

Crew Resource Management in practice

The purpose of this document is to share recommended practices and information on Crew Resource Management (CRM) and promote the development of CRM training for both Air Operators having CRM training responsibilities, and Competent Authorities having oversight responsibilities.

The EASA Safety Risk Management process has identified CRM as one of the most important safety factor in the domain of Commercial Air Transport (CAT) Aeroplane operations.

Under normal conditions, crew rely on highly automated systems. Complacency and overreliance on automation are well known threats and monitoring and communication have become core competences for safety.

When confronted to complex failure conditions or adverse unforeseen situations, automated systems might not be able to deliver their intended function or might revert to modes that can confuse pilots. Under such challenging circumstances, the psychological and cognitive reactions to an expected event play a critical role in maintaining control on the situation and preventing aircraft upsets. Pilot competences in non-technical skills are paramount to a safe system and are developed with CRM training.

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1 Principles and objectives

Crew Resource Management (CRM)

Crew Resource Management (CRM) training encompasses a wide range of knowledge, skills and attitudes including automation management, monitoring and intervention, resilience development, surprise and startle effect management, safety culture and cultural differences; together with all the human dimensions which each of these areas entails.

CRM can be defined as a management system, which makes optimum use of all available resources (equipment, procedures and people) to promote safety and enhance the efficiency of flight operations.

CRM training improves the cognitive and interpersonal skills needed to manage the flight. In this context, cognitive skills are defined as the mental processes used for gaining and maintaining situational awareness, for solving problems and for making decisions. Interpersonal skills include communication and a range of behavioural activities associated with teamwork. These skill areas often overlap with each other and they also overlap with the required technical skills. Furthermore, they are not confined to multi-crew in cockpit but also relate to single pilot operations and cabin crew. CRM also expand beyond the cockpit doors as crews interface with other aircrafts, controllers and ground support (operations personnel, airport personnel, ground service providers, etc...).

Threat and Error Management (TEM)

Threat and error management (TEM) was introduced in the 1990s. The philosophy of threat and error management is the practice of thinking ahead in order to prevent and mitigate errors and operational threats and manage Undesired Aircraft States (UAS) which can result from these. A foundation of TEM is the acceptance that threats and errors will occur and that they have to be identified and managed.

Human error can happen. When errors occur (whether committed by an external agent or by the crew), the flight crew shall detect and respond in an appropriate manner. The behaviours of effective error detection and management are best illustrated by verifying and cross-checking actions and their effects (action-control), and evaluating the quality of decisions made. When errors are not detected or properly addressed, the level of risk increases.

TEM has been instrumental in the development of Evidence Based Training (EBT) as a pilot training concept; indeed the EBT pilot competences are used as countermeasures in the TEM model.

EASA regulatory initiatives in the domain of CRM

The Agency has published on 1st October 2015 two Decisions on Crew Resource Management training.

[ED Decision 2015/022/R](#) introduces new items in the applicable framework for CRM training. Such items are provisions for qualification and training of inspectors of competent authorities, expanded provisions for CRM trainers, provisions for computer-based training, CRM training and management system, competency-based CRM training, resilience development, surprise and startle effect, CRM training for single-pilot and single cabin crew operations, etc. This Decision relates to Part-ARO, Part-ORO and Part-SPA of Commission Regulation (EU) No 965/2012.

[ED Decision 2015/023/R](#) introduces new items in the applicable framework for CRM training for cabin crew. This Decision relates to Part-CC of Commission Regulation (EU) No 1178/2011. In addition, Decision 2015/023/R amends the Applicable Means of Compliance (AMC)/ Guidance Materials (GM) to Commission Regulation (EU) No 965/2012 as regards CRM training.

Amendments entered into force on 1st October 2016. They establish a more practicable and more effective framework for CRM training and provide operators with more reliable tools to mitigate CRM-related hazards and risks and, therefore, are expected to increase safety during all phases of flight.

References

✓ [Presentation 1 – CRM regulatory changes](#)

EASA Safety Promotion on CRM in practice

An in-depth assessment of the safety issue concluded that additional actions in the area of safety promotion were needed. EASA identified in the European plan for Aviation Safety (EPAS) 2017-2021 a Safety Promotion Task on CRM training (SPT.079).

Following the EASA CRM workshop of 8 November 2016, EASA addressed a survey to the Aircrew and Air Operations Technical Bodies and to the Flight Standards Stakeholders Technical Bodies. This survey contributed to the identification of the main difficulties encountered with the new CRM training requirements and allowed to the collection of recommended practices. National Aviation Authorities reviewed the work performed and shared their experience during a second EASA CRM workshop on 29-30 August 2017.

This safety promotion task takes stock of the recommended practices discussed during the workshops and related information are made available below.

