

Factual Report – Attachment 23
Atlas Air Operational Safety and Crew Concepts

OPERATIONAL FACTORS

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Operational Safety and Crew Concepts

Adherence to Standards

While errors are normal by-products of being human, deliberate disregard for published standards is not normal and must be avoided. All rules, regulations, policies and procedures started as lessons-learned, at great cost. Knowing and applying the technical standards and following published procedures in manuals and checklists are basic assumptions of professional piloting. Safety audit information indicates crews who intentionally violate SOPs are three times more likely to make errors than those who conduct operations as outlined in Company and manufacturer operating manuals.

The standards cannot - nor are they intended to - address every possible situation that can arise. Instead, the manuals, procedures and checklists are designed to give flight crews a set of best practices in support of safe and regulatory compliant commercial operations.

Flight crews, especially PICs, are charged with evaluating the unique circumstances affecting each flight and applying their experience and initiative to meet the five stated goals of the company's flight operations; refer to *Command Authority and Expectations* on page 10.1.1. The procedures and information provided are the absolute best practices written to aid crews in the decision-making process in support of those goals. The standards are kept current by revision as new and better ways of maintaining operational excellence are learned.

While much of the information reflects regulatory requirements, at no time are crews bound to any procedure which may compromise the primary and overriding objective of safety. A Captain is expected to use his or her emergency authority, if necessary, to ensure the safety of customers, crew and cargo.

Safety is the single objective which cannot be compromised. Company Dispatchers and flight crews must make every decision against the backdrop of this mandate. Ensuring that the best, most safety-minded course of action is taken in every case requires operations personnel to be well versed in the policies and procedures contained in their operating manuals and have the experience and broad perspective to apply those policies in a safe and effective way.

While crews are expected to concurrently manage and achieve all five previously stated company goals at the same time, it is important to be aware that there are certain times when working toward the achievement of all five goals simultaneously may cause priority conflicts that directly impact flight safety. When priority conflicts arise, pilots should refer to these five goals as a priority list where each objective is addressed and achieved in consecutive, sequential order. No one goal is addressed until those before it are ensured.

Occasionally, operational excellence may mean putting concern for maintaining the integrity of the schedule completely aside while solving other, safety-related issues. Thus, maintaining the schedule, the comfort of the passengers and operational efficiency of the flight are only valid concerns once crewmembers have reasonably assured themselves that they have done everything to both achieve compliance with the rules and ensure the safety of flight.

Having a comprehensive understanding of the standards as well as actively maintaining situational awareness while engaged in flight operations is the best way to ensure that the best decision is made when action outside the regulations/policies may be necessary.

Normal Circumstances

Under normal circumstances, operating standards provide pilots with instructions on how best to meet the Company's safety and commercial expectations. The vast majority of aviation decision-making is already covered by known best practices; therefore, adherence to the standards is considered mandatory during normal operations.

Normal operations constitute a significant majority of line flying situations. The definitions of should, shall, must and may (as used in Company manuals) give little leeway.

Operational Safety and Crew Concepts

Extenuating Circumstances

Even if all pilots adhered to all of the standards all of the time, the contemporary view of human error recognizes that in time, individual pilots will make potentially consequential mistakes. If errors are inevitable and, despite pilots' best intentions to abide by the rules and regulations, some mistakes could still result in events where the outcome depends more on luck than skill, are aviation accidents and incidents just an inevitable part of commercial aviation?

Given the safety record of the industry, the answer to that question is clearly not. Accidents and incidents in air carrier operations have been managed down to a low likelihood by training professional crews to apply the best practices of commercial aviation as well as the lessons of crew resource management to their flight deck actions.

Scientific flight deck observations have shown that while very few flights are free from pilot error, the errors that are made are not necessarily consequential. Said another way, every flight crew makes mistakes on each flight, yet not every flight suffers negative outcomes from those errors. Experience supports that only some inevitable errors lead to situations where a negative safety outcome is manifested.

