ACT ARC Recommendation 16-4: Training Elements for Training the Pilot Monitoring

I. Submission

The recommendations below were submitted by the Flight Path Management Workgroup (FPM WG) for consideration by the Air Carrier Training Aviation Rulemaking Committee (ACT ARC) Steering Committee at F2F-9. The ACT ARC Steering Committee adopted the recommendations with unanimous consent, and they are submitted to the Associate Administrator for Aviation Safety (AVS-1) as ACT ARC Recommendation 16-4.

II. Statement of the Issue

The FAA has recognized that despite a very
safe national airspace system, flight path monitoring errors occur daily but are mitigated by professional flight crews and air traffic controllers. Given the frequency of known occurrences, it is imperative that operators establish operational policy and procedures on Pilot Monitoring duties, including monitoring, and implement effective training for flight crews and instructors on the task of monitoring to help the Pilot Monitoring expeditiously "identify, prevent and mitigate events that may impact safety margins." These operational policies and procedures are foundational to addressing Flight Path Management and the duties of the Pilot Monitoring, those areas will be addressed in a subsequent recommendation by the Flight Path Management Working Group.

The NTSB has identified a lengthy list of incident and accidents in which inadequate monitoring was identified as a contributing factor. In each case, the flight crew failed to observe and respond to a critical event affecting the aircraft flight path. Contributing to those failures was inadequate operator policy and procedures for monitoring of the flight path, as well as poor training for flight crews. Most notably, Colgan Air flight 3407, Air France flight 447 and Asiana flight 214 are exemplars for all categories of monitoring deficiencies.

Historically, the FAA and industry have referred to the individual performing pilot monitoring duties as the "Pilot Not Flying." In 2003, Advisory Circular (AC) 120-71A emphasized the term "Pilot Monitoring" as opposed to pilot-not-flying stating that "…it makes better sense to characterize pilots by what they *are* doing rather than by what they are not doing." The change in orientation was an acknowledgement that despite a very safe commercial air transport system, incidents and accidents continued to occur that pointed to monitoring failures as a major contributor. Subsequent studies provided corroborative material but only recently has information evolved to help operators develop programs and train the Pilot Monitoring on what it means to monitor the flight path. Following two significant papers on monitoring, "*A Practical Guide for Improving Flight Path Monitoring"* from the Flight Safety Foundation and "*Monitoring Matters, Guidance on the Development of Pilot Monitoring Skills*" from the Civil Aviation Authority, the FAA published a Safety Alert for Operators (SAFO) 15011 which "…encourages operators to define roles and responsibilities for the PF and PM."

Based on the deficiencies noted by the FAA in the training of the role of the Pilot Monitoring, the FAA posed the following questions to the ACT ARC relative to the role of Pilot Monitoring. These questions were assigned to the FPM WG and incorporated in the FPM WG Terms of Reference (TOR) document. (See FPM WG TOR, II.3.b.i, ii & iii.).

- Identify the best practices for training the PM.
- Identify the academic training elements required for the PM to be effective.
- Identify the flight training elements required to reinforce PM knowledge and skills.

This recommendation also partially addresses FPM WG TOR Section II.2.d.

- Instructors/evaluator training for the development of skills and knowledge to teach and evaluate airplane flight path management, including use of automated systems.

The body of the recommendation will answer the questions related to identifying the training elements, while the best practices (recommended practices) will be discussed in the appendix.
This recommendation is focused specifically on the questions from the FAA which are Pilot Monitoring centric. Many of the training elements are applicable to both the Pilot Flying and Pilot Monitoring and there is no intent to suggest that the Pilot Flying does not also require and utilize these skills.

III. Recommendations

The ACT ARC proposes the following recommendations for FAA consideration:

The ACT ARC recommends the FAA incorporate academic and flight training elements for training the role of the Pilot Monitoring (PM), instructor elements for training the role of the PM, as well as best practices for training the PM in advisory guidance for industry stakeholders (e.g., Advisory Circular) and accompanying inspector handbook guidance for FAA personnel.

Note: In response to the questions posed by the FAA, the FPM WG identified the elements deemed necessary for training for the Pilot Monitoring and Instructors/Evaluators in Attachment A to this recommendation.

