



# Guidance Material for Improving Flight Crew Monitoring

**1**st | Edition

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# Publications

The table below shows a non-exhaustive list of publications, issued by Regulators and the industry, addressing the subject of this manual.

Publication	Date	Abbreviated essentials
FAA AC 120-71	2003	<p>Standard Operating Procedures for Flight Deck Crew Members</p> <ul style="list-style-type: none"> <li>• Effective crew coordination and crew performance, two central concepts of crew resource management (CRM), depend upon the crew's having a shared mental model of each task. That mental model, in turn, is founded on SOPs.</li> <li>• Conversion of the term pilot not flying (PNF) to Pilot Monitoring (PM), and related Appendix addressing "Crew Monitoring and Cross-Checking."</li> </ul>
FAA AC 120-74	2012	<p>Flight crew Procedures during Taxi Operations</p> <ul style="list-style-type: none"> <li>• Encourage jump seaters to monitor communications.</li> <li>• All pilots should monitor taxi route and changes to pre-taxi instructions</li> <li>• Flight crews should use a "continuous loop" process to actively monitor and update their progress and location during taxi.</li> <li>• Procedures for when a crew member has to stop monitoring and procedures for bringing pilot back into the loop for changes that occurred during their absence.</li> </ul>
FAA SAFO 15011	2015	<p>Roles and Responsibilities for Pilot Flying (PF) and Pilot Monitoring</p> <ul style="list-style-type: none"> <li>• Guidance for Operators for defining operational roles and responsibilities for PF and PM</li> </ul>
CAA Paper	2013	<p>Monitoring Matters – Guidance on the Development of Pilot Monitoring Skills</p> <ul style="list-style-type: none"> <li>• Guidance on better understanding of the monitoring discipline and to identify potential monitoring related training and assessment practices</li> </ul>
CAA CAP 737	2013	Flight-crew human factors handbook
Flight Safety Foundation	2014	A Practical Guide for Improving Flight Path Monitoring
PARC/CAST Flight Deck Automation Working Group	2013	<p>Operational Use of Flight Path Management Systems</p> <ul style="list-style-type: none"> <li>• Discusses the complexities, vulnerability, and monitoring issues flight crews face when interacting with automated systems and managing tasks on the flight deck</li> <li>• Provides findings and recommendations</li> </ul>



## Guidance Material for Improving Flight Crew Monitoring

Publication	Date	Abbreviated essentials
Enhancing Flight-crew Monitoring Skills Can Increase Flight Safety (Sumwalt, Thomas, Dismukes)	2002	Flight Safety Foundation/ 55th International Air Safety Seminar (IASS) <ul style="list-style-type: none"><li>• Crew monitoring performance can be improved through policy changes, training and by pilots following an active monitoring concept.</li></ul>
Checklists and Monitoring in the Cockpit: Why Crucial Defenses Sometimes Fail (Dismukes, Berman)	2010	NASA paper – <i>study conducted to explore why checklists and monitoring sometimes fail to catch errors and equipment malfunctions as intended. Includes ways to improve the effectiveness of checklists and monitoring.</i>



# Abbreviations and Acronyms

A/C	Aircraft
ACARS	Aircraft Communications Addressing and Reporting System
AFDS	Automatic Flight Director System
AP	Auto Pilot
APU	Auxiliary Power Unit
AOV	Area of Vulnerability
ASR	Air Safety Report
ASRS	NASA Aviation Safety Reporting System
AT	Autothrottle/Autothrust
ATC	Air Traffic Control
ATO	Approved Training Organization
ATPL	Airline Transport Pilot License
AQP	Advanced Qualification Program (FAA)
ATQP	Alternative Training and Qualification (EASA)
CAST	U.S. Commercial Aviation Safety Team
CPL	Commercial Pilot License
CPDLC	Controller–Pilot Data Link Communications
CRM	Crew Resource Management
CTA	Cognitive Task Analysis
EFB	Electronic Flight Bag
EFPM	Effective Flight Path Monitoring
FD	Flight Director
FDM	Flight Data Monitoring
FL	Flight Level
FltDAWG	PARC/CAST Flight Deck Automation Working Group
FMA	Flight Mode Annunciator
FMC	Flight Management Computer
FPM	Flight Path Management
F/O	First Officer
FSTD	Flight Simulation Training Device
ICAO	International Civil Aviation Organization



## Guidance Material for Improving Flight Crew Monitoring

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IFALPA	International Federation of Air Line Pilots' Association
ILS	Instrument Landing System
IOE	Initial Operating Experience
LNAV	Lateral Navigation
LOC	Localizer
LOE	Line Oriented Evaluation
LOFT	Line Oriented Flight Training
LOSA	Line Operations Safety Audit
MCP	Mode Control Panel
MEL	Minimum Equipment List
MPL	Multi-crew Pilot License
NAA	National Aviation Authorities
NASA	U.S. National Aeronautics and Space Administration
NTSB	U.S. National Transportation Safety Board
OEM	Original Equipment Manufacturer
PARC	U.S. Performance-based Operations Aviation Rulemaking Committee
PF	Pilot Flying
PM	Pilot Monitoring
PNF	Pilot Not Flying
RNAV	Area Navigation
SA	Situation Awareness
SOP	Standard Operating Procedure
SPOT	Special Purpose Operational Training – used in AQP
TEM	Threat and Error Management
TOGA	Take-off/Go-around
VNAV	Vertical Navigation
VVM	Verbalize, Verify, Monitor

# Foreword

Dear Colleagues,

It is my pleasure to introduce the first edition of the IATA Guidance Material for Improving Flight Crew Monitoring.

This guidance material is the second document produced with the support of the IATA Pilot Training Task Force (PTTF) and follows the publication of IATA's Guidance and Best Practices for Implementation of UPRT. This chronological order makes sense since effective monitoring is identified as a key safety net in the prevention of accident and incident in general and in the prevention from loss of control accidents and incidents in particular.

There is Industry consensus on the importance of enhancing monitoring. This consensus is based on data analysis from many sources, including accident and incident investigations, line operations safety audit (LOSA), aviation safety action programs (ASAP), flight operational quality assurance (FOQA)/flight data monitoring (FDM), and the U.S. National Aeronautics and Space Administration Aviation Safety Reporting System (ASRS).

In 2003, the FAA published Advisory Circular 120-71 which introduced two significant changes. The first one was the conversion of the term Pilot not Flying (PNF) to Pilot Monitoring (PM). The second change was the addition of a related appendix addressing "Crew Monitoring and Cross-Checking." This appendix to AC 120-71 focuses on developing and implementing SOPs to improve monitoring. It stresses the monitoring responsibility of both, the Pilot Flying and the Pilot Monitoring. Recommendations and guidance material regarding monitoring have since been published, which include new requirements for training monitoring duties for all pilots.

In 2010, the High Level Safety Conference (HLSC) of ICAO also made a recommendation to review the requirements on flight deck activities, checklist and standard operating procedures design, taking into account the increased automation in the cockpit and applying threat and error management (TEM) and safety management principles. This then generated a task which has been fulfilled by the completion of this manual in coordination with the Flight Operations Panel of ICAO.

The objective of this guide is not to repeat what has already been written or published on monitoring, but to provide practical guidance to operators wishing to enhance their own training for developing monitoring skills for pilots in line operations.

It is our belief that the shared efforts put into the development of this guide will contribute to achieving our common goal of improving aviation safety worldwide.

Best regards,



**Gilberto Lopez Meyer**

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# Section 1—Scope of the Manual

This manual serves as guidance material for operators to better understand the concept of monitoring, the flight crew monitoring functions and roles, and current practices for integrating monitoring knowledge and skills into flight training programs, such as ab-initio, conversion, upgrading, type rating and recurrent training. It provides practical guidance for defining pilot roles and responsibilities for monitoring during line operations, for training monitoring tasks and skills, and for instructors to properly teach monitoring. The manual also includes recommendations for operators cooperating with Approved Training Organizations (ATO) that provide licensing training for their ab-initio cadets.

The term “monitoring” as used in this manual refers to the definition in Section 2.1, and is independent of assigned roles. To take this into account, the term flight crew is used throughout the manual to refer to flight crew members with assigned duties on the flight deck.

This manual includes current practices at various airlines and information already available within the industry, including publications produced by international working groups, e.g., “*A Practical Guide for Improving Flight Path Monitoring*” published by the Flight Safety Foundation, and “*Monitoring Matters*” published by the UK Civil Aviation Authority(CAA). A complete list of documents consulted is listed in the Publications section at the beginning of this manual. These documents are good reference materials for developing monitoring skills.

This manual may be used for all training programs. Syllabi and air exercises included are based on practices already used by operators and Approved Training Organizations (ATOs) around the world.

As sufficient study material is available, existing information will only be replicated when needed for better understanding or readability. Academic training is not fully detailed in this manual; however, essential topics and sources are discussed.

This manual is provided for information and guidance purposes. It describes examples of means, but not the only means, of developing training for teaching monitoring knowledge and skills for pilots, in order to achieve compliance with regulations and standards. Operators are responsible for ensuring compliance with regulations and standards and for obtaining approval from their National Aviation Authorities (NAAs) for their training programs.

**Note:** The pronoun “he” is used synonymously for “she” or “he” throughout this manual.

## Section 2—Overview of Monitoring

### 2.1 Definition

**Monitoring is an overarching process requiring knowledge, skills and attitudes that enables flight crews to perform safely, effectively and efficiently.** Monitoring includes the process of observing and creating a mental model, by seeking out available information to compare actual and expected aircraft state.

Effective monitoring is important for CRM and TEM.

**Predictive monitoring** supports anticipation of expected threats and the mitigation of consequences.

**Reactive monitoring** supports:

- identification of unexpected/pop-up threats and the mitigation of consequences
- detection and correction of errors
- recognition and recovery of undesired aircraft states

### 2.2 Scope of Monitoring

Most flight crew tasks include some form of monitoring or the tasks themselves are monitored as part of the overall task management of the flight. Monitoring is performed during all phases of flight, from aircraft ground and pre-flight operations to take-off until landing, to after landing and post flight operations, and should be adapted to each phase of the flight. (Please see in the Attachments Section, Section 2 – Attachment 1 for phase of flight discussion).

Monitoring is not done in isolation; it must be performed concurrently while performing other required tasks, including operating aircraft controls, making data entries and communicating with others. “Good monitoring relies upon effective task management and making time for monitoring”.<sup>1</sup>

The primary job of the flight crew is the flight path management, including managing the energy state of the aircraft at all times. This requires effective monitoring, whether operating in manual or automated flight. Monitoring of the flight path is done through the observation of essential instruments including primary flight displays, navigation displays, mode control panel, flight mode annunciations, configuration status, etc.

Secondly, the flight crew is also required to monitor all operational tasks not directly related to the flight path. These include monitoring of aircraft systems, destination and enroute weather, operational factors, observing other flight crew members, cabin crew, dispatcher functions, etc.

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<sup>1</sup> Monitoring Matters, Guidance on the Development of Pilot Monitoring Skills, CAA Paper, April 2013, Page 28.

Monitoring requires a combination of cognitive resource allocation such as attention, and a link to previously acquired knowledges (scripts and scenarios), which allow a pilot to detect, understand, project into the future, and then take the right decision/action. Monitoring includes comparing desired state against actual state, identifying deviations, proposing solutions, correcting, or intervening if necessary. When monitoring in a multi-crew environment, effective crew monitoring requires maintaining a shared mental model between flight crew members and communicating any changes or intentions with other flight crew members.

Monitoring is required in all functional roles (i.e., captain, first officer, relief pilot, flight engineer, examiner, or safety pilot) as well as assigned roles (pilot flying, pilot monitoring) during the flight. Flight path monitoring applies to Pilot Flying (PF) and Pilot Monitoring (PM) with no consideration to the seat occupied in the flight deck (left or right) or their position in the airline (captain, first officer, instructor, evaluator, etc.). Monitoring should be exercised by all qualified flight crew members present in the cockpit (e.g., examiner for assessment purposes, extra pilot(s) for long range flights, etc.) in the interest of the safe conduct of the flight and in accordance with the operator's policy.

### 2.3 Monitoring As a Role versus a Task

Flight crews must understand the two fundamental aspects of monitoring as a "role" versus monitoring as a "task".

**Monitoring as a role**, describes the assignment of monitoring to the designated functional roles of the pilot, such as captain/first officer/relief pilot, and to the assigned roles as Pilot Flying and Pilot Monitoring during different phases of flight. Each operator should clearly define the roles of Pilot Flying and Pilot Monitoring<sup>2</sup> and integrate operational policy, procedures and training in order to enhance a flight crew's monitoring for both tasks and roles. (Please see Attachments Section, Section 2 – Attachment 2.)

#### **Monitoring as a task:**

- Requires the flight crew to observe, interpret and understand all relevant data (i.e., configuration, energy-state, parameters, automation modes, automated systems, behavior of flight crew and information) related to the phase of flight
- Involves a cognitive comparison against expected values, modes and procedures
- Requires flexibility to allow flight crew to adapt and handle variability in the changing conditions of flight
- Requires communication, including means to alert when significant deviations occur, and
- Includes intervention in a timely manner when the situation requires it

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<sup>2</sup> FAA SAFO 15011

### **2.4 The Need to Improve Knowledge, Skills and Attitudes for Monitoring**

Because a flight crew member has successfully progressed in flight training, the assumption is sometimes made that he already is competent in monitoring. As a result, some training programs may not concentrate on training individual flight crew members on how to become better monitors. Instead, the emphasis might be on crew procedures and assigned duties and roles and not on the actual monitoring process itself.

Today's combination of modern aircraft and a more demanding environment requires a higher level of expertise than ever before. Analyses of accidents and incidents often show that better monitoring by the crew could have prevented them. Analyzing the root causes, determining where the monitoring process broke down and enhancing flight crew monitoring are critical to improve safety. If it is assumed that the flight crew already knows how to monitor, the focus could incorrectly be put on developing new SOPs or assigning specific monitoring duties based on designated assigned roles (such as PM), instead of developing and improving the individual monitoring abilities of each flight crew member.



## Section 3—Complexity of Monitoring

To mitigate monitoring vulnerabilities in flight operations, it is important to understand the complexity of the monitoring process when designing effective policies and training programs. Monitoring requires cognitive resources, attention management, task management, prioritization, a shared mental model and good communication between the flight crew members.

Human performance, time and cognitive resources are limited; flight crews need to effectively manage these resources along with other crew resources to safely manage the flight. One cannot improve monitoring by simply asking flight crews to be better monitors and to pay more attention. An Operator needs to integrate monitoring guidance and training throughout all operations to accurately reflect the complexities and human performance limitations that surround monitoring in order to enhance a flight crew's monitoring skills.

### 3.1 Understanding the Complexity of Monitoring

While flight path management has the highest priority, the flight crew is required to monitor everything related to the flight, not just the flight path.

"The mechanics of monitoring are complex and involve the selective application of mental resources to encode the sensory inputs whilst performing a goal directed task."<sup>3</sup> Some of the issues that can contribute to the complexity of monitoring include:

- Workload management to
  - prioritize and perform tasks effectively and efficiently, and
  - manage and recover from interruptions, distractions, variations and failures
- Different types of monitoring based on the action itself (e.g., different monitoring required for a call out versus monitoring the weather ahead of aircraft)
- Prioritization based on desired outcomes
- Conditions requiring modifying monitoring goals when conditions change

Another cause of the complexity of monitoring might be called "ironies of automation".<sup>4</sup> Advanced aircraft systems are very reliable and flight crews rarely deal with malfunctions. As discussed in the Flight Deck Automation Working Group (FltDAWG) final report, the high reliability of systems may result in expectation of normalcy amongst flight crews, which can create trust or over-reliance in the automated systems which then can result in breakdowns in the monitoring process.<sup>5</sup>

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<sup>3</sup> Monitoring Matters, Guidance on the Development of Pilot Monitoring Skills, CAA Paper, April 2013, Part 1, page 10

<sup>4</sup> Ironies of Automation, Lisanne Bainbridge, 1983

<sup>5</sup> PARC/CAST Flight Deck Automation Working Group Final Report, Operational Use of Flight Path Management Systems, 2013.



**Note:** Complexity of monitoring is also discussed in the 2013 final report from the U.S. PARC/CAST Flight Deck Automation Working Group (FltDAWG), titled "Operational use of Flight Path Management Systems". The report includes findings based on accidents, incidents, and LOSA data, and includes recommendations for operator training and guidance. While the document is relevant to flight path management, Sections 3.2.4, 3.4, 3.5, and 3.7 are specifically relevant to monitoring in general.

## 3.2 How Cognitive Skills and Mental Processes Affect the Complexity of Monitoring

Flight crews need to actively manage mental processes to build their situation awareness.

Monitoring involves effective management of attention, vigilance, memory, prioritizing, information processing, communication and adaptability. Its dependence on mental processes along with the limitations of the human capabilities, make monitoring a highly complex process in today's advanced flight decks and ATC environment. In addition, human factors such as memory, vigilance, and focus of attention bring complexity into monitoring; these are the subject of scientific research and some of them are still being debated.

## 3.3 What Promotes Effective Monitoring?

"Good monitoring requires knowledge, skills and attitudes as well as experience and communication; none of these can be taken in isolation."<sup>6</sup>

Knowledge is provided through training. Experience is the application of knowledge, and skill is the product of both knowledge and experience.

**Communication** is fundamental to monitoring to ensure that the flight crew maintains the same complete mental model of presence and anticipation; "both as output and as input".<sup>7</sup> Interactive briefings and facilitated (self-) debriefings used in daily operations may also be used to review and discuss mental models and behaviors that affected monitoring during the flight.

<b>An Operator's Debriefing Example</b>
<b>TEM:</b> Did we anticipate/identify all threats? Did we develop the proper mitigation strategies? Did we detect and correct our errors? Did we recognize and recover undesired aircraft states? Which countermeasures worked effectively?
<b>Procedures:</b> As a crew, did we make any procedural error? How did we detect and correct the error?
<b>Pending questions:</b> Are there any phases of flight to clarify (CRM...)? Any report to be completed? (Air Safety Report, Technical Log...)
<b>Improvements:</b> What could we have done better?

<sup>6</sup> Monitoring Matters, Guidance on the Development of Pilot Monitoring Skills, CAA Paper, April 2013, Part 1, Page 28

<sup>7</sup> Monitoring Matters, Guidance on the Development of Pilot Monitoring Skills, CAA Paper, April 2013, Part 1, Page 28

### **Mental Model and Attention Management**

Mental models help provide an understanding of what is happening and what is likely to happen.

An errant or incomplete mental model may cause misinterpretation of data and fail monitoring. Multitasking, distractions, automation biases and false expectations may hamper the monitoring process and should be avoided or managed.

Attention management is an essential cognitive process of monitoring. Flight crews need to manage their attention in all phases of flight in order to perceive and to process available goal related data, which will allow them to create and maintain their mental model; a prerequisite for good situation awareness. (Please see in the Attachments Section, Section 3 – Attachment 1.)