The same flight deck observations that describe the inevitability of pilot error also show how two pilots on the flight deck work together has a major impact on the likelihood of a mistake becoming consequential. While mistakes may be inevitable, it appears that the likelihood of consequence from those mistakes is largely in the hands of a coordinated flight crew.

Working as a team allows two pilots to compensate for each other's likelihood to make a mistake.

Emergency Circumstances

By definition, in emergency situations, the operational environment has reached a point where the necessary decision-making is beyond the scope of the standards. Due to the high-reliability nature of commercial flight operations, emergency situations are rare.

The Captain is the final authority to the safe operation of the aircraft. He may deviate to the extent necessary to meet the requirements of that emergency. Depending on the situation, should, shall, must and may might no longer apply, though the intent of the standards - safe operation - is always the overriding concern. As always, in an emergency and/or when a distress situation (mayday) is declared and operations outside the expectations of the standards are undertaken, the Captain should be able to articulate his or her choices.

Adherence to the published standards, then, means decision-making in support of the stated goals of company flight operations during normal, extenuating and emergency circumstances.

Crew Concept

The individual training and checking environment that has long characterized the aviation industry, along with the 'rugged individualism' that is a core trait of Americans, has left us with the subconscious impression that on a given leg one pilot is flying and the other is resting and helping out with 'working the radios' and some administrative details. Since this subtle attitude is so embedded in our culture (national, industry-wide and organizational) we have to adopt the position that each leg is actively and fully flown by both crewmembers and that we trade out crew roles from one leg to the next. This subtle shift in thinking can magnify the effectiveness of a well-trained crew.

Operational Safety and Crew Concepts

Pilot Roles*Pilot Flying*

The Pilot Flying (PF) is the pilot who is tasked with manipulating the flight controls, either directly or through the aircraft's autoflight systems. The PF's primary task is to fly and navigate the aircraft in a manner consistent with safe operations and in accordance with the standards and instructions. The PF plans flight operations, ensures a shared mental model exists with all crewmembers, and then executes the plan.

Pilot Monitoring

The Pilot Monitoring (PM) is the pilot who is tasked with observing and commenting on the flight's progress. This PM's primary task is to 'quality check' the flight's operation by ensuring that the plan the PF has shared is in accordance with the standards and the briefing. Recognizing the inevitability of human error on the flight deck, the PM is expected to actively verify that the flight is proceeding according to the plan and alerts the PF if the flight deviates from the assumptions of that plan. In addition to the primary duty of flight path monitoring, the pilot monitoring conducts a series of support roles (i.e., running checklists, communicating over the radios, etc.). Because of the broad nature of the role, arguably, PM duties can be more difficult than PF duties.

Additional Flight Crewmember

The role of an additional flight crewmember is to actively monitor the PF, PM, aircraft flight path and energy, and assist in the safe conduct of the flight. The additional flight crewmember shall allow the operating crew the ability to comply with the prescribed policies in the FOM, and operate in accordance with the FCOM for that particular fleet. They shall do so without significant interruption or interference to the operating crew unless the additional flight crewmember determines a threat to the safety of the flight exists. An additional flight crewmember is also responsible for any applicable items delegated to them by the Captain. See *Augmented Flight Crews* on page 12.1.1.

Leadership/Followership

Pilot flying and pilot monitoring roles are integrated into the standards as the foundation of flight deck team behavior. Pilot roles are the best way for a Captain and First Officer to plan, fly and crosscheck one another during air carrier operations. These roles are different from, and subservient to, the leadership/followership roles that form the backbone of the Captain/First Officer team layout.

While the pilot monitoring role is to monitor the flight's conduct in accordance with the shared expectations of the flight-deck team, the Captain always maintains the leadership role on the flight deck. The Captain remains the final authority as to the safe and efficient operation of the aircraft. First Officers are responsible to the Captain during flight. While the Captain holds the position of command, a good Captain solicits the input of a First Officer as a natural part of aeronautical decision making, mentors new First Officers, and actively assists senior First Officers in preparation for command. In turn, a good First Officer is a good follower - note that good followership does not mean mind-less compliance. Followership includes the practice of the inquiry/advocacy/assertion behaviors discussed later in this section.