IV. Rationale

Definitions :

"Flight Path" is the aircraft trajectory and energy state, in flight or on the ground.

"Flight Path Management" is the planning, execution, and assurance of the guidance and control of the flight path.

"Thorough Understanding" is the understanding to the correlation level, which according to FAA Handbook 8083-9A is defined as associating what has been learned, understood, and applied with previous or subsequent learning.

Academic and Flight Training Elements for training the role of Pilot Monitoring

These academic and flight training elements are specifically focused on the role of Pilot Monitoring. Many of these training elements are applicable to both the Pilot Flying and Pilot Monitoring. There is no intent by the FPM WG to suggest that these elements are only applicable to the Pilot Monitoring. Additionally, in the scope of this recommendation the WG intends the term 'flight path management systems' to include the systems the pilots use to manage the flight path, including manual flight controls, autopilot, auto throttles, flight control systems, envelope protection, FMS, flight directors and associated pilot interfaces.

1. Train pilots on all the operator's policies and procedures related to monitoring the flight path (e.g., callouts, double-pointing, etc.). This training should also include any of the carrier's recommended practices.

   Rationale: Various industry and NTSB reports indicate an item contributing to incidents and accidents is the "breakdown in...monitoring responsibilities". Policies and procedures need to be developed regarding proper Flight Path Monitoring. Then, once improved/explicit policies and procedures are defined, ensure those policies and procedures are included in training.

   Note: This recommendation complements ACT ARC Recommendation 15-5: Using Safety Management System (SMS) to Address Flight Path Management (FPM) Issues in 121 Air Carrier Training

2. Train pilots on applicable common errors in monitoring the flight path.

   Rationale: Monitoring errors have occurred with all experience levels and pilots need to know they are vulnerable to those errors. Include training on appropriate methods of recognizing precursors to, and signs of, degraded monitoring, and on resolving monitoring errors/lapses. As one industry document mentions, "Simply exhorting pilots to 'do a better job' or 'pay more attention' will not work" to change the behavior of an untrained skill. These common errors can be identified through an operator's SMS program, including safety data programs such as LOSA, ASAP, and FOQA, and industry programs (e.g. manufacturer-operator meetings, InfoShare, accident reports, and ASIAS).

3. Train pilots on the concept that there are predictable situations during each flight when the risk of a flight path deviation is increased, heightening the importance of proper task/workload management.

   Rationale: A crew that is effectively monitoring/cross-checking is more likely to detect any problems, omissions or errors than a crew that is not effectively monitoring/cross-checking. And a crew that is aware of problems, omissions or errors is more likely to
   successfully manage them than a crew that remains unaware of them. The PM role is critical to ensuring the PF's awareness of such situations.

If the PM is trained to recognize the flight phases or situations when they are most vulnerable to flight path deviations (including when little time exists to correct deviations) he/she could strategically plan workload and manage distractions to maximize monitoring during those phases. (For a practical example of this recommendation, the FPM WG endorses the concept of the AOV model as described in "*A Practical Guide for Improving Flight Path Monitoring"* from the Flight Safety Foundation).

a. Train pilots to manage distractions that interfere with monitoring the flight path. Provide guidance on managing task priorities and train them to effectively switch between other tasks and monitoring of the flight path so that flight path vigilance is always maintained. Include information and task management strategies that enable pilots to use charts, EFBs, ACARS, etc. while also effectively monitoring the flight path and airplane energy state.

   Rationale: Every flight is vulnerable to distractions and interruptions, therefore pilots need training to understand how to protect the flight path and aircraft energy state, while managing distractions and interruptions. They need to know how to prioritize tasks and switch between tasks so that they do not neglect monitoring of the flight path for a sustained period of time or during vulnerable states (low altitude lateral or vertical changes). They also need to know how to monitor for the specific purpose of protecting the flight path while they are engaged in concurrent tasks.

   Pilots need to know how to dynamically re-allocate tasks to ensure the workload is appropriately distributed. Pilots must know which flight phases or situations are vulnerable to flight path deviations, be able to plan for them, brief them, recognize when the situation occurs during the flight, and communicate effectively to the other pilot.

   Monitoring and cross-checking should be designed to create shared awareness of the flight path between the PF and PM and enable the crew to detect problems or errors, because crews that detect problems or errors are more likely to manage them in a timely manner. The PM's role is crucial to ensuring the PF understands the current state of aircraft trajectory, as well as the state of any issues being managed.