### **Workload Management, Leadership and Teamwork**

Humans have many attentional limitations by nature; the main limitation of attention is that it is a finite, limited resource. Each situation or flight phase demands the assignment of a certain level of mental and physical resources. In some instances, data overload and the complexity of the task can quickly exceed the flight crew's attentional capacity (a form of task saturation). Training in effective workload management, leadership and teamwork will contribute to maintaining sufficient attentional capacity.

Please see in the Attachments Section, Section 3 – Attachment 1 for example schemes used for teaching communication, workload management, leadership and teamwork.

## Section 4—Monitoring Policies and Procedures

Monitoring should be embedded in all flight crew licensing and multi-crew training, independent from the intended operational environment the pilot will be acting in. OEMs, operators and ATOs should define monitoring policies; these should be part of the overall flight path management policy.

Reasons why a monitoring policy should be defined by the operators in their specific operations:

- Monitoring is embedded in both technical and non-technical competencies. This is particularly relevant in the escalation phase (culminating, for example, in potential takeover of controls) where monitoring needs to be embedded in a sound and blame-free operational culture that allows unhindered monitoring and acting.
- Operator specific monitoring techniques might be included to address specific cultural aspects of the nationalities that make up the operators flight crew group.
- Flight monitoring tasks need to be integrated within assigned and functional duties. Regulators and operators assign specific roles and responsibilities to Captains, First Officers, and other flight crew members. Furthermore, additional roles, responsibilities, and tasks are assigned to the PF, PM, and other flight crew on the flight deck. All of these roles and responsibilities need to be fully integrated and compatible within the flight deck culture to allow effective monitoring and intervention (when required).

### 4.1 Operators Monitoring Policy

As monitoring is vital to maintain safety of flight, it is of utmost importance that operators define in their operation manual an overarching policy providing guidance on the monitoring process, monitoring tasks, assigned flight crew monitoring duties, crew communications, and SOPs related to monitoring. Additionally, the operator's flight crew training or flight crew techniques manual should describe in detail effective monitoring training, including observable behaviors, briefings/debriefings, and expected performance.

The operator should mandate that the Flight Standards Department coordinates coordinate the review or the design of the monitoring policy with the training department and the fleet(s) technical department. In order to reduce confusion or conflict between SOPs, the operator's Flight Standards Department should ensure that the monitoring policy and procedures remain consistent with other subjects already included in the operation manual. This coordination should ensure consistency between the operator's monitoring policy and the:

- Operator Flight Path Management Policy, which for example includes the use of automation, manual flight operations, communication, etc.
- Operator policy concerning briefings, de-briefings, etc.
- SOPs described in FCOM and FCTM (based on OEM documentation)
- Threat and Error Management (TEM) / Crew Resource Management (CRM), and
- Operator training policy

Operational and training data should also be collected and used to revise definitions of flight crew member roles and responsibilities to ensure their effectiveness. The goal is for an operator to have a global and consistent approach for monitoring issues and to ensure that the SOPs do not conflict with each other.

### 4.2 Suggested Content for an Operator's Monitoring Policy

The operator monitoring policy should describe monitoring duties and responsibilities of all flight crew members with assigned duties on the flight deck, which includes pilots, flight engineers, relief pilots, safety observers and check airmen.

As an example, the following could be used in a monitoring policy:

*Monitoring is the observation and the understanding of all elements related to the flight path, the airplane systems, the operational context and the crew. Monitoring is to be actively performed by all flight crew members and is independent from their functional roles (Captain, F/O, PF, PM, Observer, etc.).*

*Flight crew members should seek information and observe, anticipate, communicate and if necessary intervene in the event of a deviation between an intended and the observed situation.*

*Intervention (information, suggestion and direct action) can be an inherent outcome of the monitoring process. Escalation should not be constricted by functional ranks, seniority or other psychological restraints and is evidence of a sound operational culture and good airmanship.*

An operator's policy should specify that the flight crew's highest priority is to control the flight path of the aircraft whether using manual control or automation. As a consequence, operational policies and procedures should be reviewed or developed to ensure that the division of duties and responsibilities between flight crew members protects the ability of the PF to control the flight path. In addition, the operator's policy should also include the allocation of tasks between the PF and PM.

#### 4.2.1 Flight Crew Member Roles and Responsibilities

Operators' manuals should clearly define overall flight crew monitoring tasks. The operator's policy, procedures and monitoring responsibilities should be defined for both functional and assigned roles for all flight crew members (i.e., pilot in command (PIC), first officer, and other flight crew members assigned to the flight deck). The split of responsibilities and crew coordination techniques should also be included. See Attachments Section, Section 4 – Attachment 1, for an example of how to assign extra flight crew duties and responsibilities.

SOPs should be defined that assign specific tasks of the PF and the PM in general<sup>8</sup> and include monitoring duties as well. Assigning non-flight path-related tasks to the PF should generally be avoided, especially

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<sup>8</sup> See Attachments Section, Section 2 – Attachment 2: U.S. FAA Safety Alert for Operators (SAFO) 15011, which focuses on PF/PM duties each US operator should explicitly include in their monitoring policy.

during critical phases of flight. Please see Attachments Section, Section 4 – Attachment 2 for an example of a partial monitoring policy.

Operators' manuals should clearly address barriers to effective monitoring and explicitly address monitoring as part of a comprehensive flight path management policy that includes guidance on the use of automated systems and manual handling operations. Section 3 of the Flight Safety Foundation (FSF) document, "A Practical Guide for Improving Flight Path Monitoring", provides an excellent discussion on the barriers to effective monitoring<sup>9</sup>. Chapter 4 of the FSF guide provides recommendations to improve monitoring performance which are based on policies, procedures and practices currently in use in some organizations' flight operations.

The operator's policy and training should include specific language addressing transfer of Pilot Flying (PF) and Pilot Monitoring (PM) roles. The designated PF is responsible for flying the aircraft, in accordance with the operational brief, and for monitoring the flight path. The PM will have an explicit set of activities designated by the Standard Operating Procedures (SOPs), and as such will have a specific and primary role to monitor the aircraft's flight path, communications and the activities of the PF.

Flight crews are responsible for maintaining their own mental picture gained through monitoring and cross-checking each other's actions, communication of intent and diligent observation of the PF/PM selections, mode activations and aircraft responses.

Role reversal (changing roles) increases the risk for a monitoring error. The transfer of roles should be done positively with verbal assignment and verbal acceptance. It should also include a short brief of aircraft state from the PF to the PM. This reinforces and reconfirms the shared mental model of aircraft state between the pilots and allows the PM to ask questions. "Takeover" training that provides practical experience for Captain (and F/O) taking aircraft over during critical moments of flight should be provided. Please see Attachments Section, Section 4 – Attachment 4 for further discussion on takeover training.

An operator's policy and procedures should also include guidance on how flight crews deal with distractions; if an SOP distracts or conflicts with another SOP, or distracts from monitoring. Conducting a LOSA can help identify these conditions. It is also important to include and train practices for pilots to resume effective monitoring after distractions and interruptions, including during non-normal and emergency conditions.

Multi-crew cooperation involves the PM in the entire flight operation. During the decision making process he will seek information, generate options and analyze risks; he will support the PF in workload management by offering assistance, reviewing, monitoring and cross-checking and helping to recover from interruptions and distractions.

Additionally, the operator's policy should emphasize the cognitive resources needed to monitor and should state that monitoring must be adapted to the phase of flight. This implies highlighting the importance of situation awareness and workload management to support effective monitoring. The Flight Safety Foundation (FSF) document provides one example of how to manage cognitive resources by using the concept of Area of

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<sup>9</sup> Flight Safety Foundation 2014 Practical Guide for Improving Flight Path Management, Section 3

Vulnerability (AOV) for managing flight path deviation errors. For further information on AOV, please refer to the FSF document and see Attachments Section, Section 4 – Attachment 3 in this guide for an example of how one operator has implemented this concept.

### 4.2.2 Importance of Communication in General

Operators should promote and train proper crew communication procedures, which include:

- Monitoring responsibilities as part of crew briefing:
  - Brief non-routine items
  - Brief specific things for PM to monitor\*
  - Brief specific actions and callouts PF wants PM to do that are not routine
- Briefing PM on flight path plans
- Encouraging any flight crew member to call out any deviation from the briefed plan
- Briefing specifics about anticipated threats and mitigations
- Standardizing cockpit crew communication
- Challenging and acknowledging monitoring actions

*\*The PF should clearly request in his briefings what he expects from the PM. If the PF leaves it up to the PM to decide what to monitor, then the PF accepts to only be backed up according to the PM's perception of the situation. The PM could also be the last person to intervene and initiate a go-around from an unstabilized approach (an undesired aircraft state).*

### 4.2.3 Communication and Intervention Strategy

The monitoring policy should include communication and intervention strategies for when the PM or other flight crew members observe any actual or impending aircraft or system deviation from the expected state. This communication and intervention strategy should take into account the magnitude of the deviation, the state of the aircraft or system and the available time to react.

The operator should consider including the communication and intervention strategy in the operation manual because of close commonality with technical announcements (call out), automation policy, and CRM and TEM training. If the operator's training includes the AOV concept, the operator should at least place intervention strategy in the training part of the operation manual in order to have a common and consistent reference for pilots, instructors, evaluators and training managers.

When expectation and observation are inconsistent, it is the duty of the PM to escalate this inconsistency in several steps:

- **Informing** (questioning) the other pilot on his own observation/concern
  - *This may require rephrasing and/or repeating*
- **Suggesting** alternative actions/solutions
- **Enforcing** alternative actions/solutions
  - *This stage maybe preceded by a commonly trained warning trigger (word or phrase)*
  - *This stage might require intervention*

An example of an operator policy for Pilot Monitoring intervention is shown in the Attachments Section, Section 4 – Attachment 5.

The monitoring outcome is considered satisfactory as long as any input, action or reaction of the other pilot matches the (cognitively built) mental picture and expectation of the crew.



# Section 5—Observable Behaviors for Monitoring

Accomplishment of monitoring is first of all an internal (cognitive) process which is in many cases not observable. To effectively train monitoring it is essential to identify objective criteria. Defining monitoring tasks and skills with associated observable behaviors\* can be considered an effective way to achieve this goal. The use of observable behaviors is the main focus in state of the art pilot training programs.

\*The term “observable behavior” used in this manual can be considered synonymous to “behavioral indicator” used in ICAO Doc 9995, Manual of Evidence-based Training.

Observable behaviors should encompass monitoring of general flight tasks as well as monitoring required in specific functional and assigned roles. Observable behaviors should be defined so they are easily understood, observable, and usable for measuring flight crew performance.

Observable behaviors should cover:

- Sharing your mental model
- Communicating any changes or intentions to the other pilot
- Actively monitoring actual state against expected state
- Spotting deviations
- Proposing solutions
- Ordering correction / intervening

Observable behaviors for monitoring should be defined for both PF and PM separately or as a crew.

## 5.1 Basic Elements of Monitoring for all Training Programs

The defined observable behaviors should be identical for any kind of operation and should be used to train and assess pilots in all training frameworks.

The purpose of monitoring is to support the effective use of countermeasures against threats, errors and undesired aircraft states.

Monitoring is embedded in all pilot competencies; it is not a pilot competency in itself. Monitoring is a fundamental component of each existing pilot competency and each competency is stimulated by effective monitoring.

This situation becomes clear when we look for example at Flight Path Management - automation, as a more technical competency. The observable behaviors are:

- Controls the aircraft using automation with accuracy and smoothness as appropriate to the situation
- Detects deviations from the desired aircraft trajectory and takes appropriate action

- Maintains the desired flight path during flight using automation whilst managing other tasks and distractions
- Selects appropriate level and mode of automation in a timely manner considering phase of flight and workload
- Effectively monitors automation, including engagement and automatic mode transitions

Looking at Situation Awareness, a more non-technical competency, observable behaviors are typical active monitoring activities and very useful to anticipate threats:

- Identifies and assesses accurately the state of the aircraft and its systems
- Identifies and assesses accurately the aircraft's vertical and lateral position, and its anticipated flight path
- Identifies and assesses accurately the general environment as it may affect the operation
- Keeps track of time and fuel
- Maintains awareness of the people involved in or affected by the operation and their capacity to perform as expected
- Anticipates accurately what could happen, plans and stays ahead of the situation
- Develops effective contingency plans based upon potential threats
- Identifies and manages threats to the safety of the aircraft and people
- Recognizes and effectively responds to indications of reduced situation awareness

Monitoring is also present in observable behaviors related to Application of Procedures, Communication, Leadership and Team Work, Problem Solving and Decision Making, Workload Management and Flight Path Management – manual control.

It is important that the operator identifies among the performance behaviors the ones that are especially related to monitoring. This should facilitate the design of the training program when reviewing the training needs and defining the training objectives. This is particularly true for line oriented evaluation and scenario-based training when monitoring activities are targeted with surprise effect, high workload management, etc.

Once an operator develops a set of observable behaviors based on its monitoring policy and procedures, the operator should incorporate the observable behaviors into its training and assessment program. Conducting a LOSA can be very effective to assess the effectiveness of the training.

## 5.2 Characteristics of Observable Behaviors for Monitoring

Observable behavior indicators serve, for the instructor and the trainee, as a benchmark (a reference) that describes the target of the training in a concise and unambiguous way. They must be clearly defined and observable by the trainer or evaluator. Definitions of observable behaviors should include examples of expected pilot performance.

Monitoring can be evaluated using the observable behaviors that should meet the required level of performance, as established by the operator for its specific operation. Not all behaviors can be observed all the time and it is important for the instructor/evaluator not to assume what is in the mind of the flight crew, this would not be “observable”. Just because a pilot looks at a certain system status page it does not mean that the pilot monitored all the parameters on the page.

### 5.3 Using Observable Behaviors for Monitoring in Training

Observable behaviors can serve to develop training programs. They can also serve as a tool for assessing performance and for debriefing.

In order to enhance the crew member’s comprehension, an operator should publish definitions and descriptions of a set of CRM and TEM skills categories that are foundational for flight crews to use during flight operations and training for that operator. As a minimum, published guidance should include the following:

- Associated skill
- Definition
- Description
- Observable behaviors
- Expected performance (how to demonstrate effectiveness)
- Effective strategies and tools, and
- Barriers to effectiveness

Each CRM and TEM skill is manifested through desirable observable behaviors to be practiced during training and employed during line operations. These observable behaviors, when employed effectively, enhance safe operations. Conversely, when CRM and TEM skills are not employed effectively, it can result in an error, an undesired aircraft state, and possibly an incident or accident.

Examples of observable behaviors could include, but are not limited to:

- Continuously shares information to self-correct
- Verbalizes developments (fuel, weather, ATC, aircraft status, etc.)
- Briefs anticipated threats and the required actions to prepare
- Asks relevant questions
- Monitors instruments, systems, weather communications, traffic
- Verifies “action – reaction” when moving switches and making inputs
- Coordinates and communicates inputs to automated systems
- Reports fatigue in self and other crew members
- Reports stress in self and other crew members

- Seeks a second opinion when instrument readings are ambiguous
- Assesses crew situation awareness
- Continuously checks system status and flight/taxi path
- Verifies paperwork
- Cross-checks charts
- Cross-checks FMC and MCP
- Alerts crew when “heads-down”
- Intervenes when flight guidance and aircraft actions conflict
- Clearly defines the monitoring role of each pilot
- Follows SOP regarding independent verification
- Checks system(s) status in context of current situation
- Plays an active role
- Maintains situation awareness, particularly regarding the tasks of other crew members
- Provides input to the tactical (short term) and strategic (long term) plan for the flight
- Performs monitoring tasks as defined by SOPs
- Monitors parameters not immediately apparent to other crew members
- Monitors activities of other crew members
- Provides back-up to the PF (ensures redundancy; PM takes over control when the PF does not respond to cues or fails to ensure safety)
- Makes call-outs of deviations from SOPs and/or limitations
- Monitors aircraft systems status according to published operating procedures
- Uses appropriate escalation of communication to resolve deviations identified by monitoring, to include active intervention if necessary
- Monitors and detects deviations from the desired aircraft trajectory and takes appropriate action
- Monitors and detects deviations from the desired aircraft energy state and takes appropriate action
- Maintains the desired flight path using manual or automated control systems
- Maintains the desired flight path using manual or automated guidance systems
- Monitors flight guidance systems including engagement and automatic mode transitions
- Monitors automated systems, including engagement and mode changes
- Monitors execution of decisions, reviews and adapts them if required

Observable behaviors may address monitoring as a primary focus, such as “monitors activities of other crew members” or may exist embedded in other behaviors as secondary elements, without mentioning the verb “monitors.” For example, the observable behavior “Maintains the desired flight path” also requires that the pilot “monitors” the flight path as a secondary element.

These CRM and TEM skills may be initially trained as a stand-alone course and then embedded throughout all training and line operations. Please refer to Attachments Section, Section 5 – Attachment 1, for an example of how one operator defines and uses the Monitor/Cross-Check skill and observable behaviors in CRM.

### 5.4 Using Observable Behaviors for Monitoring in EBT

Core competencies are used by operators using recurrent Evidence-Based Training (EBT). They are also used by some operators in other training programs.

A set of eight Core Competencies is described in both IATA guidance material and in ICAO documents Doc 9868, PANS-TRG and Doc 9995, Manual of Evidence-based Training. They are listed below in alphabetical order:

- Application of Procedures
- Communication
- Aircraft Flight Path Management, automation
- Aircraft Flight Path Management, manual control
- Leadership and Teamwork
- Problem Solving and Decision Making
- Situation Awareness
- Workload Management

Each core competency in Doc 9995 has a description and is associated with observable behavioral indicators.

Doc 9995 encourages operators to define their own set of competencies. In such a case operators would also adapt the associated observable behavioral indicators to their operational needs or to an existing and historically validated competency system<sup>10</sup>.

As mentioned before, monitoring resides in all competencies, regardless of the number of competencies used by the operator.

EBT is closely connected to TEM. Section 7 describes how monitoring is embedded in the TEM model.

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<sup>10</sup> ICAO Doc 9995 Paragraph 3.2 COMPETENCIES

## Section 6—How to Train and Apply Monitoring

Where the different types of training (CPL, MPL, ATPL, Type Rating and Recurrent) may involve a pilot with differing levels of competence, training of monitoring should include the same objectives and standards for all these different types of training. Therefore, because the same monitoring concepts apply to all pilots, this manual will not differentiate between different types of training courses.

A graduated approach should be taken in developing an integrated Pilot Monitoring Training Program. It should start with solid grounding in theoretical knowledge, followed by instructor-led case studies. This should include videos and finally LOFT training.

The purpose of this program is to progressively build on each layer. Developing the right attitude is the most important aspect of this training program. Monitoring requires motivation and discipline and has to be a continuous effort. The primary aim for the flight crew members should be to effectively monitor the flight path, but first, flight crews must be well trained in flying skills and discipline. Without these, effective monitoring may not be possible.

The basics:

### 1. Knowledge

Without proper knowledge of systems and automation, the flight crew will not be able to understand nor predict the aircraft's behavior.

