

CAP 737

Crew Resource Management (CRM) Training

**Guidance For Flight Crew, CRM Instructors (CRMIS) and
CRM Instructor-Examiners (CRMIES)**

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Revision History

Amendment 1/2006**November 2006**

This amendment brings Appendix 16 into line with the recent amendment to Standards Document 29.

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Explanatory Note

1 Introduction

- 1.1 The purpose of this publication is to provide a comprehensive guidance document on Crew Resource Management (CRM), from a UK perspective. This document should contain, or reference, all the information which flight deck crew, CRM Instructors (CRMIs), or CRM Instructor-Examiners (CRMIEs) need to know concerning CRM. It will also be relevant to cabin crew CRM and, to some extent, human factors training in other aviation contexts (such as military aviation, maintenance, ATC, etc.).
- 1.2 The secondary purpose of the document is to explain the procedures involved for the issue and revalidation of CRMI and CRMIE, to indicate the requirements to be met by applicants in respect of their experience, training and other matters affecting their ability to be CRMIs or CRMIEs.

2 Applicability

- 2.1 CRM applies to all areas of flying operations, from commercial air transport to corporate and to private operations. However, formal accreditation of CRM Instruction is only required for commercial air transport, but best aviation practice is that all Instructors (including single pilot operations) should study and implement CRM procedures. Nevertheless, in the application of CRM principles, the Civil Aviation Authority (CAA) recognises that the operations to which this CAP will apply are numerous and varied and will endeavour to adopt as flexible an approach as is consistent with the maintenance of good standards. Small aircraft operators should bear this in mind when reading this document and considering its implications for their style of operations.
- 2.2 JAR-OPS 1 Amendment 7 expands upon CRM training for cabin crew. This CAP will, therefore, encompass the requirements for those instructors who wish to provide CRM courses for cabin crew (more details below) in accordance with Amendment 7 to JAR-OPS 1 Subpart O. Whilst detailed guidance for cabin crew CRM is not yet included in this CAP, it is the intention to provide such guidance in a later issue.
- 2.3 CAP 737 has been designed to facilitate the development of an operator's CRM programme for their crews. Its purpose is to augment the CRM requirements of JAR-OPS 1 and 3. A CRMI or CRMIE applicant will, not unreasonably, wish to know what precisely he needs to do to satisfy the CAA about these matters. The answer is essentially that he complies with CAP 737.

3 General

- 3.1 In this document the word "must" is used to indicate where the CAA expects the operator to respond and adhere closely to the defined requirement. The word "should" is used to indicate that the operator has a degree of latitude, particularly where the nature of the operation affects the degree of compliance. The use of the word "should" must not, however, be taken to mean that nothing need be done. If the operator response is deemed to be inadequate or inappropriate by the CAA, a specific requirement may be applied as a condition of compliance with the requirements.

- 3.2 References to the masculine gender used for convenience in this document apply equally to the feminine where appropriate.
- 3.3 The term “flight crew” normally refers to the flight deck crew, i.e. pilots and flight engineers, and is used for convenience.
- 3.4 The Appendices in CAP 737 have drawn upon material from other published documents, sometimes including large sections of text verbatim. The style, therefore, may change between Appendices.
- 3.5 This is a living document and will be revised at intervals to take account of changes in regulations, feedback from industry, and recognised best practice.
- 3.6 If you have any comments on this edition, please send them to Flight Operations Training Standards, CAA, SRG, 1W Aviation House, Gatwick Airport South, W Sussex, RH6 0YR.

4 Acknowledgements

Acknowledgements are given to the members of the CAA staff, members of the CRM Advisory Panel, and members of the RAeS CRM Standing Group who contributed to this document, and to those authors whose work forms the bulk of the Appendices.

Glossary of Terms

ACRM	Advanced CRM (a US concept)
AFG	Accreditation Focus Group (now renamed CRM panel)
AIC	Aeronautical Information Circular
AMC	Acceptable Means Of Compliance
AOC	Air Operator Certificate
ASRS	Aviation Safety Reporting System (US)
BALPA	British Airlines Pilots' Association
CAA	Civil Aviation Authority (UK)
CMAQ	Cockpit Management Attitudes Questionnaire
CRM	Crew Resource Management
CRM CRMAP	CRM Advisory Panel
CRMI	CRM Instructor
CRMIE	CRM Instructor Examiner
FAA	Federal Aviation Administration (US)
FDQAR	Flight Data Quick Access Recorder
FMAQ	Flight Management Attitudes Questionnaire
FODCOM	Flight Operations Department Communication
FOI	Flight Operations Inspector (CAA)
HPL	Human Performance and Limitations
IRR	Inter-rater reliability
JAA	Joint Aviation Authorities (Europe)
JAR	Joint Aviation Requirements
JAR-FCL	JAR Flight Crew Licensing
JAROPS	JAR Operations
JAR-OPS	Joint Aviation Requirements – Flight Operations
JAR-TEL	Joint Aviation Requirements - Translation and Elaboration of Requirements
LLC	Line/LOS Checklist (University of Texas (UT))
LOE	Line Operational Evaluation
LOFT	Line Oriented Flight Training
LOS	Line Oriented Simulation
LOSA	Line Operations Safety Audit (University of Texas (UT))

LTC	Line Training Captain
NOTECHS	Non-Technical Skills behavioural marker system (Europe)
NPA	Notice of Proposed Amendment (relates to JARs)
NTS	Non-Technical Skills
RAeS	Royal Aeronautical Society
RETRE	Revalidation Examiner for Type Rating Examiner
ROI	Return on Investment
SFE	Synthetic Flight Examiner
SFI	Synthetic Flight Instructor
SOPs	Standard Operating Procedures
TGL	Temporary Guidance Leaflet
TI	Training Inspector (CAA)
TRE	Type Rating Examiner
TREM	Threat and Error Management (training)
TRI	Type Rating Instructor
UT	University of Texas

Chapter 1 Introduction

1 Introduction

- 1.1 CRM was developed as a response to new insights into the causes of aircraft accidents which followed from the introduction of flight recorders and cockpit voice recorders into modern jet aircraft. Information gathered from these devices has suggested that many accidents result not from a technical malfunction of the aircraft or its systems, nor from a failure of aircraft handling skills or a lack of technical knowledge on the part of the crew; it appears instead that they are caused by the inability of crews to respond appropriately to the situation in which they find themselves. For example, inadequate communications between crew members and other parties could lead in turn to a loss of situational awareness, a breakdown in teamwork in the aircraft, and ultimately to a wrong decision or series of decisions which result in a serious incident or a fatal accident.
- 1.2 The widespread introduction of the dynamic flight simulator as a training aid, allowed various new theories about the causes of aircraft accidents to be studied under experimental conditions. On the basis of these results, and in an attempt to remedy the apparent deficiency in crew skills, additional training in flight deck management techniques has been introduced by some airlines. Following a period of experimentation and development, the techniques embraced by the new training became known collectively as CRM. The importance of the CRM concept and the utility of the training in promoting safer and more efficient aircraft operations have now been recognised worldwide.

2 CRM Defined

- 2.1 CRM encompasses a wide range of knowledge, skills and attitudes including communications, situational awareness, problem solving, decision making, and teamwork; together with all the attendant sub-disciplines which each of these areas entails. The elements which comprise CRM are not new but have been recognised in one form or another since aviation began, usually under more general headings such as 'Airmanship', 'Captaincy', 'Crew Co-operation', etc. In the past, however, these terms have not been defined, structured or articulated in a formal way, and CRM can be seen as an attempt to remedy this deficiency. CRM can therefore 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.
- 2.2 CRM is concerned not so much with the technical knowledge and skills required to fly and operate an aircraft but rather with the cognitive and interpersonal skills needed to manage the flight within an organised aviation system. In this context, cognitive skills are defined as the mental processes used for gaining and maintaining situational awareness, for solving problems and for taking decisions. Interpersonal skills are regarded as communications and a range of behavioural activities associated with teamwork. In aviation, as in other walks of life, 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 aircraft, but also relate to single pilot operations, which invariably need to interface with other aircraft and with various ground support agencies in order to complete their missions successfully.

3 Cognitive Skills

3.1 Situational Awareness

3.1.1 Situational awareness involves conscious recognition of all the factors and conditions - operational, technical and human - which affect the safe operation of an aircraft. In order to establish situational awareness, human beings take in information through the five senses - touch, hearing, smell, sight and taste - both subconsciously or intuitively. This information is then transformed by the brain into a mental model of the situation, a process known as perception. The perceptive process depends not merely on current information for its evaluation of the situation but also takes account of past experience and sensations. Perception is therefore a product not only of immediate sensations but also of cultural and social influences acquired through a lifetime of experiences. Accordingly, because of the different factors which have shaped their lives, individuals interpret situations differently. Furthermore, they can also be unduly influenced by false information derived from the senses, such as illusions. Because of these factors, a high degree of situational awareness can be said to be achieved only when an individual's perception of events approaches the reality of the situation.

3.1.2 For the pilot of an aircraft, much of the information from which situational awareness is derived comes from the flight instruments and the navigational equipment on board, so the process of constructing an accurate mental model of the position of the aircraft in space, its condition, and the condition of the crew, is subject to a number of degrading influences such as inattention, distraction, under-arousal, stress, boredom, fatigue, etc., etc. In these circumstances, confirming the accuracy of mental models with other crew members by sharing information and perceptions about the situation, and by stating intentions, becomes of paramount importance for the safe and effective management of the flight. Furthermore, sharing knowledge and information not only helps to avoid the more obvious incidents and accidents arising from loss of situational awareness, such as controlled flight into terrain, but also lays a firm foundation for high quality decisions regarding the overall management of the flight.

3.2 Planning and Decision Making

3.2.1 A central aim of CRM is to ensure that high quality decisions are taken across the whole spectrum of flight operations. In this context, thorough pre-flight planning will not only provide a yardstick against which in-flight decisions can be made but will also allow all members of the crew to manage their own specific areas of responsibility successfully. Understanding the plan also allows individual crew members to contribute in the most effective way to decisions made in flight. It is important, therefore, as the flight progresses, that the Captain updates the crew at regular intervals on any changes to the original plan, so that individual crew members can maintain good situational awareness. This is particularly important during abnormal operations or in an emergency situation, where conditions affecting the progress of the flight and the safety of the aircraft are likely to change rapidly. In these circumstances, regular updates on the status of the flight allow each individual crew member to be sufficiently aware of the situation and needs of the moment to contribute in the most effective way to the decision-making process.

3.2.2 Allowing subordinate crew members to participate in the decision-making process does not mean that all decisions have to be made by committee. The degree of participation or otherwise from subordinate crew members depends to some extent on the type of behaviour which underpins the decision.

- 3.2.3 Skill-based behaviours rely to a large extent on prior learning and any associated decisions are made mainly subconsciously. In this situation, other crew members provide a passive monitoring role, although this may call for assertive intervention if the level of skill being displayed by the decision-maker falls below a safe standard (for example, if it is perceived by a non-flying crew member that the aircraft may be inadvertently descending in cloud towards high ground). Rule-based behaviours rely on previously-considered courses of action such as Standard Instrument Departures (SIDs), Standard Operational Procedures (SOPs), Flight Manuals, etc., and the associated decisions are made partly in the subconscious, where previous experience and training come into play, and also in the conscious mind, where previous learning is compared with the realities of the current situation. In these circumstances the participation of another crew member may be required to provide verification of the situation and validation of the course of action being proposed by the decision maker. Finally, knowledge-based behaviour is utilised in a situation which has not previously been encountered. In these circumstances, the crew is called upon to make a decision based upon a rational appraisal of the facts, so there may be considerable scope for the involvement of other crew members and - if time and circumstances permit - even outside agencies such as ATC or Technical Control.
- 3.2.4 The degree of participation in the decision-making process also depends to a considerable extent on the organisational culture, as well as current social norms. These factors include the aircraft commander's perception of his or her role and authority, and the way in which this perception is shared by other crew members and the various supporting agencies. In today's climate, commanders who manage the flight in an open and affiliative style, and who state their intentions from time to time in the course of the flight, are more likely to secure the co-operation and participation of other crew members than those who are overbearing and autocratic. Command style, however, is normally based on a perception of what the company or organisation expects from each individual crew member, and effective CRM will therefore flourish only where an organisational culture exists which empowers and encourages subordinate crew members to assist the Captain by participating appropriately in the decision-making process whenever the need for them to do so arises.

4 Interpersonal Skills

4.1 Communications

- 4.1.1 From the foregoing discussion on cognitive skills, it is evident that effective communication between crew members is an essential prerequisite for good CRM. Research has shown that in addition to its most widely perceived function of transferring information, the communication process in an aircraft fulfils several other important functions as well. It not only helps the crew to develop a shared mental model of the problems which need to be resolved in the course of the flight, thereby enhancing situational awareness, but it also allows problem solving to be shared amongst crew members by enabling individual crew members to contribute appropriately and effectively to the decision-making process. Most importantly, it establishes the interpersonal climate between crew members and is therefore a key element in setting the tone for the management of the flight.
- 4.1.2 The communication process invariably takes place in a social and organisational context and it is therefore profoundly influenced by company culture. Its effectiveness also depends on the experience level of the pilot or crew members involved in the transaction and their perception of their roles and position in the chain of command. The effectiveness of the communication process also depends on the

nature of the task and operational context in which the flight is taking place - e.g. the phase of flight, and whether it is being conducted under normal, non-normal or emergency conditions. In addition, it is affected by the mode of speech employed and the linguistic context in which the transaction takes place. In this context, individual styles, body language, grammatical styles and speech patterns all have their part to play. Because of these complexities, crew members need to be aware of and sensitive to the nuances of effective communication. They also need to understand and avoid where possible those elements which constitute a barrier to effective communication.

4.2 **Teamwork**

Successful teamwork is achieved when the output of the team is greater than that which could be developed by the sum of the efforts of the individual crew members acting in isolation - a process known as synergism. Synergism is produced by a process of interaction between crew members, whereby each individual is empowered and encouraged to contribute in the most effective way to the overall task of the team. Interaction is unlikely to occur, however, unless all individual members of the team fully understand their role within the group and how this role may vary depending on the circumstances under which decisions are being made and action taken. Consequently, good communications within the group, a high degree of situational awareness and a comprehensive understanding of the decision-making process by all members of the group are all prerequisites for the creation of synergy and the effective performance of the team as a whole. For operational reasons, many crew members form part of a new team on every flight, so it is important that the overall organisation culture encourages and fosters a climate in which good teamwork can flourish. It is also evident that a healthy organisational culture, which actively promotes CRM, will also foster good teamwork, since CRM and teamwork are inextricably intertwined in the realm of effective flight management techniques.

5 **Factors Affecting Individual Performance**

5.1 **Emotional Climate**

The term 'emotional climate' refers to the way that people in the team feel about themselves and each other during flight operations. Research indicates that factors which create a positive tone individually and collectively on the flight deck and among the wider operating team enhance the effectiveness of the cognitive and interpersonal skills displayed by crew members. Factors that have been shown to affect the emotional climate in which the team operates include perceptions of safety, clarity of job and task expectations, supportive communication, participation and involvement, recognition for contribution and freedom of expression. While the climate or tone of the operation depends to a large extent on the attitude and conduct of the Captain, every crew member should, nevertheless, be aware of the significance of a good working climate, and strive to put into practice those behaviours that are conducive to it.

5.2 **Stress**

A factor which can quickly undermine the emotional climate in which the crew is operating is stress - defined as a state of highly unpleasant emotional arousal associated variously with overload, fear, anxiety, anger and hostility - all of which threaten both individual performance and teamwork. Stress often arises as a result of a perceived gap between the demands of a situation and an individual's ability to cope with these demands. As stress involves the processes of perception and evaluation, it impinges directly on the cognitive and interpersonal skills which form the basis of

good CRM. Both arousal and alertness are necessary to enable each individual to achieve optimum performance in CRM-related skills, but too much or too little arousal will have a significantly adverse impact on the ability of the crew to function effectively as a team. It is therefore important for crew members not only to be aware of the symptoms of stress in themselves and others, but also to understand the effects which stress can have on CRM, and to mitigate these effects where possible by taking measures to counter them.

5.3 **Managing Stress**

In high pressure situations, stress can be relieved by establishing priorities and by delegating tasks to other members of the crew, but this technique can be successfully implemented only if an organisational culture has been established in the first instance which empowers subordinates by training them in the cognitive and interpersonal skills which will enable them to take on additional responsibility when the circumstances call for it. In a low pressure situation, where fatigue, boredom and over-familiarity with the task are the greatest hazards, careful attention to environmental conditions such as heat, humidity noise, vibration and lighting can help to maintain alertness. Concern of individual crew members for their own physical well-being by keeping fit and maintaining a healthy lifestyle, in so far as the demands of the job allow, will also help to ensure that they are best able to contribute to the team effort when the need arises.

5.4 **Commercial, Organisational Pressures and Morale**

Stress has been discussed earlier, but special mention should be given to commercial and organisational pressures, whether short term or long term, since these are often cited as being stressors, and can have an effect on morale. This topic is not specifically addressed within this document, but needs to be taken into account by CRM instructors when training, and when debriefing, and an opportunity given to the pilot undergoing training or checking to voice his/her concerns if such pressures are perceived to be a problem. Of course the solution to such a problem is not within the remit of CRM, or of training in general, but it may be appropriate for the instructor to provide feedback to the operator of this, and any other, issue(s) which might be adversely influencing the performance of flight crew, and hence CRM.

5.5 **Fatigue**

The theory of fatigue is covered in Appendix 3. Alertness and fatigue are factors which can affect individual performance and hence, CRM. The more fatigued you are, the less able you will be to cope with stress and workload. Obviously, efforts should be made to avoid undue fatigue in the first place but if it is unavoidable, good CRM should help you recognise the signs of fatigue in yourself and others, and take appropriate measures to ensure that it is not detrimental to performance (e.g. napping, where appropriate and allowable, drinking coffee, etc.). Fatigue is a major and sometimes complex topic within human factors, and is only referred to briefly here as one of the several factors which can affect performance.

5.6 **Incapacitation**

An extreme case of performance decrement is incapacitation of one, both or all flight crew members. Pilots are trained in what to do under such circumstances but must not forget that CRM in its wider context is still, in fact more, important (e.g. CRM between the non-incapacitated pilot and cabin crew, and between flight deck and ATC). Training, whether standard LOFT exercises or CRM scenarios, should ensure that flight crew can cope with situations where partial or complete incapacitation might occur.

6 CRM Training

To maximise their effectiveness in the aircraft, crew members not only need to acquire a sound grasp of the technical knowledge and skills necessary for the fulfilment of their particular role in the aircraft, but they also need to understand and develop the cognitive and interpersonal skills which are a prerequisite for good CRM. The nature of these latter skills, however, is such that they cannot readily be taught by the didactic training methods normally used to impart technical knowledge about the aircraft and its systems - methods sometimes referred to as 'chalk and talk'. Cognitive and interpersonal skills - CRM skills - are mostly concerned with understanding and interpreting behaviour, particularly behaviour which occurs in a group context, so they are more appropriately developed through a process known as experiential learning. Successful experiential learning occurs when an individual reflects on his or her past behaviour in a given organisational situation and gains sufficient insight to form a rational basis for behaving in a more effective way when faced with similar circumstances in the future. Consequently, CRM training usually takes place in groups and is often assisted by a trained facilitator who is equipped with the relevant knowledge, skills and techniques to foster the learning process. The standards required by instructors in CRM have recently been defined by an accreditation focus group (now the CRM Advisory Panel) under the auspices of the Royal Aeronautical Society. For both historical and practical reasons, CRM skills have tended to be taught separately from technical knowledge and skills, but the considerable area of overlap between the two disciplines suggests that the training would be more effective if it was integrated from the earliest stages of the aircrew training regime.

7 Behavioural Markers

Knowledge and experience about CRM built up in recent years by the use of facilitative training techniques has led to attempts to define optimum performance by the use of behavioural markers. Although these attempts are still in their infancy, a successful outcome would not only help to define more clearly the cognitive and interpersonal skills required for good CRM but also allow for a standard approach to the current problem of assessment, feedback and further training of individual crew members.

8 Conclusion

- 8.1 The concepts which underpin CRM are not new or gimmicky; rather they are an attempt to distil old axioms into a more coherent and cogent management style across the flight regime. Safe and efficient flight operations depend for their success not merely on the acquisition of sound technical knowledge and skills but also on the mastery by aircrew of the cognitive and interpersonal skills which form the basis of good CRM. Cognitive skills not only allow for the development and maintenance of good situational awareness but also underpin high quality problem solving and decision making techniques. In addition, interpersonal skills, which depend for their effectiveness on good communications, encourage the creation of synergy and the development of successful teamwork. Both cognitive and interpersonal skills are enhanced by a good emotional climate amongst the crew, but they are also easily degraded by stress, so management of the emotional climate and stress becomes an integral and important element of good CRM.

- 8.2 Currently, in many airlines, technical training and training in CRM skills is carried out separately, but in view of the crucial part which each aspect plays in the safe and efficient operation of aircraft, both types of training need to be integrated at the earliest opportunity. Moreover, CRM training would be considerably enhanced if a satisfactory and universally agreed set of behavioural standards could be developed. To ensure that the training is effective, CRM skills also need to be assessed in conjunction with the evaluation of technical knowledge and skills, based on a satisfactory method of assessing CRM skills that has been devised and accepted on an industry-wide basis.
- 8.3 CRM is not, therefore, merely an abstract management concept; it embraces principles and skills which, if combined with a high degree of technical knowledge and skill, will enable the crew to make best use of all available resources to achieve optimum efficiency in the conduct of operations while at the same time maximising the safety of the flight.

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Chapter 2 CRM History

1 Introduction

- 1.1 The fatal loss of an aircraft emphasises human weakness – man-made mistakes – with tragic results. In the early years of aviation technical defects were the main cause of accidents but more recently, as reliability has improved, the main cause has changed to the human error element. Of these human error causes, the lack of CRM skills demonstrated by the crew has been highlighted as a major contributory factor. As a result of these accidents, research has been undertaken to discover the root causes of failure of CRM skills.
- 1.2 This chapter will not address the details of the research concerning CRM, but the reader is referred to the Appendices where there is a comprehensive list of references, should they wish to delve deeper into the background of the subject, and rationale behind CRM training.
- 1.3 CRM training has been running in North America since the late '70s when a NASA-Industry sponsored workshop on "Resource Management on the Flight Deck" in 1979, and Patrick Ruffel-Smith's study of flight crew performance in a B747 simulator started the process. However, since this CAP is concerned only with CRM as applicable to UK flight crew, this chapter will summarise only history of CRM in the UK, from a regulatory perspective.

2 UK and JAA CRM Requirements

- 2.1 UK industry was first advised that CRM was to be included in flight crew training in November 1992 when CAP 360 (Air Operators' Certificates) was amended to include this requirement. Then the CAA decided in 1993 to enhance this information by publishing an Aeronautical Information Circular (AIC) on the subject of CRM training for flight crew. This was followed by another AIC in 1995 which had the original syllabus for a CRM course. In 1998, another AIC was published which contained information on the standards of CRM instruction and introduced CAA Paper 98005 (Behavioural Markers for CRM). This CAA Paper was to be the forerunner of the JARTEL NOTECHS project (an EU funded research project into the use of behavioural markers as a method of accurately assessing pilots for their CRM skills). A "Guide to Performance Standards for Instructors of Crew Resource Management in Commercial Aviation" was printed in September 1998 as another step towards improving the standards of instruction in CRM. Latterly, the JAA have produced an amendment to JAR-OPS 1 (formerly NPA OPS 16) and to JAR-OPS 3 (formerly NPA OPS 27) mandating the requirement for CRM instructors to be qualified to the acceptance of the Authority. Both amendments also require the assessment of pilots, both individually and as a crew.
- 2.2 It was, therefore, with this in mind that the CAA embarked on the process of formally accrediting all CRM instructors and instructor examiners. This process utilised the Accreditation Focus Group, a group of representatives from industry, BALPA, the RAeS, the ATA and the CAA, to consider how to set up this procedure for the accreditation of instructors. This group subsequently became the CRM Advisory Panel and its recommendations were used as the basis of the Standards Document 29 published early in 2002.

- 2.3 CRM Training requirements for cabin crew were expanded in amendment 7 to JAR-OPS 1 Subpart O (formerly NPA OPS 24) in 2004.

Chapter 3 Requirements

1 Introduction

Whilst CRM applies to all areas of flying operations, from commercial air transport to corporate and to private operations, currently this requirement is only mandated for commercial air transport aeroplanes and helicopters. However, best aviation practice is that all operators should study and implement CRM procedures. Nevertheless, in the application of CRM principles, the CAA recognises that the operations to which this CAP will apply are numerous and varied and will endeavour to adopt as flexible an approach as is consistent with the maintenance of good standards. Small aircraft operators should bear this in mind when reading this document and considering its implications for their style of operations.

2 CRM for Cabin Crew

JAR-OPS 1 Subpart O (incorporating amendment 7, 2004) includes requirements for CRM training for cabin crew, and cabin crew CRM Instructor qualifications. However, JAR-OPS does not require cabin crew CRM Instructors to be acceptable to the CAA. Therefore, it is not intended to formally accredit cabin crew CRM Instructors, but operators should ensure that they meet the requirements laid down in ACJ-OPS 1.1005.

3 CRM for Helicopter Crews

Similar CRM training requirements apply to both fixed wing and helicopter flight crew, but readers are referred to current JAR-OPS 3 requirements (incorporating amendment 3) for details of differences.

4 HPL Training for Flight Deck Crew

Before undergoing CRM training, flight crew must have an understanding of the basic underlying principles of human factors. These should be covered in human performance and limitations (HPL) training. Details of the requirement can be found in JAR-FCL.

5 Initial CRM for Flight Deck Crew

All flight crew members are required to undergo initial CRM training, which is based on the operator's syllabus. Details of the requirement can be found in JAR-OPS Subpart N 1/3.943.

6 Recurrent CRM for Flight Deck Crew

All flight crew members are required to undergo recurrent CRM training. Details of the requirement can be found in JAR-OPS Subpart N, JAR-OPS 1/3.965. The JAR-OPS requirement states that all major CRM topics should be covered at least once every three years. However, it is not essential to re-cover the whole syllabus in detail in this period. Operators should concentrate on areas applicable to their operations and aircraft types.

7 Assessment of Flight Crew CRM skills

JAR-OPS Subpart N (IEM OPS 1.943/ACJ No. 2 to JAR-OPS 3.943) states that "CRM skills assessment should be included in an overall assessment of flight crew members performance and be in accordance with approved standards". The purpose of such assessment is to: (a) provide feedback to the crew collectively and individually and serve to identify retraining, and (b) be used to improve the CRM training system". Readers are referred to chapter 7 of this CAP for further information concerning assessment of CRM. To this end, the operator should review his CRM training at least every three years.