4. Train the responsibilities of the PM to monitor the flight path.

   a. Train pilots to recognize when the PF is not adequately controlling the flight path or when the PM is not adequately monitoring the flight path. This training should include crewmember task loading and signs of diminished performance. Some examples might be, lack of communication, channelized attention, failure to make required callouts, etc.

b. Train pilots on intervention methods that PM can use to help the PF regain proper control of the flight path and provide opportunities for the PM to practice these methods. (e.g., calling out deviations, levels of assertiveness, etc.)

Rationale for 4a and 4b: Effective flight deck coordination with respect to flight path management requires continuous awareness of the current and desired flight path. Pilots should communicate deviations to the other pilot(s). During times of high task loading, pilots tend to focus on individual tasks or channelize their attention, which leads to diminished communication between the crew members. Without proper communication, pilots have a higher risk of making errors or failing to recognize undesired flight path deviations. Pilots should be trained and evaluated on their ability to recognize diminished communication, channelized attention and loss of awareness of the current and desired flight path. Training should include strategies to respond to these risks and identify the resources to be used during high workload on the flight deck.

Note: This recommendation complements ACT ARC Recommendation 15-10: Guidance Material Addressing Intervention Strategies

5. Train pilots on operationally-relevant combinations/levels of flight guidance and flight control automation.

NOTE: Combinations/levels of flight guidance and flight control automation that are considered operationally-relevant can be identified through an operator's SMS program, including safety data programs such as LOSA, ASAP, and FOQA, and industry programs (e.g. manufacturer-operator meetings, InfoShare, accident reports, and ASIAS).

a. Ensure pilots demonstrate a thorough understanding of combinations/levels of flight guidance and flight control automation (e.g., given a certain set of circumstances, what will happen next?).

b. Ensure pilots can transition seamlessly between combinations/levels of flight guidance/flight control automation (including manual flight).

Rationale: Traditional regulatory requirements tend to focus on performing discrete maneuvers correctly rather than on handling real-world issues affecting the flight path management task. For example, current flight path management systems training focuses on FMS data entry, modes, mode changes and how to accomplish normal tasks on the line (extending centerlines, etc.) in a tightly scripted manner. Training would be enhanced if pilots were taught to interpret the FMA and flight path management systems relative to aircraft state and to know what to expect based on programming, configuration, and aircraft state. In addition, the FltDAWG found that training programs typically did not explicitly address the management of deviations

or off-path operations. Also, limited training is provided on how to handle known “automation surprises” and unknown situations.

Note: This recommendation complements ACT ARC Recommendation 16-3 Operational Mode Awareness and Recommendation 15-11: Auto Flight Mode Training

6. Train pilots to anticipate, recognize, and recover from known flight guidance (includes FMS) and flight control (includes autopilot and, autothrottles) system-behavioral challenges (e.g., subtle mode reversions), and environmental/ circumstantial traps that are known to lead to flight path-related errors (e.g., vectors off, then back on, a STAR during a "descend via" clearance).

Rationale: A key aspect of training known system challenges and real world events is for pilots to be able to identify common drivers for divergences from the desired path quickly. Based on Safety Assurance data (internal and industry) as Safety Management Systems mature, the air carrier should incorporate hazards identified through safety assurance data into the training program. The use of this data has the potential to create variability in training syllabi, however, these changes could be managed through current AQP programs.

Instructor Elements for training the role of Pilot Monitoring

While the role of PM appropriately entails a wide range of diverse activities in support of the PF, the most important PM task whenever the aircraft is in motion is to insure the aircraft is on the correct flight path. Therefore, instructors must have a thorough understanding of flight path management systems to effectively train pilots in the role of Pilot Monitoring. The WG does not imply that other tasks for the PM need not be trained, but does not specifically call those other tasks out in this recommendation due to WG scope.

Additionally, in the scope of this recommendation the WG intends the term ‘flight path management systems’ to include autopilot, auto throttles, flight control systems, envelope protection, FMS, flight directors, and associated pilot interfaces.