### 2. Skill

Without the necessary skills to operate the aircraft effectively, a flight crew will be overwhelmed with the monitoring task.

### 3. Attitude / Discipline

Discipline is a foundation for monitoring. Adherence to division of duties is essential for managing workload.

## 6.1 Training Monitoring

Training monitoring knowledge, skills and attitudes for pilots should include:

1. Defining what monitoring is and training monitoring as a task:
  - Train the “monitoring process”.
  - Train how monitoring is integrated in all pilot skills and competencies.
  - Discuss how monitoring relates to TEM. (See Attachments Section, Section 6 – Attachment 1, for an example of how one operator uses the TEM model to train monitoring.)

- Discuss how monitoring relates to CRM. (Please refer to the Attachments Section, Section 6 – Attachment 2, for an example of how one operator trains monitoring from a CRM perspective.)
  - Discuss the differences between functional and assigned roles.
  - Discuss the differences between monitoring as a “task” and monitoring as a “role”.
2. Ensuring pilots are trained to possess the knowledge, skills, and attitudes to function as active monitors. Pilots need to be trained for what they should be looking for, verifying that something is working properly or that there is a problem. For example, pilots should have the ability to proficiently:
    - Predict flight mode progression
    - Plan and verbalize intentions regarding the use of automation to another crew member
    - Access, anticipate, and analyze all FMS data
    - Access and analyze information tools (e.g., ACARS, EFB, CPDLC, etc.)
  3. Defining what monitoring is and training specific monitoring tasks for Pilot Flying (PF) and Pilot Monitoring (PM) positions:
    - Develop monitoring qualification standards for training programs
    - Integrate Flight Path Management (FPM) training into type rating and recurrent training
    - Incorporate Areas of Vulnerability (AOV) into flight training, defined by phase of flight
    - Define appropriate monitoring “sample rate” for each AOV and reinforce with scenario-based training
  4. Ensuring desired monitoring skills are blended into standard operating procedures (SOPs) (e.g., verbalizing FMA changes) and identifying any SOPs that possibly hinder effective flight path monitoring (e.g., eliminating unnecessary talking during critical phases of flight).
  5. Developing and defining PM tasks and creating specific training/learning objectives and proficiency standards to be incorporated into the training syllabus. This will be necessary for instructors to train and evaluate monitoring performance. Please see Attachments Section, Section 6 – Attachment 3, for an example of a training syllabus for PM skills only.
  6. Operators to consider intervention training and the appropriate skill development for taking over and swapping PF and PM roles. Please see Attachments Section, Section 6 – Attachments 4, 5, 6 and 7 for one operator’s intervention strategy and simulator training scenarios for intervention training.
  7. Ensuring flight path monitoring skills are emphasized and incorporated from the initial stages of training through type-rating, and then continually emphasized during recurrent training and line operations.
    - Identify different means for training flight path monitoring at different phases of training (e.g., computer-based training, desktop training, fixed-based simulator, full flight simulator). For example, learning about AOV during ground training and practicing/applying during scenario-based training in the flight training phase.
    - Create training scenarios that introduce system failures to condition a level of skepticism and encourage maintaining a higher level of awareness.
    - Validate/evaluate monitoring KSAs and observable behaviors during all phases of training. (This will improve instructors’ knowledge and experience to better teach and evaluate monitoring.)

8. Improving FSTD (Simulator) Instructor and Line Check Pilot (Flight Standards) training to enhance their ability to train/evaluate flight path monitoring skills.
  - Increase the level of training instructors/evaluators receive in training pilot monitoring skills. This training should be incorporated into instructor/evaluator annual training.
  - Importance of training/evaluating EFPM must be emphasized to instructors.
  - Develop monitoring qualification standards for AQP, ATQP training programs to give instructors definitive guidelines for expected pilot performance. Failure to make one call out should not rise to the level of severity that actually violating an assigned altitude may. See Section 9 for evaluating monitoring.
9. Emphasizing monitoring tasks and procedures throughout a pilot's entire training and line operations. If a flight crew member's monitoring tasks and procedures are not continuously emphasized, the natural assumption of a flight crew member would be that they are not considered as important as other tasks/skills/SOPs. Instructors/evaluators must emphasize to pilots that monitoring skills/compliance is just as important as any other task they are trained in.
10. Including flight path monitoring elements in all briefings and debriefings (e.g., considering energy management, expected configuration, specific stabilized approach criteria to monitor and expected action of the PM, and what the expected FMA changes will be when briefing a non-ILS approach).
11. Developing special purpose operational training (SPOTs) or event sets to be administered during recurrent training that emphasize effective monitoring as a task, flight path monitoring, PM monitoring tasks and SOPs, etc.
  - Identify specific monitoring skills and observable behaviors to focus on, instead of training to a broader scope
  - Specific training scenarios should be designed to emphasize certain monitoring knowledge and skills
12. Developing interactive distance learning modules dedicated to teaching enhanced monitoring skills using scenario-based training and making them available for flight crew members to review.
13. Developing Verbal Communication Skill Training (please see Attachments Section, Section 6 – Attachment 8 for an example) as part of augmenting flight crew member CRM skills.
14. ***Lack of manual flying in training and line operations also means lack of exposure to monitoring of hand flown approaches.*** Additional training to improve manual flying skills also creates an opportunity to train predictive monitoring of the PM. Please see Attachments Section, Section 6 – Attachment 9 for an example of how one operator trains predictive monitoring during hand-flown approaches.
15. Operators to consider providing "Takeover training" to help prevent the situation where both pilots end up acting as PF while monitoring is overlooked. This can easily happen when one pilot takes over control of the aircraft from the other during critical moments and the PF fails to switch to the PM role. Please see Attachments Section, Section 4 – Attachment 4, for an example of how one operator implements practical "Takeover Training" for its flight crew.

Please see Attachments Section, Section 6 – Attachment 10 for an example syllabus used by one operator to train monitoring.



# Section 7—TEM and Monitoring

## 7.1 Monitoring Drives Threat and Error Management (TEM)

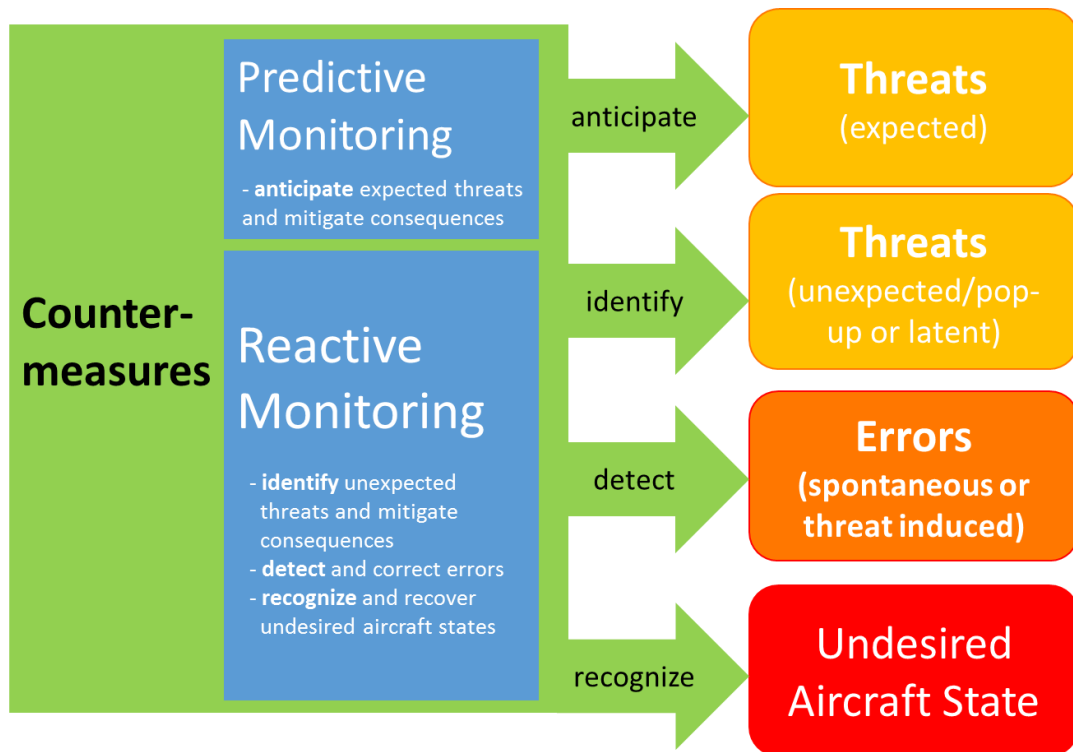
An increasing number of operators, training organizations and OEMs are using TEM as the main overarching safety concept for both, their operations and training. The essential strength of TEM is to put flight crew activities into the context of normal and abnormal operations. TEM answers the question “why” proactive and reactive crew interventions are essential for safe operations.

The “ever present rain of threats and errors” challenges flight crews to continuously deploy countermeasures in order to maintain sufficient safety margins during all phases of flight.

Obviously, recognition and management of threats, errors and undesired aircraft states would not be possible without monitoring. Monitoring is, therefore, a key enabler for TEM; it is inherent to countermeasures.

**Table 1** shows how monitoring is embedded in the TEM model.

**Table 1. Monitoring resides in TEM-Countermeasures**



Monitoring enables flight crews to manage threats, errors and undesired aircraft states.

## 7.2 Monitoring Stimulates TEM Countermeasures

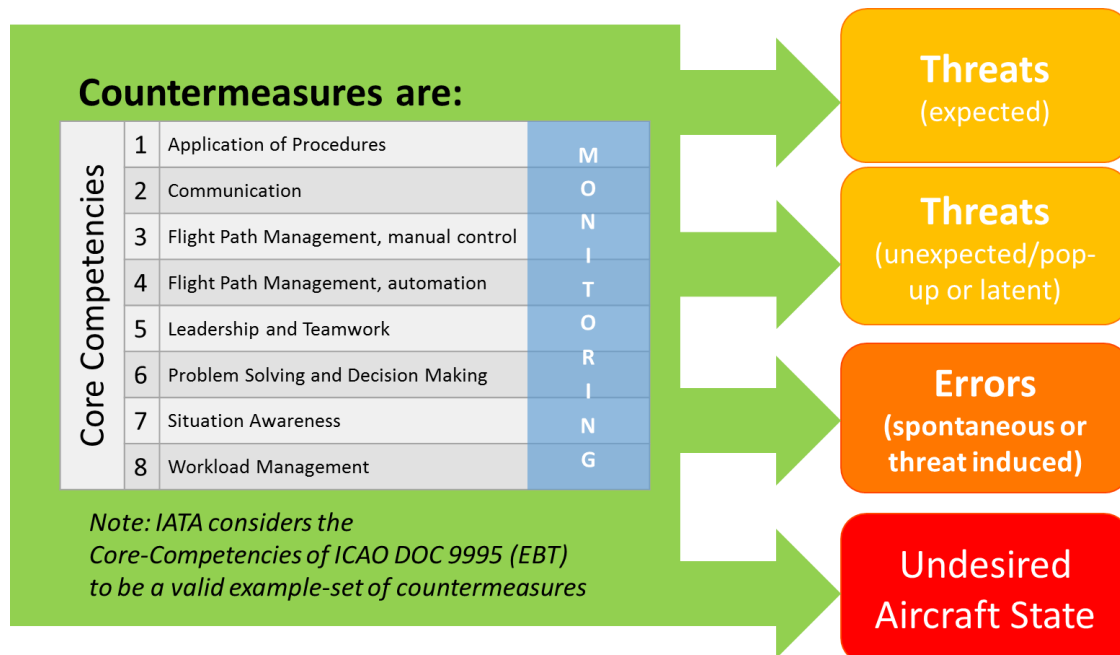
Monitoring stimulates a continuous interaction (verbal or non-verbal) between flight crew members and between the flight crew and the environment. This dialogue facilitates the application of TEM countermeasures which eventually will enhance TEM performance.

Threat and Error Management is not possible without monitoring. In the following statement, James Klinect from the LOSA Collaborative links the importance of monitoring in flight safety to TEM<sup>11</sup>:

*“Line operations safety audits (LOSA) data show that flight crews rated “poor” or “marginal” in monitoring and cross-checking had three times more mismanaged errors than crews rated “good” or “outstanding.” In this light, monitoring can be considered a core defense that flight crews use to enhance their threat and error management (TEM) performance”.*

**Table 2** shows how monitoring is embedded in the 8 Core Competencies, which serve as countermeasures against threats, errors and undesired aircraft states.

**Table 2. Competencies (with embedded monitoring) are Countermeasures**



Successful TEM is, therefore, directly related to the competencies as countermeasures.

The following paragraph shows a state-of-the-art set of countermeasures, collaboratively developed by an international working group comprised of civil aviation authorities, academic institutions, aircraft original

<sup>11</sup> Flight Safety Foundation, *Practical Guide for Improving Flight Path Management*, 2014

equipment manufacturers, airlines, international organizations, pilot representative bodies and training organizations.

### **7.3 State-of-the-Art TEM Countermeasures**

During the last decades industry and regulators have made significant progress in identifying the essences of professional flight crew “work”.

From the broad term “airmanship”, via more advanced systems like “NOTECHS”, the worldwide collaborative effort has evolved to the concept of pilots competencies in ICAO Doc 9995 “Manual of Evidence-based Training (EBT)”.

Doc 9995 stipulates an agreed set of eight pilot “Core Competencies”, which can be used by operators to describe and measure pilot performance in recurrent training; using core competencies for all other areas of pilot training would be a logical way forward because harmonized measuring criteria would enable global evaluation and innovation in safety management.

For a modern TEM model the core competencies constitute today’s state-of-the-art enhanced countermeasures.

The IATA Pilot Training Task Force considers that core competencies are a valid example set of enhanced flight crew countermeasures in a TEM model.

Each core competency should be well defined by a description and by behavioral indicators. To highlight monitoring within certain competencies, this manual suggests including additional behavioral indicators that are specific to the monitoring tasks.

**Table 3** shows an adapted set of core competencies, based on the example of Appendix 1 in ICAO Doc 9995, Manual of EBT, with descriptions and behavioral indicators (BIs):

- Behavioral indicators that have a primary focus on monitoring are in *italic* letters
- Adaptions to Doc 9995 that were considered to enhance training and assessing monitoring are in **bold letters**

**Note:** In most of the existing behavioral indicators (shown in the table in normal letters) monitoring is embedded as integral secondary element (e.g., the behavioral indicator “Contains the aircraft within the normal flight envelope” also requires that the pilot monitors the flight envelope).

Table 3.

Core Competency	Competency Description	Behavioral indicator
<p><b>Application of Procedures</b></p>	<p>Identifies and applies procedures in accordance with published operating instructions and applicable regulations, using the appropriate knowledge.</p>	<p>Identifies the source of operating instructions</p> <p>Follows SOPs unless a higher degree of safety dictates an appropriate deviation</p> <p>Identifies and follows all operating instructions in a timely manner</p> <p><i>Correctly operates aircraft systems and associated equipment</i></p> <p><b>Monitors aircraft systems status according to published operating instructions</b></p> <p>Complies with applicable regulations</p> <p>Applies relevant procedural knowledge</p>
<p><b>Communication</b></p>	<p>Demonstrates effective oral, non-verbal and written communications, in normal and non-normal situations.</p>	<p><i>Ensures the recipient is ready and able to receive the information</i></p> <p><i>Selects appropriately what, when, how and with whom to communicate</i></p> <p><i>Conveys messages clearly, accurately and concisely</i></p> <p><i>Confirms that the recipient correctly understands important information</i></p> <p><i>Listens actively and demonstrates understanding when receiving information</i></p> <p>Asks relevant and effective questions</p> <p><b>Uses appropriate escalation of communication to resolve deviations identified by monitoring</b></p> <p>Adheres to standard radiotelephone phraseology and procedures</p> <p>Accurately reads and interprets required company and flight documentation</p> <p>Accurately reads, interprets, constructs and responds to datalink messages in English</p> <p>Completes accurate reports as required by operating procedures</p> <p><i>Correctly interprets non-verbal communication</i></p> <p>Uses eye contact, body movement and gestures that are consistent with and support verbal messages</p>

Core Competency	Competency Description	Behavioral indicator
<b>Aircraft Flight Path Management, automation</b>	Controls the aircraft flight path through automation, including appropriate use of flight management system(s) and guidance.	<p>Controls the aircraft using automation with accuracy and smoothness as appropriate to the situation</p> <p><b>Monitors and detects deviations from the desired aircraft trajectory and takes appropriate action</b></p> <p><i>Contains the aircraft within the normal flight envelope</i></p> <p><i>Manages the flight path to achieve optimum operational performance</i></p> <p><i>Maintains the desired flight path during flight using automation whilst <b>monitoring and managing other tasks and distractions</b></i></p> <p><i>Selects appropriate level and mode of automation in a timely manner considering phase of flight and workload</i></p> <p><i>Effectively monitors automation, including engagement and automatic mode transitions</i></p>
<b>Aircraft Flight Path Management, manual control</b>	Controls the aircraft flight path through manual flight, including appropriate use of flight management system(s) and flight guidance systems.	<p>Controls the aircraft manually with accuracy and smoothness as appropriate to the situation</p> <p><b>Monitors and detects deviations from the desired aircraft trajectory and takes appropriate action</b></p> <p><i>Contains the aircraft within the normal flight envelope</i></p> <p><i>Controls the aircraft safely using only the relationship between aircraft attitude, speed and thrust</i></p> <p><i>Manages the flight path to achieve optimum operational performance</i></p> <p><b>Maintains the desired flight path during manual flight whilst monitoring and managing other tasks and distractions</b></p> <p><i>Selects appropriate level and mode of flight guidance systems in a timely manner considering phase of flight and workload</i></p> <p><i>Effectively monitors flight guidance systems including engagement and automatic mode transitions</i></p>
<b>Leadership and Teamwork</b>	Demonstrates effective leadership and team working.	<p>Understands and agrees with the crew's roles and objectives.</p> <p>Creates an atmosphere of open communication and encourages team participation</p> <p><i>Uses initiative and gives directions when required</i></p> <p>Admits mistakes and takes responsibility</p>

Core Competency	Competency Description	Behavioral indicator
		<p><i>Anticipates and responds appropriately to other crew members' needs</i></p> <p>Carries out instructions when directed</p> <p>Communicates relevant concerns and intentions</p> <p>Gives and receives feedback constructively</p> <p>Confidently intervenes when important for safety  <b>resolving deviations identified whilst monitoring using an escalation of communication.</b></p> <p>Demonstrates empathy and shows respect and tolerance for other people 1</p> <p><i>Engages others in planning and allocates activities fairly and appropriately according to abilities</i></p> <p>Addresses and resolves conflicts and disagreements in a constructive manner</p> <p>Projects self-control in all situations</p>
<p><b>Problem Solving and Decision Making</b></p>	<p>Accurately identifies risks and resolves problems. Uses the appropriate decision-making processes.</p>	<p><i>Seeks accurate and adequate information from appropriate sources</i></p> <p><i>Identifies and verifies what and why things have gone wrong</i></p> <p>Employ(s) proper problem-solving strategies</p> <p>Perseveres in working through problems without reducing safety</p> <p>Uses appropriate and timely decision-making processes</p> <p>Sets priorities appropriately</p> <p><i>Identifies and considers options effectively.</i></p> <p><b>Monitors execution of decisions, reviews and adapts them if required</b></p> <p>Identifies and manages risks effectively</p> <p>Improvises when faced with unforeseeable circumstances to achieve the safest outcome</p>
<p><b>Situation Awareness</b></p>	<p><b>Monitors</b>, perceives and comprehends all of the relevant information available and anticipates what could happen that may affect the operation.</p>	<p><b>Monitors</b>, identifies and assesses accurately the state of the aircraft and its systems</p> <p><b>Monitors</b>, identifies and assesses accurately the aircraft's vertical and lateral position, and its anticipated flight path.</p> <p><b>Monitors</b>, identifies and assesses accurately the</p>

Core Competency	Competency Description	Behavioral indicator
		<p>general environment as it may affect the operation</p> <p><i>Keeps track of time and fuel</i></p> <p><i>Maintains awareness of the people involved in or affected by the operation and their capacity to perform as expected</i></p> <p>Anticipates accurately what could happen, plans and stays ahead of the situation</p> <p>Develops effective contingency plans based upon potential threats</p> <p>Identifies and manages threats to the safety of the aircraft and people</p> <p>Recognizes and effectively responds to indications of reduced situation awareness</p>
<p><b>Workload Management</b></p>	<p>Manages available resources efficiently to prioritize and perform tasks in a timely manner under all circumstances.</p>	<p>Maintains self-control in all situations</p> <p><i>Plans, prioritizes and schedules tasks effectively</i></p> <p><i>Manages time efficiently when carrying out tasks</i></p> <p>Offers and accepts assistance, delegates when necessary and asks for help early</p> <p><b>Monitors, reviews</b> and cross-checks actions conscientiously</p> <p><i>Verifies that tasks are completed to the expected outcome</i></p> <p>Manages and recovers from interruptions, distractions, variations and failures effectively</p>

Competencies and behavioral indicators have become the main focus in state-of-the-art pilot training concepts; not only for operators applying Evidence-Based Training programs but also for those who use other training programs.