8 Requirements for CRM Instructors (CRMIs) and CRM Instructor - Examiners (CRMIEs)

- 8.1 In 2001, FODCOM 6/2001 advised of the requirement for formal accreditation of CRM Instructors and CRM Standards. Document 29 contains details of the scheme.
- 8.2 In order to make understanding of the system as simple as possible, it was decided to model this system on the existing one for the approval and verification of TRI ratings and TRE authorisations. This procedure would have the benefit of using a proven system and one which would be both efficient and cost effective.
- 8.3 The accreditation process has been divided into three contexts for the qualification of CRM: Instructor – Ground School, Instructor – Simulator/Base, and Instructor – Line. An instructor may be qualified in more than one role.
- 8.4 JAR-OPS (AMC OPS 1.943) requires all CRM Instructors to have current operational experience in the relevant role. Some alleviations from this requirement will be given and will be subject to the discretion of the CAA.
- 8.5 The CAA will appoint a CRMIE - Ground School after observation by a suitably trained Flight Operations Inspector (FOI), Training Inspector (TI) or a suitably qualified member of the CRM Advisory Panel. The CRMIE – Ground School may then accredit CRMIs – Ground School after ensuring that they have been suitably trained and have reached the required standard as an instructor of CRM.
- 8.6 A CRMIE - Simulator/Base will be appointed after observation in the relevant role by a TI. In the case of TRE/TRIs who are qualified on both aircraft and simulator only one observation will normally be necessary. RETREs and TRI(E)s may assume grandfather rights as a CRMIE – Simulator/Base until their first revalidation observation of their authorities by a TI.
- 8.7 A CRMIE – line will be appointed by the AOC company who should ensure that the person appointed is a senior training captain with the relevant knowledge of CRM. This post should be agreed with the company's assigned inspector and recorded in the training manual. The CAA will carry out observations of the CRMIE – line on an opportunity basis. See also Chapter 5, paragraph 6.3.
- 8.8 These proposals were implemented over a three-year transition period to allow operators to adapt to them. "Grandfather rights" applied, during this period, to those instructors who have a proven track record and demonstrated instructional experience with a recognised training organisation.

9 Management of CRM

- 9.1 Each operator should appoint one person within the company who is to be responsible for all aspects of aircrew CRM, from the development of the syllabi and course to the selection and training of CRM instructors and examiners. This would be the CRM Manager who should be cited in the training manual. It is a statutory requirement that a training manual contains all information necessary to enable those persons appointed by the operator to give or supervise training to perform their duties. This does not mean that the training manual need contain every reference to CRM. It could contain the reference to the CRM manual, which could be a separate book but yet remain a controlled document within the overall training manual. The co-ordination of all the revalidations for the CRMIs and CRMIEs would also be the responsibility of the CRM Manager.
- 9.2 Some operators may not wish to conduct their own CRM training. They may appoint a CRMI from another organisation to run their courses for them, but they (the operator) will be responsible for the standard of the course and its syllabus as well as the standard of the training given.

10 Scheme of Charges

- 10.1 The introduction of the CRMI and CRMIE qualifications will, of necessity, attract a charge for the time utilised by the TI or the Panel Member when conducting a check outside the normal three-yearly revalidation of a TRE or RETRE.
- 10.2 CRMIs will be charged at the same rate as for the appointment of a TRI (as in the Scheme of Charges). These authorisations will be individual to the instructor and as such will be mobile and can be used with another operator or training organisation.
- 10.3 The charges for CRMIEs, when observed by a CAA Inspector or suitably qualified member of the CRM Advisory Panel, will be those applicable to the appointment of a TRE or CRE. This will not normally be transferable, as the authority will be tied to a particular operator.
- 10.4 These charges were not applicable until after 31 March 2003.
- 10.5 Several documents are referred to in this publication; the following is a list of up to date publications:

Table 1 CRM References

AIC 42/2002	Accreditation of Crew Resource Management (CRM) Instructors
AIC 27/2005	Accreditation of Crew Resource Management Instructors
FODCOM 10/99	Operator CRM Courses
FODCOM 13/2000	Letter of Consultation: Proposal to Introduce a System of Accreditation for Instructors of CRM
FODCOM 21/2001	CRM Instructor Accreditation
FODCOM 6/2003	Accreditation of Crew Resource Management Instructors
FODCOM 13/2004	CRM Accreditation - all AOC Operators
CAA Paper 98005	Behavioural Markers for Crew Resource Management
JAR-OPS 1 and 3	Various references to CRM in Subpart N e.g. 1.943

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Chapter 4 CRM Standards and Training

1 Introduction

- 1.1 This chapter sets out the standards of CRM required, the competencies that individuals need, the training they require, and how that training should be given. In common with other aspects of flight crew performance, the achievement of high standards of CRM rests on a foundation that is several layers deep, and the successful achievement of each stage relies on the preceding stage. In other words, crew performance will be determined by individuals behaving and operating to a set of standards; which will require them to have certain knowledge, skills and attitudes.
- 1.2 Although achieving standards is the end result of the training process, it must be considered first because it sets out the behaviour that the industry and regulators will require aircrew to demonstrate during flying operations.

2 CRM Standards

- 2.1 There are two issues in the specification of performance standards for CRM. The first is to identify and define the categories of behaviour and the second is to define the levels or standards of performance in each category which distinguish competence from non-competence.
- 2.2 The standards are competency based and therefore can be assessed against specific performance criteria. Much work has been done worldwide on these subjects, and although there is not yet an internationally agreed set of reference points, there is obvious overlap among categories and standards defined in the documents referred to in Appendix 11. This contains a selection of behavioural markers and competency standards currently used by various organisations.

3 Objectives of CRM Training

The objectives of CRM training are as follows:

- a) To enhance crew and management awareness of human factors which could cause or exacerbate incidents which affect the safe conduct of air operations.
- b) To enhance knowledge of human factors and develop CRM skills and attitudes which when applied appropriately could extricate an aircraft operation from incipient accidents and incidents whether perpetrated by technical or human factor failings.
- c) To use CRM knowledge, skills and attitudes to conduct and manage aircraft operations, and fully integrate these techniques throughout every facet of the organisation culture, so as to prevent the onset of incidents and potential accidents.
- d) To use these skills to integrate commercially efficient aircraft operations with safety.
- e) To improve the working environment for crews and all those associated with aircraft operations.
- f) To enhance the prevention and management of crew error.

4 CRM Training Syllabus

- 4.1 CRM training should be based on the JAR-OPS Subpart N syllabus. The operator or training provider should include a detailed CRM course syllabus, based on the JAR-OPS syllabus, in their Operations Manual. However, the aim should be to ensure that crews are able to make best use of all facilities available to them, rather than to cover any particular aspect of the syllabus. Operators should therefore give due regard to the type of operation and to company culture when designing or agreeing any CRM training. For example, the syllabus will need to take account of the level of automation in use in company aircraft.
- 4.2 Operators should build their own training programme to fit in with the company culture and SOPs. Table 1 can be used as a guide but operators should include additional material gathered from case-based studies and recent events. Particular attention should be given to cultural differences where this is applicable.
- 4.3 More detailed syllabi for human factors training, human performance and limitations training, and CRM training are included in Appendices 1 and 2 for information. It should be stressed that these are only examples and an operator may wish to use other sources of information when formulating a detailed CRM syllabus appropriate to their own type of operation.
- 4.4 Crews should have received training in Human Performance and Limitations. It is acceptable if this has been completed during licence acquisition or with another operator (where this can be verified as being carried out to a satisfactory standard). This should have covered at least the items listed in Appendix 2 paragraph 4.
- 4.5 Much of this ground should have been covered during initial training, and there should be no need to repeat the theory during CRM training if course participants have already studied the topics previously and are reasonably familiar with the concepts. Where possible, it may be appropriate to assess the level of knowledge of potential course participants in advance of the training course, and adapt the theoretical content accordingly. In any event, the training should concentrate on developing an understanding of CRM concepts, and any reference to the theory of human performance and limitations should be backed up by practical examples in an aviation context.
- 4.6 Table 1 shows the level of CRM instruction required for each stage of training. The aim should be to incorporate, where possible, CRM training into other initial and recurrent training but stand alone modules should be given where appropriate. Initial training given by another operator or training provider may be acceptable provided that syllabus takes into account the current operator's requirements or the operator's conversion course is amended to cover any deficiencies or additional requirements. Notwithstanding the requirements stated in Table 1, it should be emphasised that the aim should be to develop proficiency in CRM skills and recurrent training should be focused on this aim.
- 4.7 Recurrent training may be generic or type-specific. JAR-OPS states that all the syllabus items should be covered within a three year period, for recurrent training, but the primary aim of such training should be to ensure that weak areas of CRM within the company, and individuals, are addressed, rather than a religious cycling through the syllabus once every three years irrespective of actual training needs. Operators are encouraged to tailor their recurrent training to address the threats¹ and to place more emphasis upon CRM skills rather than repetition of knowledge.

1. The ICAO Human Factors Training Manual (Doc 9863) CRM chapter was amended in 2003 to include guidance on threat and error management (TEM).

- 4.8 This chapter will not go into detail on the various syllabus topics, but human error deserves special mention. The nature of the limitations on human performance in complex organisational systems is such that errors are inevitable. Details of the theory of human error, reliability and error management can be found at Appendix 5.
- 4.9 Because of the potentially catastrophic nature of flying accidents, enormous and largely successful efforts have been made over the years to reduce errors not only through the medium of good design, ergonomics, structures, strength of materials, etc., but also through improvements in organisation, regulation and training. Despite these efforts, however, accidents attributable to human factors still occur. The purpose of CRM training, therefore, is to provide a further level of defence against such an eventuality by ensuring that all aircrew are aware of the sources of human fallibility and by developing in individual crew members the knowledge, skills and attitudes that will result in the successful management and containment of inadvertent error.

Table 1 CRM Training Syllabus For Flight Deck Crew

Core Elements	Initial CRM Training	Operator's conversion course when changing type	Operator's conversion course when changing operator	Command course	Recurrent training	
(a)	(b)	(c)	(d)	(e)	(f)	
Human error and reliability, error chain, error prevention and detection	In depth	In depth	Overview	Overview	Overview	
Company safety culture, SOPs, organisational factors		Not required	In depth	In depth		
Stress, stress management, fatigue and vigilance			Not required			
Information acquisition and processing, situation awareness workload management		Overview	Overview	Not required		In depth
Decision making						
Communication and co-ordination inside and outside the cockpit				Overview		
Leadership and team behaviour synergy						
Automation, philosophy of the use of automation (if relevant to the type)	As required	In depth	In depth	As required	As required	
Specific type-related differences			Not required			
Case based studies	In depth	In depth	In depth	In depth	As appropriate	

NOTE: Where practicable, the training should be combined with cabin staff CRM training.

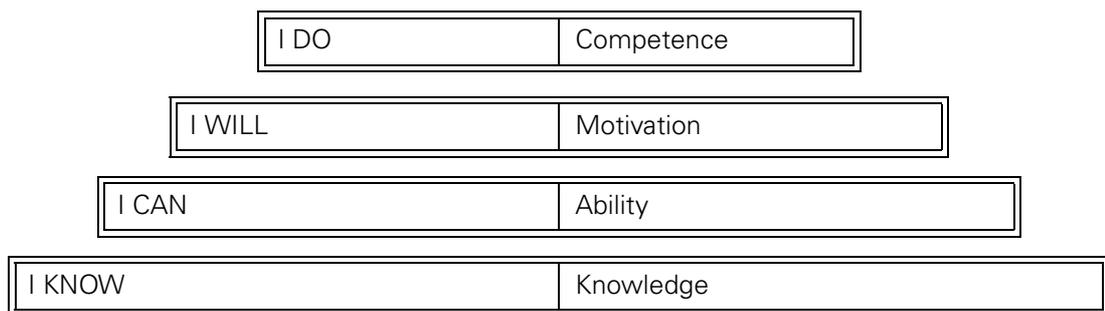
Table 2 CRM Training For Cabin Crew

Training Elements (a)	Introductory CRM Course (b)	Operator's CRM Training (c)	Aeroplane Type Specific CRM (d)	Annual Recurrent CRM Training (e)	Senior Cabin Crew Course (f)
General Principles					
Human factors in aviation General instructions on CRM principles and objectives	In depth	Not required	Not required	Not required	Overview
Human performance and limitations					
From the perspective of the individual cabin crew member					
Personality awareness, human error and reliability, attitudes and behaviours, self-assessment	In depth	Not required	Not required	Overview (3 year cycle)	Not required
Stress and stress management					
Fatigue and vigilance					
Assertiveness					
Situation awareness, information acquisition and processing					
From the perspective of the whole aeroplane crew					
Error prevention and detection	Not required	In depth	Relevant to the type(s)	Overview (3 year cycle)	Reinforcement (relevant to the Senior cabin crew duties)
Shared situation awareness, information acquisition and processing					
Workload management					
Effective communication and co-ordination between all crew members including the flight crew as well as inexperienced cabin crew members, cultural differences					
Leadership, co-operation, synergy, decision-making, delegation					
Individual and team responsibilities, decision making, and actions					
Identification and management of the passenger human factors : crowd control, passenger stress, conflict management, medical factors					
Specifics related to aeroplane types (narrow/wide bodies, single/multi deck), flight crew and cabin crew composition and number of passengers		Not required	In depth		
From the perspective of the operator and the organisation					
Company safety culture, SOPs, organisational factors, factors linked to the type of operations	Not required	In depth	Relevant to the type(s)	Overview (3 year cycle)	Reinforcement (relevant to the Senior cabin crew duties)
Effective communication and co-ordination with other operational personnel and ground services					
Participation in cabin safety incident and accident reporting					
Case based studies (see note)		Required		Required	

NOTE: In Column (d), if relevant aeroplane type-specific case-based studies are not available, then the case-based studies relevant to the scale and scope of the operation shall be considered.

5 CRM Training Methods

- 5.1 To maintain the integrity of the training process, training methods should be focused on objectives; rather than be activity driven, which tends to encourage a 'tick in the box' mentality. The objectives would be to ensure that participants develop the right knowledge, skills and attitudes. Whereas hitherto in the airline and other industries, training programmes have been constructed and assessed largely on the basis of their content, the more recent tendency is to assess programmes on the basis of the trainee outcomes they purport to achieve and the procedures they have in place to assess these outcomes.
- 5.2 This trend focuses the effort and investment in training on objectives which are defined in terms of measurable outcomes. It does not by any means render content obsolete, but recognises that content is only the means, not the end in itself, of training and education.
- 5.3 In behavioural training, where behavioural skills development and attitude changes are being encouraged, the interactive process of the actual training is what is of paramount importance. The following model in the field of training emphasises the relationship in which knowledge, skills and attitudes stand to each other in the learning and development process. The essence of the model is that knowledge, ability and motivation are all necessary to effect enduring changes in behaviour.



- 5.4 CRM training is a long term development process that encompasses a varied barrage of training resources and media, which run from the traditional and passive to the highly interactive and experiential such as: self study; classroom awareness training; modelling, classroom skills training; continual skills practice both classroom and simulator; and practice or coaching during flying operations. A selection of programmes and methods that might be considered best practice is at Appendix 9.
- 5.5 The onus for operators and regulators rests upon specifying CRM training objectives that map onto the competency standards which they require of their aircrew. Training contents and methods, and trainers themselves, need to accommodate the needs of the trainees in whatever ways, shapes and forms necessary to attain these ends, within the limits imposed by commercial and other practical considerations.
- 5.6 Cognitive and interpersonal skills - CRM skills - are mostly concerned with understanding and interpreting behaviour, particularly behaviour which occurs in a group context, so they are more appropriately developed through a process known as experiential learning. Successful experiential learning occurs when an individual reflects on his or her past behaviour in a given organisational situation and gains sufficient insight to form a rational basis for behaving in a more effective way when faced with similar circumstances in the future. Consequently, CRM training usually takes place in groups and is often assisted by a trained facilitator who is equipped with the relevant knowledge, skills and techniques to foster the learning process.

6 Summary

- a) Professional aircrew should demonstrate high standards of Crew Resource Management.
- b) Consistent with other aspects of aircrew performance, these standards should be well defined, objective and measurable.
- c) The knowledge, skills and attitudes required to meet these standards should be equally well specified, so that they can be thoroughly and systematically integrated with other aspects of aircrew training and training standards.
- d) CRM standards of performance have a bearing on flight safety and the efficiency of aircraft operations, and are essentially more explicit and refined versions of professional standards implicit in the common sense definition of 'airmanship'.
- e) These knowledge, skills and attitudes have wide applicability and should be incorporated into basic training of all personnel and their respective managers who are involved in the operation and dispatch of aircraft.
- f) The training methods and content to develop the knowledge, skills and attitudes should be appropriate to the culture and operation, and be focused on achieving the training objectives.

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Chapter 5 CRM Instructors (CRMI)

1 Requirements - General

- 1.1 The role of the CRMI derives from the JAR-OPS Subpart N.
- 1.2 CRMIs may be qualified in three contexts, namely Ground School, Simulator/Base and Line. A CRMI may be qualified in more than one context.
- 1.3 When exercising the privileges of a CRMI in an aircraft, the individual shall hold an appropriate valid and current licence.
- 1.4 With the exception of Line CRMIs, the qualification of CRMI may be carried forward from one operator to another subject to suitable training being given with regard to the second and/or subsequent company's culture, practices, and nature of operations.
- 1.5 A CRMI may be an instructor for more than one company at any one time.
- 1.6 All company CRMIs should be nominated in the company Operations Manual (Training).
- 1.7 Standardisation will be maintained by a CAA Inspector observing ground school training, LOFT training, simulator/base checks and line checks on an opportunity basis.

2 Instructor Requirements

2.1 Instructors Ground School

- 2.1.1 A CRMI (Ground) must meet the minimum standards contained in "The Short Guide" (Appendix 12), and should at least;
 - a) have completed a basic instructional technique course.
 - b) have or have had commercial air transport experience as a flight crew member; and
 - i) have successfully passed the Human Performance and Limitations (HPL) examination whilst obtaining the ATPL; or
 - ii) if holding a Flight Crew Licence acceptable under JAR-OPS 1.940 (a)(3) prior to the introduction of HPL into the ATPL syllabus, have completed a theoretical HPL course covering the whole syllabus of that course; or
 - iii) have theoretical experience in the subject of CRM or Human Factors training.Notwithstanding the above, and when acceptable to the CAA:
 - c) A flight crew member holding a recent qualification as a CRM trainer may continue to be a CRM trainer after the cessation of active flying duties;
 - d) An experienced non-flight crew CRM trainer having a knowledge of HPL, may also be, and continue to be, a CRM trainer;
 - e) A former flight crew member having knowledge of HPL may become a CRM trainer if he maintains adequate knowledge of the operation and aircraft type and meets the provisions of paragraphs a) and b) above.

- f) An instructor not meeting the above requirements may become A CRM Instructor at the discretion of the CAA after an observation by a CAA Training Inspector.

2.1.2 The CRMI must:

- a) have completed initial CRM training; and
- b) be supervised by a suitably qualified CRMI when conducting their first initial CRM training sessions; and
- c) have the knowledge and ability to teach the subjects detailed in Table 1 of Chapter 4.

2.1.3 The CRMI must demonstrate that they:

- a) have the knowledge specified for their relevant role;
- b) have the necessary instructional skills;
- c) are able to evaluate crews' CRM performance; and
- d) are able to facilitate constructive training of CRM issues.

2.2 **Instructors Simulator/Base**

2.2.1 A CRMI (Simulator/Base) must meet the minimum standards contained in "The Short Guide" (Appendix 12), and should at least;

- a) hold a TRI, TRE, CRI, CRE, SFI or SFE authority;
- b) have or have had commercial air transport experience as a flight crew member; and
 - i) have successfully passed the Human Performance and Limitations (HPL) examination whilst obtaining the ATPL; or
 - ii) if holding a Flight Crew Licence acceptable under JAR-OPS 1.940 (a)(3) prior to the introduction of HPL into the ATPL syllabus, have completed a theoretical HPL course covering the whole syllabus of that course; or
 - iii) have theoretical experience in the subject of CRM or Human Factors training.

Notwithstanding the above, and when acceptable to the CAA:

- c) a flight crew member holding a recent qualification as a CRM trainer may continue to be a CRM trainer after the cessation of active flying duties.

2.2.2 The CRMI must:

- a) have completed initial CRM training; and
- b) have the knowledge detailed in Table 1 of Chapter 4.

2.2.3 The CRMI must demonstrate that they:

- a) have the knowledge specified for their relevant role;
- b) have the necessary instructional skills;
- c) are able to evaluate and assess crews' CRM performance; and
- d) are able to facilitate a constructive debrief of CRM issues.

2.3 **Instructors Line**

2.3.1 A CRMI (Line) must meet the minimum standards contained in "The Short Guide", and should at least:

- a) have completed a basic instructional technique course;

- b) have commercial air transport experience as a flight crew member; and
 - i) have successfully passed the Human Performance and Limitations (HPL) examination whilst obtaining the ATPL; or
 - ii) if holding a Flight Crew Licence acceptable under JAR-OPS 1.940 (a)(3) prior to the introduction of HPL into the ATPL syllabus, have completed a theoretical HPL course covering the whole syllabus of that course; or
 - iii) have theoretical experience in the subject of CRM or Human Factors training.

2.3.2 The CRMI must:

- a) have completed initial CRM training; and
- b) have the knowledge detailed in Table 1 of Chapter 4.

2.3.3 The CRMI must demonstrate that they:

- a) have the knowledge specified for their relevant role;
- b) have the necessary instructional skills;
- c) are able to evaluate and assess crews' CRM performance; and
- d) are able to facilitate a constructive debrief of CRM issues.
- e) are able to meet the standards in 'The Start Guide' (Appendix 12) or company equivalent.

3 Grandfather Rights for CRMIs (Aeroplanes)

3.1 Ground School

All those personnel whose names were supplied to the CAA prior to 30 November 2001 and who had been providing ground school instruction of CRM were credited with "grandfather rights" as CRMIs for the period to 30 September 2004, provided they had been conducting CRM instruction for at least six months and had run part of at least two CRM courses. New instructors and any instructors who did not register for grandfather rights prior to 30 November 2001 who wish to give CRM tuition will need to be accredited by a CRMI Examiner (CRMIE) in accordance with Standards Document 29 (Appendix 16).

3.2 Simulator/Base

TRI, TRE, SFI or SFEs who conduct simulator or aircraft training were initially given grandfather rights until 1st October 2001. These grandfather rights remained in place until such time as their ratings or authorities were due for revalidation. All TRI, TRE, CRI, CRE, SFI and SFEs should have been accredited by 30 September 2004. New TRI, TRE, SFI and SFEs will need to obtain accreditation coincident with granting of their initial approval.

3.3 Line

Training Captains should have been accredited by 31 March 2003.

4 Grandfather Rights for CRMIs (Helicopters)

4.1 Instructors Ground School

- 4.1.1 Requirements are as Standards Document 29.
- 4.1.2 CRMIs can teach both aeroplane and helicopter crews provided they have the relevant experience.
- 4.1.3 Helicopter operators may continue with present arrangements until 1 January 2007.

4.2 Instructors Simulator/Base

- 4.2.1 Requirements are as Standards Document 29.
- 4.2.2 All TRE/CREs revalidating their authority will have to be accredited as CRMIs as from 1 May 2005.

4.3 Instructors Line

Requirements are as Standards Document 29, therefore all new line trainers will have to be accredited as CRMIs as from 1 January 2006. Existing trainers will have to be accredited by 1 January 2007. This is a Company Appointment.

5 Accreditation for CRMIs

- 5.1 In order to become accredited all instructors will need to demonstrate to a CRM Instructor Examiner (who may be a CAA Inspector) that they:
 - a) have the knowledge specified for their relevant role;
 - b) have the necessary instructional skills;
 - c) are able to evaluate, and assess crews' CRM performance; and
 - d) are able to facilitate a constructive debrief of those CRM issues.
- 5.2 On recommendation from the CRMIE, the CAA will accredit suitably experienced and qualified persons to conduct the appropriate training, for an initial period of three years. This accreditation will remain valid subject to the individual's continued employment as a CRMi.
- 5.3 Instructors without the relevant experience as aircrew who wish to instruct pilots in CRM skills must be accredited by a CAA Training Inspector.

6 Revalidation Criteria for CRMIs

6.1 Instructors Ground

With the exception of any period of grandfather rights, initial accreditation is for a period of three years. Thereafter, re-accreditation will be at the discretion of the CAA and subject to the following:

- a) The instructor should have conducted at least two courses of training in every yearly period within the three year accreditation period; and
- b) For re-accreditation, one course of training, or a part thereof, within the last 12 months of the accreditation period will be observed by a CRMIE, who may be a company examiner, a CAA Inspector, or a suitably qualified member of the CRM Advisory Panel.

6.2 **Instructors Simulator/Base**

TREs, CREs and SFEs will be accredited with CRM instructional and assessment skills when their authority is revalidated either by a CAA Training Inspector or a company. Revalidation Examiner (RETRE). TRIs and SFIs, if accredited separately from any other qualification, may be revalidated by a TRI(E), CRIs by a CAA Flight Examiner.

6.3 **Line Training Captains**

Line Training Captains will be accredited by a company CRMIE on a three yearly renewal basis. The accreditation process may be done as a workshop, during actual line training or during a simulator LOFT detail in the multi-crew environment.

For single pilot aeroplane operations the workshop may be combined with other operators who have a similar operating method.

7 Record Keeping

Records of all training courses conducted by instructors must be kept for a period of three years. These records should show the instructional course dates, the type of course or check, the name(s) of the candidate(s) and the type of simulator or aircraft (if any) that was used.

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Chapter 6 CRM Instructor- Examiners (CRMIEs)

1 Requirements - General

- 1.1 The role of the CRMIE derives from the JAR-OPS Subpart N and subsequent revisions. The CAA will authorise suitably experienced and qualified individuals as examiners to facilitate the accreditation of instructors as being competent to carry out CRM training. CRMIEs may be qualified in the three contexts of Ground School, Simulator/Base and Line. The CRMIE shall meet all the requirements of the CRMI in the context in which he is to be a CRMIE.
- 1.2 A CRMIE may be qualified in more than one context.
- 1.3 All company CRMIEs should be nominated in the company Operations Manual (Training). When exercising the privileges of a CRMIE in an aircraft, the individual shall hold an appropriate valid and current licence.
- 1.4 The CRMIE authorisation will remain valid subject to the examiner's continued employment with the sponsoring company. Should the examiner cease to be employed on examining duties, or leave the sponsoring company, the authorisation will automatically lapse.
- 1.5 A CRMIE may carry out accreditation checks on instructors not employed by the company sponsoring that examiner's authorisation subject to a written agreement between the sponsoring company and the third party. Copies of such written agreements must be forwarded to the Head of Training Standards at the CAA for his approval. The CAA will, on receipt of this copy agreement, reserve the right without prejudice, to refuse to sanction any such agreements.
- 1.6 Standardisation will be maintained by CAA Inspectors observing CRMIEs undertaking assessment of CRMIs at ground school training, LOFT training, simulator/base checks and line training/checks on an opportunity basis.

2 Examiner Requirements

Examiners in any CRM context shall be at least as well qualified and experienced as the CRMI candidate whom they are going to examine. This means that any CRMIE needs to fulfil at least the minimum qualification and experience requirements laid down for CRMIs in the relevant context.

2.1 Examiners Ground School

A CRMIE (Ground) should meet the minimum standards as those laid down for a CRMI (Ground).

2.2 Examiners Simulator/Base

A CRMIE (Simulator/Base) should hold a TRI(E) or RETRE authority.

2.3 Examiners Line

A CRMIE (Line) should hold a company appointment as a line training captain on the appropriate aircraft type. Where CRMI (Line) accreditation and/or revalidation is carried out by the means of a classroom based workshop, the CRMIE should be a senior trainer nominated by the company to the CAA for their acceptance of that appointment. See Chapter 3 paragraph 8.7.

3 Initial Accreditation

The accreditation process is divided into the three contexts of Ground School, Simulator/Base and Line.

3.1 Ground School

3.1.1 Initial accreditation of CRMIEs (Ground) will be by observation of the candidate CRMIE accrediting a CRMI (Ground) during a course, or part of a course of ground training. The observation will be carried out by a CAA Inspector or a suitably qualified member of the CRM Advisory Panel.

3.1.2 The accreditation will be for an initial period of three years.

3.2 Simulator/Base

3.2.1 TRI(E)s and RETREs who conduct TRI and TRE revalidations in simulators or aircraft have been given grandfather rights since 1st October 2001. These grandfather rights will remain in place until such time as the appropriate authority is revalidated. This revalidation is carried out by a CAA Training Inspector.

3.2.2 Extension of the existing authority to include CRM accreditation will be in accordance with Standards Document 29. All TRI(E)s and RETREs need to have been accredited by 30 September 2004.