References

✓ [Presentation 2 – EASA SPT.079 overview](#)

2 Competent Authority perspective

Since the new AMC/GM includes both new elements (i.e. resilience development, startle & surprise) and requirements for Competent Authorities (Part-ARO), the following actions were considered to properly implement the new Decisions and ensure full compliance:

- Asses differences between existing CRM training and new requirements to identify training needs for Flight Operations Inspectors. Some States formed a dedicated working group involving Operations Inspectors and Human Factors experts to do a gap analysis and identify missing learning objectives.
- Develop new mandatory training syllabus for inspectors to cover changes in ARO.GEN.200. Many States indicated that they have developed their own internal CRM training (Estonia, UK, Sweden, France, Croatia, Germany, etc.).
- Upgrade training for CRM/HF Trainers.
- Update oversight checklist and procedures.
- Inform and promote changes amongst Air Operators (Example: [ENAC Italy Compliance Checklist for CRM training](#))

References

- ✓ [*Presentation 3 – ENAC Italy / New CRM training implementation*](#)
- ✓ [*Presentation 4 – ENAC Italy / CRM training for FOI*](#)
- ✓ [*Presentation 5 – ENAC Italy / Point of view of a Regional Office*](#)
- ✓ [*Presentation 6 – Swedish Transport Agency / CRM Training Programme for FOI*](#)
- ✓ [*Presentation 7 – UK CAA / HF Principles Training*](#)
- ✓ [*Presentation 8 – CAA Luxembourg / OPS Implementing Rules, Reg. No 965/2012 \(incl. CRM\)*](#)

Flight Operations Inspectors qualifications for the oversight of operator's CRM training

Respondents to the survey indicated that the good qualification of Flight Operations Inspectors in the domain of CRM training oversight relies on both the inspectors' background and the training received to develop their competence and adapt to the latest amendments.

Flight Operations Inspectors background

To address specific concerns raised regarding flight OPS inspector qualifications, EASA developed a regulatory proposal, which was finalised in 2017 and led to the adoption of new AMC/GM to ARO.GEN.200 on inspector qualifications established by [Decision 2017/002/R](#) of 30/03/2017.

AMC4 ARO.GEN.200(a)(2) - Management system - clarifies the qualifications needed for an inspector to perform initial certification or oversight tasks relating to the flight crew operating procedures, or the aircraft/FSTD part of the flight crew training syllabi and checking programmes. The AMC ensures a certain degree of flexibility in terms of required technical background and knowledge, depending on the type of operations and products operated.

GM7 ARO.GEN.200(a)(2) - Management system – provides further guidance on how to establish inspectors experience, especially in the context of the approval and oversight of aircraft specific flight crew training and checking, where the inspector should have experience as an instructor.

In practice, many States reported that their inspectors in charge of the oversight of CRM training have previous experience in the field, or are still actively flying for operators. Preferably, Flight OPS Inspectors are former or actual Type Rated Instructor /Type Rated Examiner and are therefore very familiar with CRM concepts. The authority relies on inspectors' experience, acquired and consolidated during their engagement with operators.

Flight Operations Inspectors qualification and training

The document 'Proposal for a Competency Framework for the Competent Authorities' Inspectors' is available on the [EASA website](#).

Appropriate inspector competence is an essential enabler for the implementation of a Performance Based Environment, where the Authorities' interaction with overseen organisations and decision-making is based on multiple elements to be combined by expert judgement. To follow-up the work done on Risk-based oversight, it was felt necessary to identify the additional competences to enact this approach, which have to be held on top of the traditional domain-specific technical expertise. The focus was in particular towards a more proportionate style requiring constant dialogue with the overseen organisation in order to better understand how risks are mitigated, to assess the effectiveness of the mitigation process and the level of maturity of the organisation's safety management system.

The proposed competency model would therefore allow inspectors to act as an essential catalyst for the implementation of safety management and risk/performance-based oversight in the aviation system. Authorities may consider these competencies either to complement their existing frameworks or use them as a starting point in identifying the competencies they need to meet their specific organisational needs.

In addition to this generic competency framework, Flight Operations Inspectors in charge of the oversight of the operator's CRM training should be competent to evaluate the assessment of non-technical skills using proper techniques and methodologies.

Inspectors should be trained to effectively assess non-technical skills and "behavioural markers. It is strongly recommended to provide practical training in support of the theory. Different means can be used ranging from videos on cockpit scenarios reviewed during classroom sessions, up to mock-up training or simulator sessions.

References

- ✓ [Presentation 9 – EASA - Proposal for a Competency Framework for Competent Authorities' inspectors](#)

Assessment of the effectiveness of CRM training.

AMC1 ORO.FC.115(h) Crew resource management (CRM) training - provides detailed guidance on the assessment of CRM training. Compliance with those criteria sets the basis for its effectiveness.