To effectively work as a flight deck team, both the Captain and First Officer must understand the differences between PF and PM roles as well as demonstrate the ability to effectively integrate those roles into the duties and responsibilities commensurate with their rank. Effective leadership/followership is the practice of effective leadership through coordinating activities and maintaining proper balance between respecting authority and practicing assertiveness, while staying centered on the goals of safe and efficient operations.

Operational Safety and Crew Concepts

Additionally, during augmented crew operations, the Captain who signs for the aircraft retains final PIC authority, even during rest. Prior to leaving the flight deck, the Captain will brief the relief pilot(s) on any specific objectives which need to be accomplished in his absence. Additionally, contingency plans and bottom lines, which would require timely action, must be clearly understood by the relief pilots such that even in his absence, time critical Captain duties are still accomplished. This capitalizes on the CRM environment in that PIC qualified First Officers are able to fulfill the duties of the Captain without diminishing the authority of the Captain. (For specific guidance on items to be discussed during a crew changeover reference *Relief Pilot Change Briefing* on page 11.1.29).

Crew Resource Management

Crew Resource Management (CRM) is the effective use of all resources, including hardware, software, and people, to achieve the highest possible level of safety. In addition to pilots, the people who can help include flight attendants, air traffic controllers, maintenance personnel, Dispatchers, and any other group who may interact with the flight deck crew. CRM addresses the human factors aspect of flying, and is an essential part of everyday operations influencing how safely and effectively crewmembers do their jobs.

The current view of aviation safety is more progressive than its traditional counterpart. It acknowledges the complexity of the environment and the fallibility of human pilots. At the same time, it recognizes the synergistic value of a properly trained flight deck team, working with one another to ensure the best possible outcomes.

The contemporary stance acknowledges the inevitability of pilot error and the need for judgment and decision-making. It seeks to replace the traditional disciplinary response to mistakes with learning and professional improvement. A central tenet, however, is that non-compliance with the published standards immediately compromises safety, and increases risk, in unpredictable, sometimes catastrophic ways.

CRM Concepts

Even if all pilots adhered to all of the standards all of the time, individual pilots would still make potentially consequential mistakes. Modern views on safety take this assertion a step further by acknowledging that while very few flights are free from pilot error, the errors that are made are not necessarily consequential and that working as a team allows two pilots to compensate for each other's likelihood to make the same mistake at the same time. Integrated flight crews, adhering to the published standards and working as a team, are far less likely to experience an undesired aircraft state, much less an accident or incident.

In a positive CRM environment, the tone in the cockpit is friendly, relaxed and supportive. Both pilots recognize that they can perform the job of airline operations more easily and safely when working as a team. Since most crew pairings involve differing backgrounds and varying levels of aviation experience, crewmembers must have an ability to adapt to the personalities of others.

As a supportive team member, pilots in a positive CRM environment recognize symptoms of psychological stress and fatigue in themselves and in others. As an example, a task-saturated pilot recognizes when he or she is experiencing 'tunnel vision' and seeks help from the other pilot. Conversely, an alert pilot will note when another crewmember is not communicating and draw him or her back into the team.

Additionally, it is important that each crewmember be familiar with the duties of the other crewmembers at every stage of the flight so they can properly monitor and crosscheck one another. Such knowledge helps to avoid miscommunication, unrealistic expectations, and inappropriate requests of other crewmembers. During emergencies, each crewmember should know exactly what to expect from the other crewmembers so they can work together effectively.

