review. "When sightseeing is conducted by flight crew members below 10,000 feet, not only is it potentially dangerous, but it is illegal."

The cockpit voice recorder (CVR) transcript of Flight 212 illustrated the danger of sightseeing. (See first paragraph of this article).

"It is apparent that during this discussion a considerable degree of the flight crew's attention was directed outside the cockpit", the NTSB said. "This particular distraction assumes significance because during this period the aircraft descended through ... the altitude which should have been maintained until it crossed ... the final approach fix (FAF)."

PARTIAL TRANSCRIPT OF EASTERN FLIGHT 212's CVR

- Captain.....There's Carowinds [amusement park], I think that's what that is.
- Captain.....Carowinds.
- First Officer...Ah, that tower-would that tower be it or not?
- Captain.....No I [unintelligible words] Carowinds, I don't think it is. We're too far - too far in, Carowinds is in back of us.
- First Officer....I believe it is.
- Captain.....By [non-pertinent word] that looks like it, you know, it's [unintelligible words] Carowinds. Yeah, that's the tower.
- First Officer....Gear down please, before landing.
- Captain.....That's what that is.

(Sounds similar to [landing] gear extension.) (Sound of terrain warning.)

- Captain.....Carowinds. That's Carowinds there.

(70 seconds later the aircraft became a controlled-flight-into-terrain accident.)

FLIGHT ATTENDANT NOTIFICATION POLICIES VARY

Because the cockpit should remain sterile below 10,000 feet MSL, cabin crews need a method of determining whether the aircraft is above or below 10,000 feet. A 1988 U.S. Department of Transportation (DOT) report highlighted cabin crew difficulties determining precisely when sterile cockpit procedures were in effect. DOT researchers surveyed pilots and flight attendants, and of the 35 flight attendants from 16 airlines who responded, 80 percent said that their companies had a signal or policy to indicate when sterile cockpit procedures were in effect.

Nevertheless, some confusion was suggested by the respondents; some flight attendants stated that their airlines had such procedures, while others from the same airlines said no such procedures were in place.

Flight attendants reported several different procedures by flight crews for notifying the cabin crews when sterile cockpit procedures were required. "Some airlines have advocated the 10-minute rule, i.e., the sterile cockpit rule should be in effect for 10 minutes after take-off and 10 minutes before landing", said the DOT report. *"However, there are problems associated with trying to estimate a time span before an event."*

At least one flight attendant noted that company procedures required cabin crews to estimate when 10,000 feet has been reached. The DOT report concluded that this method was difficult under ideal conditions, and impossible under restricted visibility.

"A few airlines have attempted to deal with [sterile cockpit notification] by using the chime-call or another signal when the 10,000 foot mark has been crossed", said the DOT report. *"This provides a good-indication of sterile cockpit as long as the signal is heard and is not confused with another signal (e.g., passenger requesting assistance)."*

Another procedure was illumination of the "No Smoking" light as a sterile cockpit cue; with non-smoking flights increasingly widespread, this procedure may require re-evaluation.

Association of Flight Attendants (AFA) Safety Representative Noreen Koan said that the ideal notification tool is a PA announcement from the flight deck as the aircraft climbs and descends through 10,000 feet. The DOT report acknowledged that this might be a good technique, but said, *"The success of this method depends entirely on the reliability of the announcement. Even in cases where the announcement is company policy, it is not always made"*.