Knowledge Objectives for instructors on monitoring the flight path should include:

1. Policies and procedures, for the role of Pilot Monitoring

Rationale: Various industry and NTSB reports indicate a contributing factor to incidents and accidents is the "breakdown in...monitoring responsibilities". Policies and procedures need to be developed regarding proper Flight Path Monitoring. Then, once improved/explicit policies and procedures are defined, those policies and procedures must be included in training. The instructors must be well versed in the policies and procedures for the role of Pilot Monitoring. This will enable the instructors to reinforce them during the various training events.

2. Applicable common errors in monitoring the flight path

   Rationale: Monitoring errors can and have occurred with all experience levels and pilots need to know that they have a chance of being vulnerable to those errors. Instructors must be taught and understand these errors and any underlying issues associated with these errors. Include training on appropriate methods of recognizing precursors to, and signs of, degraded monitoring, and how to resolve monitoring errors/lapses. As one industry document mentions, "Simply exhorting pilots to 'do a better job' or 'pay more attention' will not work" to change pilots' behavior. These common errors can be identified through an operator's SMS program, including safety data programs such as LOSA, ASAP, and FOQA, and industry programs (e.g. manufacturer-operator meetings, InfoShare, accident reports, and ASIAS).

3. CRM/TEM principles and human performance vulnerabilities related to monitoring, the importance of monitoring and the company-approved practices that achieve effective monitoring of the flight path.

   Rationale: As has been documented elsewhere, effective Pilot Monitoring actions are intertwined with appropriate application of effective CRM/TEM foundation skills, such as: good crew communications, teamwork, time management, and workload/task management. Therefore, instructors must be taught not only the fundamentals of these skills, but also effective techniques to teach and evaluate these skills. Development of effective monitoring skills directly contributes to safety when operating highly automated, multi-crew aircraft. Research suggests that pilots who are educated in human performance limitations and trained in methods designed to mitigate these known vulnerabilities are more effective flight path monitors. Furthermore, universal crew conformity with company-approved practices is a demonstrated method of risk mitigation, including effective monitoring of the flight path.

4. Effective methods for teaching and assessing the role of Pilot Monitoring, and effective monitoring behaviors.

   Rationale: Instructors must also be taught how to properly teach and evaluate monitoring duties and behaviors. As mentioned similarly in other rationale, simply having knowledge of these duties and behaviors does not indicate a proper understanding of how to teach it.

5. System failures (other than automation) that create distractions on the flight deck that lead to ineffective monitoring and improper flight path management.

   Rationale: Accident/incident reports show that many accidents occur as the result of a flight path deviation. Flight path deviations occur due to one or more of the following: a lack of understanding of the clearance; poor aircraft control; inadequate understanding of automation behavior; and ineffective monitoring. Aircraft system failures outside of the previously discussed automation degradations may lead to distractions that negatively impact effective CRM/TEM. Flight path management must always be the primary duty of all crew members. Therefore, Instructors should integrate CRM/TEM skills that promote effective flight path management into teaching the handling of aircraft system failures. The distraction of a simple system failure may lead to a flight path deviation. (e.g. flying into terrain while distracted by an inoperative landing gear light).

Knowledge Objectives for instructors on flight path management systems should include:

1. A thorough understanding of flight guidance and flight control systems, including a thorough understanding of what will happen 'next' given a certain set of flight circumstances, and the reasons why.

   Rationale: Recent events have indicated that a flight crews' misunderstanding of a flight path management system may have been due to inadequate training of that system. A thorough understanding (correlation level of knowledge) of aircraft flight path management system's function and operational application by the instructor is critical to the safe conduct of the flight crews they train. The instructor must be the subject matter expert, both to guide pilot trainees through initial knowledge and skill acquisition, but also to teach the appropriate operational strategies in the real-world operational environment. The instructor must be fully prepared to answer trainee's follow-on questions, such as "what is it doing to me now?" and "why did it do that?" Flight path management systems can be very complex and the flight crew may unintentionally create an unexpected and/or undesired system response that leads to confusion or errors.

2. Known flight guidance and flight control system-behavioral challenges (e.g., subtle mode reversions), and environmental/circumstantial traps (e.g., vectors off, then back on, a STAR during a "descend via" clearance) that are known to lead to flight path-related errors.