3.2.3 New TRI(E)s and RETREs will need to obtain accreditation coincident with granting of their initial approval.

3.3 Line

3.3.1 Initial accreditation of CRMIEs (Line) will be by observation of the candidate CRMIE accrediting a CRMI (Line) in a workshop, on an actual line flight, or in the case of multi-pilot operators, on a simulator LOFT detail.

3.3.2 Alternatively, a company may nominate a senior trainer as a CRMIE (Line). This appointment is subject to acceptance by the CAA.

3.3.3 The accreditation will be for an initial period of three years.

4 Accreditation

In order to become accredited all instructor examiners will need to demonstrate to a CAA Inspector or a suitably qualified member of the CRM Advisory Panel that they:

- a) have the knowledge specified for their relevant role;
- b) have the necessary instructional and assessment skills;
- c) are able to assess instructors' teaching, evaluating and debriefing of CRM performance in accordance with 'The Short Guide' (Appendix 12); and
- d) are able to facilitate a constructive debrief of CRM issues.

On recommendation the CAA will accredit suitably experienced and qualified persons to conduct instructor examining for an initial period of three years. This accreditation will remain valid subject to the individual's continued employment as a CRM instructor examiner.

4.1 **Examiners Ground**

All CRMIEs (Ground) will require to become accredited prior to being authorised to examine CRM candidates.

4.2 **Examiners Simulator/Base**

All TRI(E)s and RETREs, who held valid authorisations at 30 September 2001 were given grandfather rights. These grandfather rights remain valid until the expiry of that authority at which time they will require to become accredited. To achieve accreditation an assessment will be made of their CRMIE performance to assess the teaching, evaluating and debriefing of the CRM aspects of LOFT and competency checks during the recurrent three-yearly revalidation observation.

All candidates put forward by their companies subsequent to 30 September 2001 were required to demonstrate their CRM instructor examiner performance to assess the teaching, evaluating and debriefing of the CRM aspects of LOFT and competency checks during the initial observation by a CAA Inspector.

4.3 **Examiners Line**

Line Training or Line Checking Captains have not received grandfather rights as CRMIEs (Line). Companies may nominate a senior trainer as a CRMIE (Line). Such appointment is subject to acceptance by the CAA, and standardisation will be achieved by periodic observation by a CAA Inspector observing the accreditation process.

5 Revalidation Criteria

5.1 **Examiners Ground**

Initial accreditation is for a period of three years. Thereafter, re-accreditation will be at the discretion of the CAA and subject to the following:

- The examiner should have conducted at least two accreditation checks in every yearly period within the three year accreditation period;
- For re-authorisation, one accreditation check within the last 12 months of the authorisation period will be observed by a CAA Inspector, or a suitably qualified member of the CRM Advisory Panel.

5.2 **Examiners Simulator/Base**

TRI(E)s and RETREs will be accredited with CRM instructional and assessment skills when their authority is revalidated by a CAA Training Inspector.

5.3 **Examiners Line**

Line examiners will be accredited by a CAA Inspector on a three yearly renewal basis. The revalidation may be achieved by observation of the CRMIE conducting a CRM (Line) accreditation in a workshop, during actual line training or during a simulator LOFT detail in the multi-crew environment.

6 Record Keeping

Records of all checks conducted by examiners must be kept for a period of three years. These records should show the instructional course dates, the type of course or check, the name(s) of the candidate(s) and the type of simulator or aircraft (if any) that was used.

Chapter 7 Evaluation and Assessment of Flight Crew CRM Skills

1 Introduction

- 1.1 In order to ascertain whether CRM training has been effective, it would be necessary to assess the CRM skills of flight crew members from time to time. CRM assessment is inevitable and essential if standards that address this major threat to safety are to be maintained and improved. However, if implemented inappropriately, assessment could be potentially damaging to increased safety in the long term. Trainers and examiners may be reluctant to explore CRM issues, so the objective of having CRM discussed in depth during briefings might be threatened.
- 1.2 Some methods exist for assessment of CRM skills (the NOTECHS system being one method), but operators and training providers are advised to familiarise themselves with the arguments concerning assessment of CRM and the application of behavioural marker systems before implementing such assessment. (Further information and some papers on the subject can be found on the CRM page of the Royal Aeronautical Society Human Factors Group website: www.raes-hfg.com. In particular, the paper entitled "The assessment of non-technical skills in JAR-OPS and JAR-FCL").

2 Assessment Requirement

- 2.1 Assessment is the process of observing, recording, interpreting and assessing, where appropriate, crew performance and knowledge against a required standard in the context of overall performance. It includes the concept of self-critique and feedback which can be given continuously during training, or in summary following a check.
- 2.2 There are four instances under which the assessment of Non-technical skills (NTS) or CRM takes place, namely the Licence Skill Test (LST), Licence Proficiency Check (LPC), Operator's Proficiency Check (OPC) and Line Check.
- 2.3 This assessment is in accordance with a methodology acceptable to the CAA and the purpose is to:
- provide feedback to the crew collectively and individually and serve to identify retraining where necessary; and
 - be used to improve the CRM training system.
- 2.4 At all other stages of the CRM training process, (i.e. initial CRM training, operators conversion course CRM training (whether a change of aircraft type or a change of operator), command course CRM training and recurrent CRM training), CRM should NOT be assessed with respect to pass/fail competence. However, there remains a requirement that crew members progress through the CRM training cycle should be evaluated such that feedback can be provided to the individual, any requirement for retraining can be identified, and continued improvement of the CRM training system can be implemented.
- 2.5 The subtle difference between assessment and evaluation is that assessment is made against a required standard. An assessment below that required, will require the pilot's CRM performance to be recorded as unsatisfactory and may require

remedial training. CRM skills assessment should be included in an overall assessment of the flight crew member's performance and should be in accordance with approved standards. When operating in a multi-pilot role it may be difficult to make an assessment of an individual crew member. However, this should be done where possible in order that the pilot concerned gains maximum advantage from the assessment and any recommendations that the instructor may make. If it is not possible to make individual assessments then this should be done as a crew. Individual assessments are not appropriate until the crew member has completed the full cycle of CRM recurrent training.

- 2.6 CRM assessment should only be tied to the assessment of technical issues, and not carried out as a stand-alone assessment. Suitable methods of assessment should be established, together with the selection criteria and training requirements of the assessors, and their relevant qualifications, knowledge and skills.
- 2.7 A crew member should not fail a licence or type rating revalidation check due to poor CRM unless this is associated with a technical failure (e.g. violation of SOPs, failure to observe company policies, etc.). However, an Operator Proficiency Check should not be considered as being satisfactorily completed unless the CRM performance of the pilot meets with company requirements. This does not prevent instructors and examiners from giving feedback on CRM issues where appropriate even if there has not been an effect on the technical performance of the flight.
- 2.8 Foreign TREs (non CAA approved) must be accredited as CRMIs in order to test for OPCs.
- 2.9 For individual CRM skills assessment, the following methodology is considered appropriate:
- An operator should establish the CRM training programme including an agreed terminology. This should be evaluated with regards to methods, length of training, depth of subjects and effectiveness.
 - The CRM standards to be used (e.g. NOTECHS) have been agreed by crews, operators and regulators, and reflect best practice.
 - The standards are clear, briefed, and published (in the Operations Manual).
 - The methodology for assessing, recording and feeding back has been agreed and validated.
 - Training courses are provided to ensure that crews can achieve the agreed standards.
 - Procedures are in place for individuals who do not achieve the agreed standards to have access to additional training, and independent appeal.
 - Instructors and examiners are qualified to standards agreed by all parties, and are required to demonstrate their competency to the CAA or such persons as the CAA may nominate.
 - A training and standardisation programme for training personnel should be established.
- 2.10 For a defined transition period (normally the full cycle of CRM recurrent training), the evaluation system should be crew rather than individually based.
- 2.11 Prior to the introduction of CRM skills assessment, a detailed description of the methodology (including standard terminology to be used) acceptable to the CAA, should be published in the Operations Manual (Training). This methodology should include procedures to be applied in the event that crew members do not achieve, or

maintain the required standards. Until recently the assessment of CRM training has lacked any formal measurement criteria resulting in subjective and extremely variable standards.

- 2.12 Research into means of assessment has determined that acquired CRM skills are reflected in recognisable behaviours, whose characteristics are identifiable as measurable behavioural markers. CRM skills assessment should be accomplished via a behavioural marker system (a behavioural marker is a taxonomy or listing of key non-technical skills associated with effective, safe task performance in a given operational job position). The need for a clear and simple system focusing on general concepts and their application is fundamental, as is the need for the training of the users of the system. Appendix 11 contains details of some behavioural marker systems which are currently used, the two main validated systems being (i) NOTECHS and (ii) the UT markers. A number of airlines have developed their own behavioural marker systems, and provided that these systems can demonstrate a similar level of robustness, there should be no reason why they should not be utilised.
- 2.13 Instructors and examiners should be familiar with the marker system in use by the operator in order to enable them to make constructive debriefs and give guidance to crews to improve future performance and also to make recommendations for further training where this is necessary. However, they should not use these markers as a check list when making assessments. CRM assessment should not be conducted as an activity survey for each phase of flight, but should be carried out within the overall assessment of the flight check.
- 2.14 Key to the use of any behavioural marker system is the training and standardisation of the assessors within the company. Regular re-standardisation is necessary as it has been shown that assessors' skills are degradable, and require regular re-evaluation and sharpening.

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Chapter 8 Evaluation of the Effectiveness of CRM Training

1 Introduction

- 1.1 CRM training effectiveness is particularly difficult to evaluate in terms of effectiveness, and few organisations would claim to have been successful. It cannot be measured by accident rates since there is not enough data. Incident data may sometimes be used, but other factors affect the rate and nature of incident reporting over time, often making it invalid to use incident rates as a measure. Indeed, a good safety culture can result in an apparent increase in incidents due to open and honest reporting, which does not necessarily equate to an increase in the number of CRM related errors.
- 1.2 Flight Data Monitoring (FDM) may offer a solution to a non-biased method of measuring incidents or exceedences, but without interviewing flight crew to determine the causes of the exceedences, no definite link with CRM (whether good CRM or poor CRM) can be established.
- 1.3 The methods most commonly used are based on subjective feedback from flight crew.
- 1.4 This chapter provides some information on the various methods available, but does not offer a preferred solution to the problem of how to measure the effectiveness of CRM training, since no perfect method has yet been found.

2 Methods Available

The effectiveness of CRM training can be evaluated at several different levels, namely:

- Reactions (how participants have responded to training);
- Learning (the principles, facts and skills which were understood and absorbed by the participants);
- Behaviour (whether knowledge learned in training transfers to actual behaviours on the job);
- Organisation (tangible evidence of success at an organisational level of an improvement in safety and/or efficiency).

2.1 Reactions ("happy sheets")

This method usually uses questionnaires given out to participants at the end of a training course, asking for their opinions, often in terms of their satisfaction or enjoyment of the course. Whilst a positive reaction does not necessarily equate with learning, a negative reaction is more informative in terms of an indication that the training may be flawed. If the majority of participants leave a training session frustrated or unhappy, it may suggest a problem with the course material or the way in which it was presented. CRM 'messages' are unlikely to be effective if reactions are negative.

2.2 Learning

2.2.1 Measurements of learning can be divided into two categories: (i) those assessing knowledge acquired, and (ii) those assessing attitude, or attitude change.

2.2.2 Measuring acquisition of knowledge has limited effectiveness in that a person can be knowledgeable about a subject but not agree with its aims, or adopt its principles in practice. CRM is a subject which does not lend itself readily to formal assessment of knowledge acquisition (i.e. examination/testing, especially multiple choice tests) since many of its elements do not have clear cut answers (e.g. definition of situation awareness).

2.2.3 Attitude measures are probably more useful as indicators of whether CRM training is likely to be effective, in particular if they are measures of attitude change prior to and post CRM training. However, one should be wary of assuming that apparent attitude changes immediately after training, will survive longer term, or, indeed, result in actual behavioural changes.

2.3 Behaviour

This is the most important measure as far as effectiveness of CRM training is concerned, but also the most difficult to measure. In order for CRM training to have a positive effect on behaviour, as opposed to just increasing knowledge of human factors and attitude, the following criteria must be met:

- The participants must have a desire to change;
- The participants must know what and how to make the change;
- The organisational climate must be conducive to change.

In addition, it helps if there is some reward for behavioural change (e.g. positive feedback, passing line checks).

2.4 Organisation

2.4.1 Few operators have been able to successfully measure CRM effectiveness at an organisational level. Many have tried, particularly to justify the cost of CRM training and measure return on investment (ROI). However, it is difficult to isolate just one factor, such as CRM training, in a constantly changing environment such as aviation, in order to prove a direct link between safety improvements and CRM. Mention has already been made of the problems of using incident and accident data as measures of effectiveness. However, it is possible to use incident data as an indicator of CRM training effectiveness, if used appropriately (e.g. British Airways BASIS Human Factors Reporting system).

2.4.2 Table 1 summarises the results from a study carried out by Aberdeen University¹ into methods used by UK Operators to assess CRM effectiveness.

1. Methods used to evaluate the effectiveness of flight crew CRM training in the UK aviation industry. CAA Paper 2002/05.

Table 1 Methods used by UK Operators to assess CRM effectiveness (based on 113 UK Operators)

Evaluation method	% of respondents using this method
Reactions	
reaction sheet	26
oral feedback/debriefing	74
Attitudes	
company specific attitude questionnaire	13
cockpit/flight management attitude questionnaire (CMAQ/FMAQ)	8
other (informal oral feedback)	79
Knowledge	
multiple choice test	12
written exam	12
oral feedback	76
Behaviour	
behavioural marker system	23
technical checklist	18.5
informal feedback	58.5
Organisation	
company climate survey	10
safety performance	22
incident reporting	23
business performance	13
confidential reporting	17
technical performance	8
other (all training audits)	7
360° appraisal	1

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Chapter 9 CRM for Single Pilots

1 Introduction

- 1.1 Whilst this chapter is applicable to public transport operations it is recommended as best practice for general aviation.
- 1.2 Chapter 1 gives a brief history of the development of CRM as we now understand the term. However, CRM has been around in different forms since the early years of aviation. What has changed is the increased reliability of aircraft and aircraft systems; the percentage of accidents caused by human factors; the subsequent recognition of the part played by the human element and the attempt to define good and poor CRM practice. The natural development of CRM has, not surprisingly, been mainly on multi-crew aircraft as this was supported by flight and cockpit voice recorders, and the use of simulators facilitated scenarios where CRM situations could be practised and discussed. Some high profile accidents involving multi-pilot aircraft also drew public attention to the subject. It is not surprising, therefore, that CRM tended to be regarded as being mainly applicable to multi-crew operations. This focus is understandable as much of the written material produced on CRM has been specifically written for multi-crew situations and has, to some extent, concentrated on the communication and relationships between pilots. However it should be recognised that CRM encompasses many elements which are applicable to both multi and single pilot operations. Much of this will be recognised as “airmanship” which has now developed into “non-technical skills”. These non-technical skills can be defined and assessed to facilitate improvement. The intent of this chapter is to highlight best practice, to define the various elements of CRM to enable analysis (particularly self-analysis), to facilitate debriefing and create an improvement in operating performance of single pilot crews.
- 1.3 Without in any way decrying currently available CRM publications, the CAA and CRMAP accept that the single pilot community has not been well served in respect of specifically targeted advice with regard to single pilot CRM issues.
- 1.4 The panel therefore formed a working group to look specifically at single-pilot CRM issues and to highlight information, books and videos, suitable for single pilot situations. These are listed at the end of this chapter.
- 1.5 The working group also looked critically at the information in this CAP with regard to the relevance of that information for pilots of SPA. The group came to the conclusion that most of the information was equally, or sometimes even more relevant to pilots of SPA, but that the presentation of that information was not always in a format best suited to pilots of SPA. SPA operations can be less complex with respect to certain aspects of CRM compared to MPA operations. There is no inter-crew communication and there are no flight deck issues involving authority and leadership. However, in other areas such as error management, decision making and planning, the lack of an additional crewmember can make the situation more demanding. The single pilot does not have the advantage of learning from the experience of other crewmembers on the flightdeck and often has to learn from his own mistakes. The only debriefing and evaluation available to the single pilot during normal operations is self-evaluation. The following is a summary of points the group highlighted as being particularly relevant.

2 Elements of CRM

2.1 Communication

2.1.1 Whilst communication across the flight deck may not be relevant to pilots of SPA, there are many situations in which communication is equally important. Such situations would include keeping the passengers and other non-flying crew members informed during normal and abnormal operations, liaising with ground crew and communications with ATC. The latter being particularly critical for flight safety as the cross check of instructions between crews on multi-pilot aircraft may not be available in the single pilot situation. It is absolutely vital, therefore, that if there is any doubt at all about ATC instructions, clarification is sought. Standard RT phraseology should always be used particularly when talking to ATC units that do not have English as their first language. Other factors which may affect the correct understanding of communications are:

- High workload
- Fatigue
- Distractions and interruptions
- Pre-conceived ideas.

2.1.2 It must also be recognised that communications with the company by way of keeping up to date with changes in procedures, new information, additional airport and route information etc. is more demanding as there is no one else on the flight deck with whom to crosscheck the information. However, much can be gained from liaison with fellow crewmembers before and after flights in the crew room and operations/ planning rooms.

2.2 Health

2.2.1 Incapacitation procedures have reduced the accident statistics for multi-pilot aircraft. However, these procedures are not available to safeguard SPA in the case of incapacitation of the pilot. It is even more important, therefore, that pilots ensure that they are in a properly fit condition to fly if they are the only member of the flight crew. In the event of feeling unwell during flight do not press on but land at the nearest suitable airport making use of all assistance available by declaring an emergency and making full use of any automatics.

2.2.2 Appendices 2 and 3 cover the Human Performance and Limitations aspects and as such are equally applicable to single-pilot operations.

2.3 Workload Management

2.3.1 Workload management is probably the most important item of single pilot CRM. There is no opportunity to delegate tasks in the air and there is a greater potential for the single pilot to become overloaded especially during an unusual, abnormal or emergency situation. Maintaining situational awareness and preserving mental capacity for planning and decision making is more difficult. Attention to, and being aware of, the process of prioritisation is one way to try to maintain some spare capacity.

2.3.2 Comprehensive self-briefing and pre-flight planning are essential. The aim should be to have a thorough understanding of all the aspects of the flight, weather conditions, airport procedures, routeing, aircraft serviceability etc. and that as much of the work as possible should be carried out on the ground, prior to flight. Problems should be anticipated and "what if?" procedures thought through so that in the event of any

unplanned events the contingencies can be put into place without the workload increasing to an unmanageable level.

- 2.3.3 In the event of an abnormality or emergency it is even more important to comply with standard operating procedures. This will help one to stay calm, make proper diagnosis of the problem and take the appropriate action. Reduce workload as much as possible, engage the autopilot if available, advise ATC and request for radar positioning. Many accident investigations highlight the fact that the checklists were not used and that inappropriate action was taken which prevented or reduced the likelihood of reaching a successful conclusion.

2.4 **Error Management**

- 2.4.1 Much of the error management in a multi-crew environment relies on cross checking of vital data and actions by the other crewmember. This facility is not available to the single pilot and therefore other techniques have to be employed.

- 2.4.2 In an ideal world the system will have eliminated latent errors (see Appendix 5 page 6). However, in the real world latent errors ready to trap the unwary pilot do exist in many guises. Therefore one needs to be constantly alert for these traps and be conversant with the aircraft and the operation to the greatest extent possible. Adherence to SOPs is again one of the main defences and all pilots should be alert to situations which are new, untried, distract from normal operations or are outside SOPs. The pilot should be comfortable with the operation. If not then it is probably necessary to take action to restore the comfort factor even if this means a decision to delay or cancel the flight.

- 2.4.3 Workload planning will allow the pilot to make decisions in good time and to self cross check any critical actions before implementation.

2.5 **Decision Making**

- 2.5.1 There are a number of guides and mnemonics' which are designed to assist the decision making process for multi-pilot crews. These generally involve

- Assessing the situation and gathering data
- Considering options
- Deciding on the "best" option
- Communicating your intentions
- Carrying out the actions
- Checking/reviewing the situation
- Adapting to new information or changing situations.

- 2.5.2 Research shows that experienced pilots use previous experience of similar situations to "short cut" the decision making process. However, no two situations are exactly the same and it is important to recognise that the decision making process is driven by the pilot's situation assessment.

- 2.5.3 In the SPA case there is usually no one to help gather the information and cross check actions. Also, facing an abnormal or emergency situation alone can be a frightening and traumatic experience. A natural reaction can be one of shock (surprise) or disbelief, which is called startle reflex. This is a completely normal and instantaneous phenomenon as the brain can absorb information about an emotionally significant event (such as fear) before we are consciously aware of it. This initial startle reflex can provoke a desire to try to resolve the situation quickly - perhaps leading to incorrect actions being taken. Therefore, one should try to stay calm and above all continue to

fly the aircraft. There are some situations which require immediate action but the majority of incidents will tolerate a short delay while you gather your thoughts and assess the situation.

2.6 **Situational Awareness**

2.6.1 Situational awareness relates both to the status of the aircraft and its systems and to the geographical position of the aircraft. Careful monitoring of the aircraft systems together with a good technical knowledge will help the pilot maintain situational awareness and to stay ahead of the aircraft. This, combined with good workload management, will increase spare capacity and allow better anticipation of potential problems.

2.6.2 Geographical position and safety altitude should be constantly monitored and crosschecked using all available aids. Environmental influences such as bad weather should also be anticipated and a plan of action formulated in case the planned flight path, destination etc. has to be changed. A mental picture of the aircraft's position should be maintained at all times.

2.6.3 Situational awareness is particularly critical in the departure/approach and landing phases of flight. Many Controlled Flight Into Terrain (CFIT) type accidents have occurred due to loss of situational awareness and proximity of terrain. Statistics indicate that this is a high risk area to SPA types. The risk may be increased due to the aircraft being fitted with less sophisticated equipment but lack of planning, "press on itus" etc, also aggravate the situation.

2.7 **Commercial Pressures**

In the single-pilot environment commercial pressures may be greater and more personalised. The pilot may be "persuaded" by the operator who may also be the owner of the business. With no one else to share the burden one may be more prone to accede to such pressures and accept a situation which is against your better judgement. Such pressures may also come from passengers who may be anxious to get to an important meeting or simply want to get home.

3 **Instructor Training**

Generally CRM Instructors for SPA will have to meet the requirements given in Chapter 5 but a more flexible approach may be applied by the CAA. Normally a prospective CRMI will be required to have attended a basic instructional technique course such a TRI Core Course. Evidence of some other instructional ability such as previous experience as a teacher or instructor in another field may be acceptable.

4 **Instructors Ground School**

4.1 Ground School instructors are authorised to carry out initial and recurrent CRM training. As such it is critical that they meet all the requirements for CRMI (Ground) (Chapter 5, paragraph 2.1) in order that they are able to set the right example to a new trainee. If CRM is not presented correctly at this stage it may be difficult or even impossible to recover the situation later even with an experienced CRM trainer.

4.2 It is recognised that having a fully qualified CRMI (Ground) may place a large burden on a small operator. It would be perfectly acceptable for ground training to be done by another operator or CRM provider as long as the training is orientated towards the operator's activity and particular needs.

5 Instructors Simulator/Base

Normally a CRMI (Simulator/Base) will have completed a TRI/CRI core course. The CRMI should demonstrate an adequate knowledge of CRM aspects and be able to use facilitation skills on a one to one basis. Training for the CRMI should be appropriate to the particular operation. A CRMI should be able to demonstrate an adequate level of competency and be able to role model good CRM. (See Appendix 11 and Appendix 16 Annex E)

6 Instructors Line

A CRMI (Line) should normally have completed a basic instructional technique course such as a CRI core course but an alternative may be acceptable at the discretion of the CAA. This may be aviation related such as a technical instructor. Another non-aviation related qualification may also be acceptable provided the CRMI is able to demonstrate an adequate level of instructional ability combined with an acceptable level of CRM knowledge. This must include facilitation skills and teaching ability appropriate to the operation.

7 Single Engine Operations

Single engine aircraft are normally employed on local flights only and instructors of these aircraft have not been required to have any formal CRMI qualifications other than to have completed a basic CRM awareness course. However, from 1 January 2007 CRMI accreditation requirements will apply to instructors of these aircraft.

8 Assessment

Assessment for single pilot operations is divided between formal assessment as required by JAR-OPS and self assessment.

8.1 Self Assessment

The single pilot does not have the benefit of feedback from another crew member and therefore has to learn from his own experiences. However, much can be gained from a little self analysis. After a flight it is worth reflecting on what went well and why this was the case; what did not go so well is probably more easily recalled and one can speculate the reasons for this and how one could handle a similar situation in future. The problem with self assessment is one of keeping a balanced view. This may be helped by discussing events with a colleague who can give a more independent opinion. This will also allow single pilot crews to gain some benefit from each other's experience. A mark of good CRM is being open about one's mistakes and sharing the experience with others.

8.2 Formal Assessment

8.2.1 JAR-OPS requires that a pilot is assessed on his/her CRM skills. (reference). The reason for this is so that feedback can be given to the individual and to the crew and so that the CRM training system can be improved. However, another way of looking at it is this:

- Assessment is an evaluation of one's CRM performance and provides feedback and knowledge of how you are doing, but
- If you don't measure (evaluate) you don't know.
- If you don't know you can't fix, and;

- If you don't fix it's only a matter of time!!!!
- 8.2.2 Companies are required to have an assessment system which is published in the operations manual. It is recommended that this is based on the NOTECHs system but operators are free to develop alternative systems acceptable to the CAA.
- 8.2.3 The system used should not be over complicated and should reflect the scale of the company operations and the type of operations undertaken.

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Appendix 1 CRM Skills and Example CRM Syllabi

1 ICAO Human Factors - Skill Requirement

The following text is taken directly from the ICAO Human Factors Manual (Doc 9683).

While the initial emphasis in human performance training should be upon knowledge and comprehension of basic Human factors, instructors must also bear in mind the need to develop appropriate operational behaviour and skills. In other words, to make this academic knowledge useful, pilots must develop those skills and attitudes necessary to maximise their operational performance. For example, a pilot with proper knowledge of physiology should be able to identify an unfit condition with potentially dangerous and undesirable consequences and elect not to fly, thus exercising what can be considered as a judgement skill. Obviously training activities directed towards the development of suitable attitudes and skills should always be given the highest possible priority.

Human Factors skill identification and training applications remain a relatively underdeveloped field in pilot training and can be expected to undergo considerable development in years to come. For many skills, the major training requirement will be to identify and specify suitable training materials and techniques, and to successfully integrate these into the ground and airborne training syllabi. In one major training school, for instance, the heading "pilot judgement" and supplementary notes have been included in all briefing and instructional materials, including those used during ground instruction. This serves as a trigger for instructors to discuss relevant pilot judgement skills.