Assessment usually takes place during practical observation of a training and inspectors should develop a good and up to date knowledge of what the indicators of effective CRM are.

Operators themselves should develop a methodology to evaluate the effectiveness of their CRM training and be able demonstrate to the inspectors its application during practical sessions.

In addition, the CRM program and its evolution should be linked to the operator's Safety Management System and should provide mitigation means against identified safety risks.

3 Air Operator perspective

Most of the operators surveyed indicated that the following developments were made to properly implement the new CRM training requirements:

- Adaptation of the Operation Manual Part D & ATO Manuals
- Review all existing training programmes including cabin crew training
- Adaptation of the Training Manual for CRM trainers
- Nomination of experienced flight crew CRM trainers
- Implementation of combined CRM Training with new exercises
- Introduction of CRM check in Operator Proficiency Check and Line Check forms

Large organisations might develop their own CRM training internally. CRM training can then be fully integrated into all involved staff training curricula. This offers a standard approach with training sessions bringing together aircrews, cabin crews as well as other ground operational staff, as appropriate.

CRM training can also be partially or fully subcontracted. Contractors are then able to integrate the feedback of different organisations and increase the quality of training for companies with limited exposure. Alternatively, small operators can team up to have one CRM Instructor training all pilots. When the training is subcontracted, the operator should anyway be able to demonstrate that he retains the ultimate responsibility for the CRM training and that no decisions are outsourced. In addition, the operator remains responsible for the Compliance Monitoring function, which should remain functionally independent.

The respondents to the survey highlighted the following proposals to properly implement CRM training:

- A good safety environment requires open and unrestricted communications between the operator and its pilots. Crew representatives should, as far as possible, be involved in the development of CRM assessment methodology.
- Develop new assessment forms.
- Develop CRM libraries for crew, instructors and examiners on an e-Learning platform.
- Allocate more time to CRM training.

References

- ✓ [Presentation 10 – Ryanair / CRM in Operations](#)
- ✓ [Presentation 11 – Jetttime /Implementation of a “new” CRM Training](#)
- ✓ [Presentation 12 – ECA / CRM Training, the flight crew perspective](#)

Connecting CRM training to the organisation Management System

Main sources for CRM training developments are:

- Operational risks identified by the Safety Management System
 - Safety analysis trends and risks assessments.
 - Air Safety Reports, Confidential Safety Reports, Online news and Safety Information Bulletins provided by Competent Authorities.
 - FDM reports and analysis.
 - Incident/accident reports on similar operations or aircraft.
 - IATA reports, sharing of info between operators
 - Participation in safety conferences
- Training Issues
 - Reported from Operator Proficiency Check (OPC), Line Check (LC) or recurrent training, using for instance de-identified results of CRM assessments. The usage of digital OPC forms facilitate the recording of CRM indicators in electronic format and the central monitoring of pilot competences. Safety Performance Indicators also contribute to monitor the safety standards
 - Flight Simulator data analysis (recurrent program).
- Compliance Monitoring System and Change Management when introducing a new type of operation or product.

4 General guidance and reference documents

The documents below provide few main references for CRM training.

A table with an explanation of the terms used in the AMC/GM was presented to the Competent Authorities in the second workshop. This document is shared as a non-binding supporting document to facilitate the common understanding of the new inspector CRM qualifications and training described in the ED Decisions 2015/022/R and 2015/023/R.

References

- ✓ [Presentation 13 – EASA / Inspector's qualification and training – terms used in the AMC](#)
- ✓ [EASA - Explanation of the terms used -used in the AMC for Inspector's qualification and training](#)
- ✓ ICAO – PANS Training (Doc 9868)
- ✓ ICAO Doc 9683 - Human Factors Training Manual (Doc 9683)
- ✓ [CAA UK CAP 73: Flightcrew human factors handbook , 16 December 2016](#)
- ✓ [IFALPA Pilot Training Standards – 1st Edition, September 2012](#)
- ✓ [Flight Safety Foundation ALAR Briefing Note 2.2 "Crew Resource Management"](#)
- ✓ [Operator's Guide to Human Factors in Aviation \(OGHFA\) - a project of the Flight Safety Foundation \(FSF\) European Advisory Committee.](#)
- ✓ <http://www.crewresourcemanagement.net>

Automation and the philosophy on use of automation

Automation has substantially improved flight operations and safety through improved flight path management, increased flight precision and flight envelope protections.

Optimum use of automation requires adherence to the aircraft design and operating philosophies. Design philosophy has evolved with new aircraft generations and require the development of new knowledge and skills regarding the usage of automated systems.

Operating procedures and philosophies of each manufacturer provide the basis for operators to develop their standard automation policy.