   Rationale: It is important that the instructor have a thorough understanding of real-world events that illustrate these challenges, as opposed to scripted linear events that emphasize sequenced button-pushing. Automated systems are individually and collectively complex. This complexity sometimes creates non-obvious, non-intuitive or transparent flight path management system changes, which can create significant challenges for the flight crew. Many of these system behaviors may be "as designed" by the manufacturer, so do not represent a "system failure," per se, which could be addressed by a non-normal checklist.

Nonetheless, many non-obvious or non-intuitive system challenges are known to occur during normal operations. Many of these conditions are known to the operator, including for example, known ATC-induced workload challenges. Collectively, a library of such events can be trained so that flight crews can avoid or recover from undesirable flight path management system behavior. The instructor plays the critical role in designing training events that emulate the actual real-world. To be an effective teacher/evaluator, instructors should be thoroughly trained in all such known scenarios from this "library", and should be an expert in the non-obvious, non-intuitive behaviors of the flight path management system so he/she can pass along such knowledge/skill to his/her pilots.

3. Flight Path Management systems degradations and failures and operational consequences requiring flight crew action.

Rationale: Basic flight path management system knowledge must be enhanced with known system degradations and failures to include operational situations that challenge a pilot's recognition of an impending flight path management system error. An essential component of fully understanding flight path management systems is the instructor's ability to identify, explain and demonstrate the system's degraded/failure modes and the operational consequences of those modes. With the high level of integration of flight path management systems on flight decks, a degradation or failure of one system may (and most frequently does) functionally affect other systems (cascade effect). Understanding the failure characteristics of individual flight path management systems and the interrelationships with other flight deck systems is vital for an instructor to train effective decision-making processes on established mitigation and recovery procedures. Flight path management system failures will occur during normal operations and the instructor must have the system knowledge to train flight crews on those failures and consequences, to include the capability to intelligently analyze the degradation or failure and apply corrective action for which established flight crew procedures may not exist. These system failures and/or degradations must not be limited to the flight path management system, but should incorporate other systems which may have an impact on the use of the flight path management systems.

4. Effective methods for teaching and assessing the use of flight path management systems

Rationale: Recent studies have indicated that most instructors are prepared to teach the basic operation of the flight path management system, but may not be thoroughly familiar with the underlying principles and intricacies of how it works. Once an instructor gains the level of knowledge listed in these recommendations, effective methods should be identified on how to properly teach and assess the use of the flight path management system. Simply having knowledge of the system does not indicate a proper understanding of how to teach it. Therefore, it

is imperative that the instructor not only be adept at systems behavior, operation, and application, but also have the ability to explain, demonstrate, question, observe and assess the pilot's progress of understanding and anticipating the behavior of flight path management systems.

Note: During the discussion of this recommendation with the Steering Committee, the Airline Dispatchers Federation (ADF) requested that the following clarification be added to support the recommendation: Flight path management starts with the flight plan and the dispatcher is part of that process and the dispatcher shares the responsibility of monitoring the path in flight following and sharing any deviation that they become aware of deviation (from ATC, or ASD).

Best (Recommended) Practices for Training Pilot Monitoring

The FAA asked the Flight Path Management Workgroup to identify the best practices, herein called recommended practices, for training the PM. The rationale for calling these recommended practices versus best practices is because each recommended practice must consider the organization's culture, policies, procedures, past practices, and philosophies. A recommended practice for one organization may need modification to be applicable to another organization.

While the FPM WG believes that the recommendations for pilot and instructor/evaluator training elements do provide an answer to the FAA's questions, the WG supports the recommended practices techniques for training the PM outlined in the Flight Safety Foundation's report '*A Practical Guide to Flight Path Monitoring'.* The FPM WG suggested the FAA reference the FSF report in the advisory guidance material supporting this recommendation.

V. Background Information

FPM WG Scope of Work:

Proposed Recommendation FPM-X partially addresses the Scope of Work by answering the questions incorporated in the FPM WG TOR, Section II.3.b.,i - iii.

3. When developing guidance recommendations, the WG will initially answer the following questions:
   b. Pilot Monitoring: (14 CFR §§121.409(b)(2)(ii)(B)(5) and 121.544)
      i. Identify the best practices for training the PM.
      ii. Identify the academic training elements required for the PM to be effective.
      iii. Identify the flight training elements required to reinforce PM knowledge and skills.