The following is a list of Human Factors skills areas identified using the SHELL model (some skills are of necessity included in more than one interface). This guidance material may assist trainers with the identification of the required Human Factors skills, and should help to fill the void between the written word and its practical application. Possible skill areas for training development are:

Liveware-Liveware

- communication skills
- listening skills
- observation skills
- operational management skills; leadership and followership
- problem solving
- decision-making

Liveware-Hardware

- scanning
- detection
- decision-making
- cockpit adjustment
- instrument interpretation/situational awareness
- manual dexterity
- selection of alternative procedures

- reaction to breakdowns/failures/defects
- emergency warnings
- workload; physical, allocation of tasks
- vigilance

Liveware-Environment

- adaptation
- observation
- situational awareness
- stress management
- risk management
- prioritisation and attention management
- coping/emotional control
- decision making

Liveware-Software

- computer literacy
- self-discipline and procedural behaviour
- interpretation
- time management
- self-motivation
- task allocation

The proposed ICAO curriculum detailed above includes an interface not considered as such in the SHELL model, namely the Human Element. Human Factors skills under this heading include those relating to the psychological state and well-being of operational personnel themselves (this should not be confused with the Liveware-Liveware interface, which deals with interpersonal contacts):

The Human Element

- Recognition/coping: disorientation (motion systems), stress
- fatigue
- pressure effects
- self-discipline/control
- perception
- attitudes and the application of knowledge and exercise of judgement

It will be readily appreciated from the foregoing that the development of skills for practical application during flight operations is an important evolution from theoretical Human Factors knowledge to actual operational settings. While the emphasis in this document is necessarily directed mainly towards pure knowledge requirements, it is important to reiterate that, where possible, practical Human Factors considerations should be built into all relevant aspects of instructional activity. This should apply throughout all stages of pilot and instructor training. Instruction directed at the acquisition of Human Factors skills is the activity which is expected to yield the greatest benefit in the future.

It is anticipated that specialist training directed towards the acquisition of suitable skills will be further developed in the coming years and that suitable training techniques will be fully integrated into all pilot training activities. It is especially undesirable that, after meeting the Annex 1 knowledge requirement, trainees come to see human performance training as an academic exercise lacking in operational relevance.

2 AIC 117/1998 CRM Syllabus

AIC 117/1998 included details of a model human factors syllabus. Whilst the JAR-OPS CRM syllabus (see Table 1 in Chapter 4) is now the definitive requirement on which CRM courses should be based, the AIC 117/1998 syllabus is still included within this Appendix as an example syllabus.

Table 1 'Model' Crew Resource Management (CRM) Course and Human Factors Appreciation

1. Introduction	Objective of the course Definition of CRM
2. Statistical authentication of CRM requirement	(75% of all incidents...) Examples of HF related accidents Video/audio/reports/diagrams
3. HF - human perception	Visual limitations (eye-brain link) Illusions - landing, 'whiteout', cloud Airmis and collision problems (relate to item 2 above) Aural limitation (ear-brain link) purpose of semi-circular canals (relate to item 2 above)
4. Skills required by pilot (selection)	Psychomotor Level of intelligence Personality type Personal qualities Leadership Team membership
5. HF - Learning process	Memory and recall Limitations of memory and recall Methods of learning (visual, aural, tactile retention assisted by reinforcement) Types of knowledge Skill based Rule based Knowledge (technical)
6. HF - Stress	Definition Types Physiological Psychological Over or under arousal Notion of stress accumulation (relate to item 2 above)
7. Tiredness or Fatigue	

Table 1 'Model' Crew Resource Management (CRM) Course and Human Factors Appreciation

8. Procedures and Standard Operating Procedures (SOPs) (company)	Rule based - philosophy Checklists (practice lists or checks) Benefits and drawbacks, of both types Emergency or abnormal procedures Does the emergency fit the checklists? (and vice-versa)
9. Flight deck and cabin attendants social structure	Causes of clash or conflict-listening Causes of reduced crew performance Examples - incidents - examples from CHIRP The notion of interpersonal skills Adult to adult relationships (parent/adult/child) Clash of cognitive styles The development of a professional style
10. Case study	Documented accidents and incidents - groups to investigate and make a presentation of findings
11. The CRM loop (outline)	The notion of 'the right atmosphere' (SOP, checklist discipline) (interpersonal skills) Inquiry, Advocacy, Conflict resolution, Decision making, Critique, Feedback - notion of synergy
12. CRM loop expanded	<p>Inquiry</p> <ul style="list-style-type: none"> • right questions • collect and validate • continuous update and information • test accuracy <p>Advocacy</p> <ul style="list-style-type: none"> • frankly state opinion • express concerns • seeks others' ideas <p>Conflict resolution</p> <ul style="list-style-type: none"> • work out differences • look for reasons and causes • emphasise what is right, not who is right • clash of cognitive styles <p>(style of leadership)</p> <p>Decision making</p> <ul style="list-style-type: none"> • arrive at sound and safe decisions • change mind when convinced • work for understanding and support of crew • team membership (lead/follow) <p>Critique</p> <ul style="list-style-type: none"> • constructively review • plans and results • use feedback for learning • develop basis for improvement

Table 1 'Model' Crew Resource Management (CRM) Course and Human Factors Appreciation

13. Case study (as Unit 10)	<ul style="list-style-type: none"> • Time limited use of CRM loop to produce findings by group presentation
14. Summary and washup	<ul style="list-style-type: none"> • frailty of human perception • memory/recall • performance (variability) • need to be professional in CRM • be realistically aware of human error - encourage openness
15. Course critique	

3 An Example CRM Syllabus from an Operator

Introductions	What is CRM and why do we study it? Statistics of accidents and causal relationship between accidents and various Human Factors elements.
Legislation and brief mention of NOTECHS	
Human Information Processing	Take crews briefly through the flow diagram from sensors through to motor programmes and action (decision) include Perception.
Communication	Basic Communication looking at Verbal 7% Vocal 38% Visual 55% and the 9 key elements including listening, pauses, eye contact, posture and facial expression. Peculiarities of Flight Deck Comms – lack of visual element with ATC, looking forward, importance of appropriate assertiveness, beware of barriers caused by authority gradient.
Leadership/ Followership	Both are skills they describe and share plans (mental models), they role model high standards, share, listen, adapt if other ideas are better. In addition the follower must allow the leader to lead but be assertive if the leader is wrong.
Behaviour	Behaviour is a choice and behaviour breeds behaviour – look at types of behaviour and consider the most appropriate – assertive and why.
Decision Making and Problem solving	Rule, skill, Knowledge based DM and the Problem solving loop.
Human Error and the Error Chain	
Safety Culture and SOPS	Airline specific but stressing the need for good morale and its influence on attitudes and behaviour. Does a company pay lip service to safety and CRM or does it role model the good?
Stress and Fatigue	Types of stress causes and coping strategies. Also applies to Fatigue include concept of good rest management and of inflight rest.
Situational Awareness	Perceive, understand Project or ' knowing what is happening and what might happen'. Don't forget the situation developing or existing between individuals on the flight deck.
Automation	Benefits and pitfalls – link to sit awareness.
NOTECHS	What it is and where it fits in.

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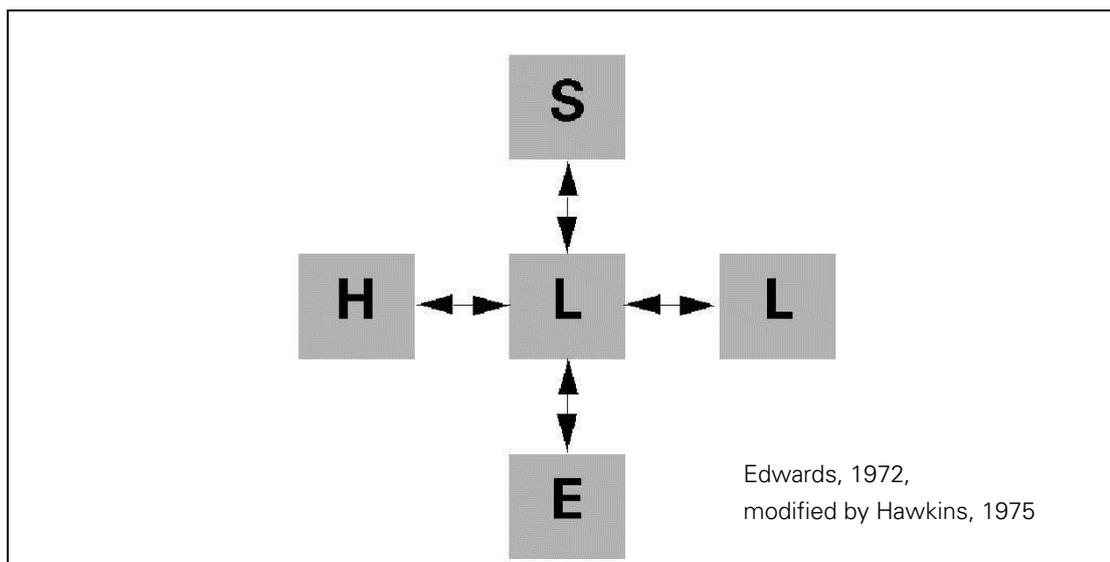
Appendix 2 Human Performance and Limitations

1 Introduction

- 1.1 All flight crew who have studied for PPL or ATPL should already be reasonably familiar with the theory of Human Performance and Limitations (HPL) and, in particular the basic aviation psychology, applicable to flying. CRM requires a reasonable understanding of such concepts as human information processing, attention and vigilance, decision making, communication, arousal and stress, and personality differences. It is important to appreciate that all humans have both physical and cognitive limitations, and to understand something about the nature of those limitations with respect to themselves and also to other crew members when flying in a multi-crew situation.
- 1.2 This Appendix will not attempt to provide detailed information on human performance and limitations - there are many texts which already do this very well. Rather, it lists those human performance limitations which are most pertinent to CRM, so that instructors and students may refresh their memories as to the theoretical science of HPL, before continuing with the applied practice of CRM.

2 Basic Theory

- 2.1 The basic theory concerning human information processing, and human error, are covered in separate Appendices.
- 2.2 For further information concerning any of the other items in the Human Performance and Limitations (HPL) syllabus, please refer to one of the textbooks listed in References.
- 2.3 ICAO has, in many of its publications, based its descriptions of human factors and HPL around a model known as the SHELL model.



S = Software (procedures, Ops manual, etc.), **H** = Hardware (Cockpit layout, aircraft design, etc.); **E** = Environment (weather, day/night, unfamiliar aerodrome, busy TMA, etc.); **L** = Liveware (the person or people).

- 2.4 Human Performance and Limitations is sometimes used as a term to describe all human factors issues (i.e. all the elements of the SHELL model), and at other times, to describe only those human factors aspects directly relating to the performance of individuals (i.e. only the "liveware" element of the SHELL model). There are various taxonomies which exist, listing the elements which are considered to be human performance and limitations, although it should be said that these are generally derived from those taxonomies used for military pilots and tend to favour the physiological aspects of performance. What is important is not to worry too much about which 'categories' the various aspects of human factors come under but, rather, to ensure that CRM training covers all those areas which are relevant, and to the appropriate level of detail.
- 2.5 For background information, the ICAO and JAR-FCL human performance and limitations taxonomies are included in this Appendix, some of the topics being of relevance within CRM training and some not relevant. It is up to individual CRM Instructors to determine which aspects ought to be included, and to what level of detail (within the guidelines given in Chapter 4, Table 1).

3 ICAO Human Performance Training Curriculum for Pilots

The following text has been taken from the ICAO Human Factors Training Manual, Doc 9683 (1998).

3.1 Module 1: Introduction to Human Factors in Aviation

In this module, the rationale for Human Factors training should be explained. A good point of departure is the fact that since 1940, three out of four accidents have had at least one contributory factor relating to human performance.

The introduction has to be carefully prepared in order to capture the pilot's interest. It is desirable that training directed at meeting any examination or test requirement associated with the revised Annex 1 be kept relevant to operational aspects of flight. A practical orientation is therefore essential to effective training. The relevance of the programme must be made quite clear to pilots – *this is not intended as an academic exercise*. Therefore, only that information which relates to pilot performance should be included. Training personnel should present the information according to their particular operational needs and may wish to take specific aspects of their local accident/incident experience into account.

The SHELL model might be usefully introduced in this module as one of the possible aids to understanding the interactions between the different components of the system, as well as the potential for conflict and error arising from the various mismatches which can occur in practice.

The SHELL concept (the name being derived from the initial letters of its components, Software, Hardware, Environment, Liveware) was first developed by Edwards in 1972, with a modified diagram to illustrate the model developed by Hawkins in 1975. For those familiar with the long-established concept of "man-machine-environment" (now referred to as "human-machine-environment"), the following interpretations are suggested: liveware (human), hardware (machine) and software (procedures, symbology, etc.), environment (the situation in which the L-H-S system must function). This building block diagram does not cover the interfaces which are outside Human Factors (hardware-hardware; hardware-environment; software-hardware) and is only intended as a basic aid to understanding Human Factors.

3.2 **Module 2: The Human Element (Aviation Physiology)**

Breathing; recognizing and coping with:

- hypoxia
- hyperventilation

Pressure effects; effects on ears, sinuses and closed cavities of:

- trapped or evolved gases
- decompression
- underwater diving

Limitations of the senses

- visual
- aural
- vestibular
- proprioceptive
- tactile

Acceleration effects; positive and negative "G's"

- aggravating conditions

Disorientation

- visual illusions
- vestibular illusions
- coping mechanisms

Fatigue/alertness

- acute
- chronic
- the effects on skill and performance

Sleep disturbances and deficits

- Circadian dysrhythmia/ jet lag
- Personal health

Effects of:

- diet/nutrition
- alcohol
- drugs (including nicotine/caffeine)
- medications (prescribed; over-the-counter)
- blood donations
- aging

Psychological fitness/stress management

Pregnancy

3.3 **Module 3: The Human Element (Aviation Psychology)**

Human errors and reliability

Workload (attention and information processing)

- perceptual
- cognitive

Information processing

- mind set and habit patterns
- attention and vigilance
- perceptual limitations
- memory

Attitudinal factors

- personality
- motivation
- boredom and complacency
- culture

Perceptual and situational awareness

Judgement and decision-making

Stress

- symptoms and effects
- coping mechanisms

Skills/experience/currency vs. proficiency

3.4 **Module 4: Liveware-Hardware: Pilot-equipment Relationship**

Controls and displays

- design (movement, size, scales, colour, illumination, etc.)
- common errors in interpretation and control
- "glass" cockpits; information selection
- habit patterns interference/design standardisation

Alerting and warning systems

- appropriate selection and set-up
- false indications
- distractions and response

Personal comfort

- temperature, illumination, etc.
- adjustment of seat position and controls

Cockpit visibility and eye-reference position

Motor workload

3.5 **Module 5: Liveware-Software: Pilot-software Relationship**

Standard operating procedures

- rationale
- benefits
- derivation from human limitations and the accident/incident record

Written materials/software

- errors in the interpretation and use of maps/charts
- design principles and correct use of checklists and manuals
- The four 'P's (philosophies, policies, procedures, practices)

Operational aspects of automation

- overload/underload and phase of flight; complacency and boredom
- staying in the loop/situational awareness
- automated in-flight equipment; appropriate use, effective task allocation, maintenance of basic flying skills

3.6 **Module 6: Liveware-Liveware: Interpersonal Relations**

NOTE: Liveware-Liveware deals with interpersonal contacts happening at the present time (here and now), as opposed to the interpersonal contacts involving people outside of the current operating situation (the latter are considered in Module 7).

Factors influencing verbal and non-verbal communication between and with:

- flight deck crew
- cabin crew
- maintenance personnel
- company management/flight operations control
- air traffic services
- passengers

How verbal and non-verbal communication affects information transfer and thus safety and efficiency of flight

Crew problem solving and decision-making

Introduction to small group dynamics/crew management (see also ICAO Circular 217 for further information on this topic).

3.7 **Module 7: Liveware-Environment: The Operating Environment**

- A systemic view of safety
- The aviation system: components
- General models of organisational safety
- Organisations structures and safety
- Culture and safety
- Procedures and safety
- Safe and unsafe organisations

3.8 **ICAO Human Performance Training Curriculum for Pilots - The Skill Requirement**

As well as the knowledge requirement covered above, the ICAO Human Factors Training Manual also contains a section on the skill requirement. This is covered in Appendix 1, paragraph 1.

4 JAR FCL Syllabus/ CAA HPL syllabus

4.1 **Human Performance and Limitations**

Human Factors: basic concepts

Human Factors in aviation

Competence and limitations

Becoming a competent pilot

- the traditional approach towards 'proficiency'
- the human factors approach towards 'professionalism'

Accident statistics

Flight safety concepts

Basic aviation physiology and health maintenance

Basics of flight physiology

The atmosphere

- composition
- Gas Laws
- oxygen requirement of tissues

Respiratory and circulatory systems

- functional anatomy
- hypobaric environment
- pressurisation, decompression
- rapid decompression
- entrapped gases, barotrauma
- counter measures, hypoxia symptoms
- time of useful consciousness
- hyperventilation
- accelerations

High altitude environment

- ozone
- radiation
- humidity

Man and Environment: the sensory system

Central and peripheral nervous system

- sensory threshold, sensitivity, adaptation
- habituation
- reflexes and biological control systems

Vision

- functional anatomy
- visual field, foveal and peripheral vision
- binocular and monocular vision
- monocular vision cues
- night vision

Hearing

- functional anatomy
- flight related hazards to hearing

Equilibrium

- functional anatomy
- motion, acceleration, verticality
- motion sickness

Integration of sensory inputs

- spatial disorientation
- illusions
- physical origin
- physiological origin
- psychological origin
- approach and landing problems

Health and hygiene

Personal hygiene

Common minor ailments

- cold
- influenza
- gastro-intestinal upset

Problem areas for pilots

- hearing loss
- defective vision
- hypotension, hypertension, coronaric disease
- obesity
- nutrition hygiene
- tropical climates

- epidemic diseases

Intoxication

- tobacco
- alcohol
- drugs and self-medication
- various toxic materials

Incapacitation

- symptoms and causes
- recognition
- operating coping procedures

4.2 **Human Performance and Limitations : Basic Aviation Psychology**

Human information processing

Attention and vigilance

- selectivity of attention
- divided attention

Perception

- perceptual illusions
- subjectivity of perception
- 'bottom-up'/'top-down' processing

Memory

- sensory memory
- working memory
- long term memory
- motor memory (skills)

Response selection

- learning principles and techniques
- drives
- motivation and performance

Human error and reliability

Reliability of human behaviour

Hypotheses on reality

- similarity, frequency
- completion causality

Theory and model of human error

Error generation

- internal factors (cognitive styles)
- external factors

- ergonomics
- economics
- social environment (group, organisation)

Decision making

Decision-making concepts

- structure (phases)
- limits
- risk assessment
- practical application

Avoiding and managing errors: cockpit management

Safety awareness

- risk area awareness
- identification of error proneness (oneself)
- identification of error sources (others)
- situational awareness

Co-ordination (multi-crew concepts)

Co-operation

- small group dynamics
- leadership, management styles
- duty and role

Communication

- communication model(s)
- verbal and non-verbal communication
- communication barriers
- conflict management

Personality

Personality and attitudes

- development
- environmental influences

Individual differences in personality

- self-concepts (e.g. action vs. state-orientation)

Identification of hazardous attitudes (error proneness)

Human overload and underload

Arousal

Stress

- definition(s), concept(s), model(s)
- anxiety and stress
- effects of stress

Fatigue

- types, causes, symptoms
- effects of fatigue

Body rhythm and sleep

- rhythm disturbances
- symptoms, effects, management

Fatigue and stress management

- coping strategies
- management techniques
- health and fitness programmes
- relaxation techniques
- religious practices
- counselling techniques

Advanced cockpit automation

Advantages and disadvantages (criticalities)

Automation complacency

Working concepts

5 Practical Notes

Whilst it is useful to know something about the theory associated with human performance and limitations, and aviation psychology, care should be taken not to cause people to form the impression that human factors is purely theory, and of little practical relevance to them and their jobs. Any theory should be backed up with practical examples from aviation contexts.

Remember that time on any training course is normally limited, and the emphasis should be on training the more important concepts of CRM rather than on imparting theoretical knowledge in isolation. It may be appropriate to assess the level of knowledge of potential course participants in advance of the training course, and adapt the theoretical HPL content accordingly.

6 Examples and Suggested Training Material

Dédale's publication "Briefings", and associated videos, address the majority of the HPL topics at a level appropriate to CRM for multi-crew situations in commercial aviation operations.

7 References and Useful Additional Reading

- a) JAR FCL
- b) ICAO Human Factors Training Manual. 1998. Doc 9683-AN/950
- c) ICAO. Fundamental Human Factors Concepts. ICAO Human Factors Digest No.1. ICAO Circular 216-AN/131 1989
- d) ICAO. Training of Operational Personnel in Human Factors. ICAO Human Factors Digest No.3. ICAO Circular 227-AN/136. 1991
- e) Campbell and Bagshaw. Human Performance and Limitations
- f) Hawkins, F. Human Factors in Flight. 2nd Edn. 1993 Ashgate. ISBN 1 85742 135 3
- g) Orlandy, H., Orlandy, L. Human Factors in Multi-Crew Flight Operations. 1999. Ashgate ISBN 0 291 39839 1
- h) DeHart, R. Fundamentals of Aerospace Medicine
- i) Dédale. Briefings: A Human Factors Course for Pilots and Aviation Professionals - Reference Manual. 2000. Publishers, Dédale France.
- j) FAA safety brochure on pilot vision
http://www.cami.jccbi.gov/aam-400A/Brochures/400_vision.html
- k) FAA safety brochure on hearing and noise
<http://www.cami.jccbi.gov/aam-400A/Brochures/hearing.htm>
- l) FAA safety brochure on alcohol
http://www.cami.jccbi.gov/aam-400A/Brochures/400_alcohol.html
- m) FAA safety brochure on medication
<http://www.cami.jccbi.gov/aam-400A/Brochures/400aotc.html>
- n) FAA safety brochure on altitude decompression sickness
<http://www.cami.jccbi.gov/aam-400A/Brochures/400altitude.html>
- o) FAA safety brochure on disorientation
<http://www.cami.jccbi.gov/aam-400A/Brochures/Disorien.htm>

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Appendix 3 **Attention, Vigilance, Fatigue, Stress and Workload Management**

1 Introduction

- 1.1 These subjects have been grouped together because they all deal with 'readiness to cope' in some sense, in terms of an individual's physical and mental ability to cope with work demands, and how he manages those work demands. The ideal would be for flight crew to be at peak fitness and alertness all the time, and to be able to manage the workload such that work demands never exceed ability to cope. However, life isn't like that, and there are times when individuals are fatigued, or stressed, and workload sometimes exceeds ability to cope. CRM aims to help flight crew to plan their workload as far as they are able, making best use of the team, and taking into account the fact that some individuals may be performing below peak levels (e.g. due to fatigue, etc.). It is also important for managers to be aware of such human performance issues when planning, e.g. rosters.
- 1.2 Fatigue will only be addressed in terms of the basic theory, and this document will not address flight time limitations and fatigue. However, references are provided at the end of the Appendix for those wishing to obtain further information.

2 Arousal and Workload

- 2.1 Arousal in its most general sense, refers to readiness of a person for performing work. To achieve an optimum level of task performance, it is necessary to have a certain level of stimulation or arousal. This level of stimulation or arousal varies from person to person. There are people who are overloaded by having to do more than one task at a time; on the other hand there are people who appear to thrive on stress, being happy to take on more and more work or challenges.
- 2.2 At low levels of arousal, our attentional mechanisms will not be particularly active and our performance capability will be low (complacency and boredom can result). At the other end of the curve, performance deteriorates when arousal becomes too high. To a certain extent, this is because we are forced to shed tasks and focus on key information only (called narrowing of attention). Best task performance occurs somewhere in the middle.
- 2.3 In the workplace, arousal is mainly effected by stimulation due to work tasks. However, surrounding environmental factors such as noise may also influence the level of arousal.
- 2.4 **Workload - Overload and Underload**
- A certain amount of stimulation is beneficial, but too much stimulation can lead to stress or over-commitment in terms of time. It is noteworthy that too little stimulation can also be a problem.
- 2.5 **Factors Determining Workload**
- 2.5.1 The tasks involved in operating an aircraft usually follow a fairly standard pattern and order, some of which is under the control of the flight crew, and some of which is outside their control. It is more difficult to assess how that work translates into workload.

- 2.5.2 As noted in the Appendix on information processing, humans have limited mental capacity to deal with information. We are also limited physically, in terms of visual acuity, strength, dexterity and so on. Thus, workload reflects the degree to which the demands of the work we have to do eats into our mental and physical capacities. Workload is subjective (i.e. experienced differently by different people) and is affected by:
- a) The nature of the task, such as the:
 - i) physical demands it requires (e.g. strength required, etc.);
 - ii) mental demands it requires (e.g. complexity of decisions to be made, etc.).
 - b) The circumstances under which the task is performed, such as the:
 - i) standard of performance required (i.e. degree of accuracy);
 - ii) time available to accomplish the task (and thus the speed at which the task must be carried out);
 - iii) requirement to carry out the task at the same time as doing something else;
 - iv) environmental factors existing at the time (e.g. extremes of temperature, etc.).
 - c) The person and his state, such as:
 - i) skills (both physical and mental);
 - ii) experience (particularly familiarity with the task in question);
 - iii) current health and fitness levels;
 - iv) emotional state (e.g. stress level, mood, etc.).
- 2.5.3 As the workload of the flight crew may vary, they may experience periods of overload and underload. This is a particular feature of some flights and sectors, but overloads are often unpredictable.

2.6 **Overload**

Overload occurs at very high levels of workload, when the individual's or crew's workload exceeds the ability to cope well. As highlighted previously, performance deteriorates when arousal becomes too high and we are forced to shed tasks and focus on key information. Error rates may also increase. Overload can occur for a wide range of reasons based on the factors highlighted above. It may happen suddenly (e.g. if asked to remember one further piece of information whilst already trying to remember a large amount of data), or gradually. It is good practice to try to plan tasks such that the flight crew are not left with several things to be done at once, possibly during the final stages of the approach. Task management between flight crew members can reduce the likelihood of one pilot being overloaded. It is particularly important to ensure that in overload situations, it is always clear as to who is carrying out the vital task of flying the aircraft.

2.7 **Underload**

Underload occurs at low levels of workload (when the pilot becomes under aroused). Underload can result from a task a pilot finds boring, or indeed a lack of tasks. The nature of long-haul flights means that workload tends to come at the start and finish of a flight, with long periods of low workload in the cruise. Hence, unless stimulating 'housekeeping' tasks can be found, underload can be difficult to avoid at times.

3 Stress: Domestic and Work Related

Stress is an inescapable part of life for all of us. Stress can be defined as any force, that when applied to a system, causes some significant modification of its form where forces can be physical, psychological or due to social pressures.

From a human viewpoint, stress results from the imposition of any demand or set of demands which require us to react, adapt or behave in a particular manner in order to cope with or satisfy them. Up to a point, such demands are stimulating and useful, but if the demands are beyond our personal capacity to deal with them, the resulting stress is a problem.

3.1 Causes and Symptoms

Stress is usually something experienced due to the presence of some form of stressor, which might be a one-off stimulus (such as a challenging problem or a punch on the nose), or an ongoing factor (such as an extremely hot hangar or an acrimonious divorce). From these, we get acute stress (typically intense but of short duration) and chronic stress (frequent recurrence or of long duration) respectively.

Different stressors affect different people to varying extents. Stressors may be:

- Physical - such as heat, cold, noise, vibration, presence of something damaging to health (e.g. carbon monoxide), the onset of fatigue;
- Psychological - such as emotional upset (e.g. due to bereavements, domestic problems, etc.), worries about real or imagined problems (e.g. due to financial problems, ill health, etc.);
- Reactive - such as events occurring in everyday life (e.g. working under time pressure, encountering unexpected situations, etc.).

The possible signs of stress can include:

- Physiological symptoms - such as sweating, dryness of the mouth, etc.;
- Health effects - such as nausea, headaches, sleep problems, diarrhoea, ulcers, etc.;
- Behavioural symptoms - such as restlessness, shaking, nervous laughter, taking longer over tasks, changes to appetite, excessive drinking, etc.;
- Cognitive effects - such as poor concentration, indecision, forgetfulness, etc.;
- Subjective effects - such as anxiety, irritability, depression, moodiness, aggression, etc.

It should be noted that individuals respond to stressful situations in very different ways. Generally speaking though, people tend to regard situations with negative consequences as being more stressful than when the outcome of the stress will be positive (e.g. the difference between being made redundant from work and being present at the birth of a son or daughter).