CRM Behaviors include:

Operational Safety and Crew Concepts

- **Leadership/Followership** - Leadership/followership means managing the difference between pilot roles and rank and striking a balance between respect for authority and assertiveness for safety
- **Vigilance** - Vigilant behaviors focus on avoiding and managing distractions and looking for potential threats
- **Interpersonal Relationships/Group Climate** - These behaviors set a tone of mutual respect, empathy and support on the flight deck so as to best work as a team
- **Communication/Decision-Making** - Communication/Decision-Making means one pilot letting the other pilot know what he is doing, what he plans to do, and when he plans to do it
- **Crew Self-Critique** - Critique behaviors ensure that pilots, crews and pilot groups learn from experiences and understand why a given outcome has occurred

Threat and Error Management (TEM)

TEM Principles

Studies show that, by applying certain airmanship behaviors, flight crews can achieve proactive, negative outcome-proof flying regularly and consistently. When considered together, these proactive flight crew behaviors are known as threat and error management or TEM.

TEM, a definable method of risk management, reflects lessons learned through practical experience combined with safety observations. Senior pilots may find that TEM amounts to a formalized way to apply common sense and the lessons-learned from their own flight experience. However, a particular advantage of TEM training is that it has been effective in allowing less experienced pilots learn the thought processes and other behaviors of veteran pilots. In effect, TEM instills experience without individual flight crews having to make the mistakes on their own.

While different from the more traditional, technically-oriented knowledge that makes up the skill set of a professional pilot, the 'non-tech' lessons of TEM are nonetheless just as important as knowledge of aircraft systems, the ability to fly an arc or the calculation of takeoff minimum reduction. Understanding the human factors at play on the flight deck allows two individual pilots to work as a team to effectively manage safety, minimize risk and prevent negative outcomes during flight.

The path to undesired aircraft states often follows a predictable course - threats lead to errors which, if left unmanaged, may result in undesired aircraft states (i.e., risky flying). These undesired aircraft states can lead to accidents, incidents and violations.

Conversely, flight crews who are most effective in achieving proactive, outcome-proof flying identify threats, manage errors, and when necessary, manage undesired aircraft states. These behaviors dramatically decrease the risk of accidents, incidents, or violations.

Threats and Their Management

A threat is defined as an event or condition that was not caused by the flight crew which increases the operational complexity of a flight and that may require flight crew attention and action in order to maintain adequate safety margins. In other words, threats increase the likelihood of a flight crew error.

The first goal of TEM is to enable flight crews to avoid errors as much as possible. This goal is pursued by actively seeking to identify and verbally announcing threats so they may be managed before mistakes are made. A threat can be obvious or latent. The increased risk associated with these threats can be mitigated through planning. In some cases, awareness of the threat alone will significantly reduce the associated risk. Other instances may require modification to the current plan, contingency planning, or other more active preparation.

Operational Safety and Crew Concepts

Errors and Their Management

Errors are defined as actions or inactions by the flight crew that lead to deviations from organizational or flight crew intentions or expectations. The goal of successful error management is to avoid, trap, or reduce errors in order to prevent or mitigate undesired aircraft states.

There are five types of errors:

- **Intentional Noncompliance (Violation)** - Conscious violations of the published standards; examples include omitting required briefings or checklists
- **Proficiency Errors** - Insufficient knowledge of the published standards or a shortcoming in 'stick-and-rudder' skill
- **Procedural Errors** - Slips, lapses or mistakes in the execution of the published standards and/or procedures; cases where a crew's intention is wrong (chose the wrong plan) or where the intention is correct, but the execution flawed
- **Operational Decision Errors** - Decisions not covered by regulation and procedure that unnecessarily increase risk; examples include extreme maneuvers on approach, choosing to fly into adverse weather or over-reliance on automation
- **Communication Errors** - Events where information is incorrectly transmitted or interpreted within the cockpit crew and external sources (such as ATC)

Avoidance of Error

The application of TEM will enable flight crews to avoid most errors altogether. This is accomplished by identifying threats and mitigating them before an error occurs. In order to avoid errors, flight crews must be vigilant to search for potential threats.

Trapping of Error

While the ideal scenario would be to identify all threats and take action to prevent them from resulting in flight crew error, the reality is that humans make mistakes in both threat identification and in error avoidance. The next key to mitigating risk is to identify those mistakes in a timely fashion and "trap" them before they become consequential. Detecting and correcting errors is the heart of error management.