**Note:** Using a harmonized set of core competencies from ICAO Doc 9995 does not necessarily require the implementation of competency-based training. Operators running classic (task-based) training systems may also use the core competencies to describe and measure pilot performance. They may also use them as training objectives. This would synchronize their existing training design with modern TEM and prepare access to possible future global data collection.

In summary, using the ICAO set of competencies as an example, we see that monitoring is not a separate (additional) competency; it is embedded in each of the eight ICAO competencies. Please see Attachments Section, Section 7 – Attachment 1 for an operator’s example.

## 7.4 Assessing and Grading Monitoring through Behavioral Indicators

### 7.4.1 Assessment

Performance of flight crews could be measured by assessing their core competencies. By observing the associated behavioral indicators (BIs) flight crews, instructors and examiners can measure the achieved level of performance.

BIs can be taken from ICAO Doc 9995 but may also be adapted by the operator to reflect specific conditions of its operations. BIs must consist of clearly observable performance criteria. When defined thoroughly they serve as the standard (benchmark) for the specific competency.

With regard to monitoring, the performance of flight crews is assessed by observing those BIs that are related to monitoring. PF and PM may be assessed separately or as a crew.

### 7.4.2 Grading

Grading describes and records the achieved level of performance of a flight crew in a certain competency. Operators may use various grading scales to grade the overall competency or specifically the monitoring part. It is desirable to place special emphasis on monitoring because good or poor monitoring will have a direct influence on the overall performance in the assessed competency.

(Please see Attachments Section, Section 7 – Attachment 2, for examples of grading systems.)

## 7.5 Including Monitoring in Existing Training Programs

TEM-centered training focuses on the pilot core competencies and their associated BIs, which include monitoring. Training events are used to enable and develop the competencies.

Line-oriented flight scenarios with selected threats are suitable to train monitoring as an element of flight crew response to expected or unexpected and latent threats.

*Predictive monitoring* (expected threats) and *reactive monitoring* (unexpected/pop-up and latent threats) are needed to manage threats in a safe, effective and efficient way. Typical examples are threats resulting from dispatch, weather, crew, technical, etc., challenges.

The required exercises for conversion or recurrent training and checking are suitable to train *Reactive Monitoring*. *Reactive Monitoring* focuses on error detection and correction and on recognition and recovery of undesired aircraft states. Typical examples are common flight crew errors during normal and abnormal situations in flight and resulting undesired aircraft states.



Training design should also include appropriate instructor education. To ensure the desired training outcome, instructors need to fully understand the philosophy of integrating monitoring in the TEM model. Instructors should be familiar with the human factor limitations (vulnerabilities and stressors) which can hamper flight crew performance, and with systemic and organizational barriers to effective monitoring. Instructors should be able to identify these factors and their possible cascading effects and convey them to their flight crews under training.

Typical examples are:

- complacency/inattention, distraction, low attentional resource, low arousal, time pressure, disorientation, tiredness as well as incapacitation, time pressure, stress response (startle and surprise) confirmation bias and fatigue, inadequate mental models, lack of feedback when monitoring lapses, and
- flight deck design, SOPs, corporate climate

# Section 8—Guidelines for Instructors in Licensing Training

## 8.1 Train the Trainer

An instructor should have appropriate qualification and experience though the extent should vary by stages of training. Instructors involved in licensing training (CPL, MPL, ATPL type rating endorsement and recurrent training) should have sufficient competency to instruct monitoring in a single and/or multi-crew environment.

All instructors should also be trained in the art of coaching. While not all instructors can be expected to be good coaches, they should understand how coaching is different from instructing. Coaching requires a non-punitive environment; the coach is there to help the trainee perform better.

Ideally, all instructors should have sufficient experience in multi-crew operations, though it can be significantly difficult at times to find such instructors for licensing training. In this case, an appropriate induction syllabus can be planned, as stipulated in Section 6.1.2.7 in ICAO PANS-TRG Doc 9868<sup>12</sup>.

These induction syllabuses should include:

- Understanding how to train and assess CRM and TEM
- Understanding the theory of monitoring
- Understanding how to train and assess effective monitoring
- Effective scan policy
- Operator's monitoring policy
- Operator's flight path management policy
- Familiarization to multi-crew cooperation and SOPs
- Observations of multi-crew training and/or airline operation

When building a training program for instructors and evaluators, operators should keep in mind the development process of the trainees, as described in the remainder of this section.

## 8.2 Developing Fundamental Attributes of Monitoring

In the early phase of their career pilots need to develop the underpinning attributes of monitoring. Active monitoring requires a fundamental understanding of flying and the environment. Core flying skills in a single

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<sup>12</sup> ICAO PANS-TRG, (Doc 9868), Procedures for Air Navigation Services – Training

pilot aircraft, including manual handling in visual, night and instrument flying conditions are indispensable; the associated monitoring skills must be acquired irrespective of the fact that the pilot will spend most of his career in airline operations where monitoring in the multi-crew environment will be normality.

Before being trained as PM, the trainee should be introduced to the theory of monitoring, observable behaviors for monitoring, the factors that hamper monitoring, and the ideal practices of monitoring. It can be hard to find instructors qualified in monitoring theory for this stage who have the appropriate multi-crew experience; this should be taken into consideration when developing the training materials.

Once the fundamentals of monitoring are learned and properly demonstrated, the trainee is ready to be trained for assigned roles and procedures as PM in a multi-crew aircraft.

### **8.3 Have the Trainee Learn Mental Model First**

The practical training program should be preceded by theoretical education where the trainee develops an understanding of the underlying knowledge and develops the skills for monitoring tasks required for flying single and multi-crew airplanes. The instructional method for training monitoring can be different from that of flying. The traditional “Demonstrate-Direct-Monitor” methodology does not always effectively work as the sole means in instructing monitoring. Besides observing a good demonstration by the instructor, the trainee needs to establish and practice developing mental models for the monitoring process through different methods, in different contexts and flight scenarios. The trainee needs to understand the monitoring process, along with the cognitive and mental processes involved, before learning how to apply monitoring in the PM role.

It would be ideal for the trainee to have some back-seat observation rides on line operation, or equivalent LOFT simulator sessions. This will allow the trainee to observe monitoring during an actual flight in order to build mental pictures of effective monitoring. Once the trainee has a good foundation of knowledge and monitoring basics, he should practice monitoring in the simulator and in flight training. In addition to the back-seat observation rides, it is important to provide the trainee with training materials that include videos of flight operations that demonstrate different examples of monitoring performance.

### **8.4 Good Pre/Post Session Briefing is a Key Element**

In the FSTD lesson, preflight and post flight briefings provide an opportunity for monitoring instruction. In the early stage of the training program, the trainee will face task management difficulties between the procedural tasks and the monitoring tasks. The instructor should help the trainee identify where those tasks saturation could occur during the lesson, and have the trainee plan and prepare during the preflight briefing.

If the video recording/playback function is installed on the training device, it can be useful for the instructor to review how the pilot’s monitoring performance was during the training session. A safety culture that includes self-debriefing and crew-debriefing tools (that can be used to debrief monitoring) for each flight and training session can also aid in debriefing monitoring and self-improvement.

## 8.5 Multi-Crew SOP

When training for a multi-crew airplane, besides normal monitoring tasks, additional monitoring tasks and procedures will be defined for assigned roles in a multi-crew cockpit, such as PF and PM. It is important to discuss and train the differences between single-pilot and multi-pilot monitoring tasks, as well as the complexity and CRM aspects required for effective crew monitoring.

In early lessons, the focus should be placed on SOP callouts and procedures. The instructor should carefully observe any omission of callouts or monitoring lapses, and facilitate the review of the lesson in post flight briefing. SOPs should include standard callouts, FMA calls, cross verification of AFDS inputs, scan policy, briefing, etc. The trainee will learn to follow procedures for those practices as the first step in monitoring.

For omission of calls, determine whether it was due to task saturation, poor prioritization or mere inattention. Any deviation in procedural wording of callouts should be corrected. The reason for the callout should be emphasized in order for the trainee to understand its importance and to ensure that next time he will put more attention resources on it.

**Note:** If multi-crew flying is introduced too early, such as before a pilot is proficient with instrument flying, there can be negative effects on the trainee's piloting and monitoring skills. For example, it would not be practical to enforce the PM to make all required deviation calls before the instrument flying skills of the PF have been consolidated; otherwise it could interfere with the learning process of the PF. This would result in negative training for the PM and possibly develop bad habits because the PM is being required to intentionally deviate from monitoring SOPs, including assigned duties, callouts, intervention, etc.

## 8.6 Deviation Calls and Procedural Deviations

As the trainee becomes familiar with multi-crew flying, training should gradually focus on deviation calls and assertion of procedural deviation by the PF. A deviation call requires active aircraft monitoring skills as well as intervention skills. This kind of procedural intervention is mechanical and ideal as first point of introduction to intervention.

Assertion of procedural deviation requires a more advanced skill set. Simple omissions or skips are easier to catch; detecting deviation from plan requires a common understanding of the plan, which should have been established through a good departure/approach briefing.

The instructor will observe and note any procedural deviation and discuss the PM's response. If there was a misunderstanding of situation and/or plan between crew, the instructor will encourage the trainees to discuss how it could have been prevented through briefing and concise and clear intra-cockpit communication.

## **8.7 Allow Time for Monitoring Skills to be Mature**

These early steps will give opportunities for the trainees to develop their monitoring skills and experience where monitoring degrades. Through trial and error their monitoring skills will slowly mature. As training progresses, the trainee will be introduced to problem-solving situations in scenario-based sessions where PF and PM collaboratively manage workload with appropriate prioritization of tasks. Those processes should be observed closely by the instructor, who should facilitate a discussion in post session briefing on how the flight crew could have managed the situation without degrading the monitoring.

## **8.8 Monitoring Requires Communication Skill**

As the trainee's fundamental skill set develops, he will become capable of accommodating active/mutual monitoring skills that require intra cockpit communication. Scenario-based training sessions in the FSTD are best suited for this type of training. Through scenario-based training, including abnormal/emergency handling or real Instrument Flight Rules (IFR) flight, the trainees will most likely face factors that hamper monitoring. The instructor should note the observation and discuss what caused the degradation of the monitoring and how it could have been prevented.

## **8.9 Subtle Failure**

Once the trainee has developed basic monitoring skills, introduction of subtle failures will serve as an ideal opportunity to further develop monitoring skills under increased workload and non-normal situations. Theoretical aspects like task/workload management or Areas of Vulnerability (AOV) should be revisited during this training.

## **8.10 Intervention in Real-life Situation**

When the trainee receives training in line operation and is performing the role of PM, the trainee is expected to intervene when appropriate with a PF who has far more experience and is most likely the instructor/evaluator of the trainee. This situation, with possibly different authority gradient, can create obstacles for the trainee, impeding him from intervening and speaking up for any deviation or omission flown by a more experienced pilot. In order to provide learning opportunities and prepare the trainee for real-life intervention during actual line operations, it is important to provide in-seat-instruction sessions in an FSTD where intervention strategies and actual interventions can be practiced in real-line scenarios with a far more experienced pilot performing the role of the PF. Please see Attachments Section, Section 6 – Attachments 4, 5, 6 and 7 for one operator's intervention strategy and simulator training scenarios for intervention strategy.

### 8.11 Develop Predictive Monitoring in IOE

Predictive monitoring requires a profound understanding of line flight operations, which can take years to develop. IOE training serves as the baseline for the development of this monitoring skill which the young pilot will continue to develop through his entire career.

Should the flight be scheduled with a jump-seat safety observer, the instructor should use any leg the safety observer flies in a control seat as a chance to provide a good training opportunity of effective monitoring. The instructor might have the trainee note any positive behavior in monitoring and discuss it with the other flight crew members in post flight briefing.

The development of monitoring skills should be continued throughout the flight crews' career. They must be instructed from the very early stages of training and revisited often throughout the crew member's career.

# Section 9—Evaluating Monitoring

## 9.1 Strategies for Evaluating Monitoring

Evaluating monitoring is challenging because some of the monitoring processes reside in the mind; they cannot be observed and are difficult to measure. Additionally, monitoring is not a stand-alone task; it is integrated in all the pilot competencies.

Currently there is no specific cognitive task analysis tool available to evaluate monitoring in aviation training. However, effortful and carefully designed training scenarios allow structured observation of the flight crew's monitoring skills. When measuring their monitoring performance, instructors and evaluators should stick to the operator's defined observable behaviors and monitoring policy. Evaluation and grading of monitoring can then be achieved by comparing the observed level of performance with the targeted values of the operator.

Deficiencies in monitoring may be observed by the operational outcome. The TEM model serves very well for instructors and evaluators to capture and analyze such deficiencies. Threats that remain unidentified, errors that are not detected and undesired aircraft states that are not recognized may be tracked back to insufficient monitoring. Suboptimal threat management, error correction and recovery of the undesired aircraft states may also be caused by monitoring failures.

To add training value for the flight crew, instructors and evaluators should properly identify the root causes of monitoring failures. Helping to identify the barriers that hampered monitoring will enable the flight crew to understand "why" the failure occurred and facilitate learning.

Evaluation of monitoring should also take into account that each flight crew member will develop his own "style" of monitoring by defining monitoring goals, prioritizing what, when, how and how often to monitor and how to manage vigilance.

To help learning, an operator should provide a safety culture that includes self-debriefing and crew-debriefing tools for each flight and training session. These debriefing tools should include discussing observed behaviors and the cognitive process of the flight crew.

Operators should have a remedial training program for monitoring deficiencies.

## 9.2 Scenario Design Helps Debriefing

Based on the desired training outcomes, an operator can include specific monitoring events in the training and evaluation and use a debriefing strategy to reinforce and evaluate monitoring. The syllabus should integrate the operators SOPs for monitoring with the SOPs for flight path management and CRM and TEM, with focus on predictive and reactive monitoring, anticipation and identification of threats, detection and correction of errors and recognition and recovery of undesired aircraft states.

Scenarios should be designed around effective monitoring in a complex/dynamic environment. Consideration should be given to how and when information will be presented to the flight crew and in what form (i.e., aural, visual, color coded or a pre-flight text). Other things to clearly define and take into account when designing the monitoring syllabus include common and possible conditions that can lead to monitoring lapses and available tools and strategies (i.e., CRM skills, SOPs, etc.) that can help flight crew cope with possible monitoring weaknesses.

Properly designed scenarios that include monitoring challenges provide opportunities for the instructor/evaluator to observe and debrief a crew on their monitoring effectiveness as individuals and as a crew. The conduct of the debriefing in regards to monitoring issues should be based on a significant event(s). After selecting an event, such as an undesired aircraft state involving monitoring issues, the instructor should have the pilot speak about this event.

Line oriented evaluation is useful to evaluate predictive monitoring. Introducing threats (such as weather, technical deviation and dispatch) in the flight preparation papers should allow the instructor/evaluator to assess the crew's ability to identify major threats in the flight profile at this stage. In this situation, monitoring activities will be centered on planning and reviewing countermeasures such as planning, inquiring, briefings, and contingency management of the potentials threats. A typical example is the management of a bad weather situation, which should be identified during flight preparation.

For pop-up threats, the flight crew should identify the pop-up threat in a timely manner and the monitoring will focus on reviewing and modifying countermeasures such as evaluation of plans.

Simple training and evaluation exercises are useful to assess reactive monitoring because error detection is centered on execution of countermeasures such as cross-check, use of checklist, announcement, corrections, take over, etc. A common example of this is the unsuccessful localizer engagement scenario during ILS approach. The instructor will observe the flight crew member's behavior during the event to evaluate their monitoring skills. The CAA paper provides many similar technical failure scenarios to train and assess reactive monitoring. Each operator shall check the suitability of the FSTD to deliver specific realistic line-oriented scenarios.

### 9.3 Evaluation Using Observable Behaviors

Observed behavior followed up by facilitated discussion to bring out the contributing factors of the behavior is critical for success.
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Observable behaviors serve as a debriefing tool for monitoring performance. As discussed in Section 5, it is important that the operator identifies among the behaviors the ones that are related to monitoring. This makes it easier for the crew member and instructor/evaluator to evaluate and facilitate the debriefing of the monitoring abilities of the PF, PM, and flight crew. This is particularly true for line oriented evaluation and scenario-based training when monitoring activities are targeted with surprise effect, high workload management, etc.



The evaluation should focus on the monitoring process and pilot performance based on observable behaviors. Remember that observable behaviors are defined to address monitoring as a primary focus for some elements/competencies, and may also be embedded in other observable behaviors as secondary elements, e.g., the observable behavior “Maintains the desired flight path” also requires that the pilot monitors the flight path. As one can only evaluate what is observed, to better understand what a crew member was thinking and why he reacted in a certain way, a facilitated debrief is a good way to understand why the crew member acted in a certain way.