3.2 Domestic Stress

Pre-occupation with a source of domestic stress can play on one's mind during the working day, distracting from the working task. Inability to concentrate fully may impact on task performance and ability to pay due attention to safety.

Domestic stress typically result from major life changes at home, such as marriage, birth of a child, a son or daughter leaving home, bereavement of a close family member or friend, marital problems, or divorce.

3.3 **Work Related Stress**

Aviation personnel can experience stress due to the task or job they are undertaking at that moment, or due to the general organisational environment. Stress can be felt when carrying out certain tasks that are particularly challenging or difficult. This stress can be increased by lack of SOPs in this situation, or time pressures. The latter type of stress can be reduced by careful workload management, good training, etc.

Within the organisation, the social and managerial aspects of work can be stressful. Pilots whose jobs are under threat due to a company reorganisation, for instance, are likely to have an increased level of background stress which, when combined with task stresses or domestic stresses, may not be conducive to safe operations.

3.4 **Stress Management**

Once we become aware of stress, we generally respond to it by using one of two strategies: defence or coping. Defence strategies involve alleviation of the symptoms (taking medication, alcohol, etc.) or reducing the anxiety (e.g. denying to yourself that there is a problem (denial), or blaming someone else).

Coping strategies involve dealing with the source of the stress rather than just the symptoms (e.g. delegating workload, prioritising tasks, sorting out the problem, etc.). Coping is the process whereby the individual either adjusts to the perceived demands of the situation or changes the situation itself.

Unfortunately, it is not always possible to deal with the problem if this is outside the control of the individual (such as during an emergency), but there are well-published techniques for helping individuals to cope with stress. Good stress management techniques include:

Relaxation techniques;

- Careful regulation of sleep and diet;
- A regime of regular physical exercise;
- Counselling - ranging from talking to a supportive friend or colleague to seeking professional advice.

There is no magic formula to cure stress and anxiety, merely common sense and practical advice.

3.5 **Time Pressure and Deadlines**

There is probably no industry in the commercial environment that does not impose some form of deadline and consequently time pressure on its employees. Aircraft flight operations is no exception. It was highlighted in the previous section that one of the potential stressors in aviation is time pressure. This might be actual pressure where clearly specified deadlines are imposed by an external source (e.g. ops management) and passed on to flight crew, or perceived pressure, where pilots feel that there are time pressures, even when no definitive deadlines have been set in stone. In addition, time pressure may be self-imposed, where flight crew have personal reasons for timely action (e.g. departing from a foreign airport before duty time limits expire and the crew can't get home). This is often referred to as "get-home-itis".

3.6 **The Effects of Time Pressure and Deadlines**

As with stress, it is generally thought that some time pressure is stimulating and may actually improve task performance. However, it is almost certainly true that excessive time pressure (either actual or perceived, external or self-imposed), is likely to mean that due care and attention when carrying out tasks diminishes and more errors will be made. Ultimately, these errors can lead to aircraft incidents and accidents.

4 Sleep, Fatigue and Circadian Rhythms

4.1 What Is Sleep?

Man, like all living creatures has to have sleep. Despite a great deal of research, the purpose of sleep is not fully understood. Sleep is a natural state of reduced consciousness involving changes in body and brain physiology which is necessary to man to restore and replenish the body and brain.

Sleep can be resisted for a short time, but various parts of the brain ensure that sooner or later, sleep occurs. When it does, it is characterised by five stages of sleep:

Stage 1: This is a transitional phase between waking and sleeping. The heart rate slows and muscles relax. It is easy to wake someone up.

Stage 2: This is a deeper level of sleep, but it is still fairly easy to wake someone.

Stage 3: Sleep is even deeper and the sleeper is now quite unresponsive to external stimuli and so is difficult to wake. Heart rate, blood pressure and body temperature continue to drop.

Stage 4: This is the deepest stage of sleep and it is very difficult to wake someone up.

Rapid Eye Movement or REM Sleep: Even though this stage is characterised by brain activity similar to a person who is awake, the person is even more difficult to awaken than stage 4. It is therefore also known as paradoxical sleep. Muscles become totally relaxed and the eyes rapidly dart back and forth under the eyelids.

Stages 1 to 4 are collectively known as non-REM (NREM) sleep. Stages 2-4 are categorised as slow-wave sleep and appear to relate to body restoration, whereas REM sleep seems to aid the strengthening and organisation of memories. Sleep deprivation experiments suggest that if a person is deprived of stage 1-4 sleep or REM sleep he will show rebound effects. This means that in subsequent sleep, he will make up the deficit in that particular type of sleep. This shows the importance of both types of sleep.

As can be seen from Figure 1, sleep occurs in cycles. Typically, the first REM sleep will occur about 90 minutes after the onset of sleep. The cycle of stage 1 to 4 sleep and REM sleep repeats during the night about every 90 minutes. Most deep sleep occurs earlier in the night and REM sleep becomes greater as the night goes on.

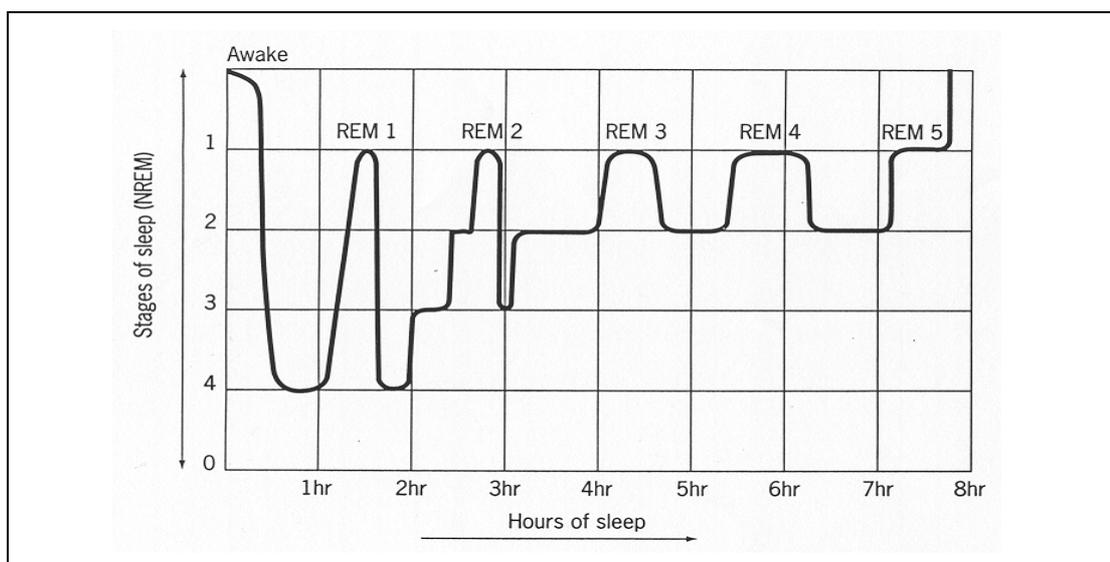


Figure 1 Typical Cycle of Stage 1-4 (NREM) sleep and REM Sleep in the Course of a Night

4.2 Circadian Rhythms

Apart from the alternation between wakefulness and sleep, man has other internal cycles, such as body temperature and hunger/eating. These are known as circadian rhythms as they run on an approximately daily basis. Circadian rhythms are physiological and behavioural functions and processes in the body that have a regular cycle of approximately a day (actually about 25 hours in man).

Although, circadian rhythms are controlled by the brain, they are influenced and synchronised by external (environmental) factors such as light. An example of disrupting circadian rhythms is by taking a flight that crosses time zones. This will interfere with the normal synchronisation with the light and dark (day/night). This throws out the natural link between daylight and the body's internal clock, causing jet lag, resulting in sleepiness during the day, etc. Eventually however, the circadian rhythm readjusts to the revised environmental cues.

Figure 2 shows the circadian rhythm for body temperature. This pattern is very robust, meaning that even if the normal pattern of wakefulness and sleep is disrupted (by shift work for example), the temperature cycle remains unchanged. Hence, it can be seen that if you are awake at 4-6 o'clock in the morning, your body temperature is in a trough and it is at this time that it is hardest to stay awake. Research has shown that this drop in body temperature appears to be linked to a drop in alertness and performance in man.

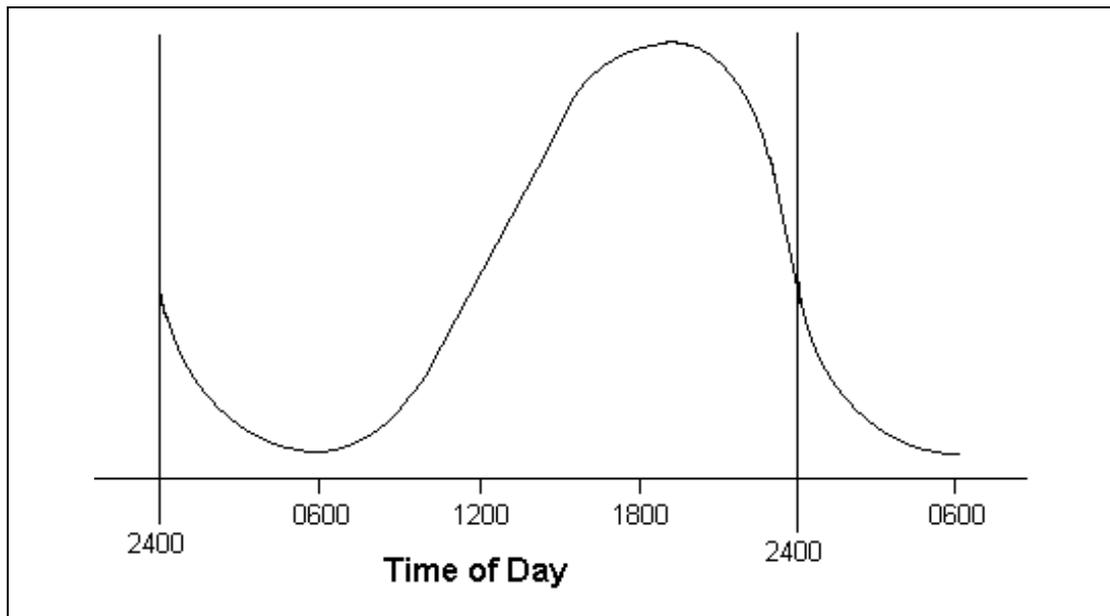


Figure 2 The Circadian Rhythm for Internal Body Temperature

5 Fatigue

Fatigue can be either physiological or subjective. Physiological fatigue reflects the body's need for replenishment and restoration. It is tied in with factors, such as recent physical activity, current health, consumption of alcohol and with circadian rhythms. It can only be satisfied by rest and eventually, a period of sleep. Subjective fatigue is an individual's perception of how sleepy they feel. This is not only affected by when they last slept and how good the sleep was but other factors, such as degree of motivation.

Fatigue is typically caused by delayed sleep, sleep loss, desynchronisation of normal circadian rhythms and concentrated periods of physical or mental stress or exertion. In the workplace, working long hours, working during normal sleep hours and working on rotating shift schedules all produce fatigue to some extent.

Symptoms of fatigue (in no particular order) may include:

- diminished perception (vision, hearing, etc.) and a general lack of awareness;
- diminished motor skills and slow reactions;
- problems with short-term memory;
- channelled concentration - fixation on a single possibly unimportant issue, to the neglect of others and failing to maintain an overview;
- being easily distracted by unimportant matters;
- poor judgement and decision making leading to increased mistakes;
- abnormal moods - erratic changes in mood, depressed, periodically elated and energetic;
- diminished standards.

The Centre for Human Sciences at Farnborough has developed a sophisticated fatigue model which predicts when flight crew are likely to become fatigued, and the level of that fatigue, depending on what rosters they fly¹.

5.1 **Fatigue Management**

Most individuals need approximately eight hours sleep in a 24 hour period, although some individuals will know that they need more or less than this to be fully refreshed. People can usually perform adequately with less than eight hours sleep for a few days, building up a temporary sleep 'deficit'. However, any sleep deficit will need to be made up, otherwise performance will start to suffer. A good rule of thumb is that one hour of high-quality sleep is good for two hours of activity.

Publications exist which advise on how to manage sleep and rest, particularly when circadian disruption occurs during long haul flights.

6 **Alcohol and Medication**

All pilots should be aware that their performance may be affected by alcohol, medication or illicit drugs. Both UK and JAA legislation precludes the consumption of alcohol or the use of illicit drugs by flight crews when working. Readers are referred to JAR-FCL 3 for details of the current requirements and restrictions regarding alcohol, medication and drugs.

6.1 **Alcohol**

Alcohol acts as a depressant on the central nervous system, dulling the senses and increasing mental and physical reaction times. It is known that even a small amount of alcohol leads to a decline in an individual's performance and causes their judgement (i.e. ability to gauge their performance) to be hindered.

Alcohol is removed from the blood at a fixed rate and this cannot be speeded up in any way (e.g. by drinking strong coffee). In fact, sleeping after drinking alcohol can slow down the removal process, as the body's metabolic systems are slower.

1. References to recently published reports on this CAA sponsored research may be found in the "Blue Book", www.caa.co.uk

The affects of alcohol can be made considerably worse if the individual is fatigued, ill or using medication.

6.2 Medication

Any medication, no matter how common, can possibly have direct effects or side effects that may impair performance. "Medication" can be regarded as any over-the-counter or prescribed drug used for therapeutic purposes.

JAR-FCL 3 (3.040) contains information concerning drugs, medication and alcohol. Flight Crew are advised to seek up-to-date advice from their Authority concerning which medication is permissible, since the details change from time to time.

7 Practical Notes

The following text has been extracted from Document 29 (Appendix 16) and JARTEL WP5

Workload management demands clear prioritisation of primary and secondary operational tasks. Based on sound planning, tasks should be distributed appropriately among the crew. Signs of stress and fatigue should be communicated and taken into account. Available external and internal resources (including automation) should be used to accomplish timely task completion.

Examples of poor practice:

- Flying 'solo', in multi-pilot aircraft, without other crew members involved
- Allowing secondary operational tasks to interfere with primary flight duties
- Inadequate workload planning
- Ignoring signs of stress and fatigue

Examples of good practice:

- Distributes tasks among the crew, checks and corrects appropriately
- Secondary operational tasks are prioritised to retain sufficient resources for primary flight duties
- Allocates enough time to complete tasks

8 Initial Training and Objectives

Whilst many pilots may already have studied the theory of alertness, vigilance, fatigue, stress and workload management within the context of JAR-FCL HPL, it may be appropriate to cover these topics again in greater depth for initial CRM training, emphasising the practical aspects and using examples from flight operations.

9 Recurrent Training and Objectives

9.1 During LOFT exercises, flight crew are likely to be at their most vigilant, expecting to be tested on emergency situations. This is not, therefore, the best mechanism for flight crew to learn about the effects of fatigue or low alertness. The simulator environment is, however, a very good way to learn about workload management.

9.2 Incidents and sharing "war stories" may be a good way to learn about the effects of fatigue, as long as care is taken not to allow a 'macho' culture to develop where

individuals may refuse to acknowledge that their performance is likely to degrade when fatigued.

10 Examples and Suggested Training Material

- Dédale. Briefings: A Human Factors Course for Pilots - Videos. 1994 (and reissued in 2000). Publishers Dédale, France .
- Incidents/accidents.
- CHIRP.

For stress, it may be useful to run a "how stressed are you" questionnaire - there are several available.

11 References and Useful Additional Reading

- a) JAR-FCL 3.
- b) Stokes, A., Kite, K. Flight Stress: Stress, Fatigue and Performance in Aviation. Avebury.
- c) Smith, A. P., Jones, D. M. Handbook of Human (Vol III - State and Trait). Academic Press. Chapter 11: Symptoms of acute and chronic fatigue.
- d) Thom, T. Human Factors and Pilot Performance. 1994. Chapter 5. Airlife.
- e) Dédale. Briefings: A Human Factors Course for Pilots - Reference Manual. 1994 (and reissued in 2000). Publishers Dédale, France. (chapter 4 Stress and adaptation; chapter 9 Vigilance, Attention, fatigue).
- f) The Fatigue Model. Qinetiq. 2002. For further information, contact Steve Griffin, Research Management Dept, CAA Safety Regulation Group, Aviation House, Gatwick Airport (South Area), W Sussex, RH6 0YR.
- g) ICAO Human Factors Training Manual. 1998. Doc 9683-AN/950.
- h) CAP 371 Avoidance Of Fatigue in Air Crews. 1990. CAA. www.caa.co.uk.
- i) FODCOM 12/01 Letter of Consultation: Proposal to amend Civil Aviation Publication (CAP) 371 for the purpose of clarifying the texts to reflect current interpretations and practices. August 2001. www.caa.co.uk.
- j) Amalberti et al. Vigilance, attention, fatigue. Chapter 9 of "Briefings: A Human Factors Course for Pilots - Reference Manual". Dédale. 1994 (and reissued in 2000). Publishers, Dédale France.

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Appendix 4 Information Processing

1 Introduction

- 1.1 The intention of this Appendix is to provide an overview of mental human performance characteristics which flight crew use, such as attention and perception, information processing, memory, judgement and decision making. The theoretical knowledge is addressed in the section "basic theory"; practical application of this knowledge is discussed in subsequent sections and Appendices.
- 1.2 This Appendix examines the way in which information gathered by the senses is processed by the brain. The limitations of the human information processing system are also considered. The theory of decision making is also covered, albeit not in depth. Further references are included for those readers requiring more in-depth information on information processing and decision making.

2 Basic Theory of Information Processing

2.1 Information Processing Definition

Information processing is the process of receiving information through the senses, analysing it and making it meaningful.

Decision making is the choice between two or more alternatives.

2.2 An Information Processing Model

Information processing can be represented as a model. This captures the main elements of the process, from receipt of information via the senses, to outputs such as decision making and actions. One such model is shown in Figure 1.

2.3 Sensory Receptors and Sensory Stores

Physical stimuli are received via the sensory receptors (eyes, ears, etc.) and stored for a very brief period of time in sensory stores (sensory memory). Visual information is stored for up to half a second in iconic memory and sounds are stored for slightly longer (up to two seconds) in echoic memory. This enables us to remember a sentence as a sentence, rather than merely as an unconnected string of isolated words, or a film as a film, rather than as a series of still pictures.

2.4 Attention and Perception

Having detected information, our mental resources are concentrated on specific elements - this is "attention". Although attention can move very quickly from one item to another, it can only deal with one item at a time. Attention can take the form of:

- selective attention;
- divided attention;
- focused attention;
- sustained attention.

Selective attention occurs when a person is monitoring several sources of input, with greater attention being given to one or more sources which appear more important. A person can be consciously attending to one source (e.g. the co-pilot) whilst still sampling other sources in the background (e.g. ATC transmissions). Psychologists refer to this as the 'cocktail party effect' whereby you can be engrossed in a conversation with one person but your attention is temporarily diverted if you overhear your name being mentioned at the other side of the room, even though you were not aware of listening in to other people's conversations. Similarly, flight crew may be talking with one another, but as soon as they recognise their own callsign on the radio frequency, their attention is diverted. Distraction is the negative side of selective attention.

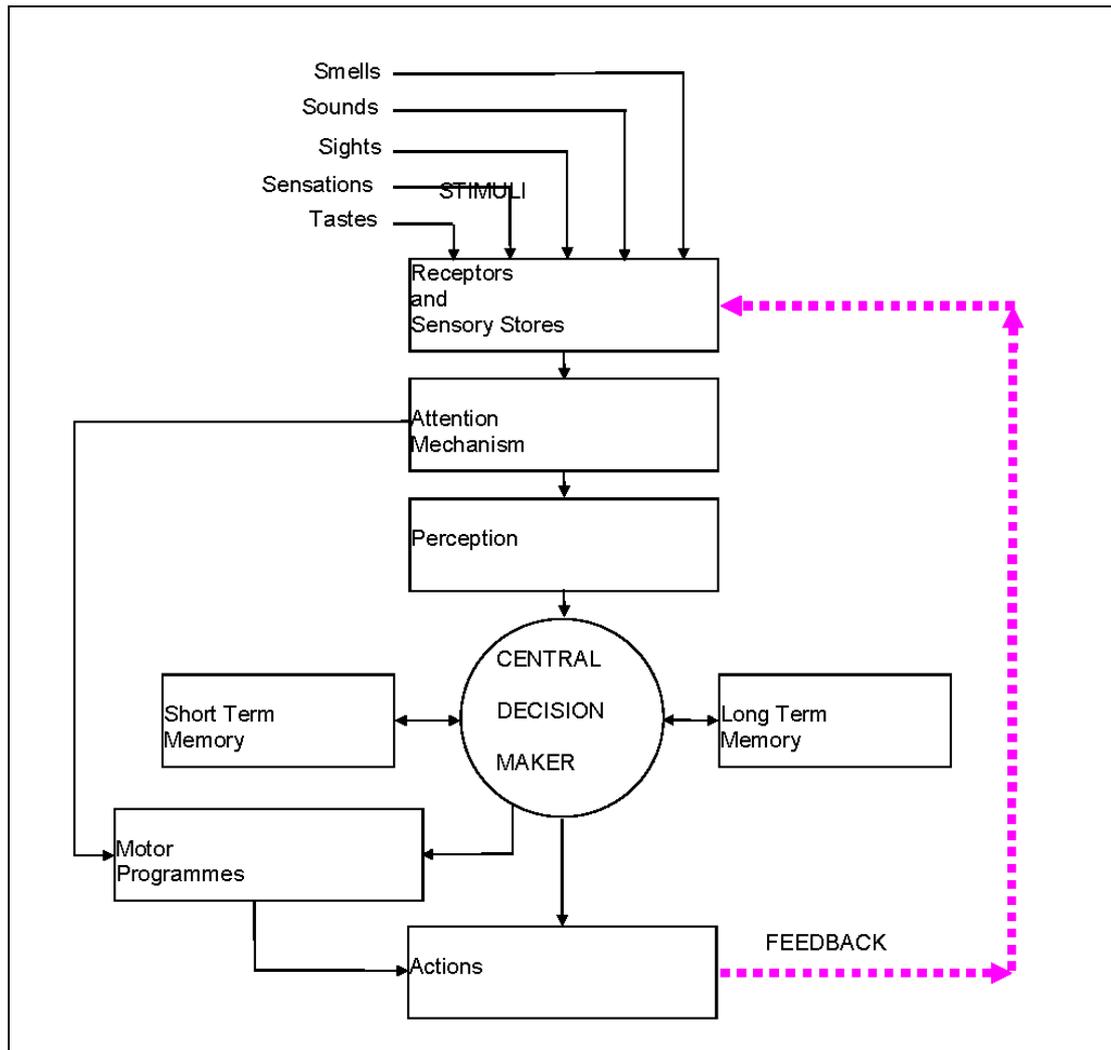


Figure 1 A functional model of human information processing

Divided attention is common in most work situations, where people are required to do more than one thing at the same time. Usually, one task suffers at the expense of the other, more so if they are similar in nature. This type of situation is also sometimes referred to as time sharing.

Focused attention is merely the skill of focusing one's attention upon a single source and avoiding distraction. Cognitive 'blackholing' is the negative side of focused attention, where attention is so focussed on one area that other important information is not noticed.

Sustained attention as its name implies, refers to the ability to maintain attention and remain alert over long periods of time, often on one task. Most of the research has been carried out in connection with monitoring radar displays.

Attention is influenced by arousal level and stress. This can improve attention or damage it depending on the circumstances.

Perception involves the organisation and interpretation of sensory data in order to make it meaningful, discarding non-relevant data, i.e. transforming data into information. Perception is a highly sophisticated mechanism and requires existing knowledge and experience to know what data to keep and what to discard, and how to associate the data in a meaningful manner.

An example of the perceptual process is where the image formed on the retina is inverted and two dimensional, yet we see the world the right way up and in three dimensions; if the head is turned, the eyes detect a constantly changing pattern of images, yet we perceive things around us to have a set location, rather than move chaotically.

2.5 **Decision Making**

Having recognised coherent information from the stimuli reaching our senses, a course of action has to be decided upon. In other words decision making occurs. Decision making is the generation of an alternative course of action based on available information, knowledge, prior experience, expectation, context, goals, etc. and selecting one preferred option. It is also described as thinking, problem solving and judgement.

This may range from deciding to do nothing, to deciding to act immediately in a very specific manner. A GPWS "pull up" warning, for instance, may trigger a well-trained sequence of actions without further thought (i.e. pull back on stick); alternatively, an unfamiliar cockpit warning may require further information to be gathered before an appropriate course of action can be initiated.

We are not usually fully aware of the processes and information which we use to make a decision. Tools can be used to assist the process of making a decision, the most common in flight operations being checklists and QRHs containing SOPs. Thus, good decisions are based on knowledge supplemented by written information and procedures, analysis of observed symptoms, performance indications, etc. It can be dangerous to believe that existing knowledge and prior experience will always be sufficient in every situation as will be shown in the section entitled 'Information Processing Limitations'.

Finally, once a decision has been made, an appropriate action can be carried out. Our senses receive feedback of this and its result. This helps to improve knowledge and refine future judgement by learning from experience.

2.6 Memory

Memory is critical to our ability to act consistently and to learn new things. Without memory, we could not capture a 'stream' of information reaching our senses, or draw on past experience and apply this knowledge when making decisions. Memory can be considered to be the storage and retention of learning, experience and knowledge, as well as the ability to retrieve this information.

Memory depends on three processes:

- registration - the input of information into memory;
- storage - the retention of information;
- retrieval - the recovery of stored information.

It is possible to distinguish between three forms of memory:

- ultra short-term memory (or sensory storage);
- short-term memory (often referred to as working memory);
- long-term memory.

Ultra short-term memory has already been described when examining the role of sensory stores. It has a duration of up to two seconds (depending on the sense) and is used as a buffer, giving us time to attend to sensory input.

Short term-memory receives a proportion of the information received into sensory stores, and allows us to store information long enough to use it (hence the idea of 'working memory'). It can store only a relatively small amount of information at one time, i.e. 5 to 9 (often referred to as 7 ± 2) items of information, for a short duration, typically 10 to 20 seconds. As the following example shows, capacity of short term memory can be enhanced by splitting information in to 'chunks' (a group of related items).

A telephone number, e.g. 02086466951, can be stored as 11 discrete digits, in which case it is unlikely to be remembered. Alternatively, it can be stored in chunks of related information, e.g. in the UK, 0208 may be stored as one chunk, 648 as another, and 6951 as another, using only three chunks and therefore, more likely to be remembered. In mainland Europe, the same telephone number would probably be stored as 02 08 64 86 95 1, using six chunks. The size of the chunk will be determined by the individual's familiarity with the information (based on prior experience and context), thus in this example, a person from the UK might recognise 0208 as the code for London, but a person from mainland Europe might not.

This duration can be extended through rehearsal (mental repetition of the information) or encoding the information in some meaningful manner (e.g. associating it with something as in the example above).

The capacity of long-term memory appears to be unlimited. It is used to store information that is not currently being used, including:

- knowledge of the physical world and objects within it and how these behave;
- beliefs about people, social norms, values, etc.;
- motor programmes, problem solving skills and plans for achieving various activities;
- abilities, such as language comprehension.

Information in long-term memory can be divided into two types: (i) semantic and (ii) episodic. Semantic memory refers to our store of general, factual knowledge about the world, such as concepts, rules, one's own language, etc. It is information that is not tied to where and when the knowledge was originally acquired. Episodic memory refers to memory of specific events, such as our past experiences (including people, events and objects). We can usually place these things within a certain context. It is believed that episodic memory is heavily influenced by a person's expectations of what **should** have happened, thus two people's recollection of the same event can differ.