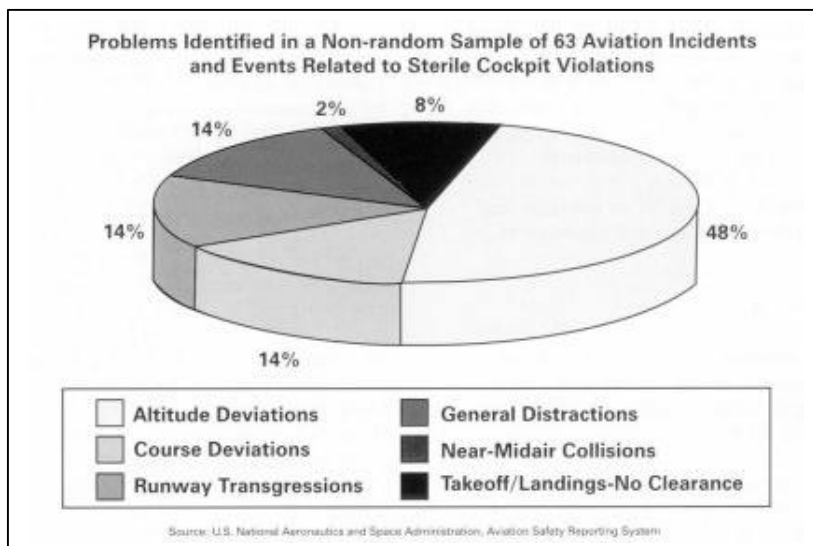
The ASRS review suggested another weakness with procedures such as PA announcements at 10,000 feet and calls to flight attendants on the inter phone. *"These procedures require one [cockpit] crew member to be 'out of the [communications] loop'. And as evidenced by literally thousands of ASRS reports, the potential for problems (such as misunderstood clearances and altitude deviations) increases when a crew member is out of the loop.... For those who develop company procedures, consideration should be given to developing something that doesn't create its own set of distractions. With the increased use of two crew member cockpits this consideration is increasingly important."*

The DOT report said, *"Perhaps the best signal as to when sterile cockpit procedures are in effect is an indicator light above the cockpit door or on the annunciator panel"*. Unlike a discrete tone or a PA announcement, this method was less likely to be missed or confused with another signal, according to the report. For optimum performance, a light should be installed near the cockpit door and adjacent to the interphone on each flight attendant communications panel. The indicator light's major disadvantage is that it requires installation.

MISINTERPRETATIONS OF STERILE COCKPIT ARE POSSIBLE

Although the sterile cockpit was implemented to increase safety by minimizing distractions during critical flight phases, there is evidence to suggest that safety can be impaired by misunderstandings. An airline captain, for example, was observed reprimanding his first officer for accomplishing the after-take-off checklist below 10,000 feet. The first officer's actions, however, were entirely appropriate because the checklist function was required for flight safety and was clearly stated as such in the company's operating procedures.

Misunderstandings can also prevent important safety-related information from reaching the flight deck. *"Flight attendants, many already intimidated by the authority and mystique of the flight deck, are expected to determine which situations are essential to the safe conduct of the flight",* according to Rebecca Chute and Earl Wiener in a recently published crew communications study. *"Rather than take the chance of being wrong and thereby breaking the law or, at the very least, embarrassing themselves and perhaps subjecting themselves to a reprimand from the captain, they [may fail to] communicate valuable, safety-related information to the pilots."*



In 1984, a United Air Lines Boeing 727 encountered a severe windshear on take-off from Stapleton International Airport, Denver, Colorado, U.S. The windshear caused the take-off roll to be excessively long, resulting in the 727's underside being dragged through the localizer antenna at the departure end of the runway. The antenna punctured the fuselage and remained lodged there. The cockpit crew was unaware that the aircraft had struck the antenna, but could not determine why the aircraft would not pressurize. The flight attendants, on the other hand, had heard and felt a loud thump and

vibration shortly after take-off, but did not notify the cockpit crew because of the senior flight attendant's desire to adhere to the sterile cockpit procedures. Captain Ricky Davidson, chairman of the U.S. Air Line Pilots Association's (ALPA) Accident Survival Committee, said, *"It is crucial [that flight attendants] understand that it is better to risk interruption and break the sterile cockpit rule than to fail to communicate"*.

Of the 25 pilots surveyed in the 1988 DOT report, 72 percent indicated that they had experienced problems because of a lack of information about the sterile cockpit. Eighty percent of the pilots and 86 percent of the flight attendants surveyed indicated that cabin crews needed more specific guidance about when sterile cockpit interruptions were appropriate.

Training is the key to minimizing the potential for misunderstandings, officials said. *"The quality of the decisions (as to whether or not to contact the cockpit) made by the flight attendants will be directly related to the information they received in training. The clearer the flight attendant's understanding of sterile cockpit procedures and flight operations, the better these decisions will be"*, said the DOT report.