### 9.4 Facilitated Debriefs

Airlines have been using facilitated debriefs for years to improve aviation safety. Facilitated debriefs are effective for both technical and non-technical events. A facilitated debrief is one effective method to help trainees better understand the circumstances surrounding an event and create a plan for self-improvement. Many instructors/evaluators have used this method successfully for training and evaluating TEM/CRM, which includes monitoring. The success of the facilitated debrief is based on the pilot knowing that the lessons being captured are for the sake of improvement and not punishment. There is no judgement in the facilitated debrief process.

In a facilitated debrief, the facilitator is not restricted by specific rules to guide the discussion. The facilitator is free to ask any question to allow the crew member to seek and identify root causes for the incident or monitoring breakdown and to offer tangible solutions. Facilitated debriefs provide crew members with opportunities for self-reflection and self-improvement. Pilots should feel free to discuss what went well and what areas need improvement without the fear of reprisal.

Topical areas addressed should include the TEM/CRM elements, competencies, observable behaviors, expected and actual performance, barriers to effectiveness, and the use of strategies and tools for improvement.

Please refer to the Attachments Section, Section 9 – Attachment 1, for one operator’s guidance on facilitated debriefs.

### 9.5 Evaluating the “Pilot Monitoring (PM)” Role

During assessment and training, instructors and evaluators should balance their observation between PF and PM roles to identify learning opportunities.

It is important that the PM’s skills are assessed holistically. This means that the evaluator should not concentrate on the number of errors or deficient observable behaviors the PM demonstrated. The errors associated with the observable behaviors should be weighed against criticality. The weighting should be based on the severity of the error and operational consequences, as opposed to a more generic term of safety. It is important that the evaluator makes assessments according to how the PM’s performance affected the flight.

# Attachments

This section contains a non-comprehensive demonstration of how monitoring skills are trained by different operators. The examples provided may serve as guidelines for operators and ATOs in the development of their own training programs. This section also contains some operators' policy examples.

## ***Disclaimer***

Many airline operators and trainers, the "Contributors", have gratuitously provided training samples that have been included in this section. No Contributor shall be held liable for any error or omission in the samples and shall not be liable for any damages that may occur by using the examples provided in the following pages.

## Section 2 – Attachment 1: An Example of Monitoring vs Phase of Flight

### Monitoring during phases of flight

As mentioned earlier, the crew monitors everything related to the flight, from prior to preflight to after landing and engine shutdown, with managing a safe flight path and energy management being the primary goal. Monitoring is the responsibility of both pilots (PF and PM). Effective monitoring starts from the planning stage until the end of the flight with engines shut down and passenger disembarkation. Throughout the flight, TEM, workload and distraction management are important factors to improve monitoring.

### Pre-Flight Planning and Briefing

At this stage of their duty, the flight crew can start monitoring all elements related to the flight. For example, the alertness of the flight and cabin crew, the accuracy of the flight plan, the calculation of the fuel, the status of the A/C, the expected weather for departure and arrival, etc.

### Before Pushback (at the parking bay)

The monitoring duty for the flight crew continues at this phase of the flight and includes: the refueling of the aircraft, the correct loading of the aircraft, the boarding of the passengers, the process of the cockpit setup, the calculation of the takeoff data, etc.

Before engine start, it is important that the flight crew brief their actions in case of any emergency during takeoff. In addition, it is good practice to identify the possible threats associated with the departure. The emergency and the departure briefing will enhance the monitoring skills of the flight crew.

### Pushback and Engine Start

The flight crew will be mainly monitoring the engine start sequence during this phase of the flight. However, they must not forget to monitor the ATC communication, the direction of the pushback, the completion of any relevant checklist, etc.

### Taxi

Flight path monitoring is the most essential task for the flight crew from this phase until parking and engine shut down. The taxi stage is considered to be an area of vulnerability which can affect effective monitoring. The flight crew's responsibility is to ensure that only flight path activities have priority over any non flight path activities. For example, looking outside and knowing the aircraft position has priority over conducting a checklist.

### Takeoff, Climb, Descent and Landing

During these phases of the flight, workload is high. The flight crew should focus all their attention to flight path monitoring. The flight crew should delay actioning any task that is not related to the flight path. If the task is a time critical one, then the distribution of workload is very important before one of the flight crew members performs the assigned task. For example, if a technical malfunction is detected by the aircraft systems or by the flight crew, performing the abnormal checklist will be the responsibility of the Pilot Monitoring.

### Parking and Engine Shutdown

The responsibility of the flight path monitoring ends after setting the parking brake at the final parking position. However, monitoring needs to continue until all the passengers disembark and post flight duties are completed.

### Section 2 – Attachment 2: Safety Alert for Operators (SAFO) 15011

#### FAA Safety Alert for Operators (SAFO) 15011

On 17 November 2015 the U.S. FAA released SAFO 15011 which indicates that each US operator should explicitly define the roles of the PF and PM to include:

1. At any point in time during the flight, one pilot is the PF and one pilot is the PM.
2. The PF is responsible for managing and the PM is responsible for monitoring the current and projected flight path and energy of the aircraft at all times.
3. The PF is always engaged in flying the aircraft (even when the aircraft is under autopilot control) and avoids tasks or activities that distract from that engagement. If the PF needs to engage in activities that would distract from aircraft control, the PF should transfer aircraft control to the other pilot, and then assume the PM role.
4. Transfer of PF and PM roles should be done positively with verbal assignment and verbal acceptance to include a short brief of aircraft state.
5. The PM supports the PF at all times, staying abreast of all air traffic control instructions and clearances and aircraft state.
6. The PM monitors the aircraft and system states, calls out any perceived or potential deviations from the intended flight path, and intervenes if necessary.

This SAFO suggests content for an operator's monitoring policy. It is important to note that this SAFO focuses on the PF/PM duties, and is not all-inclusive of what should be required in an operator's policy or what should be trained for all the monitoring tasks. For example, this SAFO does not address the fact that flight monitoring duties need to be integrated between assigned tasks to the PF and PM and the functional tasks, roles and responsibilities of the Captain and First Officer

## Section 3 – Attachment 1: Using Competencies to Improve Monitoring – Air France Example

### SITUATIONAL AWARENESS (SA)

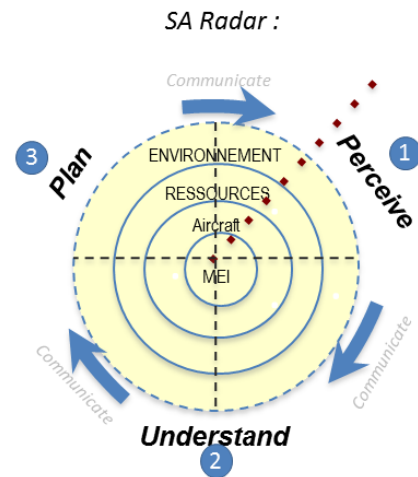
*“ knowing and understanding the condition, the situation and the environment of the aircraft, the condition of the crew and the impact these elements will have on the flight “*

#### What is it ?

**Being conscious of a situation means being active and alert :**

- 1 **Perceive:** detect (e.g., a low deceleration rate)
- 2 **Understand:** analyze (e.g., I understand that the runway is contaminated)
- 3 **Plan:** anticipate the future consequences on the flight (e.g., the landing distance will be longer)

An appropriate SA allows to anticipate, to give margin and to plan alternative actions.



#### How to develop ?

- Carry out systematic and arranged sweeping (scanning) with a rhythm dependent on the time pressure
- Communicate in order to validate each step of the SA
- Perform regular briefings in order to share the same mental scheme and the same plan of action
- Prepare moments of heavy workload by allocating tasks in advance
- Develop the culture of doubt and look for signs of degraded SA : ambiguity, tunnel vision, confusion
- In order to retrieve the SA : talk about it, multiply cross-checks, accomplish repetitive tasks with particular attention

**Did you know?**

*Accidents are often caused by an erroneous perception or a lack of perception.*

*Tiredness, self-satisfaction and workload increase the risk of degraded SA*

#### Which questions do we ask ourselves in order to improve ?

- *Are all anomalies detected? (non-nominal situations)*
- *Have the pilots frequently communicated and validated all three stages of the situation awareness : perceive, understand, plan?*
- *Have all signs of consciousness of the degraded mode been identified and have all doubts been expressed and lifted ?*

## WORKLOAD MANAGEMENT (WM)

*“Get priorities straight, organize task sharing and task interruptions according to the available resources and the situation.”*

### WHAT IS IT?

**Handling workload means organizing the work in order to maximize its efficiency.**

- **Plan:** prioritize and distribute tasks
- **Do:** do and get done according to the defined action plan
- **Check:** monitor the execution (compliance with the action plan and its efficiency)
- **Adjust:** readjust the plan if necessary

The final goal of the workload management is to optimize the use of available resources in order to enhance flight safety.

*Task planning is not enough. We must check the result and*



### HOW TO DEVELOP?

- **Fly, navigate, communicate:** all things, secure the execution of the priority actions.
- **Perform regular TEM briefings integrating workload management in the strategy:** What resources do we have available? Who will do what? In how much time?
- **Act when you detect poor workload management:**
  - Understand why and adjust the use of resources
  - Identify potential mistakes (perception, representation...)
- **In a downgraded situation, favor a PM position as a CPT** which will allow him the necessary hindsight and also to run the operations.

#### Did you know?

*High workload as well as low workload increases the potential for error as they may lead to overloaded or complacent crew members. “Extensive analyses during LOEs confirm an increase in crew errors when Captain assumes the PF role.” (Delta)*

### Which questions do we ask ourselves in order to improve?

- *Did we brief critical phases? Did we set up a TEM strategy?*
- *Did we drop secondary tasks to focus on primary ones when necessary?*
- *Did I pay attention to poor SA signals: workload and resources poorly balanced, poor anticipation, feeling behind the plane, surprise...*

# LEADERSHIP - TEAM WORK

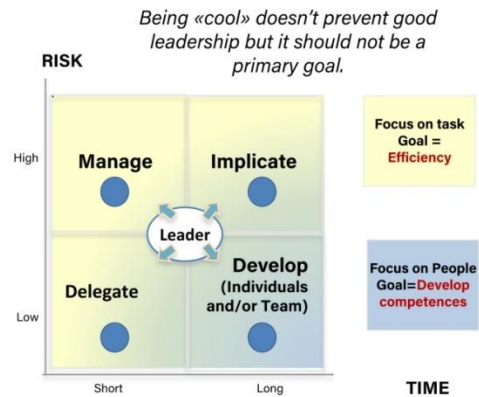
*“The ability to promote, to implicate and maintain the crew cooperation and take up its responsibilities.”*

## WHAT IS IT ?

Leadership is the ability to mobilize the crew in order to achieve a common goal; it has to be situational and adapted in function of time and risk.

Each crew member has to show its ability to work in a team; propose solutions, express doubts or disagreements and support decisions taken.

The Captain remains entirely responsible.



## HOW TO DEVELOP ?

In order to develop ones leadership, one has to identify the situation (weather, risks, available resources) and find the efficient way centered on the task and/or the human aspect:

- **Manage:** take urgent unilateral decisions and dictate to each and every one the tasks to be accomplished (rare because of the extremely urgent character of this kind of situation (e.g., fire, etc.)
- **Implicate:** encourage the participation of the different actors according to their competence / experience in order to maximize the pertinence of the taken decisions and to enforce adherence (e.g., engine stall, landing gear issues, etc.)
- **Delegate:** entrust a part of ones activity to another competent actor of the flight.
- **Develop:** take the opportunity in a given situation to reinforce ones competences and resources by coaching and exemplarity (e.g., during briefing revise a procedure or explain the NITS)

For a crew to function, all members have to share the same goal (give sense to the mission), take into account others' opinions, define commonly the modes of application and actively support the decisions taken.

*The revealed weaknesses during LOSA concern the “let it be” leaderships as well as the “autocratic” leaderships.*

## WHAT QUESTIONS DO WE ASK OURSELVES IN ORDER TO IMPROVE?

- *Have I been able to efficiently progress my way of leadership according to the given situation?*
- *Have I given the example? Have I given a sense and taken into consideration every actor?*
- *Have I expressed my opinions and actively supported the decisions taken?*

## Communication (COM)

*“The ability to understand and to be understood by others without any ambiguity”*

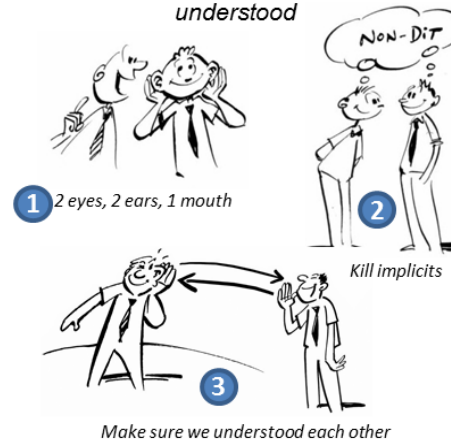
### WHAT IS IT ?

- To communicate means to exchange information verbally or non-verbally within the crew.

- 1 Listen (know when not to talk, ask for advice before expressing yours).
- 2 Express ideas without any ambiguities (raise any doubts, no implicit).
- 3 Verify that the message has been received and understood.

The goal is to share an identical mental plan.

*Saying something is not enough. We must listen and make sure the message is understood*



### HOW TO DEVELOP?

- Set the tone:** communicate before the flight, being watchful about the form, the intention to favor the dialogue and the cooperation and specify how the crew will function (e.g., briefing, manage task interruptions, clean the cockpit, etc.)
- Communicate without ambiguity and aggressiveness:** Share action plans, distinguish facts and analyses, choose the adapted tone of message, adjust to the person you are speaking to, ask questions, prefer “we” rather than “I”, think in terms of “what is right, not “who is right”.
- Use a common language:** TEM briefing, technical announcements, NITS (Nature, Intentions, Time, Specificities)
- Analyze together the quality of the communication after the flight.**

#### Did you know?

Communication = 10% by verbal, 50% body expression and 40% by the tone of the voice. “With Emirates, pilots came from the entire world which was ultimately very efficient because each and every one communicated in a manner without any ambiguity and we didn’t take any chance of interpretation”  
AF F/O, ex Emirates.

### WHICH QUESTIONS TO ASK IN ORDER TO IMPROVE?

- Did we share the same mental plan? Did we understand each other correctly? Why?*
- Are there any doubts (risks, menaces, errors, ambiguities) that we haven’t shared, analyzed, treated?*
- Did we renounce to speak supposing we understood the intention of others?*
- Have the briefings and technical call outs been performed at the right moment?*



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## **Section 4 - Attachment 1: Policy / Extra Flight Crew Duties and Responsibilities - United Airlines Example**

### **United Airlines policy / Extra flight Crew Duties and Responsibilities**

The responsibilities of augmenting crew members or Safety pilot include participation in pre-flight and post flight briefings and flight planning.

Whilst on board the aircraft, and not resting:

- a) To participate in flight deck briefings and to actively monitor the flight path of the aircraft and the actions of the PF and PM.
- b) To maintain a situational and operational awareness.
- c) To bring to the attention of the operating crew any abnormalities or departure from SOPs OR previously briefed intentions.
- d) To carry out any duties delegated by the Captain.

## Section 4 – Attachment 2: Monitoring Policy – Air France Example

### Air France Monitoring Policy

This portion of an operator’s monitoring policy puts emphasis on task and workload management, monitoring vs phase of flight, and introduces intervention strategy.

#### Monitoring

Monitoring is a mental process which consists of keeping watch (observe) and understanding all the elements related to the flight path, the airplane systems, the operational context and the crew.

PF duties	PM duties
<ul style="list-style-type: none"><li>• The PF primary task is to fly, to keep control and monitor the flight path and the navigation in compliance with SOPs</li><li>• The secondary PF task is to monitor the actions non directly related to flight path (ATC communications, C/L completion, aircraft system check, other operational duties)</li></ul>	<ul style="list-style-type: none"><li>• The PM primary task is to monitor the flight path and the navigation. In case of deviation the PM shall immediately inform the PF and intervene if necessary.</li><li>• The secondary PM task is to accomplish the actions non directly related to flight path (ATC communications, C/L completion, aircraft system check, other operational duties)</li></ul>

The pilots must manage disturbance in order to always secure primary task completion.

As the mental resources are limited, the pilots must manage workload to allow efficient monitoring.

The pilots use all their competencies in order to anticipate and intervene, if necessary, in the event of deviation between the action planned and the observed situation.

## Section 4 – Attachment 3: Area of Vulnerability (AOV) to Flight Path Deviation – Air France Example

### Air France Policy regarding the Areas of Vulnerability

#### AOV Concept (Area of Vulnerability)

There are 3 types (low, medium and high) describing the areas of vulnerability to a flight path deviation.

The areas of vulnerability indicate to the pilots the phase of the flight when they should:

- ✓ Have a strategy regarding the workload management
- ✓ Manage task interruption and perturbations
- ✓ Adapt the monitoring pace

#### High AOV: Highly responsive flight path

Any flight path deviation is critical.

Flight crew has very little time to detect and correct potential deviations:

- ✓ Both pilots are engaged in flying the aircraft and monitoring the flight path
- ✓ The scanning frequency is done at high sampling rate
- ✓ The Pilot Monitoring performs only mandatory secondary task

#### Medium AOV: Slowly responsive flight path

Flight crew has limited time to detect and correct potential deviations:

- ✓ Both pilots are engaged in monitoring the flight path
- ✓ The scanning frequency is done at elevated sampling rate
- ✓ The Pilot Monitoring performs no time consuming secondary tasks

#### Low AOV: Steady flight path

Flight crew has time to detect and correct potential deviations:

- ✓ At least one pilot is monitoring the flight path
- ✓ The scanning frequency is done at normal sampling rate
- ✓ Secondary task can be accomplished

(\*) Sampling rate is the frequency with which a pilot directs his visual and mental attention to the various items or indicators that represent the flight path.

## Section 4 – Attachment 4: Takeover Training – Preventing the “Absence of PM” – Japan Airlines Example

### Preventing the “Absence of PM”

Through analysis of incidents, situations are identified where both pilots ended up acting as PF while monitoring was being overlooked. This could happen when F/O is flying from the right seat and, especially, when the Captain is taking over aircraft control in a critical moment.

JAL provides “Takeover Training” to provide practical experience on the captain taking over control of the aircraft during critical moments of flight, including approach and landing. F/O should maintain the role as PF in the right seat while the captain in the left seat should act as PM, though final authority of decision making always remains with the captain. At critical moment in landing (i.e., below 300ft), the captain will take over the control of the aircraft when things go wrong (captain reverts to PF) and the F/O reverts to PM. It is easier for the captain to revert to PF than F/O to revert to PM instantly.

### Practical training in recurrent FFS #1

#### “Takeover Training”

##### AIM

- “Takeover should be initiated not because the situation is critical but to prevent it from becoming a critical situation.”
- Make sure both “The Control” and “The Monitoring” are maintained continuously through the takeover and that the pilots switch roles as required.