2.7 Motor Programmes

If a task is performed often enough, it may eventually become automatic and the required skills and actions are stored in long term memory. These are known as motor programmes and are ingrained routines that have been established through practice. The use of a motor programme reduces the load on the central decision maker. An often quoted example is that of driving a car: at first, each individual action such as gear changing is demanding, but eventually the separate actions are combined into a motor programme and can be performed with little or no awareness. These motor programmes allow us to carry out simultaneous activities, such as having a conversation whilst driving.

2.8 Situation Awareness

2.8.1 Although not shown explicitly in Figure 1, the process of attention, perception and judgement should result in awareness of the current situation.

2.8.2 Situation awareness is the synthesis of an accurate and up-to-date 'mental model' of one's environment and state, and the ability to use this to make predictions of possible future states.

2.8.3 Situation awareness, in the context of the flight deck, describes the pilot's awareness of what is going on around him, e.g. where he is geographically, his orientation in space, what mode the aircraft is in, etc. It refers to:

- the **perception** of important elements, e.g. seeing a low oil pressure indication.
- the **comprehension** of their meaning, e.g. Is there a leak? Is it a faulty indication?
- the **projection** of their status into the future, e.g. Does this require a diversion?

2.8.4 As with decision making, feedback improves situation awareness by informing us of the accuracy of our mental models and their predictive power.

3 Information Processing Limitations

The basic elements of human information processing have now been explored. It is important to appreciate that these elements have limitations. As a consequence, the pilot, like other skilled professionals, requires support such as a QRH.

3.1 Attention and Perception

3.1.1 A proportion of 'sensed' data may be lost without being 'perceived'. An example with which most people are familiar is that of failing to perceive something which someone has said to you, when you are concentrating on something else, even though the words would have been received at the ear without any problem. The other side of the coin is the ability of the information processing system to perceive something (such as a picture, sentence, concept, etc.) even though some of the data may be missing. The danger, however, is that people can fill in the gaps with information from their own store of knowledge or experience, and this may lead to the wrong conclusion being drawn.

- 3.1.2 Once we have formed a mental model of a situation, we often seek information which will confirm this model and, not consciously, reject information which suggests that this model is incorrect.
- 3.1.3 There are many well-known visual 'illusions' which illustrate the limits of human perception. Figure 2 shows how the perceptual system can be misled into believing that one line is longer than the other, even though a ruler will confirm that they are exactly the same.

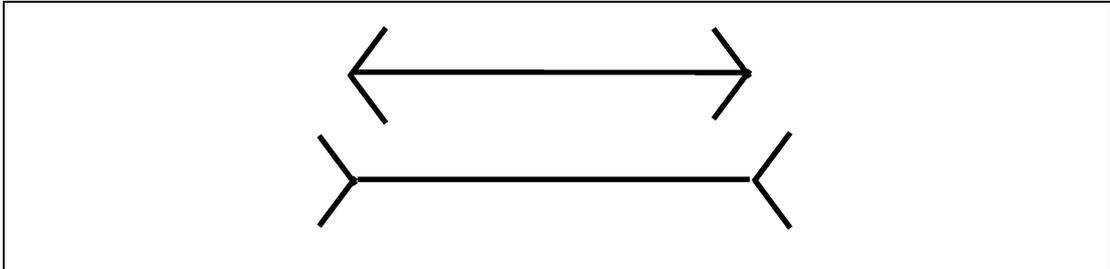


Figure 2 The Muller-Lyer Illusion

- 3.1.4 Figure 3 illustrates that we can perceive the same thing quite differently (i.e. the letter "B" or the number "13"). This shows the influence of context on our information processing.

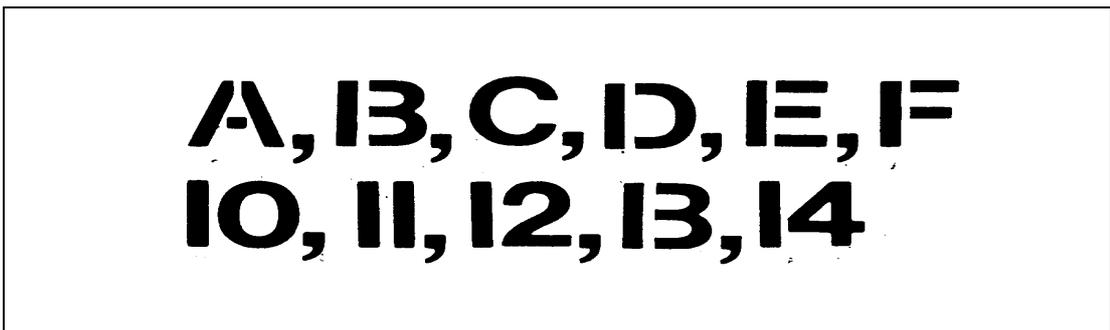


Figure 3 The Importance of Context. Source: Coren, et al, 1994

- 3.1.5 In flight operations it is often necessary to refer to checklists or charts with which the flight crew can become very familiar, especially if they are flying the same route on a regular basis. It is possible that a pilot can scan a checklist or chart and fail to notice that subtle changes have been made. He sees only what he expects to see (expectation). To illustrate how our eyes can deceive us when quickly scanning a sentence, read quickly the sentence below in Figure 4.

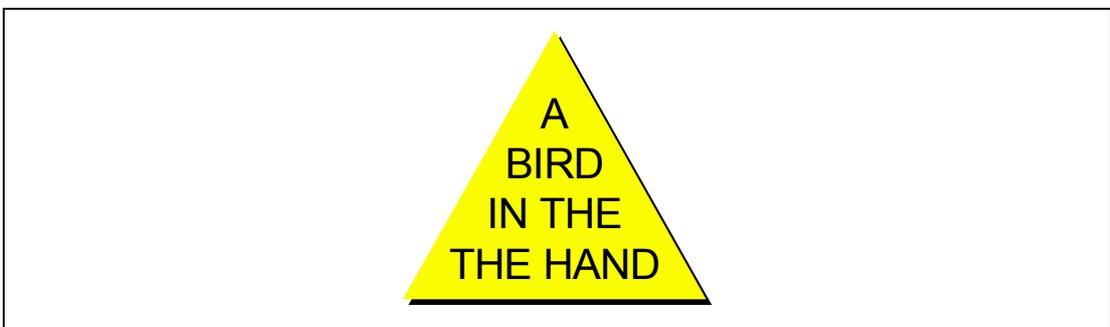


Figure 4 The Effects of Expectation

- 3.1.6 At first, most people tend to notice nothing wrong with the sentence. Our perceptual system subconsciously rejects the additional "THE".

3.2 **Decision Making, Memory, and Motor Programmes**

3.2.1 Attention and perception shortcomings can clearly impinge on decision making. Perceiving something incorrectly may mean that an incorrect decision is made, resulting in an inappropriate action. Figure 1 also shows the dependence on memory to make decisions. It was explained earlier that sensory and short-term memory have limited capacity, both in terms of capacity and duration. It is also important to bear in mind that human memory is fallible, so that information:

- may not be stored;
- may be stored incorrectly;
- may be difficult to retrieve.

3.2.2 All these may be referred to as forgetting, which occurs when information is unavailable (not stored in the first place) or inaccessible (cannot be retrieved). Information in short-term memory is particularly susceptible to interference, an example of which would be trying to remember a part number whilst trying to recall a telephone number.

3.2.3 It is generally better to use checklists and aides-memoires rather than to rely upon memory, even in circumstances where the information to be remembered or recalled is relatively simple. For instance, a pilot may think that he will remember a frequency setting without writing it down, but between speaking to ATC and dialling in the frequency, he may forget the setting or confuse it (possibly with a different frequency setting appropriate to another Sector with which he is more familiar). Additionally, if unsure of the accuracy of memorised information, a pilot should seek to check it, even if this means consulting the manual or chart to do so. Noting something down can avoid the risk of forgetting or confusing information.

4 **Practical Notes**

As with human performance and limitations, the basic theory of information processing should already have been covered by anyone who has studied for the HPL exam. In the context of CRM training, information processing should be addressed from a practical perspective, explaining why each area is relevant to the task of flying and operating an aircraft, and illustrating theoretical concepts with practical examples wherever possible. Avoid presenting unrelated theory, or duplicating theory which course participants may already know.

5 **Initial Training and Objectives**

See practical notes (above).

6 **Recurrent Training and Objectives**

There are many aspects of information processing which it may be appropriate to address in recurrent training, such as situation awareness and decision making. However, these should be addressed from a practical operational perspective, avoiding unrelated theory. Situation awareness is covered in more detail in a separate Appendix.

7 Examples and Suggested Training Material

- 7.1 Dédale's publication "Briefings", and associated videos, address information processing theory at a level appropriate to CRM for multi-crew situations in commercial aviation operations.
- 7.2 There are many case studies which can be used to illustrate information processing and decision making failures. The report "Propulsion System Malfunction and Inappropriate Crew Response" contains examples where pilots have shut down the wrong engine. Some of these examples may be suitable for use during both initial and recurrent training. There are also training videos (one distributed for free by the FAA; another in preparation) available which may help in training pilots to correctly diagnose engine problems and make the appropriate decision.

8 References and Useful Additional Reading

- a) ICAO Human Factors Training Manual. 1998. Doc 9683-AN/950
- b) ICAO. Fundamental Human factors Concepts. ICAO Human Factors Digest No.1. ICAO Circular 216-AN/131 1989
- c) ICAO. Training of Operational Personnel in Human Factors. ICAO Human Factors Digest No.3. ICAO Circular 227-AN/136. 1991
- d) Dédale. Briefings: A Human Factors Course for Pilots - Reference Manual. 1994 (and reissued in 2000). Publishers IFSA, France.
- e) Campbell and Bagshaw. Human Performance and Limitations
- f) Hawkins, F. Human Factors in Flight. 2nd Edn. 1993 Ashgate. ISBN 1 85742 135 3
- g) Thom, T. Human Factors and Pilot Performance. 1994. Chapter 6
- h) AIA/ AECMA. Propulsion System Malfunction and Inappropriate Crew Response (PSM+ICR). Vols 1 and 2. November 1998.
- i) Turbofan Engine Malfunction Recognition and Response - video and training notes. FAA and ATA, November 2000. (For a free copy, write to FAA Engine and Propellor Directorate, ANE-110, 12 New England Executive Park, Burlington, MA 01803, USA)
- j) Turboprop Engine Malfunction Recognition and Response. Training video and notes. In preparation - may be ready late 2002 or early 2003. For further information, write to FAA Engine and Propellor Directorate, ANE-110, 12 New England Executive Park, Burlington, MA 01803, USA
- k) Approach and Landing Accident Reduction (ALAR) Toolkit. 2000/2001. Flight Safety Foundation. Free to FSF members. www.flightsafety.org/pdf/alar_flyer.pdf
- l) Amalberti, R. The pilot's intellectual abilities and limitations. Chapter 3 of "Briefings: A Human Factors Course for Pilots - Reference Manual". Dédale. 1994 (and reissued in 2000). Publishers, Dédale France.

Appendix 5 Human Error, Reliability and Error Management

1 Introduction

- 1.1 The science of Human Factors accepts the fact that human error is inevitable - what is important is to ensure that human error does not result in adverse events such as air accidents. This can be addressed in two ways: reducing errors in the first place, and controlling errors such that they, or their immediate effects, are detected early enough to allow remedial action. CRM addresses both types of mitigating strategies, but concentrates particularly on error detection, especially in the multi-crew situation.
- 1.2 Human reliability is the science which looks at the vulnerability of human beings to make errors (or less than perfect performance) under different circumstances. One could argue that it is more of an art than a science, since it is very difficult to predict, in quantifiable terms, human reliability in different situations, and from individual to individual. However, there are certain conditions under which humans are more likely to make errors (e.g. during circadian lows, when stressed, when overloaded, etc.), but these will be covered in other Appendices rather than under "human reliability" as such. If readers wish to find further information on the science of human reliability, a few references are included at the end of this Appendix.
- 1.3 The following text, which draws heavily from Professor James Reason's book "Human Error", explains some of the basic theory of human error.

2 Basic Theory

2.1 Introduction to Human Error

- 2.1.1 It has long been acknowledged that human performance is at times imperfect. Nearly two thousand years ago, the Roman philosopher Cicero cautioned "It is the nature of man to err". It is an unequivocal fact that whenever men and women are involved in an activity, human error will occur at some point.
- 2.1.2 In his book "Human Error", Professor James Reason defines error as follows:

"Error will be taken as a generic term to encompass all those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcome, and when these failures cannot be attributed to the intervention of some chance agency".

2.2 Error Models and Theories

To appreciate the types of error that it is possible to make, researchers have looked at human error in a number of ways and proposed various models and theories. These attempt to capture the nature of the error and its characteristics. To illustrate this, the following models and theories will be briefly highlighted:

- design- versus operator-induced errors;
- variable versus constant errors;
- reversible versus irreversible errors;
- slips, lapses and mistakes;
- skill-, rule- and knowledge-based behaviours and associated errors;
- the 'Swiss Cheese Model'.

2.3 Design- Versus Operator-Induced Errors

2.3.1 In aviation, emphasis is often placed upon the error(s) of the front line operators, who may include flight crew, air traffic controllers and aircraft maintenance engineers.

2.3.2 However, errors may have been made before an aircraft ever leaves the ground, by aircraft designers. This may mean that, even if an aircraft is maintained and flown as it is designed to be, a flaw in its original design may lead to operational safety being compromised. Alternatively, flawed procedures put in place by airline, maintenance organisation or air traffic control management may also lead to operational problems.

2.3.3 It is common to find when investigating an incident or accident that more than one error has been made and often by more than one person. The 'error chain' captures this concept. It may be that, only when a certain combination of errors arise and error 'defences' breached (see the 'Swiss Cheese Model') will safety be compromised.

2.4 Variable Versus Constant Errors

In his book "Human Error", Professor Reason discusses two types of human error: variable and constant errors. It can be seen in Figure 1 that variable errors in (A) are random in nature, whereas the constant errors in (B) follow some kind of consistent, systematic (yet erroneous) pattern. The implication is that constant errors may be predicted and therefore controlled, whereas variable errors cannot be predicted and are much harder to deal with. If we know enough about the nature of the task, the environment it is performed in, the mechanisms governing performance, and the nature of the individual, we have a greater chance of predicting an error.

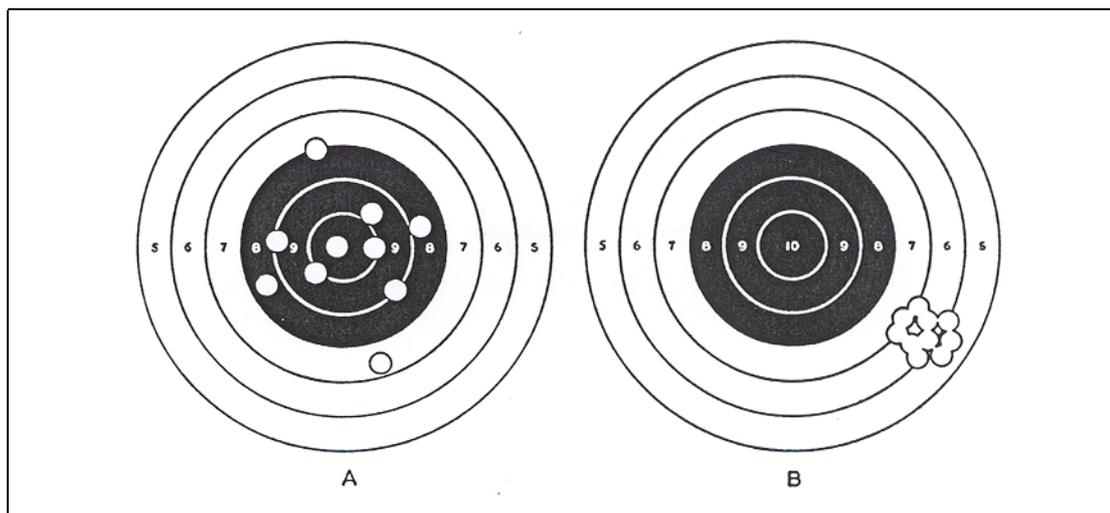


Figure 1 Variable versus Constant Errors

Target patterns of 10 shots fired by two riflemen. Rifleman A's pattern exhibits no constant error, but large variable errors; rifleman B's pattern exhibits a large constant error but small variable errors. The latter would, potentially, be easier to predict and to correct (e.g. by correctly aligning the rifle sight).

Chapanis, 1951

However, it is rare to have enough information to permit accurate predictions; we can generally only predict along the lines of "fatigued pilots are more likely to make errors than alert pilots", or "The SOPs for task X on aircraft type Y is known as being ambiguous and likely to result in pilot error". It is possible to refine these predictions with more information (e.g. The SOPs in Operator Z's QRH are known as being

ambiguous), but there will always be random errors or elements which cannot be predicted.

2.5 **Reversible Versus Irreversible Errors**

Another way of categorising errors is to determine whether they are reversible or irreversible. The former can be recovered from, whereas the latter typically cannot be. For example, if a pilot miscalculates the fuel he should carry, he may have to divert to a closer airfield, but if he accidentally dumps his fuel, he may not have many options open to him.

A well designed system or procedure should mean that errors made by flight crew are reversible. Thus, if a flight crew member incorrectly selects fuel feed which results in an imbalance, the aircraft systems should generate an appropriate alert.

2.6 **Slips, Lapses, Mistakes and Violations**

Professor Reason highlights the notion of 'intention' when considering the nature of error, asking the questions:

- Were the actions directed by some prior intention?
- Did the actions proceed as planned?
- Did they achieve their desired end?

Professor Reason suggests an error classification based upon the answers to these questions as shown in Figure 2.

The most well-known of these are slips, lapses and mistakes.

Slips can be thought of as actions not carried out as intended or planned, e.g. 'finger trouble' when dialling in a frequency or 'Freudian slips' when saying something.

Lapses are missed actions and omissions, i.e. when somebody has failed to do something due to lapses of memory and/or attention or because they have forgotten something, e.g. forgetting to lower the undercarriage on landing.

Mistakes are a specific type of error brought about by a faulty plan/intention, i.e. somebody did something believing it to be correct when it was, in fact, wrong, e.g. switching off the wrong engine.

Slips typically occur at the task execution stage, lapses at the storage (memory) stage and mistakes at the planning stage.

Violations sometimes appear to be human errors, but they differ from slips, lapses and mistakes because they are deliberate 'illegal' actions, i.e. somebody did something knowing it to be against the rules (e.g. deliberately failing to follow proper procedures). A pilot may consider that a violation is well-intentioned, e.g. electing not to climb in response to a TCAS RA, if he is certain that the other aircraft has already initiated avoiding action. There is great debate about whether flight crew should follow SOPs slavishly, or should elect to diverge from SOPs from time to time. Whatever the case, and however well-intentioned, this would still technically constitute a 'violation' rather than an error.

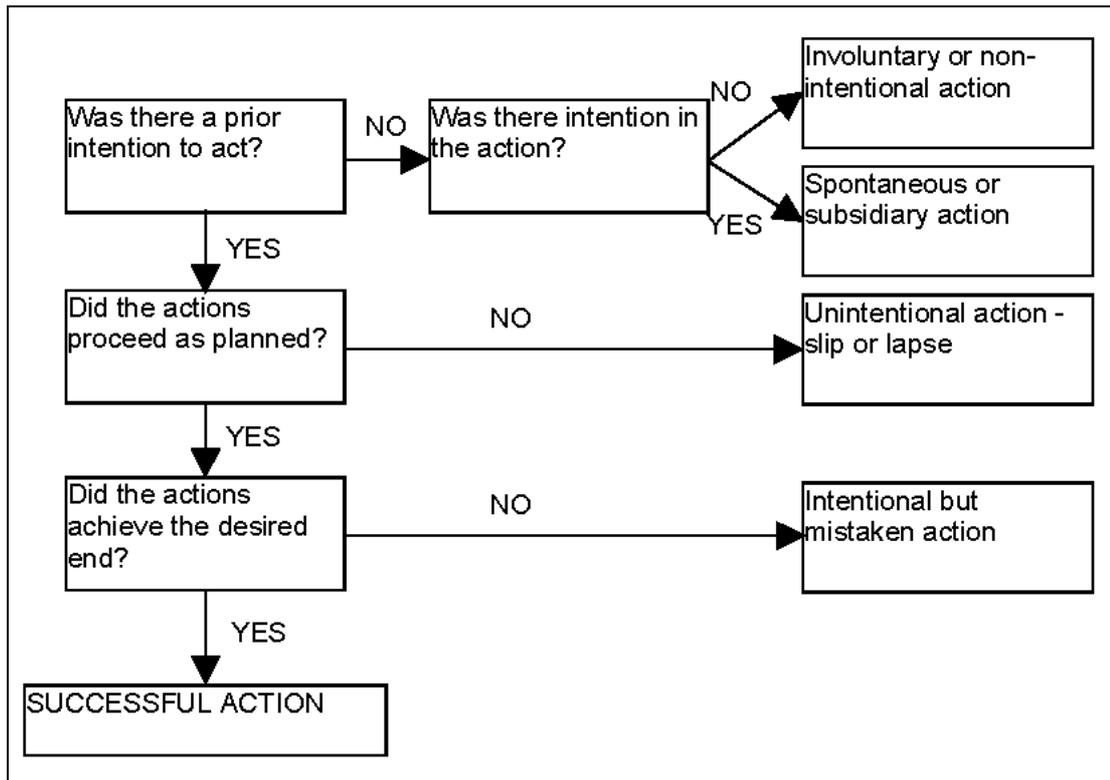


Figure 2 Error types base on intention. Source: Reason, 1990

2.7 Skill-, Rule- and Knowledge-Based Behaviours and Associated Errors

Human behaviour can generally be broken down into three distinct categories: skill-based, rule-based and knowledge-based behaviour. These are covered in greater detail in Professor James Reason's book "Human Error".

Each of these behaviour types have specific errors associated with them.

Examples of skill-based errors are action slips, environmental capture and reversion. Action slips as the name implies are the same as slips, i.e. an action not carried out as intended. The example given in Figure 3 may consist of a pilot intending to key in FL110 into the FMS but keying in FL100 by mistake, after having been distracted by a query from his co-pilot.

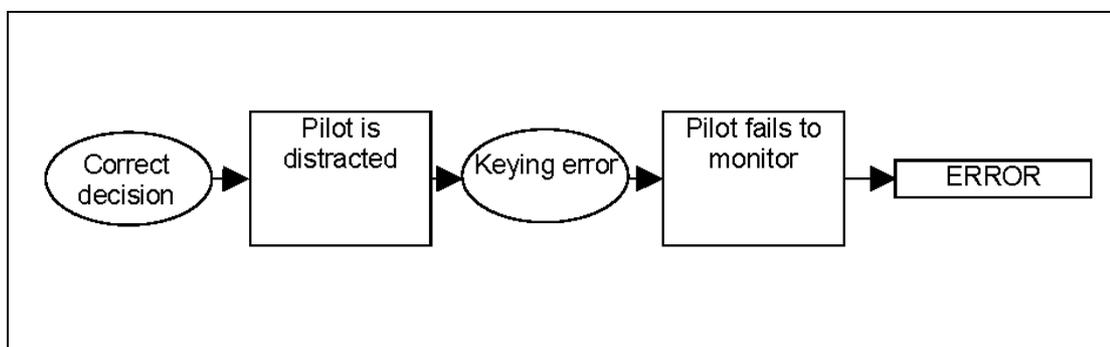


Figure 3 Example of an Action Slip

Environmental capture may occur when a pilot carries out a certain task very frequently in a certain location. Thus, a pilot used to reaching for a certain switch to select function A on an Airbus A320, may inadvertently select the same switch on an Airbus 321 when, in fact, it has a different function.

Reversion can occur once a certain pattern of behaviour has been established, primarily because it can be very difficult to abandon or unlearn it when it is no longer appropriate. Thus, a pilot may accidentally carry out a procedure that he has used for years, even though it has been recently revised. This is more likely to happen when people are not concentrating or when they are in a stressful situation. Reversion to originally learned behaviour is not uncommon under stress.

Rule-based behaviour is generally fairly robust and this is why the use of procedures and rules is emphasised in aircraft maintenance. However, errors here are related to the use of the wrong rule or procedure. For example, a pilot may misdiagnose a fault and thus apply the wrong SOP, thus not clearing the fault. Errors here are also sometimes due to faulty recall of procedures. For instance, not remembering the correct sequence when performing a procedure.

Errors at the knowledge-based performance level are related to incomplete or incorrect knowledge or interpreting the situation incorrectly. An example of this might be when a pilot makes an incorrect diagnosis of a situation without having a full understanding of how the aircraft systems work. Once he has made such a diagnosis, he may well look for information to confirm his (mis) understanding, while ignoring evidence to the contrary (known as confirmation bias).

2.8 Violations

It is a fact of life that violations occur in aviation operations. Most stem from a genuine desire to do a good job. Seldom are they acts of laziness or incompetence.

There are three types of violations:

- Routine violations;
- Situational violations;
- Optimising violations.

Routine violations are things which have become 'the normal way of doing something' within the person's work group (e.g. flight crew from one company base). They can become routine for a number of reasons: flight crew may believe that procedures may be over prescriptive and violate them to simplify a task (cutting corners), to save time and effort. This rarely happens in flight operations, since flying tasks are so proceduralised, but it is not unusual to see these type of violations in maintenance engineering.

Situational violations occur due to the particular factors that exist at the time, such as time pressure, high workload, unworkable procedures, poorly designed man-machine interface in the cockpit. These occur often when, in order to get the job done, pilots consider that a procedure cannot be followed.

Optimising violations involve breaking the rules for 'kicks'. These are often quite unrelated to the actual task. The person just uses the opportunity to satisfy a personal need. Flying an illegal circuit over a friend's house might be an example.

Time pressure and high workload increase the likelihood of all types of violations occurring. People weigh up the perceived risks against the perceived benefits, unfortunately the actual risks can be much higher.

3 Error Management

One of the key concepts associated with error management is that of "defences in depth", based on the premise that there are many stages in any system where errors can occur, and similarly many stages where defences can be built to prevent and trap errors. Professor James Reason covers error management in his book "Human Error".

3.1 Reason's 'Swiss Cheese Model'

In his research, Reason has highlighted the concept of 'defences' against human error within an organisation, and has coined the notion of 'defences in depth'. Examples of defences are pre-flight checks, automatic warnings, challenge-response procedures, etc., which help prevent to 'trap' human errors, reducing the likelihood of negative consequences. It is when these defences are weakened and breached that human errors can result in incidents or accidents. These defences have been portrayed diagrammatically, as several slices of Swiss cheese (and hence the model has become known as Professor Reason's "Swiss cheese" model) (see Figure 4).