To minimize ambiguity about the sterile cockpit rule, American Airlines provides a home study course for flight attendants. *"Sterile cockpit rules can be interrupted for an emergency or safety related item that could potentially be of danger to the passengers, crew or the aircraft"*, said American's training guide. *"if you encounter something unusual, don't be afraid to report it so the cockpit [crew] can help determine first if it is serious."*

The following guidelines, a combination of the American Airlines course and other industry sources, provide specific examples of when sterile cockpit interruptions may or may n be appropriate:

Situations That Warrant Sterile Cockpit Interruptions

- Fire, burning odor or smoke in cabin;
- Medical emergency;
- Unusual noise or vibration;
- Auxiliary power unit (APU) torching;
- Fuel or other fluid leakages;
- Exit door unable to be armed/ disarmed;
- Extreme temperature change;
- Evidence of de-icing problems;
- Suspicious, unclaimed bag or package;
- Cart stowage problem; and,
- Any other condition that seems abnormal or that a flight attendant believes the flight crew should know about.

Situations That Do Not Warrant Sterile Cockpit Interruptions

- Non-safety-related logbook items;
- Meal references;
- Gate information;
- Misconnected baggage;
- Catering problems;
- Passenger accommodations such as wheelchairs; and,
- Rude passengers.

This list, along with appropriate regulatory requirements, provides a starting point for guidelines, which can be modified to suit the needs of each operator.

In addition to operators' training and specific guide-lines, the captain of each flight can play an important role in encouraging, flight attendants to voice safety concerns to the cockpit crew. Captain Alan Price, Delta Air Lines' coordinator of human factors, has recommended that captains mention handling of the sterile cockpit during the pre-flight briefing.

A sample briefing, according to Price, might be: *"Let's start with the sterile cockpit policy. Don't you worry about it! Let me do that. If anything happens that concerns you and you think we should know about it, pick up the phone and give us a call, or come see us. I'll let you know if it's a poor time to talk. We need and want to hear from you."*

The safety benefits of using sterile cockpit procedures are not limited to U.S. commercial air carriers. Operators not governed by the FARs (such as corporate and non U.S. operators) are also encouraged to voluntarily adopt sterile cockpit procedures. The FAA noted: *"Extraneous conversation in the cockpit during critical phases of flight causes crew distraction in small as well as large aircraft"*. The accident and incident records send a clear message: aviation safety can be enhanced by using sterile cockpit procedures.

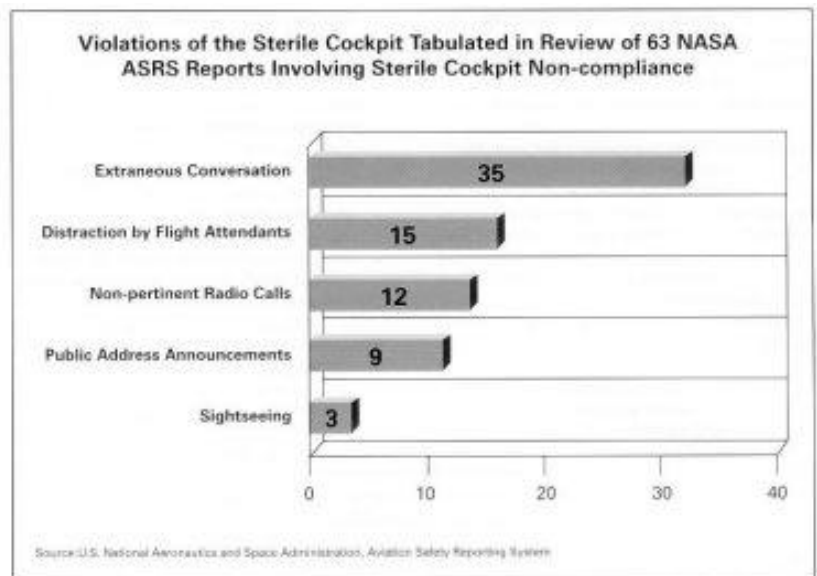


Figure 2