Mitigation of Error

Errors are mitigated when the chain of events leading to an undesired state has begun, but the flight crew recognizes the danger and takes appropriate action. The goal of error mitigation is to effectively bring the situation back in line with the safety parameters.

Undesired Aircraft States and Their Management

It is important to make a distinction between error management and undesired aircraft state management. If an undesired aircraft state exists, the flight crew must recognize there is a risk to the safety of the flight and correct the situation. Errors may exist, but trapping those errors must take second place to correcting the undesired state. It is important that the mitigation plan does not lead to other, more serious situations.

Operational Safety and Crew Concepts

It is very easy to focus on error management, rather than transitioning to undesired aircraft state management. When the aircraft is in an undesired state, the basic task of the flight crew is to prioritize undesired aircraft state mitigation over error management. The human tendency to focus on a single task during times of stress is a limitation on all pilots, resulting in numerous aircraft accidents.

In other words, the only acceptable response to any undesired aircraft state must be to promptly return the aircraft to a safe state. The original goal (e.g., landing) must be temporarily abandoned and priority must be given to reaching a safe aircraft state. This "escape" maneuver must be immediate and decisive. Upon reaching an undesired aircraft state, margins are reduced to a point at which time spent deliberating can result in unacceptable levels of risk.

While some undesired aircraft states are somewhat unclear and may be debated, other undesired aircraft states are not subject to debate. Training exposes all pilots to these undesired aircraft states, which include:

- Unstabilized approaches
- Windshear
- Stall warning
- GPWS alerts
- TCAS RA

To aid in the recognition and recovery of these particular undesired aircraft states, defined recognition criteria and recovery procedures are published. These must be followed immediately and without question. Any time wasted in the decision making process may lead to an unrecoverable state.

TEM Countermeasures

Effective flight crews practice threat identification, error management, and undesired aircraft state management by applying TEM countermeasures. TEM countermeasures are divided into three categories: Planning, Execution, and Review. In short, make a plan, fly that plan, and alter it when and if the operational assumptions change.

Threat Management (Planning Countermeasures)

The first set of countermeasures is aimed at getting the entire flight crew mentally ahead of the aircraft. Planning countermeasures looks ahead of the current location and situation and projects into the future to allow the flight crew to prepare for upcoming events and their attendant threats. This planning includes conducting operational briefings emphasizing how the flight crew will conduct an operation. Additionally, sharing the smaller details of the flight with one another on an ongoing basis helps maintain the shared mental model and allows both pilots to operate proactively.

Planning Countermeasures include:

- **Briefings** - Briefings are interactive and operationally pertinent
- **Plans Stated** - Operational plans and decisions are communicated and acknowledged
- **Workload Assignment** - Roles and responsibilities are defined for normal and non-normal situations
- **Contingency Management** - Crewmembers develop effective strategies to safely manage threats

Operational Safety and Crew Concepts

Error Management (Execution Countermeasures)

The second set of countermeasures contains those behaviors designed to prevent, trap, or correct errors in the current phase of flight. These execution behaviors focus on error trapping/detection utilizing crosschecking and monitoring, along with the effective use of automation. In other words, flight crews can not fix an unknown error.

Execution Countermeasures include:

- **Monitoring/Cross-checking** - Crewmembers actively monitor and crosscheck systems, the flight path and each other
- **Workload Management** - Operational tasks are prioritized and properly managed to handle primary and secondary flight duties
- **Automation Management** - Automation is properly managed to balance situational and/or workload requirements

Active Review Countermeasures

Active Review Countermeasures are essential for managing the changing conditions of a flight. These involve evaluation and modification of plans as the situation changes and the classic CRM skills of inquiry, advocacy, and assertiveness.