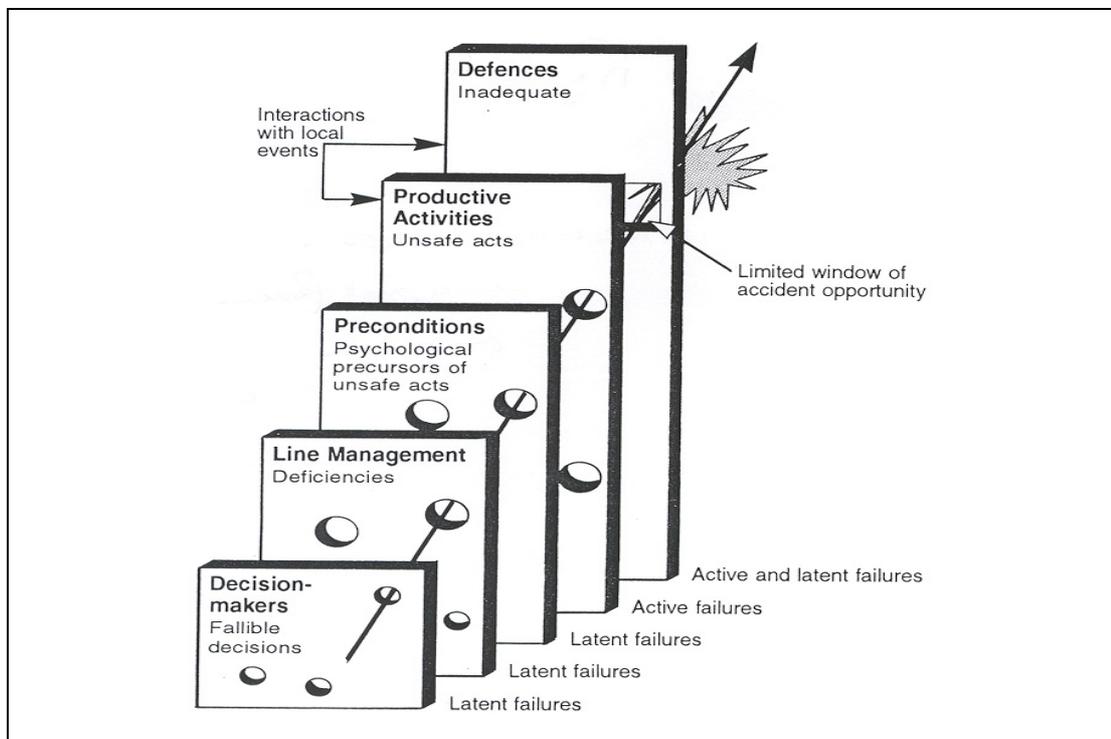


Figure 4 Reason's Swiss Cheese Model

Some failures are 'latent', meaning that they have been made at some point in the past and lay dormant. This may be introduced at the time an aircraft was designed or may be associated with a management decision. Errors made by front line personnel, such as flight crew, are 'active' failures. The more holes in a system's defences, the more likely it is that errors result in incidents or accidents, but it is only in certain circumstances, when all holes 'line up', that these occur. Usually, if an error has breached the design or engineering defences, it reaches the flight operations defences (e.g. in flight warning) and is detected and handled at this stage. However, occasionally in aviation, an error can breach all the defences (e.g. a pilot ignores an in flight warning, believing it to be a false alarm) and a catastrophic situation ensues.

3.2 **Error Detection and Prevention**

The concept of redundancy should be applied at all stages of the aviation system, never assuming that one single mechanism, especially if human, will detect and prevent an error. CRM provides a form of redundancy in that it emphasises the role of the second pilot to check what the first pilot has done. There is a potential danger with independent checks that the second person will trust the first person not to have done anything wrong, and therefore not to carry out the second check properly. CRM dual checking is one of the last lines of defence, especially if no automatic system checks and alerts are present, and pilots should always be alert for the possibility that their colleague may have made an error, when carrying running through SOPs which require challenge-response checks, no matter how much they might trust and respect the other pilot. Similarly, the pilot carrying out the first action should never become complacent and rely upon the other pilot detecting an error. (The same applies with pilot-ATC communications, and readbacks). It is essential to remember that we are all human therefore we all make mistakes from time to time, so assume the worst.

4 **Practical Notes**

It is important for both students and facilitators to accept the fact, from the outset, that human error is inevitable to some extent. Whilst CRM training should aim to reduce error as far as possible, it should also concentrate upon detecting and controlling error. As with HPL and information processing, teaching unrelated theory should be avoided; the emphasis should be upon practical guidance as to how to avoid and detect errors made by oneself and others.

It may be useful to link in this module with information about the company's occurrence reporting scheme, stressing the importance of open and frank reporting of errors in order that lessons can be learned from them. However, this can be a sensitive area, and care should be taken not to jeopardise any confidentiality agreements, if using real examples of errors from the occurrence database.

5 **Initial Training and Objectives**

It is quite important to understand the theory of error, in particular the distinctions between slips, lapses, mistakes and violations, and their possible causes. It is also important for company managers to appreciate the concept of layers of defence, and what can be done to ensure that error provoking situations (e.g. poor procedures, poorly designed cockpits, undue commercial pressure, bad rosters, etc.) are minimised, and that the pilot does not become the one and only layer of defence.

6 **Recurrent Training and Objectives**

LOFT exercise debriefs are probably the best way to learn from ones own errors and those of the crew, but care should be taken to ensure that errors are treated as learning exercises, and not as criticisms of personnel performance.

For recurrent training carried out in a classroom environment, use of scenarios where errors have taken place is probably the most effective means of learning how to detect and prevent such errors in the future. Positive examples, as well as negative, can be useful.

7 Examples and Suggested Training Material

Videos featuring errors, and how they should be detected and rectified.

Examples of common errors (e.g. keying in FL100 instead of FL110).

Occurrences from the company database where errors have occurred, and how they might have been prevented or detected earlier.

Occurrences from other sources (e.g. CHIRP, AAIB reports, ASRS, etc.).

Studies of types and frequency of errors.

8 References and Useful Additional Reading

8.1 Further Reading on Human Error:

- a) Reason, J. Human Error. Cambridge University Press. 1990 ISBN 0-521-31419-4
- b) Reason, J. Managing the Risks of Organisational Accidents. 1997. Ashgate. ISBN-1 84014-105-0
- c) ICAO Digest No 2. Flight Crew Training: CRM and LOFT. ICAO Circular 217-AN/132 (now out of print) - reprinted as CAP 720.
- d) HSE. Reducing Error and Influencing Behaviour. HSG48, 2nd Edition, 1999. HSE Books. <http://www.hsebooks.co.uk/homepage.html>
- e) Green, R., Muir, H., James, M., Gradwell, D., Green, R. Human Factors for Pilots (2nd edition). 1996. Ashgate.
- f) Pariès, J and de Courville, B. Human error and human reliability. Chapter 5 of "Briefings: A Human Factors Course for Pilots - Reference Manual". Dédale. 1994 (and reissued in 2000). Publishers Dedale, France.

8.2 Further Reading on Human Reliability:

Human Reliability Assessment – a Critical Overview. ACSNI Study Group on Human Factors. HSE Books 1991. ISBN 0 11 885695 2

Appendix 6 Situation Awareness

1 Introduction

Situation Awareness (SA) is "knowing what is going on around you" and is fundamental to correct decision making and action. Information processing tends to be the term used for the psychological mechanism of receiving and analysing information; situation awareness is a description of an individual's, or team's, understanding of the aircraft state and environment, based on perceived and processed information.

SA is more than just perception - it is understanding the meaning of what you perceive, how it might change in the future, and the implications. Decision making is based on situation awareness, therefore if you have poor SA, you are likely to make poor decisions. SA has sometimes been referred to as "perception of reality" and it is quite possible for different crew members to have different perceptions of reality. The aim of SA training should be to ensure that all flight crew members have good SA and a common (and correct) perception of the state of the aircraft and environment. This can be achieved by good teamworking and communication. SA is, therefore, an important element of CRM.

2 Definitions

There are many definitions of Situation Awareness.

One definition of SA is:

"the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future"
(Endsley 1998).

Another definition is:

"Situation awareness relates to one's ability to accurately perceive what is in the cockpit and outside the aircraft. It is also one's ability to comprehend the meaning of different elements in the environment and the projection of their status in the near future"
(CAA Document 29).

A third definition (ICAO - HF Digest 2) is:

" Situation awareness refers to one's ability to accurately perceive what is going on in the cockpit and outside the aircraft. It further extends to the planning of several solutions for any emergency situation which could occur in the immediate future. Maintaining a state of awareness of one's situation is a complex process, greatly motivated by the understanding that one's perception of reality sometimes differs from reality itself. This awareness promotes ongoing questioning, cross-checking, and refinement of one's perception. Constant, conscious monitoring of the situation is required. Note that the situation referred to here includes the human environment. The evaluation of oneself and others for partial or total incapacitation is vital but often overlooked."

Team SA has been defined by Wagner and Simon as "The crew's understanding of flight factors that affect (or could affect) the crew and aircraft at any given time".

3 Basic Theory

The basic theory of SA is that of cognitive psychology, in particular, attention, perception, information processing, memory and decision making. Much of this has already been addressed in the Appendix dealing with information processing.

Whilst the term "situation awareness" is usually used, in the context of flight operations, to describe awareness of all aspects of the whole flight, this can be broken down into specific elements, of which flight crew need to be aware to varying extents at certain times of the flight. For instance, a pilot needs very good SA concerning runway and taxiway assignments prior to take-off, but this information ceases to be useful after departure. Information on the frequency concerning your own aircraft is more important than ATC instructions to other aircraft, but it may be useful to retain some SA of the latter 'party-line' information, in case ATC mistakenly clear another aircraft to your level. Table 1 distinguishes between geographical SA, SA of aircraft position and movement, aircraft system SA, environmental SA and, more for military aircraft, tactical SA.

Table 1 Types of SA (modified from Endsley)

Geographical SA	own aircraft other aircraft terrain features airports cities waypoints navigation fixes position relative to designated features path to desired location runway and taxiway assignments path to desired location climb/descent points
Spatial/Temporal SA	attitude altitude heading velocity vertical velocity flight path actual values relative to assigned projected flight path projected landing time
System SA	system status functioning and settings radio altimeter transponders flight modes and automation deviations from correct settings ATC communications present fuel impact of degrades and settings on performance time and distance available on fuel

Table 1 Types of SA (modified from Endsley)

Environmental SA	weather formations and movement temperature icing ceilings fog turbulence, winds sun visibility IFR/VFR conditions areas to avoid flight safety projected weather conditions
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One could also argue that "People SA" should be included, but this is not one of the elements in Mica Endsley's model.

Mica Endsley has categorised SA into three levels: perception, comprehension and projection. These are described further in Table 2. The more experienced and skilled a pilot, the better his SA at all three levels tends to be. Novice pilots tend to be competent at level 1 SA, but poor at levels 2 and 3. On the other hand, some skilled and experienced pilots may make errors at the level 2 stage, in that they may perceive the correct information but draw an incorrect conclusion based on previous experience of a similar event.

Table 2 SA Error Taxonomy (Mica Endsley, 1995)

Level 1 SA: failure to correctly perceive the situation	A: Data not available B: Data difficult to detect/perceive C: Failure to scan or observe data 1. omission 2. attentional narrowing/distraction 3. high taskload D: Misperception of data E: Memory failure
Level 2 SA: Failure to comprehend situation	A: Lack of/poor mental model B: Use of incorrect mental model C: Over-reliance on default values in model D: Memory failure E: Other
Level 3 SA: Failure to project situation into the future	A: Lack of/poor mental model B: Other
General	Failure to maintain multiple goals Habitual schema

Individual factors which can influence SA are those described already in the Appendix on information processing. Human beings have a limited information processing capability and cannot attend to all sources of information all the time. It is necessary to switch attention from one source to another, often in fairly rapid succession, and store the information in memory. Appropriate training can help pilots develop and practice good 'attention sampling' strategies, to ensure that one or more sources of information do not get neglected. A simple example of this is the instrument scanning pattern which many pilots learn at an early stage in their flying training, in order not to miss a potentially important source of information.

Working memory capacity is a limit on SA, since its capacity can soon be overwhelmed when used to store perceived information, comprehending the meaning of that information, combining it with existing knowledge to achieve a composite picture, and predict future outcomes whilst still maintaining a good appreciation of the current situation. The load on working memory and processing capabilities can be reduced as tasks become more and more automatic, with the development of skill. However, this very 'automaticity' can have a down side in that it can lead to failure to perceive new stimuli (e.g. hearing what you expect to hear, or seeing what you expect to see).

Stress can have an affect on SA, sometimes positive, but more usually negative. Stress can be physical (noise, vibration, heat, cold, fatigue, etc.) or social/psychological (fear, anxiety, uncertainty, mental load, time pressure, perceived time pressure, consequences of events, etc.). High workload is a form of stress, either long term high workload (e.g. a short-haul flight through several sectors in busy airspace, with an inexperienced crew), or short term or even momentary high workload or overload (e.g. bad weather on approach).

Depending on the individual, some degree of stress may improve performance in general, including SA. More often, however, stress results in reduced SA since it competes with SA for an individual's limited attention capacity, and may result in attentional narrowing. Other consequences may include reduced working memory capacity, and reduced information intake. Aural inputs may be significantly reduced, with peripheral visual inputs suffering next. This is a strong argument for placing master warning lights in the central visual area in cockpits, rather than rely upon peripheral attention-getters or aural warnings.

Stress can also result in decisions being made without all the pertinent information having been considered (e.g. shutting down wrong engine without looking to see which one is on fire!), and also with failing to take account of contradictory information once a decision has been made, attention being given only to information which supports the decision. Training can make people aware that this is a danger, help them to recognise the symptoms of stress and reduced SA, and train them to actively search for, and attend to, all pertinent sources of information before making a decision or acting upon a decision.

Recognition of reduced SA is almost as important as subsequent retrieval of good SA. LOFT exercises and debriefs are a useful way to improve on recognising when SA is reduced, with regard to both individuals and the flight deck crew team. Mica Endsley advocates a training method whereby LOFT exercises are stopped midway through, in order to test individuals on their SA, and make them aware of their actual levels of SA, rather than their perceived levels, particularly at the end of an exercise.

Table 3 Clues to Loss of SA (adapted from Bovier, 1997)

These "clues" can warn of an error chain in progress - a series of events that may lead to an accident. Most accidents involving human error include at least four of these clues.

- Ambiguity - information from two or more sources that doesn't agree
- Fixation - focusing on any one thing to the exclusion of everything else
- Confusion - uncertainty or bafflement about a situation (often accompanied by anxiety or psychological discomfort)
- Failure to fly the aircraft - everyone is focused on non-flying activities
- Failure to look outside - everyone heads down
- Failure to meet expected checkpoint on flight plan or profile ETA, fuel burn, etc.
- Failure to adhere to SOPs
- Failure to comply with limitations, minimums, regulatory requirements, etc.
- Failure to resolve discrepancies - contradictory data or personal conflicts
- Failure to communicate fully and effectively - vague or incomplete statements

Table 4 Tips for Good SA Management (Bovier, 1997)

- 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

Training can help flight crew manage their workload to avoid overload situations and the associated reduction in SA. Training can help flight crew recognise reduced SA when it happens. CRM training can help improve teamwork such that team members can have good team SA, as well as monitoring one another to ensure that individual team members are maintaining SA. One of the key benefits of training, however, is to train individuals and teams how to cope in a non-normal or emergency situation, and how to maintain SA under stress. Training aids and videos are available for specific situations, e.g. approach and landing, engine failure, CFIT, turbulence, etc., but generic training in how to maintain and improve SA is valuable to give flight crew a good understanding of the techniques available.

4 Practical Notes

The following text has been extracted from Document 29 (Appendix 16) and JARTEL WP5 and WP7:

4.1 Situation Awareness

4.1.1 Awareness of aircraft systems

The crew needs to be constantly aware of the state of different aircraft systems.

Examples of poor practice:

- Does not ask for updates;
- Does not signal awareness of changing systems.

Examples of good practice:

- Monitors and reports changes in system states;
- Acknowledges entries and changes to systems.

4.1.2 Awareness of external environment

The crew needs to be aware of their environment (position, weather, air traffic, terrain).

Examples of poor practice:

- Does not acknowledge - repeat ATC directions;
- Does not enquire about environmental changes;
- Does not comment on relevant environmental factors, or is surprised by them.

Examples of good practice:

- Collects information about the environment;
- Contacts outside resources when necessary;
- Shares information about the environment with others.

4.1.3 Awareness of time

The crew needs not only to be aware of the present state of the aircraft systems and environment, but must also be able to predict future states in order to anticipate future events.

Examples of poor practice:

- Does not set priorities with respect to time limits;
- Does not discuss relationship between past events and present - future;
- Is surprised by outcomes of past events.

Examples of good practice:

- Discusses contingency strategies;
- Identifies possible - future problems.

5 Initial Training and Objectives

Initial training should introduce the concept of SA and illustrate the dangers of poor SA (possibly using well-known incidents and accidents). Factors which contribute to good and bad SA should be covered.

6 Recurrent Training and Objectives

Good SA acquisition needs to be trained as a skill, ideally using a simulator (see below for methods). Team skills are important in ensuring that the crew as a whole have the correct perception of aircraft and environment status, and to avoid each individual crew member having their own (incorrect) SA. Good communication skills and procedures are necessary in ensuring that all pertinent information is shared between the crew.

7 Examples and Suggested Training Material

Mica Endsley, of SA Technologies Inc, advocates SA training in the simulator, where scenarios are stopped midway in order to ascertain the flight crews' SA. In this way, if individuals are failing to take in information from certain sources, or to understand that information, this can be pointed out at an early stage during the simulation exercise allowing them more opportunity to correct their working methods as the scenario progresses. If debriefing is left until the end of a LOFT exercise, as is traditional, the trainer may not be aware of where the SA deficiencies lie, since the flight crew may have acquired all the necessary information eventually, albeit not very efficiently. Further information on Mica Endsley's SA training techniques can be found on her website www.satechnologies.com.

There is an FAA sponsored training manual "Guidelines for Situation Awareness Training" which CRM instructors may find useful. This document contains very practical information on how to design training and LOFT scenarios to help flight crew improve SA.

The ESSAI project has produced some useful material which might assist CRM trainers. Some of the material is in the form of computer based training (CBT), and includes video extracts, but was still under development at the time of writing this document. Further details can be found on the NLR website (www.nlr.nl).

There are some well-known incidents and accidents which illustrate poor SA, and which can be used as training examples. These include:

- Cali accident American Airlines flight 965, Dec 20, 1995;
- US Airforce accident, CT-43A (B737), near Dubrovnik, April 3, 1996.

8 References and Useful Additional Reading

- a) NAWCTSD/UCF/FAA Guidelines for Situation Awareness Training. Prince, C.
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- c) Endsley, M., Robertson, M. Training for Situation Awareness. In: Situation Awareness Analysis and Measurement. Endsley, M., Garland, D. (2000). Mahwah, NJ: Lawrence Erlbaum Associates.
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- i) Approach and Landing Accident Reduction (ALAR) Toolkit. 2000/2001. Flight Safety Foundation www.flightsafety.org/pdf/alar_flyer.pdf.

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- k) AIA/ AECMA. Propulsion System Malfunction and Inappropriate Crew Response (PSM+ICR). Vol 1. November 1998.

Appendix 7 **Communication, Teamwork, Leadership, Decision Making and Managerial Skills**

1 Introduction

One of the basic underlying premises of CRM is that a team can, and should, perform better than two (or three) individuals in the cockpit. The aim of CRM is to ensure that $1+1>2$, as opposed to $1+1<2$ (in a two pilot cockpit), and that team performance takes precedence over individual performance. Good CRM is getting the balance right as a team, whilst recognising that the Captain has the final say and responsibility for the safety of the aircraft.

In order to be effective, team members must be able to talk to each other, listen to each other, share information and be assertive when required. Commanders should take particular responsibility for ensuring that the crew function effectively as a team.

Whilst the emphasis in CRM is primarily upon the cockpit crew, and how they work as a team, it is also important to look at wider team effectiveness, namely the whole flight crew. CRM principles may also extend to situations where ATC, maintenance, company experts, etc., are considered to be part of the team (especially in emergency situations).

2 Communication

Good communication is important in every industry. In aircraft operations, it is vital. Communication, or more often a breakdown in communication, is often cited as a contributor to aviation incidents and accidents. Communication is defined in the Penguin Dictionary of Psychology as: "The transmission of something from one location to another. The 'thing' that is transmitted may be a message, a signal, a meaning, etc. In order to have communication both the transmitter and the receiver must share a common code, so that the meaning or information contained in the message may be interpreted without error".

2.1 Modes of Communication

We are communicating almost constantly, whether consciously or otherwise. We may need to communicate:

- information (e.g. "ATC have instructed us to...");
- feedback/challenger/response (e.g. "checked" or "set");
- ideas/proposals/counter-proposals (e.g. "I disagree. What about XX instead?");
- feelings (e.g. "I'm not happy with...").

As the sender of a message, he will typically expect some kind of response from the person he is communicating with (the recipient), which could range from a simple acknowledgement that his message has been received (and hopefully understood), to a considered and detailed reply. The response constitutes feedback.

2.2 Verbal Communication

Verbal communication may be either social or functional/operational. Both serve a useful purpose, the former helping to built teamwork, and the latter being essential to the task of flying an aircraft.

For a spoken or written message to be understood, the sender has to make sure that the receiver:

- is using the same channel of communication;
- recognises and understands his language, including any subtleties;
- is able to make sense of the message's meaning.

The channel of communication is the medium used to convey the message. For spoken communication, this might be face-to-face, or via the radio or intercom. Written messages might be notes, information keyed in, or tone messages (e.g. between flight deck and cabin crew). Oral/aural communication is the primary mode of communication in an aircraft.

Pilot-ATC communication is a very important area, almost warranting a separate Appendix. However, it is not appropriate to go into too much detail in this document, other than to stress that CRM principles should also apply to pilot-ATC communications (within the restrictions of standard phraseology and air-ground communications procedures) as well as face-to-face communications.

2.3 **Non-verbal Communication**

Non-verbal communication can accompany verbal communication, such as a smile during a face-to-face chat. It may constitute acknowledgement or feedback (e.g. a nod of the head). It can also be used when verbal communication is impossible, such as a thumbs-up in a noisy environment.

Body language can be very subtle, but often quite powerful. For example, the message "No" accompanied by a smile will be interpreted quite differently from the same word said whilst the sender scowls.

Non-verbal communication may also take the form of written information or notes, between pilots or flight deck and cabin crew.

Future ground-air communications are increasingly more likely to be non-verbal as data link technology and associated procedures gradually replaces oral/aural RTF communications between ATC and pilots. As mentioned above, this is not addressed in any detail in this document.

Non-verbal communication is the predominant manner by which systems communicate their status. For instance, most displays in the aircraft cockpit present their information graphically. However, man-machine interface issues are not covered in this document.

2.4 **Communication Problems**

There are two main ways in which communication can cause problems. These are lack of communication and poor communication. An example of the former is a young first officer who is very IT-literate, who is engrossed with programming the FMS but doesn't explain to the less-IT-literate Captain what he is doing. An example of the latter is a flight deck crew who advise the cabin crew that there will be a precautionary emergency landing, but fail to tell them not to evacuate the cabin. Both problems can lead to subsequent human error.

Communication also goes wrong when one of the parties involved makes some kind of assumption. The sender of a message may assume that the receiver understands the terms he has used. The receiver of a message may assume that the message means one thing when in fact he has misinterpreted it. Assumptions may be based on context and expectations, which have already been mentioned in this Appendix.

Problems with assumptions can be minimised if messages are unambiguous and proper feedback is given.

There are several hazards which reduce the quality of communications:

- failures during the transmitting process (e.g. the sending of unclear or ambiguous messages, language problems);
- difficulties caused by the medium of transmission (e.g. background noises or distortion of the information);
- failures during receiving (e.g. the expectation of another message, wrong interpretation of the arriving message or even its disregard);
- failures due to interference between the rational and emotional levels of communication (e.g. arguments); and
- physical problems in listening or speaking (e.g. impaired hearing or wearing of the oxygen mask).

It is the task of Human Factors training to prevent or minimise communication errors. This task includes the explanation of common communication problems as well as the reinforcement of a standard of language to ensure the error-free transmission of a message and its correct interpretation. Ambiguous, misleading, inappropriate or poorly constructed communication, combined with expectancy, have been listed as elements of many accidents, the most notorious one being the double 747 disaster in Tenerife.

3 Leadership/Followership

The following text has been adapted from ICAO HF Digest No. 1: Fundamental Human Factors Concepts. ICAO Circular 216-AN/131.

A leader is a person whose ideas and actions influence the thought and the behaviour of others. Through the use of example and persuasion, and an understanding of the goals and desires of the group, the leader becomes a means of change and influence.

It is important to establish the difference between leadership, which is acquired, and authority, which is assigned. An optimal situation exists when the two are combined. Leadership involves teamwork, and the quality of a leader depends on the success of the leader's relationship with the team. Leadership skills should be developed for all through proper training; such training is essential in aircraft operations where junior crew members are sometimes called upon to adopt a leadership role throughout the normal performance of their duties. This may occur when the co-pilot must take over from an absent or incapacitated captain, or when a junior flight attendant must control the passengers in a particular cabin section.

Skilled leadership may be needed to understand and handle various situations. For instance, personality and attitude clashes within a crew complicate the task of a leader and can influence both safety and efficiency. Aircraft accident and incident investigations have demonstrated that personality differences influence the behaviour and performance of crew members. Other situations requiring skilled leadership may be rooted in the frustrations of first officers over slow promotions, or of pilots who are employed as flight engineers.

Both leadership and followership are essentially skills which can be learnt. The skills are similar but in the case of the follower they should be exercised in a supporting role that does not attempt to undermine the leader. One upmanship would be a classic case of inappropriate behaviour both for the leader and the follower.

4 Teams

In most companies, flight crews do not comprise the same individuals on a regular basis. Teams, therefore, have little opportunity to grow and form over time, and must function effectively from the moment they are formed, perhaps only an hour or so before the flight. It is important, therefore, to have a common understanding among team members as to how they will all be expected to work together as a team, from the outset. Company and operating procedures will cover the functions and actions, but CRM training is needed to show what behaviours and attitudes are expected and to help standardise across the company.

It is important for the team to establish openness from the outset, and for the commander, particularly, to demonstrate that he will welcome input from other team members, in particular the other flight deck crew. A glowering Captain who speaks to no one in the crew bus on the way to the aircraft is unlikely to set the appropriate atmosphere for the rest of the flight! Talking about a hypothetical situation on the way to the aircraft (e.g. what to do if a drunk and disruptive passenger boarded) may help to establish mutual expectations and encourage open communication.

There may be a large difference in age and experience between the various team members, with a younger, less experienced pilot being reluctant to challenge or query the Captain's actions in any way. Similarly, there may be a reluctance on the part of the cabin crew to 'bother' the flight crew with concerns. It is important to ensure that communication between team members is encouraged from the outset, even if that information often turns out to be non-relevant or not important, or a challenge by a co-pilot proves the Captain to be correct. Team members should not be afraid or embarrassed to speak up.

Assertiveness training should help ensure that people speak out when appropriate, and using illustrations of incidents and accidents where team communication or functioning has been poor (or particularly good) helps reinforce the training.

5 Crew Co-ordination¹

Crew co-ordination is the advantage of teamwork over a collection of highly skilled individuals. Its prominent benefits are:

- an increase in safety by redundancy to detect and remedy individual errors; and
- an increase in efficiency by the organised use of all existing resources, which improves the in-flight management.

The basic variables determining the extent of crew co-ordination are the attitudes, motivation and training of the team members. Especially under stress (physical, emotional or managerial), there is a high risk that crew co-ordination will break down. The results are a decrease in communication (marginal or no exchange of information), an increase in errors (e.g. wrong decisions) and a lower probability of correcting deviations either from standard operating procedures or the desired flight path. Additionally, emotional conflicts in the cockpit may result.

The high risks associated with a breakdown of crew co-ordination show the need for CRM training. This kind of training ensures that:

- the pilot has the maximum capacity for the primary task of flying the aircraft and making decisions;

1. Text taken from ICAO HF Digest No. 1: Fundamental Human Factors Concepts. ICAO Circular 216-AN/131

- the workload is equally distributed among the crew members, so that excessive workload for any individual is avoided;
- co-ordinated co-operation – including the exchange of information;
- the support of fellow crew members and the monitoring of each others' performance – will be maintained under both normal and abnormal conditions.

6 Practical Notes

The following text has been extracted from Document 29 (Appendix 16) and JARTEL WP5 and WP7.

6.1 Leadership and Managerial Skills

Effective leadership and managerial skills help to achieve joint task completion within a motivated, fully-functioning team through co-ordination and persuasiveness.