Training shall ensure that pilots are competent to make the best use of automated systems and monitor automation, in particular mode transitions and reversions. Automation level should be appropriate to the situation taking into account the task to be performed (strategic vs tactical), the flight phase, and the time available. However, there is no simple and clear level of automated systems hierarchy. FAA report on Operational Use of Flight Path Management System stress that a policy on using flight path management is more appropriate than an automation policy. The automated systems and their selection are directly guided by the policy enacted.

References

- ✓ [PARC Report – Operational Use of Flight Path Management Systems](#)
- ✓ [EASA Automation Policy – May 2013](#)
- ✓ [SIB 2014-17- Aeroplane Mode Awareness During Final Approach](#)
- ✓ [SIB 2013-05 - Manual Flight Training and Operations](#)
- ✓ [SIB 2010-33R1 - Automation Policy - Mode Awareness and Energy State Management](#)
- ✓ [Operator's Guide to Human Factors in Aviation – Automated Cockpit Guidelines](#)
- ✓ [Flight Safety Foundation ALAR Briefing Note 1.2 “Automation”](#)
- ✓ [Eurocontrol, Hindsight 20 - Winter 2014](#)
- ✓ [Cockpit Automation: Advantages and Safety Challenges \(SkyBrary article\)](#)

Monitoring and intervention

Flight crew members should receive training on the use of automated systems in accordance with an automation policy based on manufacturer provisions and Standard Operating Procedures. This policy usually indicates which level of automation should be used in each phase of flight or depending on circumstances and usually gives special attention to human limitations, mode awareness, automation surprises and over-reliance, including a false sense of safety and complacency.

CAA Paper 2013/02 and IATA Guidance Material for Improving Flight Crew Monitoring reflect on the complexity of monitoring. Pilot Monitoring duty is a subset of Standard Operating Procedures where pilots are trained and evaluated on their monitoring competence.

The reference documents summarise the respective skills and observable behaviours integrated within existing non-technical skills pertinent to good monitoring competence. Monitoring, communication and intervention strategies play a fundamental role by stimulating a dialogue among the flight crew, which helps to anticipate threats, detect errors, and recognise and manage UAS.

CAA paper 2013/02 also provides guidance on how operators can monitor the efficiency of the monitoring skills using FDM and ASR reports.

References

- ✓ [IATA Guidance Material for Improving flight Crew Monitoring \(1st Edition\)](#)
- ✓ [CAA Paper 2013/02 - Monitoring Matters - Guidance on the Development of Pilot Monitoring Skills](#)
- ✓ [Flight Safety Foundation - A practical Guide for Improving Flight Path Monitoring](#)

Resilience development

Resilience is defined as the ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions.

Resilience competences are natural abilities linked to personality but people are also capable of learning and developing to become more resilient.

One of the leaders in the area of training resilience, Luxair, has shared their training material freely on the Royal Aeronautical Society website so that other airlines can learn from their experience.

References

- ✓ [Presentation 14 - Cargolux / Resilience Development](#)
- ✓ [Royal Aeronautical Society Human Factors in Flight Operations and Training \(HFG\[Ops\]\)](#)

Surprise and startle effect

Whereas startle occurs as a response to a sudden, high-intensity stimulus, surprise can be elicited by an unexpected stimulus or by the absence of a stimulus foreseen in the situation.

Unexpected or unusual and stressful situations covering surprises and startle effects can influence flight crew performance in many detrimental ways. Because these effects serve as a distraction, which can disrupt normal operation and erode safety margins.

CRM training should address:

- Recognising and reducing startle and surprise effects through emotional and cognitive control;
- Developing and maintaining the capacity to manage crew resources;
- Developing, maintaining and using adequate automatic behavioural responses; and
- Recognising possible loss of situation awareness and re-building awareness and control.

Sudden and unexpected Pilot-induced, Environment-induced or System-induced events with a level of threat or upset can significantly impair the pilot information processing capacity. Such startle effect, if not rapidly and properly managed, can lead to losing control on the situation, which can result in upsets and loss of control accidents.

EASA launched end of 2015 a research on Startle Effect Management. This study suggests a 3 step “mental upset” recovery method, which was successfully tested in simulator by NLR at the KLM Training Center:

1. Unload, giving an active way of relaxing and controlling emotions after a startle or surprise;
2. Roll, giving a method to resume the cognitive process and rebuild situational awareness;
3. Power, projecting the situation into the future and foreseeing what mitigating measures can be taken to avoid eroding safety margin.

References

- ✓ [*Presentation 15 - EASA Research on Startle Effect Management*](#)
- ✓ [*IATA –Environmental Factors Affecting Loss of Control In-Flight: Best Practice for Threat Recognition & Management \(1st Edition\)*](#)
- ✓ [*CAT Magazine 1/2014 – Prepared to be surprised*](#)

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