Active Review Countermeasures include:

- **Evaluation/ Modification of Plans** - Existing plans are reviewed and modified when necessary
- **Inquiry and Advocacy** - Crewmembers ask questions to investigate and/or clarify current plans of action when time is not a threat
- **Assertiveness** - Crewmembers state critical information and/or solutions with appropriate persistence with a focus on what is right, not who is right during time critical situations

Crewmember Strategies

A strong crew concept is the most important aspect of operating in a robust TEM environment. The PF/PM dynamic plays an important role in the TEM environment and each pilot is expected to prioritize between primary duties and secondary duties. With proper prioritization, the PM should immediately identify deviations from a briefed plan. TEM strategies in the operational context are as follows:

Verbalize: PFs (or Captains as applicable) will establish an action plan for the flight by briefing the expected plan. The plan should include all known and potential threats and subsequent mitigation strategies. The use of automation should be briefed in detail as well as any potential contingency plans. A shared mental model of the aircraft's flight path, trajectory, and energy is paramount.

Verify: Crewmembers will review and verify that the briefed plan is appropriate and ensure that strategies to manage known threats have been discussed. High vigilance is required prior to and when changing the aircraft's flight path, trajectory, or energy.

Monitor: Crewmembers will actively monitor the flight against a well understood plan of action and review any potential changes. Task prioritization and active monitoring will ensure unanticipated threats and crew errors are recognized in a timely manner. All secondary duties should be suspended when operating in a critical phase of flight, defined as:

- Taxi out
- Takeoff

Operational Safety and Crew Concepts

- Within one-thousand feet of level off (climb and descent)
- Course changes over navigation fixes/waypoints
- Course intercepts
- Approaching descent points
- Landing
- Taxi in

"Confirm/Execute"

Analysis of ASAP data and safety investigations of lateral and vertical deviations reveal that one or more pilots were unaware that their aircraft was not flying in accordance to its clearance until queried by ATC or alerted by the aircraft's systems.

Therefore, prior to any lateral or vertical change in the FMC requiring selection of the "Execute" prompt, the company incorporates the inquisition by the PM of "Confirm?" in order to articulate to the PF what is about to change and the word "Execute" from the PF once the change is agreed upon. To avoid complacent repetition of the words "Confirm? Execute", Pilots should include the nature of the change to the verbal exchange.

For example, if cleared direct to the MEM VOR, the PM shall make the change in the FMC, and prior to hitting the execute button, will announce: "Direct MEM... Confirm?" The PF will visually confirm the change in the FMC and will command "Direct MEM...Execute". Once the PM has executed the change, the PM will announce "LNAV is available" on the FMA. The PF will engage LNAV and once LNAV is boxed on the FMA, will complete the exchange by saying "LNAV engaged".

This exchange gives both pilots multiple opportunities to ensure the change in course is done properly and promotes active monitoring of the aircraft's new trajectory during an area of high vulnerability.

"I'm Not Comfortable With This"

Regardless of rank or role, when one crewmember expresses discomfort with a certain situation by saying "I am not comfortable with this", it is then the responsibility of both pilots to take action to resolve that discomfort. Failing to do so can result in an immediate and complete breakdown of CRM and SA, resulting in a single pilot's decisions and choices becoming controlling. This, in turn, exposes the flight to the inevitability of human error at a time when at least one crewmember already has concerns for the course of actions taking place.

Failures in CRM where one crewmember was not comfortable with a situation have been identified as a causal factor in some of the worst aviation disasters recorded. This kind of a breakdown cannot be allowed to take place during air carrier operations. Both pilots must understand that a crewmember expressing discomfort with the situation indicates that a serious breach in safety protocol is approaching. PICs especially, shall take decisive action to resolve that discomfort in a way that ensures the safety of flight is maintained. In many cases, practicing the skills for error management or undesired aircraft state management is sufficient to resolve that discomfort.

Conclusion

When the skillset of individual crewmembers combines with the toolset of company standards, these daily behaviors become habits, and thus the common mindset of the pilot. Once this embodiment occurs, pilots will cease to think of CRM/TEM as a separate area of competency but as an integral part of their professional lives.