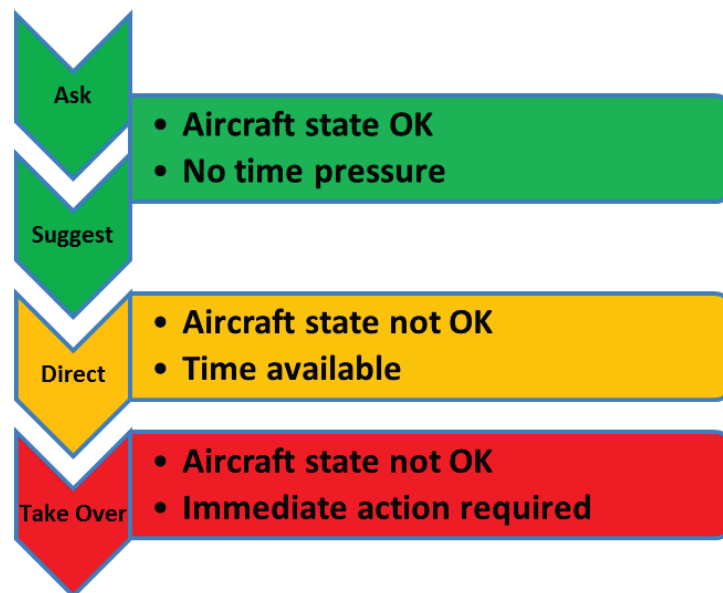
##### Training

- Have F/O fly approach from right seat
- Set up a situation where Captain (PM) is required to takeover and F/O (PF) reverts to PM instantly. Some example scenarios might include:
  - Rejected Landing
  - Rejected Landing just around touch down
  - Rejected Takeoff

## Section 4 - Attachment 5: Policy / Communication and Intervention Strategy - Emirates Example

### Emirates Policy / Communication and Intervention Strategy (Emirates Policy)

Effective pilot monitoring depends upon shared situation awareness and, critically, shared responsibility for the PF task. An intervention policy is necessary to address the issue of loss of situation awareness or inappropriate aircraft handling by the PF. The hierarchy of intervention considers the actual or potential aircraft state and the time available for crew reaction, providing four ways for the PM to take action to preserve flight safety. Where necessary, the PM shall apply the appropriate intervention, up to and including taking over the PF duties, as follows:



At any time, the PM can use the **trigger word “uncomfortable”** to clearly express concern regarding the actual or future aircraft state. The hierarchy is also relevant for crew positioned in the jump seats, such as augmenting pilots or trainers.

**Ask Why:** When the PM asks a question it is a clear sign that the mental model of the future aircraft state is not shared completely between all pilots.

**Suggest How:** The PM provides the PF with guidance.

**Direct What:** The PM provides a clear command on action required.

**Take Over: “I have control”.** The PM becomes the PF. In this extreme case, applicable only in situations where immediate action is required to prevent aircraft damage or worse, the PM must be knowledgeable in the takeover procedure and aware that there would likely be little support from the other pilot due to his loss of SA and the startle factor.

## Section 5 – Attachment 1: Monitor/Cross-Check – United Airlines Example

### MONITOR/CROSS-CHECK (MC)

Actively verify aircraft systems, aircraft position/configuration, and crew member actions; resolve inconsistency and uncertainty.

<b>AQP Ref:</b>	<b>Skill:</b>
12.11.7.1	Verifies status of aircraft systems
12.11.7.2	Verifies aircraft position and configuration
12.11.7.3	Verifies crew member actions
12.11.7.4	Resolves inconsistency and uncertainty

### Observable Behaviors:

- Continuously share information to self-correct
- Verbalize developments (fuel, weather, ATC, aircraft status, etc.)
- Brief anticipated threats and the required actions to prepare
- Ask relevant questions
- Monitor instruments, systems, weather communications, traffic
- Verify “action – reaction” when moving switches and making inputs
- Coordinate and communicate automation inputs
- Report fatigue in self and other crew members
- Report stress in self and other crew members
- Seek a second opinion when instrument readings are ambiguous
- Assess crew situation awareness
- Continually check system status and flight/taxi path
- Verify paperwork
- Cross-check charts
- Cross-check FMC and MCP
- Alert crew when “heads-down”
- Intervene when flight guidance and aircraft actions conflict
- Clearly define the monitoring role of each pilot

- Follow SOP regarding independent verification
- Check systems status in context of current situation

Inadequate **Monitor/Cross-check** was cited in 84% of NTSB reviewed accidents that were crew-caused. Over three-quarters of the monitor/cross-check errors occurred while the aircraft was in a vertical phase of flight (climbing, descending, or approach). Additionally, data collected from numerous airline flights using LOSA audits revealed that 64% of errors went undetected by the flight crew. Effective monitoring and cross-check skills can provide the last line of defense against an incident/accident.

### Monitor

It is the primary responsibility of each pilot to **monitor** the aircraft. Several SOPs (e.g., sterile cockpit, altitude change, both pilots have 10-9 pages out on taxi, brief approach prior to top of descent, etc.) support monitor/cross-check during times or areas where pilots are particularly vulnerable to threats and errors.

Actively monitor/cross-check three primary areas for new information or changes that require action:

**The Plan.** Are we doing what we briefed? Does the plan need to change? Have we briefed changes to the plan? As a crew, continue to actively monitor the implemented plan/strategy. Communicate as necessary when making adjustments to ensure the plan is executed properly.

**The Aircraft.** Are we on course and altitude? Is aircraft movement consistent with automation programming? Aircraft warning systems call attention to significant changes in aircraft systems status. Effective crews use these resources in combination with monitoring aircraft flight instruments for indications of impending conditions that could impact safe operations.

**The Crew.** Monitor the crew for signs of stress, fatigue, complacency, and distraction. Initiate strategies to combat these situations. The effective monitoring of the crew is as important to safe operations as the actual manipulation of flight controls.

### Cross-Check

**Cross-check** the current plan, aircraft indications, and crew member actions to confirm status, intended results, and accuracy. Verbalize, Verify, and Monitor (VVM) is an excellent tool for validating crew member actions when employing the Monitor/Cross-Check CRM/TEM skill.

## Effective Strategies and Tools

### Adherence to Standard Operating Procedures (SOPs)

**Standard Operating Procedures** form the framework for safe operations. Consistent adherence to SOPs underpins United Airlines' strategy for error avoidance and repair. CRM/TEM training is most effective within a program centered on clear, comprehensive SOPs. Each FM Normals chapter contains SOPs. In addition to normal SOPs, non-normal SOPs are outlined in the aircraft FM Introduction chapter. Compliance with SOPs



allows crews to operate confidently with any other crew member, enhances workload management and maintains safe operations.

The ability to monitor and challenge rests on the use of SOPs. Operating outside SOPs raises doubt as to whether there is error or intentional non-compliance, reduces PM effectiveness and increases unresolved errors. Every United Pilot has the right to expect compliance with the SOP.

### **Verbalize, Verify, Monitor (VVM)**

**VVM** is an effective TEM tool to counter threats and errors. Crew members who **verbalize** plans and ideas, **verify** them with others, and **monitor** for the expected result are better threat and error managers.

### **Clearly Define Roles**

Multiple LOSA, NTSB and NASA safety studies highlight that crews cannot be expected to remain 100% vigilant during low workload portions of all flights (e.g., long haul flights). A useful strategy is for crew members to take turns monitoring/cross-checking during low workload periods. Communicate with the other crew member when relaxing monitoring. This strategy puts emphasis on the importance that at least one crew member is actively monitoring/cross-checking at all times during low workload periods. Both pilots must actively monitor/cross-check during high workloads and in areas of vulnerability.

### **Resolve Doubts**

The NASA guidelines for safe flight state that "all doubts must be stated and resolved." Basically, where there is doubt there is danger. Effective crews question each other. Never hesitate to verbalize concerns and bring attention to a potential problem.

When in **Doubt** challenge or express concern with other crew members. Ensure information is clearly understood by all crew members and that it is considered and acted upon, if appropriate. The goal is to verify information has been heard and understood in the same way by all crew members.

### **Monitor/Cross-Check (MC) Observable Behaviors**

#### **How to Demonstrate MC**

*MC 5.1 Maintain awareness of automation modes.*

"Why is it doing that?" A very large percentage of these exclamations are a result of "mode confusion".

The FMA is a direct indication of the FMS/FMGC active or armed status. The second, but just as important, indication is the actual aircraft and its basic performance and navigation instruments. Reference automated systems to these two sources.

*MC 5.2 Coordinate entries and changes to systems.*

Only one pilot loads or makes changes to the FMS/FMGC at any given time. The pilot who is loading or making changes verbalizes those inputs. This builds SA for the entire crew. Verify the changes and monitor the aircraft's flight path.



*MC 5.3 Verbalize information until resolution.*

Verify information has been heard and understood. Ensure that information is considered and acted upon, if appropriate.

*MC 5.4 Monitor current conditions.*

Continually assess the current conditions by comparing planned outcomes versus actual outcomes. Verbalize and discuss any discrepancies.

*MC 5.5 Monitor developments.*

Monitor, assess, and share interpretation of weather forecasts, reroutes, fuel burn, etc. Determine if any changes in operation are necessary.

*MC 5.6 Challenge situations that contain doubt.*

Monitor developments, compare mental notes, and ask questions to confirm understanding. Direct attention to information or conditions that may have been missed or are unclear. Resolve all doubt.

*MC 5.7 Resolve conflicting information.*

Use all available resources to resolve conflict. Examples might be to use ATC to resolve navigation issues, or Dispatch to solve takeoff data conflicts. Respectfully question information until resolution.

*MC 5.8 Verbalize mistakes and deviations.*

Verbalize mistakes and deviations immediately. Take corrective action.

### **Barriers to Monitor/Cross-Check**

MC may *not* be effective if:

- SOP non-compliance (e.g., PM not calling, "Go around, airspeed")
- PM is unaware of automation status of the aircraft
- Not calling out changes to MCP
- Non-flight related distractions allowed to impact operation
- Apathy, complacency on flight deck
- More than one pilot loading/inputting information at the same time
- Roles not clearly defined in briefings
- FMAs changes not verbalized
- FMAs not confirmed
- PM does not challenge PF when doubt exists

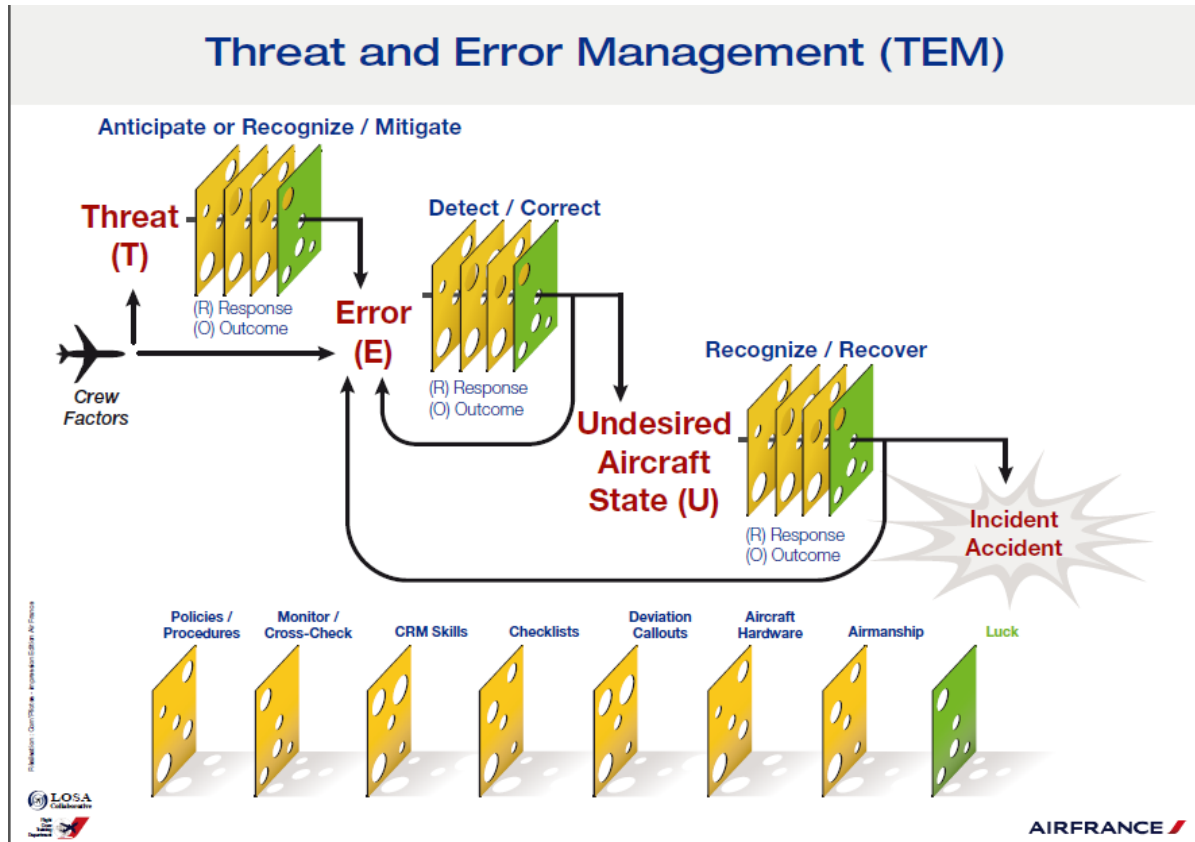
## Section 6 – Attachment 1: Sample of TEM model used in Training and Operation – Air France Example

### Sample of TEM model used in training and operation:

The model shown below in Figure XX represents one example of how instructors can train monitoring using the TEM model, and then use the TEM model to debrief pilots regarding their monitoring and TEM performance. This model can also be used in the simulator and line operations as a flight crew self-debriefing tool. The flight crew would evaluate itself on its crew performance in regards to how effective they were in monitoring and TEM throughout the flight and discuss how they could improve as a crew. This debriefing should be done after each leg.

Please note the second left Swiss cheese slice countermeasure: “monitor/cross check”

FIGURE XX: Threat and Error Management (TEM) Slide



## Section 6 - Attachment 2: Training for Monitoring from a CRM Perspective - Emirates Example

*Below is an example from the Emirates CRM Manual that shows how Emirates trains monitoring from a CRM perspective:*

The aircraft manages and self-monitors many of the functions that were previously in the domain of the crew members.

Most notable of the differences from a flight-deck perspective is that humans are poor monitors and good at accepting revised plans. The principle task allocated to humans on the flight deck involves monitoring for which we are not ideally suited. The automation on the other hand may need to be re-programmed for last minute changes, an area of weakness in interface design.

Manual flight without flight director: requires the pilot to manually fly the airplane and monitor the closing rate of the inbound track and adjust accordingly. This is a high workload situation, although 'fly-by-wire' will still be assisting.

Autopilot with fully managed modes [LNAV/VNAV]: The pilot no longer has to calculate closing rate information or fly the aircraft. In its current mode the aircraft will intercept the inbound course. There is a reduced cognitive load, so the overall workload is drastically reduced. Monitoring or supervising is the principle role left to the pilot.

Appropriate feedback makes the task of monitoring system failures or anomalies more effective. Feedback is also required for monitoring normal system status change.

Using automation requires:

- U Understanding each mode before selection.
- A Anticipating how the aircraft will react to the mode change.
- E Evaluating whether the desired effect has been achieved.

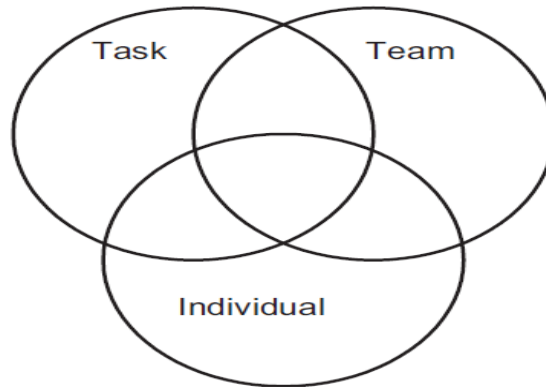
Appropriate feedback makes the task of monitoring system failures or anomalies more effective. Feedback is also required for monitoring normal system status change; a lack of, or subtle, feedback results in a reduction of situational awareness.

### **Action-Centered Leadership**

Pilots tend to be naturally task-focused individuals. However, the leader also has other areas of responsibility. The leader must balance the demands of the task, the team and the individual.

The importance of each sphere of responsibility will change dynamically according to the situation. Emirates SOPs and technical training support this function of leadership, with use of the Assess, Action, Manage decision-making model.

**Figure 1. Task Team Individual Balance**



## **Task**

To achieve the task, consider the following:

- Planning
- Communication of intent
- Avoid over-involvement as it reduces the capacity to think ahead
- Maintain situation awareness
- Monitor and evaluate the task's progress

## **Directing and Coordinating Crew Activities**

The leader must function as crew manager to provide orientation, coordination and direction for group performance.

- Directing and coordinating crew activities
- Monitoring and assessing crew performance
- Providing planning and orientation
- Setting priorities

## **Cockpit Authority Gradient**

In addition to the style adopted by the Captain, the interaction between the flight-deck members will define the authority gradient between the two. A steep gradient results in ineffective monitoring from the co-pilot, and a flat one reduces the Captains' authority by constant [unnecessary] challenge.

The optimum gradient, which may differ between individuals and national cultures, encourages an open atmosphere to monitor and challenge, while respecting the Captain's legal authority. Emirates encourages a minimal cockpit authority gradient, since there are a number of nationalities and levels of experience among

the workforce in the company. Nevertheless, the duties and responsibilities of the pilot-in-command should in no way be affected by this need.

**Divided Attention**

Problems occur when we need to attend to more than one matter at a time. We are unable to effectively monitor our principle task. The ‘cocktail party’ syndrome provides a useful example of this. During a busy, noisy social function it is quite possible to sustain a conversation with someone, even though they do not have the loudest voice. The brain will filter the unwanted background noise, but it is not being ignored completely. If someone nearby were to mention a key topic of interest to you (such as your name), it would become increasingly difficult to maintain the original conversation, as firstly you would detect this new signal and secondly try to monitor it as well as the initial conversation. Attention is believed to be a single-channel function. It is only possible to concentrate on one signal at a time. Those who believe that they can monitor two channels simultaneously, are actually switching from one to the other, at some point they will lose part of one or other signal.

**Levels of Situation Awareness**

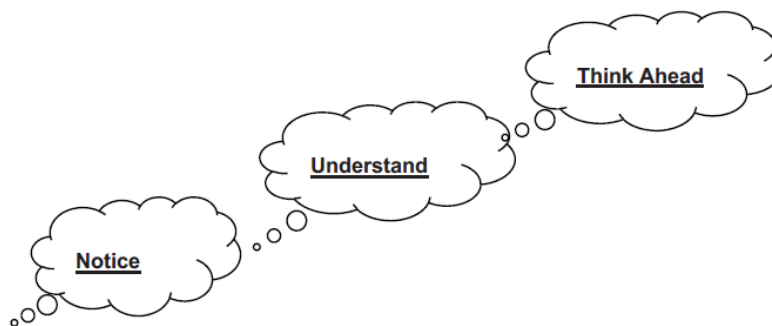
Endsley has produced the commonly accepted definition of situation awareness as:

“The perception of the elements within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future.”<sup>13</sup>

This is quite complex, but what it means is that there are three levels of situation awareness. It is not just enough to notice a situation; one must understand and think ahead.