ACT ARC Initiatives:

ACT ARC Recommendation 16-3 partially addresses Initiative #35 assigned to the FPM WG.

Source Reports:

UK CAA, *Monitoring Matters, Guidance on the Development of Pilot Monitoring Skills*, February 2013

Flight Safety Foundation, *A Practical Guide for Improving Flight Path Monitoring*, November 2014

Operational Use of Flight Path Management Systems, Performance-Based Operations Aviation Rulemaking Committee (PARC)/Commercial Aviation Safety Team (CAST) Flight Deck Automation Working Group (FltDAWG) final report, September 2013

Attachment A:

Academic and Flight Training Elements for training the role of Pilot Monitoring

1. Train pilots on all the operator's policies and procedures related to monitoring the flight path (e.g., callouts, double-pointing, etc.). This training should also include any of the carrier's recommended practices.
2. Train pilots on applicable common errors in monitoring the flight path.
3. Train pilots on the concept that there are predictable situations during each flight when the risk of a flight path deviation is increased, heightening the importance of proper task/workload management.
    a. Train pilots to manage distractions that interfere with monitoring the flight path. Provide guidance on managing task priorities and train them to effectively switch between other tasks and monitoring of the flight path so that flight path vigilance is always maintained. Include information and task management strategies that enable pilots to use charts, EFBs, ACARS, etc. while also effectively monitoring the flight path and airplane energy state.
4. Train the responsibilities of the PM to monitor the flight path.

    a. Train pilots to recognize when the PF is not adequately controlling the flight path or when the PM is not adequately monitoring the flight path. This training should include crewmember task loading and signs of diminished performance. Some examples might be, lack of communication, channelized attention, failure to make required callouts, etc.

    b. Train pilots on intervention methods that PM can use to help the PF regain proper control of the flight path and provide opportunities for the PM to practice these methods. (e.g., calling out deviations, levels of assertiveness, etc.)
5. Train pilots on operationally-relevant combinations/levels of flight guidance and flight control automation.

    NOTE: Combinations/levels of flight guidance and flight control automation that are considered operationally-relevant can be identified through an operator's SMS program, including safety data programs such as LOSA, ASAP, and FOQA, and industry programs (e.g. manufacturer-operator meetings, InfoShare, accident reports, and ASIAS).

    a. Ensure pilots demonstrate a thorough understanding of combinations/levels of flight guidance and flight control automation (e.g., given a certain set of circumstances, what will happen next?).

    b. Ensure pilots can transition seamlessly between combinations/levels of flight guidance/flight control automation (including manual flight).

6. Train pilots to anticipate, recognize, and recover from known flight guidance (includes FMS) and flight control (includes autopilot and, autothrottles) system-behavioral challenges (e.g., subtle mode reversions), and environmental/ circumstantial traps that are known to lead to flight path-related errors (e.g., vectors off, then back on, a STAR during a "descend via" clearance).

   Note: Pilots commonly refer to such examples as “gotchas.”

Instructor Elements for training the role of Pilot Monitoring

Knowledge Objectives for instructors on monitoring the flight path should include:

1. Policies and procedures, for the role of Pilot Monitoring.
2. Applicable common errors in monitoring the flight path.
3. CRM/TEM principles and human performance vulnerabilities related to monitoring, the importance of monitoring and the company-approved practices that achieve effective monitoring of the flight path.
4. Effective methods for teaching and assessing the role of Pilot Monitoring, and effective monitoring behaviors.
5. System failures (other than automation) that create distractions on the flight deck that lead to ineffective monitoring and improper flight path management.

Knowledge Objectives for instructors on flight path management systems should include:

1. Known flight guidance and flight control system-behavioral challenges (e.g., subtle mode reversions), and environmental/circumstantial traps (e.g., vectors off, then back on, a STAR during a "descend via" clearance) that are known to lead to flight path-related errors.

   Note: Pilots commonly refer to such examples as “gotchas.”

2. Flight Path Management systems degradations and failures and operational consequences requiring flight crew action.
3. Effective methods for teaching and assessing the use of flight path management systems.
4. A thorough understanding of flight guidance and flight control systems, including a thorough understanding of what will happen ‘next’ given a certain set of flight circumstances, and the reasons why.