The problems with SA in accident cases have mostly revolved around pilots failing to notice.

**Figure 2. Levels of Situation Awareness**



32. Endsley, M, 1994.

33. Endsley, M R. 1988, Design and evaluation for situation awareness enhancement. In Proceedings of the Human Factors Society 32nd Annual Meeting.

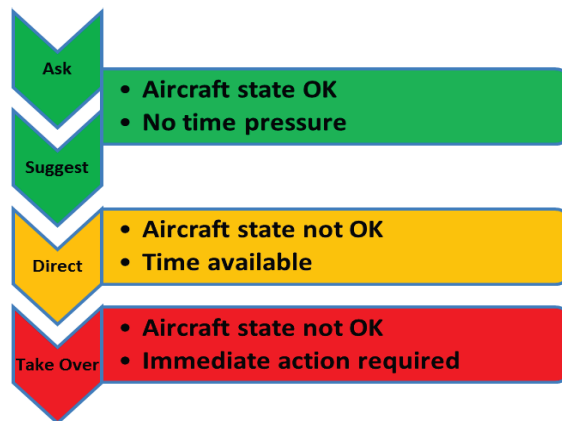
<sup>13</sup> Endsley, Mica R. (1995). Situational Awareness

**The key to situation awareness is knowing what comes next.**

In addition to three levels of SA, there are different domains that must be monitored by the pilot. The pilot must monitor the aircraft [flight-path, automation modes, systems, fuel and time], the environment [terrain and weather] and the people [ATC, crew, passengers and company]. In a well-known phrase: Aviate, Navigate, Communicate.

**Pilot Monitoring Intervention**

Effective pilot monitoring depends upon shared situation awareness and, critically, shared responsibility for the PF task. An intervention policy is necessary to address the issue of loss of situation awareness or inappropriate aircraft handling by the PF. The hierarchy of intervention considers the actual or potential aircraft state and the time available for crew reaction, providing four ways for the PM to take action to preserve flight safety. Where necessary, the PM shall apply the appropriate intervention, up to and including taking over the PF duties, as follows:



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**Take Over:** “I have control”. The PM becomes the PF. In this extreme case, applicable only in situations where immediate action is required to prevent aircraft damage or worse, the PM must be knowledgeable in the takeover procedure and aware that there would likely be little support from the other pilot due to his loss of SA and the startle factor.

**Example:** During a circling approach the aircraft is on a right hand downwind for 30L. The PF initiates the turn and the PM determines that the bank angle is too steep and it appears that they will line up for 30R. The

PM now ASKS the PF why he is turning so steeply. This prompt may result in the PF reviewing his action and then adjusting the bank to ensure a roll out on 30L. If not, the PM now states how the PF can ensure lining up for 30L by SUGGESTING he reduces the bank angle. If this is not successful, the PM now DIRECTS the PF on what to do by stating that he “rolls out, continues for a while and then lines up for 30L”. If this is not successful, the PM now TAKES OVER by stating “I have Control” and flies the aircraft to line up with 30L.

Basic skills that high SA crews exhibit are; communications, scan patterns, and checklist use. Advanced skills include pre-flight planning, contingency planning, self-monitoring, task management and prioritization.

### **Techniques for Better Situational Awareness Management**

- Predetermine crew roles for high-workload phases of flight.
- Develop a plan and assign responsibilities for handling problems and distractions.
- Solicit input from all crew members including cabin, ATC, maintenance, dispatch, etc.
- Rotate attention from plane to path to people – don’t fixate.
- Monitor and evaluate current status relative to your plan.
- Project ahead and consider contingencies.
- Focus on the details and scan the big picture.
- Create visual and/or aural reminders of interrupted tasks.
- Watch for clues of degraded SA.
- Speak up when you see SA breaking down.

## Section 6 – Attachment 3: Training Syllabus for Pilot Monitoring (PM) Skills – An Operator’s Example

This is an example of training designed for the PM role only, and does not address initial ab-initio monitoring training, training monitoring as a task, or monitoring training for the PF role.

### 1. Academics Prior to Training

- a) At home study involving case studies as example of effective and non-effective pilot monitoring.
- b) Information on what are behaviors associated with pilot monitoring.

### 2. Academics During Training

- a) Briefings present what is monitoring and flight path management.
- b) Briefings detail a thorough review of SOPs.
- c) Review Procedure for Recognition, Confirmation and Recovery from an unexpected Flight Path Exceedance.

### 3. FTD/FFS Tasks for Training to Improve Pilot Monitoring

- a) These task sets contain variations of the same objective, they also build from simple to complex; straight-forward to not so obvious and so forth. The end result should be an active PM.
- b) As an overall “theme” to these tasks, there may be a tendency for the trainee to miss these items or be incorrect in their response, but the benefit lies in debrief and realization of error aspect to missing this. The hope is that after the first time or even the next time they miss the monitoring error, the importance of monitoring skills is understood. With this approach, training has taken place and learning has occurred in the monitoring skill set.
- c) These tasks allow demonstration in general of the following items:
  - i. Recognizing and responding to any deviations in a timely, appropriate and effective manner
  - ii. Communicating developing or expected abnormal or adverse conditions
  - iii. Alerting or verbalizing changes to automation and configuration
  - iv. Recognizing and communicating errors by another crew member
- d) These tasks present observable metrics of pilot monitoring including but not limited to:
  - i. Reaction time
  - ii. Accuracy of recognition
  - iii. Error rates or unfavorable outcomes
- e) *“Anticipation Task 1”*
  - i. The objective of this task is to be able to determine what the desired flight path is.
  - ii. During any phase of flight, the PF should be verbalizing and briefing what the intentions are in regards to the flight path. The pilot monitoring should be expected to take that information and recognize and verbalize any deviations from that expectation. The flight crew must first



demonstrate the ability to extract that information from the appropriate indications/locations for normal flight.

- iii. Perform the following task (in general terms, but can be applied in all phases of flight)
    - Give the crew a flight related task (climb, descent, heading change, DESC via RNAV Arrival, etc.), but prior to performing this ask the PM to verbalize what they expect to see in regards to the aircraft's flight path, automation, and associated aircraft systems to achieve this.
  - iv. These tasks should be specifically indicated in the syllabus to avoid overkill and at appropriate time in training, preferably in the normal procedures and maneuvers phases.
- f) *"Actively Monitoring Task Set 1"*
- i. The objective of this task is to teach the role in actively staying ahead of the airplane and maintaining situational awareness in regards to the flight path.
  - ii. This task draws upon the need to stay ahead of the airplane by knowing what the aircraft is doing at all times in order to better stop the chain of events that lead to a deviation or undesirable state. It demonstrates that a trainee is actually maintaining awareness of what is going on in relation to the flight path.
  - iii. Perform the following task (in general terms, but can be done in all phases of flight)
    - While the crew is performing any task related to training/flight (missed approach, running a checklist, making a frequency change, flying a departure, etc.), freeze the simulator or blank the displays indicating automation/pitch attitude/bank and so forth, then ask the trainee some degree of the following questions (turning away from displays if you only use the freeze method):
      - What is my pitch/bank?
      - Where is my thrust?
      - What is the indication on my FMA?
      - What mode am I in related to automation?
      - What is the active waypoint?
      - Where is the closest airport?
      - What is my fuel?
      - What is the level of automation? ATs? AP? FDs? Manual?
  - iv. These tasks should be specifically indicated in the syllabus to avoid overkill and at appropriate time in training, preferably in the normal procedures and maneuvers phases of curriculum.
- g) *"Actively Monitoring Task Set 2"*
- i. The objective of this task is to demonstrate that the pilot monitoring's primary duty is to support the PF in managing the flight path.

- ii. In a dynamic environment, the PM may trap or catch a developing deviation before the PF does. In this regard, the PM is supporting the PF's job of flying the airplane.
  - iii. Perform the following task (in general terms, but can be done in all phases of flight)
    - Vector or reposition the crew into a "real-world scenario" visual approach or precision approach
    - When they are vectored or repositioned, do so in one of the following ways:
      - Reposition or vector above or below the normal glidepath for the approach
      - Reposition or vector in a high speed/high energy state that calls for coordination of configuring the aircraft to be stabilized for the approach
      - Reposition or vector on a visual approach that forces judgement on when to configure, descend, and maneuver for landing
  - iv. By focusing not only on the PF, but the PM's role in assisting in the flight path, it is reinforced that the PM is not just along for the ride, but plays a role.
  - v. Judgment of the instructor is important in determining that the PM is not leading another trainee (PF) to accomplish the maneuver.
  - vi. The PM should be verbalizing things such as "you are 3 miles at 1700 feet, high", thus still allowing PF to digest and perform accordingly.
  - vii. These task should be specifically indicated in the syllabus to avoid overkill and at appropriate time in training, preferably in the normal procedures, maneuvers phases of curriculum, but also be incorporated into LOFTs/SBT/LOEs so that application to the line is transferred.
- h) *"Subtle/Startle Events on a Basic Level Task Set 1"*
- i. The objective of this task set is to reinforce normal operations by introducing the element of surprise through non-normal operations.
  - ii. It is not to build a trainee that is always looking for something that is wrong, but one that is incorporating the above skills learned in the previous tasks. The benefit of these events lies in creating and incorporating them such that the trainee does not know about them prior or is prebriefed. These are recognition events that require a subsequent reaction or further evaluation
  - iii. This level of Subtle/Startle Events are systems/malfunctions that should be transparent to the PM.
  - iv. Perform the following tasks (can be done in various phases of flight)
    - Fail capturing of altitude near desired altitude while climbing or descending
    - Fail capturing of the GS or LOC on a precision approach
    - Uncommanded flight control change (pitch change in level cruise)
    - Autopilot drops off or does not engage when turned on
    - Failure of programmed thrust reduction at thrust reduction height during climb

- Thrust fails to reduce or advance dependent on required flight path (example; during level off leading to speed excursion)
  - v. These task should be specifically indicated in the syllabus to avoid overkill and at appropriate time in training, preferably in the normal procedures, maneuvers phases of curriculum, but also be incorporated into LOFTs/SBT/LOEs so that application to the line is transferred.
- i) *"Subtle/Startle Event Graduate Level Task Set 2"*
- i. The objective of this task set is to reinforce normal operations by introducing the element of surprise through non-normal operations.
  - ii. It is not to build a trainee that is always looking for something that is wrong, but one that is incorporating the above skills learned in the previous tasks. The benefit of these events lies in creating and incorporating them such that the trainee does not know about them prior or is prebriefed. These are recognition events that require a subsequent reaction or further evaluation at a higher level than the previous set.
  - iii. This level of Subtle/Startle Events are systems/malfunctions that maybe transparent, but can occur in high workload environments thus truly stressing on the role of the PM.
  - iv. Perform the following task (phase of flight identified)
    - Failure of TOGA switches on missed approach
    - Fuel Leak while flying a LOE/LOFT at cruise
    - Pitot Static Failure during descent on arrival to destination
    - Missed Approach from altitude above minimums (prior to stabilized approach requirements, intermediate altitude prior to minimums)
    - Out climbing Aircraft Max Altitude Capability, subsequent speed loss, high thrust state. (Temperature Inversion) while at cruise.
  - v. These tasks must be specifically identified in the syllabus. They can be incorporated throughout the syllabus.
- j) *"Coordinated Failure Task Set 1"*
- i. The objective of this task is to apply monitoring skills to the line environment.
  - ii. This should follow the subtle/startle event mindset and will be coordinated prior with each individual PF for the module to assess the level of monitoring the PM has achieved.
  - iii. An index card or private discussion detailing what is expected of the PF would be required for this and his/her role.
  - iv. Again here, the PM trainee should not be briefed prior.
  - v. Perform the following task (specifically identifies when it should occur):
    - During an RNAV departure with a turn, advise PF to hand fly and subsequently drift left or right of the required course. Adding saturation of a frequency change will provide a distraction element. Will require PM to voice deviation, comply when they recognize.

- During a descent clearance, tell the PF to intentionally place the wrong altitude in the MCP Altitude. Will require PM to recognize, comply when they recognize.
  - During the same above clearance, require PF to cross at a specific altitude, have the PF intentionally stay above the path to the point that intervention to get back on the path is required. Doing this during descent/approach checklists would provide a distraction element. Will require PM to voice deviation, comply when they recognize.
  - During a taxi clearance, tell the PR to turn in the wrong direction, preferably during a checklist or high workload point in taxi. PM should recognize, comply when they recognize
  - During approach, have the PF remain fast and behind on configuring the airplane. PM should recognize and voice what needs to be done, comply when they recognize.
- vi. These tasks only need to be used once and are most advantageous to be done during the LOFT/LOE phase of training to assess the monitoring level of PM.

## **Section 6 - Attachment 4: FFS 04U - Emirates Example**

### **1.13 FFS 04U**

#### **1.13.1 Session Preparation**

This session is designed to train intervention skills during critical phases of flight. The instructor's role is to give the student exposure to a range of industry common errors and teach the appropriate intervention techniques.

Unreliable Airspeed exercises are also introduced with a review of the Back Up Speed Scale (BUSS).

#### **1.13.2 Session Objective**

- To learn and apply intervention techniques
- To practice takeoff intervention
- To practice approach and landing intervention
- To review the unreliable airspeed procedure and flying the BUSS

## Section 6 – Attachment 5: Flight Intervention Training (FIT) 1 – Emirates Example

### 1.5.7.2 Preparation Requirements for FIT 2

During this simulator session each trainee is to conduct a line training flight on a short sector. The Tutor will act as a student who has just been released without a safety pilot. The Trainee Instructor will be required to demonstrate airborne instructional techniques while operating the flight in a safe and efficient manner. This session is designed for two trainee instructors, each conducting one of the two sectors. There are no NOTAMs for these flight sectors. Plight plan details and weather are provided in the simulator setup table (A380 FIT 2 Simulator Setup) below.

### 1.5.8.3 Instructor and Trainee Guidance

#### Objectives

During this simulator session trainees will have the opportunity to practice airborne instructional techniques and common errors during critical flight phases that require appropriate instructor intervention. The methods of intervention will have already been discussed during classroom exercises therefore this simulator session will concentrate on practical application.

During this simulated flight intervention training session the trainees will have to:

- Recognize common trainee errors during critical phases of flight and correct an unsafe situation.
- Recognize when intervention is required and through practice apply techniques learnt during classroom training.
- Ascertain allowable tolerances and identify personal boundaries. Only partial role play is required, Tutors are required to announce when the exercises begin and end, i.e., “Bloggs (or similar) ON/OFF.”

#### Briefing

A briefing is to be provided by the Tutors to ensure that the Trainees are fully aware of the exercises to be completed and to review the following:

- Establish roles and expectations.
- Emphasize that appropriate intervention should be used: Hint, Suggest, Direct, Take over.
- Only partial role play is required, Tutors are required to announce when the exercises begin and end, i.e., “Bloggs (or similar) ON/OFF.” The trainees are to then conduct a mini briefing on their chosen topic, maximum 10 minutes. The Tutor will then provide a debrief.

- The tutors are to conduct a review of the following subjects highlighting A380 specific threats.
  - Geometrical A/C limits
  - Standard Call Outs
  - Stabilization Criteria
  - Landing Zone
  - Take Over Techniques

### **Section 6 – Attachment 6: LOS 1 CM1 PF - Intervention Training, In-seat Instruction (ISI) Part 1 – Emirates Example**

#### **Module (B): LOS 1 CM1 PF**

This LOS is a scheduled flight EK501 from Mumbai (VABB) to Dubai (OMDB), during the monsoon season. CM1 is pilot flying for this module.

The LOS is started at taxi point M7, the tug has been disconnected and the after start checklist is complete. The aircraft has been dispatched with the APU INOP. To save time, a review of the MEL and the majority of the normal briefing (CTOW) is to be completed in the briefing room.

Use the weather in the vicinity to make the simple return decision more difficult.

This LOS will focus on the following competencies:

- Problem solving and decision making
- Teamwork, leadership and support
- Situational awareness
- Communication
- ECAM Management
- Knowledge

#### **Module (E): Intervention Training – In-seat Instruction (ISI)**

In-seat Instruction (ISI) should follow a predetermined scripted scenario. It is achieved by the instructor occupying a pilot seat and performing pre-determined exercises acting as the PF or PM for the purposes of monitoring and intervention by the other pilot.

Where a pilot is expected to respond to an error induced during ISI, the response should be according to the behavior expected in line operations. Ensure there is appropriate emphasis on the use of the word “uncomfortable” and the new CRM pilot monitoring intervention model (CRMM 9.5.1) – Ask, Suggest, Direct, Take-Over. When the Instructor is PF, he/she should ensure the PM is under a high workload.

When CM1 is the trainee the instructor shall occupy the CM2 seat and vice versa for when CM2 is the trainee. Instructors should target 4 intervention exercises per crew member; with the minimum acceptable for module completion being 3. Time permitting, these may be repeated as required.



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## Section 6 – Attachment 7: Intervention Training, In-seat Instruction (ISI) Part 2 – Emirates Example

### Module (D): In-seat instruction (ISI)

In-seat instruction (ISI) follows a predetermined scripted scenario. It is achieved by the instructor occupying a pilot seat and performing exercises acting as the PF or PM for the purposes of monitoring and intervention by the other pilot.

Where a pilot is expected to respond to an error induced during ISI, the response should be according to the behavior expected in line operations. Ensure there is appropriate emphasis on the use of the word “uncomfortable” and the new CRM pilot monitoring intervention model – Ask, Suggest, Direct, Take-Over. The Instructor should conduct a mix of PF and PM events. When the Instructor is PF ensure the PM is under a high workload.

When CM1 is the trainee the Instructor shall occupy the CM2 seat and vice versa for when CM2 is the trainee. Instructors should target 4 intervention exercises per crew member; with the minimum acceptable for module completion being 3. Time permitting, these may be repeated as required.

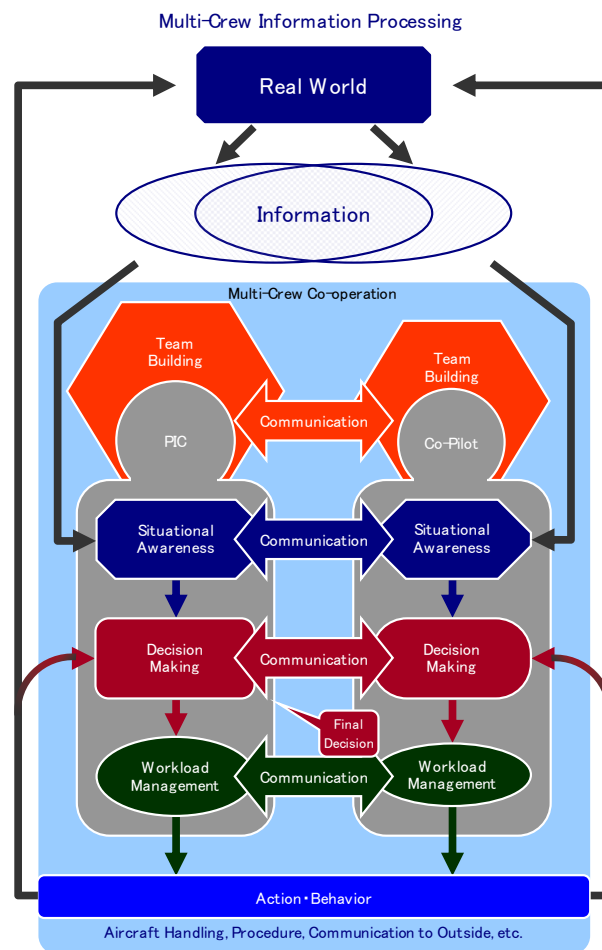
## Section 6 – Attachment 8: Communication Skills as Underpinning Attribute of Monitoring – Japan Airlines Example

### Communication Skills as underpinning attribute of Monitoring

We use the figure below to show how both pilots in a multi-crew environment interact on non-technical skills.

This Figure is used to explain how to:

- establish common *Situation Awareness* between both pilots from real world
- proceed with team *Decision Making* for optimum decision
- conduct *Workload Management* to avoid overload of each pilot
- maintain a functioning team through *Team Building*, and...
- use *Communication* to enhance non-technical skills



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### The Training to enhance Communication

- Establishing and maintaining a common planning through briefing and intra-cockpit communication is a fundamental element of monitoring, though communication styles may vary from culture to culture.
- For each culture, the communication style appropriate for intra-cockpit communication can be introduced and enhanced during the recruit training process.
- A training course of "Language Art for Flight Crew" has been introduced as part of the CRM training during new-hire training aimed at enhancing communication skills.
- This Language Art course includes introduction and practical exercises on how to communicate effectively and concisely using verbal language. The course includes:
  - How to observe
  - How to analyze
  - How to express
- Language Art Training includes the following elements:
  - Understanding communication style in our culture
  - Distinction between fact and opinion
  - Appropriate order to express
  - Showing the facts or evidence (warrant)<sup>14</sup>
  - Construct with paragraphs
  - Awareness of point of view
  - Method of explanation
- In our training, we include:
  - For new hires, a full day course in MPL/CPL initial theory training
  - For existing crews, we are running Language Art refresher seminar every year

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<sup>14</sup> Warrant is just like the evidence that a prosecutor shows in court to prove the crime. Warrant is the reasoning why one insists on making a statement to express an opinion.

## Section 6 – Attachment 9: Monitoring the Hand-Flown Approach – Japan Airlines Example

### The “Monitoring hand-flown approach”

*Lack of hand flying in training and line operations also means lack of exposure to monitoring of hand flown approaches.* It is broadly accepted that manual flying skills are in the trend of decline. Along with additional training to create an opportunity for hand flying, use this opportunity as training for predictive monitoring for PM.

### Practical training in recurrent FFS #2

“Manual Flying and Monitoring”

#### AIM

- Practice manual flying skills (PF) and monitoring (PF and PM) during manual flight.
- For effective Predictive Monitoring, share detailed plan in briefing.
- Monitor the manual flown approach based on previously shared plan and finding deviation from the planned maneuvering.

#### Training

Choose a complicated approach which is used often in the airline. Allow sufficient time to prepare and brief. We used RJTT ILS-X 34L from KAIHO arrival.

- Repeat 3 times in different set-up and/or different approaches.
  - Start from FL180. Manual flying by Captain with FD off.
  - Start from 6,000ft. Manual flying by Captain with basic modes of FD.
  - Start from 5,000ft. Manual flying by F/O with FD. Non precision approach.

## Section 6 – Attachment 10: Sample Syllabus for Training Monitoring – Singapore Airlines

Here is a high-level outline of a sample syllabus from Singapore Airlines for training monitoring.

A graduated approach should be taken in developing an integrated Pilot Monitoring Training Program. It should start with solid grounding in theoretical knowledge, followed by instructor led case studies. This should include videos and finally LOFT training.

The purpose of this program is to build on each layer progressively. Developing the right attitude is the most important aspect of this training program. Monitoring requires discipline and it has to be a continuous effort, not a secondary after thought. The primary role of both crews should be flight path monitoring.

To effectively monitor flight path, flight crews must first be well trained in the basics, which includes pilot skills and discipline. Without these basics, which are part of the foundation of airmanship, effective monitoring may not be possible. This must be clearly made known to the trainees.

### 1. Skill

Without the necessary skills to operate the aircraft at an optimal level, a flight crew member will be overwhelmed with the monitoring task. Furthermore without proper automation and systems knowledge, the flight crew will not be able to understand nor predict the aircrafts behavior.

### 2. Discipline

Discipline is a foundation of monitoring. Adherence to division of duties is essential in managing workload. Often this line is blurred, especially during non-normals, e.g., the PF reading the checklist together with the PM when the PF should be monitoring the flight path. Another example is when the PM is not monitoring the flight path, because it is assumed it is his secondary role. Another is failure to adhere to the silent cockpit rule during high areas of vulnerability. All of these situations, as well as others, require discipline.

### Sample Syllabus:

#### 1.1 Theoretical Knowledge

- 1.1.1 Defining Monitoring (FSF 1.2)
- 1.1.2 How we monitor – Information Processing Model (CAA Paper Annex A)
- 1.1.3 Classification of Monitoring Types (CAA Paper Annex C)
- 1.1.4 Barriers to Effective Monitoring (FSF Section 3)
- 1.1.5 What promotes good monitoring (CAA Paper 1.5)

#### 1.2 Case Studies – Instructor Led Briefings

- 1.2.1 Videos UK CAA Monitoring Matters (Available from UKCAA)
  - 1.2.1.1 Crew to identify monitoring errors
  - 1.2.1.2 Crew to identify TEM
- 1.2.2 FSF Appendix C: Selected Accidents in which Inadequate Monitoring Was a Factor

### 1.3 Practical Exercises – Loft Training

- 1.3.1 Crew to practice good monitoring behavior using FSF Appendix D: What Skilled Monitors Do, as a template.
- 1.3.2 Crew to Practice Workload Management (FSF Section 4 – Areas of Vulnerability)
- 1.3.3 Refer to CAA ANNEX E: Subtle LOFT events suitable for assessing monitoring competency
- 1.3.4 The debrief should consists of:
  - 1.3.4.1 Were the PF and PM roles clearly defined?
  - 1.3.4.2 Did the crew exercise discipline in adhering to these roles?
  - 1.3.4.3 How did TEM help improve monitoring?
  - 1.3.4.4 Identify the competencies that helped improve monitoring?
  - 1.3.5.5 What were the root causes of monitoring lapses?

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## Section 6 - Attachment 11: Steps for Teaching Monitoring in Initial Training

There is a basic set of steps to good monitoring training. Predictive monitoring is the goal in ab initio training; understanding what monitoring is, how to apply the monitoring process, how to monitor tasks, and how to apply effective monitoring during flight operations in all assigned tasks and roles and how to intervene.

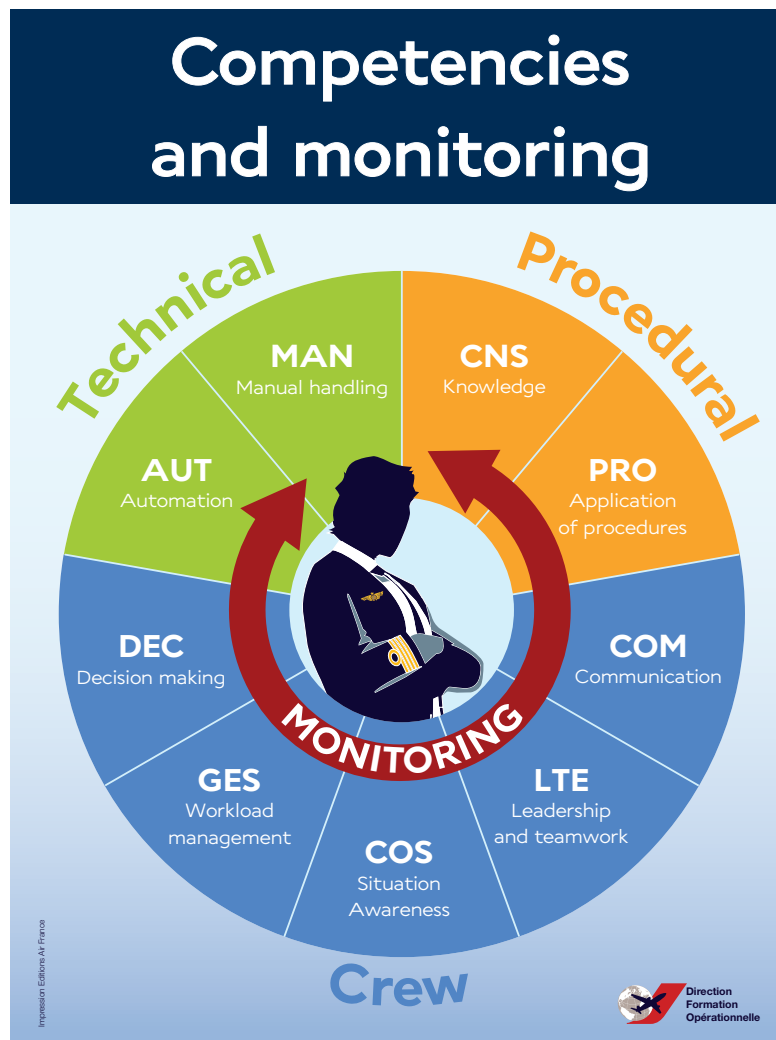
This table summarizes steps to be taken to train monitoring.

- Predictive monitoring is the goal in initial training.
- Give foundation knowledge of monitoring early in the training.
- Train fundamental flying skills enabling monitoring.
- Train multi-crew SOPs, callouts, cross verification, mutual briefing (train skills fortifying monitoring, i.e., sharing plans through briefing).
- Train workload management and communication skills through scenario-based training.
- Give opportunity to intervene.

## Section 7 - Attachment 1: Monitoring at the Center of the Competencies - Air France Example

Figure 1 below shows how monitoring was illustrated by an operator as the center of gravity of the pilot competencies. In this example the operator uses an adapted set of competencies; the competency "Knowledge" was added to the typical set of eight ICAO core competencies. Additionally the operator chose to group the competencies into "technical", "procedural" and "crew" competencies.

Figure 1





## Section 7 – Attachment 2: Examples of Grading Systems

**Example 1** below shows a grading system. “Assessment” was defined as the process of observing, recording and interpreting performance against a defined standard in the context of overall performance.

Competency-based assessment is seen as a continuous process during each session, by observing, recording, analyzing and determining pilot, instructor or examiner performance. Pilot (or instructor or examiner) performance is graded with reference to a 5-point scale.

The defined pass/fail limit is Grade 3 in each lesson.

Each grade is based on Behavioral Indicators (BIs). These indicators must not be used as a checklist. However, the achieved grade is a direct function of quality and quantity in demonstrating behavioral indicators taking into consideration:

- HOW WELL +
- HOW OFTEN +
- HOW MANY of the BIs were applied - and
- THE OUTCOME (in terms of safety)

GRADE	HOW WELL	HOW OFTEN	HOW MANY	OUTCOME
1	Not effectively (not standard)	Rarely	Few	Unacceptable reduction in safety margin
2	Marginally (but below standard)	Occasionally	Some	Reduction in safety margin or effectiveness
3	Adequately (standard)	Regularly	Many	Standard safety level
4	Effectively (above standard)	Regularly	Most	Enhanced safety and effectiveness
5	Exemplarily	Always	All	Enhanced safety, effectiveness and efficiency

**Example 2** shows a learner centered grading scale, to be used normally in training of inexperienced pilots. It contains 5 levels of performance; “not observed” represented by grade 6. The instructor or examiner can identify the achieved level of performance by assessing the 3 areas, instructor intervention, task completion and how often the relevant BIs were correctly applied.

<b>Grades / descriptors</b>	<b>Application of behavior indicators</b>	<b>Task completion</b>	<b>Instructor intervention</b>
<b>5</b> (Master)	<i>Always</i> applied	<i>Ideally</i> (safe, effective, efficient)	Not required, <i>inputs for optimization</i> welcome
<b>4</b> (Consolidate)	<i>Regularly</i> applied	<i>Safe and effective</i>	<i>Coaching</i> triggers quick correction of minor errors
<b>3</b> (Practice)	<i>Mostly</i> applied	<i>Safe</i> (see flight test tolerances)	<i>Assistance</i> temporary required
<b>2</b> (Apply)	<i>Occasionally</i> applied	Not yet safe	<i>Active</i> instruction
<b>1</b> (Describe)	Can be related to the tasks	Can be described	Demonstration and active instruction
<b>6</b> (not obs.)	-	-	-

## Section 9 – Attachment 1: The Facilitated Debriefing – United Airlines Example

*United Airlines provides the following guidance to its pilots, instructors and examiners regarding facilitated debriefings.*

### THE FACILITATED DEBRIEFING

The FOM states the following regarding the facilitated debrief:

An informal interactive debriefing of the crew's effectiveness in managing threats and/or errors that may have impacted safe operations shall be conducted for each flight. This assessment may occur during an appropriate phase of flight, at the conclusion of the flight, or deferred to take place in a setting that encourages an open discussion. This assessment should address the following points:

- Effectiveness employing CRM/TEM skills
- Clarification of any unresolved issues or conflict
- Capture lessons learned
- Accomplish appropriate mentoring and training

### Instructor/Examiner Facilitated Debriefing Training

This is a summary of the strategies and technique to guide the debriefing session. The two main goals of the debriefing session are:

1. Have the crew perform an in-depth analysis of the situation that confronted them, how they understood and managed the situation, the outcome, and ways to improve.
2. Have the crew participate in a proactive, rather than reactive, manner in which they initiate discussion and elaborate beyond the minimal.

The IE *must* clarify these goals up front, emphasizing that they enhance both learning and take-away.

### Facilitating LOFT/LOE Debriefings ~25 minutes

Proper facilitation:

- Encourages crew to evaluate their performance and, if appropriate, discuss ways to improve
- Encourages crew to explore CRM/TEM issues, how CRM/TEM affected their performance, and/or how CRM affects line operations
- Keeps focus on crew rather than IE by using techniques such as:
  - active listening which can range from simple acknowledgment such as "uh huh"
  - reflective listening in which IE repeats what is said
  - following up on crew-initiated topics, and
  - encouraging crew to address each other

Ask questions (as necessary) to introduce issues, elicit crew participation, and evoke deeper analysis.

- Allow at least 3 seconds of silence after IE questions and crew comments to allow crew to formulate thoughtful responses and encourage continued crew discussion and in-depth analysis
- If necessary, rephrases questions to avoid answering for crew
- Refrain from lecturing to crew or analyzing or evaluating crew performance without attempting to elicit substantial analysis and evaluation by the crew (unless absolutely necessary because crew will not participate or cannot grasp an essential concept)

### **Trainer Checklist for Facilitation Skills**

#### **Do:**

- Give an introduction and set expectations
  - Purpose - to encourage self-analysis (research says that it is the best form of learning)
  - Participation from them is needed and required
- Allow pilots to set the agenda order by asking:
  - Which bits of the session they want to discuss
  - What went well
- Use open questions (who, where, when, what, why, how)
- Deepen the discussion with supplementary questions
- Let them analyze what happened/why it happened/what they could improve on?
- Listen and encourage
- Use names, nod, smile, eye contact
- Sit forward to show interest
- Use silence/pauses (allow them time to think for several seconds)
- Mix instruction with facilitation for issues on which they don't have the knowledge themselves
- Summarize discussion to meet training aims

#### **Don't:**

- Skip the introduction - it is the most common way to impair facilitative training
- Lecture
- Use chronological agenda
- Short change high performing crews with quick debrief
- Interrupt
- Answer your own questions (better to reword the question)

- Just use question and answer
- Think or answer for them

**SELF CHECK:**

- Who is talking most - you or them?
- Have you used at least 2 questions per issue (to deepen discussion)?
- Are the pilots doing the analysis themselves?
- Are the training points being covered?
- Have the pilots spoken to each other?
- Has positive behavior been reinforced?

**IE Facilitated Debriefing Assessment**

Total score= total number of CRM/TEM or technical topics addressed during the debriefing.

Final IE score = Total score minus the number of items which were not addressed via facilitated debriefing (direct debriefing).

**Crew Member Facilitated Debrief****Successful Behaviors:**

- Debrief key events - positive and negative
- Continuously provide information to self-correct
- Captains mentor and train crew members
- Openly discuss successes and mistakes
- Ask, "How could we have done better?"
- Address and resolve any sources of conflict
- Crew using terms such as "we" instead of "you"
- Discuss what is right, not who is right

Crew members should have the goal of continually improving their performance. Lessons learned can be captured from every flight segment conducted during line operations as well as simulator training events. The crew part of this Facilitated Debrief is to assess crew performance. It is as important to discuss and learn from what you did right as it is to discuss and learn from mistakes. Discuss "what happened, not who did it."

Captains have the responsibility to mentor and train their crew. One of the most effective methods of mentoring is by conducting an operationally focused Facilitated Debrief. By openly discussing threats, errors, SOP deviations, and any Undesired Aircraft States encountered, everyone can learn to become better, more

effective, crew members. Additionally, the Facilitated Debrief provides a means to address any un-resolved issues or conflict.

The Facilitated Debrief should be structured but not rigid. Although unusual circumstances may require more time, most debriefs can be completed in just a couple of minutes. The Captain should keep two objectives in mind: learning and improvement. This is mentoring. One side of the United Airlines CRM/TEM lanyard card (see figure below) provided to each United Pilot includes a tool to accomplish the Facilitated Debrief.

**Brief:** What are the anticipated Threats?  
How do we prepare for them?

**Debrief:** Address the following topics at the conclusion of a specific phase of flight or post flight. Incorporating the CRM/TEM skills into the debrief is recommended.

**1. Threats**

- What threats were identified?
- How did we prepare for them?

**2. Errors**

- What errors were identified?
- How did we repair them?

**3. Safety /UAS**

- Were safety margins eroded?
- What UAS was identified?
- How did we recover?

**4. Standards**

- Were SOPs violated?
- When? How? Why?

**5. Unresolved issues / Conflict**

- Questions / conflict addressed?

**6. Lessons learned**



**Barriers to Effective Debriefing**

The Facilitated Debrief may not be effective if the crew:

- is defensive and / or is unwilling to self-evaluate
- is abrasive or arrogant about another crew member's performance
- does not participate or interact
- uses a confrontational tone
- emphasizes "who" vs "what" is wrong
- uses "I" instead of "we"
- is highly critical or judgmental
- refuses to discuss differences of opinion
- fails to recognize/resolve conflict

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