6.1.1 Use of authority and assertiveness

The use of authority and assertiveness infers the ability to create a proper challenge and response atmosphere. The given command authority of the Captain should be adequately balanced by assertiveness and crew member participation. If a situation requires, decisive actions are expected.

Examples of poor practice:

- Hinders or withholds crew involvement;
- Passive, does not show initiative for decisions, own position not recognisable;
- Does not show appreciation for the crew, coaches very little or too much.

Examples of good practice:

- Advocates own position;
- Takes initiative to ensure involvement and task completion;
- Takes command if situation requires;
- Motivates crew by appreciation and coaches when necessary.

6.1.2 Providing and maintaining standards

Providing and maintaining standards refers to the compliance with essential standards (SOPs and others) for the task completion. Supervision and intervention in case of deviations from standards by other crew members is also part of this skill. If the situation requires, non-standard procedures might be necessary. Such deviations shall be discussed and announced.

Examples of poor practice:

- Does not comply to SOPs, does not monitor crew for SOP compliance;
- Does not intervene in case of deviations;
- Applies non-standard procedures without announcement or consultation of crew members.

Examples of good practice:

- Ensures SOP compliance;
- Intervenes if task completion deviates from standards;
- Having consulted the crew deviates from standard procedures if situation requires.

6.1.3 Planning and co-ordination

Planning and co-ordination refers to applying an appropriate concept for organised task-sharing and delegation in order to achieve top performance and to avoid workload peaks and dips. Communication of plans and intentions leads to co-ordinated activities within the whole crew.

Examples of poor practice:

- Plans only for self, does not involve crew;
- Intentions not stated or confirmed;
- Changes plan without informing crew or follows plans blindly.

Examples of good practice:

- Encourages crew participation in planning and task completion;
- Clearly states intentions and goals;
- Having consulted crew, changes plan if necessary.

6.2 **Decision Making**

Decision making is the process of reaching a judgement or choosing an option.

6.2.1 Problem definition and diagnosis

Problem definition and diagnosis is the ability to collect the information needed to define a problem and its causal factors.

Examples of poor practice:

- Nature of the problem not stated or failure to diagnose;
- No discussion of probable causes.

Examples of good practice:

- Gathers information and identifies problem;
- Reviews causal factors with other crew members.

6.2.2 Option generation

Option generation refers to the ability of a crew member to generate multiple responses to a problem.

Examples of poor practice:

- Does not search for information;
- Does not ask crew for alternatives.

Examples of good practice:

- States alternative courses of action;
- Asks crew members for options.

6.2.3 Risk assessment and option selection

Risk assessment and option selection refers to the ability of a crew member to successfully assess risks and benefits of different responses to a problem, and to select the best response. Both should be accomplished through discussion with other crew members.

Examples of poor practice:

- Inadequate discussion of limiting factors with crew;
- Failing to inform crew of decision path being taken.

Examples of good practice:

- Considers and shares risks of alternative courses of action;
- Talks about possible risks for course of action in terms of crew limitations;
- Confirms selected course of action.

6.3 **Co-operation**

Co-operation is the ability to work effectively in a crew.

6.3.1 Team-building and maintaining

Team-building and maintaining is about the ability to establish positive interpersonal relations between crew members and their active participation in fulfilling the tasks.

Examples of poor practice:

- Blocks open communication;
- Keeps barriers between crew members;
- Competes with others.

Examples of good practice:

- Establishes atmosphere for open communication and participation;
- Encourages inputs and feedback from others;
- Does not compete with others.

6.3.2 Consideration of others

Consideration of others involves the acceptance of others and understanding their personal condition.

Examples of poor practice:

- Ignores suggestions of other crew members;
- Does not take account of the condition of other crew members;
- Shows no reaction to other crew members' problems.

Examples of good practice:

- Takes notice of the suggestions of other crew members even if s/he does not agree;
- Takes condition of other crew members into account;
- Gives appropriate personal feedback.

6.3.3 Support of others

Support of others relates to giving help to other crew members when they need assistance.

Examples of poor practice:

- Hesitates to help other crew members in demanding situations;
- Does not offer assistance.

Examples of good practice:

- Helps other crew members in demanding situations;
- Offers assistance.

6.3.4 Conflict solving

Conflict solving is about the articulation of different interpersonal positions and giving suggestions for solutions.

Examples of poor practice:

- Overreacts in interpersonal conflicts, sticks to own position without considering a compromise;
- Accuses other crew members of making errors.

Examples of good practice:

- Keeps calm in conflicts;
- Suggests conflict solutions;
- Concentrates on what is right rather than who is right.

7 Initial Training and Objectives

To ensure that flight crew understand what is expected of them in their role.

To be aware of company procedures relating to the responsibilities of Captains and other flight crew members.

To be aware of what constitutes good and bad communication in the cockpit, and elsewhere.

8 Recurrent Training and Objectives

To improve upon own communication and team skills, based on feedback from a TRE, CRM instructor or colleagues.

9 Examples and Suggested Training Material

- Videos;
- Incident/ accident case studies;
- Examples from CHIRP;
- Role play exercises.

10 References and Useful Additional Reading

- a) ICAO HF Digest No. 1: Fundamental Human Factors Concepts. ICAO Circular 216-AN/131.
- b) Amalberti, R. Communication in the cockpit. Chapter 6 of "Briefings: A Human Factors Course for Pilots - Reference Manual". Dédale. 1994 (and reissued in 2000). Publishers Dedale, France.
- c) Dunlap, J., and Mangold, S. Leadership/Followership; recurrent training. Instructor manual and student manual. Feb 1998. FAA.

Appendix 8 Automation

1 Introduction

CRM in highly automated aircraft presents special challenges, in particular in terms of situation awareness of the status of the aircraft. Many researchers and practitioners have looked at training for modern automated aircraft, in particular Mica Endsley, in the context of situation awareness of automation modes. This has been addressed to a certain extent within Appendix 6.

The following text has been adapted from ICAO Digest 05 (Automation) Chapter 3.

2 Training for Automation

Pilot training is very important and it is also very expensive. There is no argument regarding its importance, but there is not always agreement on the kind and amount of training required to enable pilots to operate new and different aircraft safely and efficiently.

The controversy regarding the effect of automation on training is an entirely separate issue. Some claim that automation requires additional skills, while others propose that automation reduces training costs and also reduces the level of traditional flying skills required in older (conventional flight deck) aircraft; in contrast, others propose that one of the greatest misconceptions about automation is that it reduces training requirements. Notwithstanding these conflicting opinions, there is little doubt about the importance of training. The interface between transport aircraft and the pilots who operate them is of great importance, as are the interfaces between the pilot and the manufacturer, procedures, Standard Operating Procedures and company operating philosophies. This Appendix identifies some issues that have been raised regarding training in advanced flight deck technology aircraft.

One controversial issue already mentioned has been the changing role of the flight crew in automated flight deck aircraft. It comprises at least two basic questions:

- Is the pilot a control operator, a systems manager, or both?
- If a difference exists, is it in the pilot's role, or in the elements of that role?

Analysis suggests that the primary role of the transport pilot has not changed at all: since the goal is (as it has always been) to complete the planned flight safely and efficiently and with a maximum of passenger comfort, the role is to achieve that goal - to fly safely and efficiently from point A to point B. The functions still include monitoring, planning, and making decisions in reference to the operations, and the tasks are those traditionally performed (communicating, navigating and operating). The question is how best to train pilots for advanced technology aircraft.

The consensus seems to indicate that, as a general approach, automation should take a greater role in maintaining basic stability and control of the aircraft. Higher-level functions, such as flight planning/pre-planning, system status management and decision-making, should be performed primarily by humans with the help of automation. Training should reflect the increased emphasis on the pilot's decision-making, knowledge of systems, monitoring and crew co-ordination. One point is clear, however: automation has not reduced the need for the basic airmanship skills and knowledge which have always been required of airline pilots. The importance of

those fundamentals should be emphasised in the early phases of training, and general aircraft instruction should always precede detailed instruction in automatic features.

The training should be sensitive to the varying needs of a pilot population that differs widely in areas such as total flight experience, corporate experience, recency of last transition training, computer literacy, etc.

2.1 **Assessment of training requirements**

One of the lessons learned regarding advanced technology aircraft is that assessment of training requirements should be made when a new aircraft type is designed. Determination of the general training requirements needed to enable pilots to operate new equipment safely and efficiently should be considered an integral part of the design process. These requirements need not be - and probably should not be - very detailed. They should clearly indicate what the designer of the system believes the pilot should know in order to operate that system safely and efficiently. The next occasion to do this would be when the new type is introduced. This gives an opportunity to introduce operational changes, but any inefficient practices existing at the time of introduction will tend to endure. This is the time to appreciate and understand the manufacturers' design and operating intents, since they heavily influence training and operational issues. Those responsible for the introduction of new types, or charged with the responsibility of training development, should possess more background information with regard to the basic design philosophy than was needed in the past. This is important since most of the existing training programmes for new technology aircraft were originally developed for conventional aircraft.

2.2 **Adequacy of training requirements**

Careful considerations should be given to the adequacy of the transition training programme. The complexity of many of the systems may require a higher level of initial understanding and operational skill than was required with previous aircraft. The basic question is: do pilots, after completing their transition training, have sufficient skills, knowledge and understanding to operate these aircraft safely and efficiently? Although some believe that the traditional high level of manual skills will be required to a lesser extent, greater demands are placed on intellectual or mental skills due to the complexity of the systems and the environment in which they are operated. There is also evidence that routine operation of automatic modes may not provide adequate training opportunities. Flight deck observations have shown that pilots use only a few of the features available to them, because of incomplete knowledge about how to use other features. This says much about the inadequacy of the training and the complexity of the systems and modes.

2.3 **Depth of training**

The depth of training should ensure that pilots thoroughly understand systems interdependencies. This understanding may no longer be intuitively obvious even to highly experienced pilots. Training must provide more specific information about systems than was previously required when systems interdependencies were much less pronounced. The following examples, proposed by Jean-Jacques Speyer, with Airbus Industrie, illustrate this point:

“The link between A320 nosewheel steering and the Air Data Inertial Reference System (ADIRS) would have been impossible to achieve in previous design generations. Yet, the conceptual advantage - nosewheel steering sensitivity as a function of aircraft speed - is quite straightforward. As with most automation concepts, however, the benefits are often counterbalanced by an increased need for an in-depth

operational understanding which may not be intuitive. A pilot experiencing difficulties with nosewheel steering may need to work through the operation of the steering, the ADIRS and their interactions in order to understand and cope with the anomaly. Similarly, the advantage of linking both pressurisation computers with both Flight Management and Guidance Computers (FMGCs) and all three ADIRs on the A320 is that planned and actual flight profiles can be continuously compared for adequate pressurisation control in any phase of flight. However, the pilot is then placed in the position of having to understand the interactive system functioning in order to exercise the ultimate accountability function.”

Training time devoted to aircraft operation with the automated system(s) failed would increase pilot confidence in taking manual control early and effectively.

2.4 **Value and applicability of part-task trainers**

It must also be remembered that “surface” competence during the normal operation of a new system may well differ considerably from “real” competence which can withstand high stress and high workload. To withstand such pressures, skills need to be overlearned. This is basic knowledge which does not seem to be always applied in practice. In order to obtain the necessary intensive hands-on training, the value and applicability of part-task trainers has been recognised. These devices include a high-fidelity simulation of a particular system (or even the actual piece of equipment) which allows the student to concentrate on it without the extra load and distractions which might be imposed by a full flight simulator. They are less elaborate, and can range from large photographs which emulate the flight deck around the simulated system, to sophisticated desk-top computer-assisted training (CAT) devices. Part-task trainers can be highly cost-effective in developing the skills required for efficient system operation. The major drawback of some of these devices - as presently designed - appears to be a lack of functional realism (e.g. at a given point of any exercise, there may be only one allowed sequence of responses, whereas in the real system much more freedom is available).

The use of home computers to fulfil training requirements and for voluntary self-instruction should be explored. There is potential for misuse here, but there is also a considerable potential for fulfilling the needs and desires of pilots, management and authorities. Although implementation may be a particular challenge, experience indicates that some basic computer literacy (i.e. being comfortable with an alphanumeric keyboard) will make transition to new technology flight decks easier.

2.5 **Recency**

The time elapsed since the last transition training is an important factor when considering pilots' needs. Flight guidance systems and other automated systems are certainly more complex than in previous aircraft, yet it has been noted that quite often some pilots making the transition to these aircraft had not been to ground school for periods as long as 15 years. This may have contributed to the difficulties of some of these pilots, for whom transition training to new technology may not always go smoothly and may involve higher than expected training costs. A lack of meaningful operating experience (which can be quite different than total flight time) should be expected for the period immediately following training. One way to solve this problem may be to expose the flight crews to highly realistic flight situations in high-fidelity simulators. In many countries this is called LOFT (Line-Oriented Flight Training)¹. Because of the sophisticated equipment, the variety of situations that can be

1. For a complete discussion on LOFT, refer to ICAO Circular 217.

simulated, and the highly technical training methods now available, it enables pilots to gain flight experience (in addition to training) that in some cases may be even better than actual flight.

2.6 **Specific training issues**

Specific issues also related to transition training include the transition from electromechanical instruments to electronic flight instrument systems; training for the loss of all the electronic displays (the aircraft would be controlled on standby instruments which are essentially the same as those in previous generation aircraft, but the step down in data available is much greater); and the use of the autopilot, flight management system and mode control panel. The manner in which these systems allow the flight to be conducted enables the pilot to become detached from the immediate state of the aircraft (position, speed, height, etc.). Crew procedures and training methods must ensure that no automation complacency is fostered by this process, and that the pilot maintains a satisfactory level of situational awareness. The training should be hands-on and line-oriented, and should stress sound practices.

2.7 **Guidelines on the use of automation**

Guidelines on the use of automation should be provided. They should indicate to the crew when to use automation, and, more importantly, when not to use it. Even when guidelines are available (usually through company policy or standard operating procedures), they reflect preferred practices in the context of particular operational environments. The existence of such guidelines does not necessarily mean that they are universally applicable, nor is the purpose of this Appendix to provide them.

2.8 **Use of accident/incident data**

In line with the well established practice of programming wind-shear profiles as part of flight simulator training, it might be worthwhile to explore the benefits of replaying incidents or accidents where automation has been considered a factor. The flexibility of contemporary simulator-computer systems and the information available from safety reporting systems makes this possible. Similarly, some contend that there is a need to include and review problems and incidents encountered in day-to-day operations.

2.9 **Need to monitor**

The need to monitor should be constantly reinforced, both during training and proficiency checking. The vast literature on vigilance shows, however, that humans are not uniformly effective monitors, and frequently miss system faults or wrong set-ups. This trait is sometimes aggravated by operations in a low stimulus environment, such as that found in long-range, "back-of-the-clock" operations. The possibility of more or different training has been raised as a remedy, although it seems difficult to achieve consistent gains in this way. Some attention has been directed to placing more emphasis on creating the sort of stimuli (displays, procedures, additional meaningful tasks) that enhance the pilot's ability to monitor them. It is also a fact that pilots can do specific kinds of monitoring very well - for example, monitoring pilot flying performance during an approach from outer marker to touchdown. Many believe, however, that the influence of systems design must be investigated as an alternative to alleviate the problem.

2.10 **Adequacy of differences training**

The adequacy of “differences” training must be considered when a new aircraft is considered “common” with an older aircraft. It is not unusual for some operators to have not only several different flight deck configurations for the same basic airplane model, but also different computers and software. When such a situation is coupled with mergers and fleet integration, the pilots can be exposed to quite different flight deck arrangements in quick succession. Also, prolonged absence from advanced technology aircraft may result in a marked diminution of skill. This has been demonstrated to have a greater impact on piloting proficiency than a similar absence from the flight deck of an older technology aircraft. This loss of proficiency is directly related to the operation of the flight guidance system.

2.11 **Requalification training**

Requalification training, when a pilot is returning to a less automated aircraft, must be very thorough. A major training consideration should be deprogramming the pilot's expectations: for example, automatic altitude capture and level off, a common feature of automated flight decks, may not be available on older technology aircraft. Evidence from field studies in automation indicates that pilots are also concerned about the degradation in their cognitive (mental) skills due to the ease of navigation and maintenance of situational awareness using electronic maps. Management should be aware of the potential hazards of these reassignments.

2.12 **Standardisation and simplification**

The need for standardisation and simplification of all aspects of operation of two-person crew automated aircraft should be given a high priority. Standardisation is one of the foundations of safety, and its importance has been accentuated by the appearance of aircraft leasing organisations, airline mergers, consolidations, etc. Flight crews may be faced with different names for the same item, different procedures to operate the same systems, different symbology to display the same information, and all of this often under demanding conditions. Such problems may also be due in part to the constant improvements in aircraft, their systems and flight deck symbology. Standardisation of symbology is receiving considerable and well deserved attention these days. Symbols should be intuitive and their meanings consistent from one system design to the next. Standardisation should be emphasised, and this emphasis should be extended to flight operations and equipment manuals, operating procedures and checklists.

2.13 **Operational procedures and checklists**

Operational procedures and checklists should be carefully examined with particular attention to the workload required to perform them. In their operation of two-person crew aircraft, many operators have not reflected the advances that have been made in flight deck technology and in the understanding of flight crew behaviour. Special training considerations should be given to flight crew members making the transition to automated two-person crew airplanes from a three-person crew airplane. The use of Line-Oriented Flight Training as a tool to demonstrate heavy workload conditions is proposed in the following paragraphs. More importantly, LOFT can be an ideal tool to identify workloads which are a product of inappropriate policies or procedures, as considerable flight crew workload can be created by having to perform non-operational tasks at inappropriate times (calls for passenger connections, meal requirements, wheel chairs, etc.). This is not a new problem, but it is more critical in the automated environment and with the proliferation of high density operations. (Some aspects of this problem are being met on many of the new airplanes with separate communication facilities for the cabin crew.)

2.14 Tailoring of CRM and LOFT training

It has previously been assumed that Crew Resource Management (CRM) training programmes are model-independent. However, there is increasing evidence that at least some aspects of crew co-ordination and communication in the automated flight decks are qualitatively different from the flight decks of older aircraft. Recent experiments suggest, for instance, that there is a trend towards less verbal inter-pilot communication as the degree of flight deck automation increases. If this hypothesis can be confirmed through research, then customised modules of CRM training programmes should be developed to deal with such differences. These customised modules should also take account of the nature and the needs (culture) of the organisation. The following areas of concern in CRM of automated aircraft are the result of observations during actual flights. They indicate that highly automated flight decks may require special scrutiny in the areas of crew co-ordination and resource management, both in the assignment of tasks and the standardisation of their performance.

- Compared to traditional models, it is now physically difficult for one pilot to see what the other is doing. For example, in previous generation aircraft the autopilot mode control panel was easily observable by both pilots; in automated flight decks the selections are made in the control display unit (CDU), which is not visible to the other crew member unless the same CDU page is selected. Proper procedures and intra-cockpit communication appear to be the answers to this problem.
- It is more difficult for the captain to monitor the work of the first officer, and vice-versa. New or revised procedures and intra-cockpit communication are again the apparent answer.
- Automation can induce a breakdown in the traditional roles of the controlling pilot and monitoring pilot, and there is a less clear demarcation of who does what. This is particularly relevant, since it has already been mentioned that standardisation is one of the foundations of safety. The answer to this problem might be found in procedures and standard operating procedures
- Automated flight decks can produce a redistribution of authority from the captain to the first officer. This is unintended, and is a product of an apparently greater proficiency of some first officers in CDU data entry compared to that of the captains, plus the delegation of these duties to the first officer. Particularly in times of high workload, the captain may surrender some responsibility to the first officer in order to accomplish the task. A somewhat shallower trans-authority gradient¹ may be the result, although captains, recognizing the superior CDU skills of their first officers, may follow good CRM principles and use them to their advantage.
- There is a tendency of the crew to help each other with programming duties when workload increases, which can dissolve a clear demarcation of duties. This seems to be computer-induced behaviour, since no similar situation is observed in traditional aircraft.

Although little is known about the implications of automation for the design and conduct of Line-Oriented Flight Training, some particular issues can be highlighted. The automated flight deck offers new opportunities for scenario design. In conventional flight decks it was necessary to introduce system failures to elevate the workload and stress of the crew in a realistic manner, but the automated flight deck has enough built-in stressors to do this job, especially in the area of ATC instructions.

1. Trans-cockpit authority gradient is the authority relationship between captain and first officer. The term was first introduced by Prof. Elwyn Edwards. For example, in the case of a domineering captain and an unassertive first officer, the gradient will be steep. If two captains are rostered together, the gradient may be shallow.

The “glass cockpit” presents new opportunities for scenario design that do not require abnormal conditions or emergencies - difficult problems at the human-automation interface will suffice. There now exists the opportunity to design scenarios that will address the problems and opportunities of working in automated flight decks, where their peculiar characteristics can be stressed and where CRM principles can be easily exercised. For example, an ATC instruction including an unexpected, non-depicted holding pattern over a fix defined by a radial/DME value, provides considerable opportunities to practice CRM principles without the necessity of introducing any system failure.

Aircraft manufacturers are giving more importance to human performance issues in automated flight decks. At least one of them has joined efforts with a training development company to integrate present and future training programmes in Cockpit Resource Management into the transition training courses for its aircraft. The manufacturer's instructor pilots will receive CRM training. Current training courses for pilots and maintenance technicians will also incorporate CRM programmes. This particular manufacturer claims that CRM courses to be developed will be airplane-tailored, with a different CRM course for each specific model of aircraft in the production line. The justification for this decision is based on the need to align training with longer-term behavioural education, as well as to concentrate on the assigned duties and responsibilities of the flight crews. Most importantly, it is the tacit recognition that Human Factors education is no longer an exclusive responsibility of the operators, but an integral part of present-day system operations.

Adequate instructor/check pilot training is necessary, and must be emphasised, since some instructors may have only a little more meaningful (i.e. operational) experience and knowledge than the students. A strong case can be made for practical experience input to instructor and student training. The need for more emphasis on behavioural issues (CRM and LOFT training) has also been suggested. Though the Human Factors profession has recognised the problem, the issue of instructor training in relation to automation has not yet been properly addressed, and training specialists have no source to consult for guidance on the question of training for automation. Instructor selection and training continues to be determined by the same time-honoured methods and criteria applied for conventional flight decks, although the training issues are quite different on automated flight decks.

2.15 **Role of the regulator**

The role of the regulatory authority in the development of training programmes and instructor training must not be overlooked. During the certification process, the regulatory authority evaluates information presented by the manufacturer. These certification data must be delivered to the operator, since it provides the foundation upon which to build the training programmes. By knowing, for example, the manufacturer's design intent, the operator can develop procedures in which tasks can be properly identified. The training programmes thus defined must then be validated based on the same sources of information, closing the manufacturer-regulatory authority-operator loop. Training should be part of the integral system design, and it must be contemplated as part of a systems engineering approach.

3 References and Useful Additional Reading

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- [4] ICAO. Operational Implications of Automation in Advanced Technology Flight Decks. ICAO Human Factors Digest No.5. ICAO Circular 234-AN/142 and Human Factors Training Manual Doc. 9683-AN/950.
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Appendix 9 Facilitation Skills

1 Introduction to Facilitation Skills

The following aims to explain why there is a need for facilitation, what facilitation is and some of the skills required to use this training technique, plus some general guidelines.

To be competent in any job a person requires a certain amount of knowledge, an adequate level of skills, and the right set of attitudes. This is true for doctors, hotel receptionists, lawyers, footballers, soldiers, artists and of course flight crew. The role of a trainer in any discipline is to help people develop their knowledge, their skills and their attitudes so that they are able to do their jobs well. In many of the professions the formal training emphasis is often on developing knowledge and skills, with the examination of competence almost exclusively concerned with measuring knowledge and skills against a set of standards.

In aviation it is no different. The vast majority of training resources and all formal examination have been aimed at ensuring people have the appropriate knowledge and skills, rather than the right attitudes. The fact that attitudes are fundamental to competence has not been officially recognised, even though incorrect attitudes are suspected to have contributed to many of the major accidents - the ultimate consequence of a lack of competence. The reason for this omission is uncertain, but a reasonable assumption may be because training and examining 'attitudes' have been less precise and more difficult to carry out successfully.

CRM training has attempted, with variable success, to try and redress the imbalance. Most experts and practitioners are in agreement that the variability in the effectiveness of CRM training is largely linked to the quality of the delivery and not the content, and that training with a high degree of facilitation has been more successful.

This can be explained by exploring the two main techniques that are available to trainers, namely instruction and facilitation. Instruction can be described as being primarily a telling activity, where knowledge and skills are developed in trainees through either direct communication or demonstration, with questioning primarily used to check understanding or reinforce key messages. Facilitation on the other hand, can be described as a technique that helps trainees to discover for themselves what is appropriate and effective, in the context of their own experience and circumstances.

Both techniques are useful and have their place. In order to transfer knowledge and many skills, instruction is the most efficient technique to employ; it would be laborious and unnecessary to teach a straightforward and precise subject such as an electrical system using facilitation. Furthermore, instruction can be used to train larger numbers of people, and is particularly useful if only certain answers are acceptable.

On the other hand, trying to encourage appropriate attitudes using instruction as the technique, normally has limited success. People, particularly adults, do not like being told how to behave and what to think. There are rare occasions when a sharp 'kick up the backside' delivered by the right person at the right time has the desired effect, but in general, telling people to change their attitude is not usually effective. This is particularly so if the person doing the telling does not have the respect of the recipient, or represents an authority that lacks credibility. Ironically, this is also

consistent with the instruction of positive behaviour, such as 'keep up the good work' which has been known to produce an adverse reaction.

The reason for this is that a person's behaviour is based on their past experiences, values and beliefs which will be different from those of others. Therefore, telling people to behave differently carries the implication that their values and beliefs are wrong, and this is not convincing. People generally behave in a way that they think is rational, and often find it easy to justify their behaviour to themselves and others. However, what they may not be aware of is the effects of their behaviour on other people or the operation; and that an alternative behaviour, which does not question their values but has a more positive effect, may be something they might wish to consider.

The technique of facilitation allows this process to occur, although it is not just for the poor performer nor for the development of attitudes. Facilitation can be equally used to reinforce effective behaviour because it gives people an understanding of why they are good which encourages their continued development. Furthermore it can be used in the development of skills and even knowledge, because it is an effective tool for allowing self analysis and in depth thought, which is an easier way for people to learn, as there is less recourse to memory techniques. The skills of self analysis are not just to get the most from the training session, but can also be continually used for self development on the line.

Table 1 Differences between Instruction and Facilitation

	Instructing	Facilitating
1. What do the words imply?	Telling, showing	Making easy, enabling
2. What is the aim?	Transfer knowledge and develop skills	Gain insight/self analysis to enable an attitude change
3. Who knows the subject?	Instructor	Both
4. Who has the experience	Instructor	Both
5. What is the relationship?	Top down	Equal
6. Who sets the agenda	Instructor	Both
7. Who talks the most?	Instructor	Student
8. What is the timescale?	Finite	Infinite
9. Where is the focus?	Instructor/task	Student/attitudes/behaviour
10. What is the workload?	Medium/high	Intense
11. What are trainers thoughts?	Judgemental	Non-judgemental
12. How is progress evaluated?	Test	Observation/self assessment

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Notes on Table

- 1 Although instructors have used facilitation techniques naturally for many years; in its purest sense instructing has a lot to do with telling, demonstrating and checking that the task is being done in accordance with a standard. Whereas facilitation means that students are given the opportunity to discover what they are doing and the effect it has on others and the task, so that they can make the decision themselves to alter their behaviour or even reinforce any positive behaviour. This process should be made as easy as possible.
- 2 The principle purpose of instructing is to transfer knowledge and skills efficiently, whereas with facilitation the principle purpose is to encourage a change in attitude or behaviour by the student gaining insight or becoming aware of what they are doing, and being motivated to change. People tend to only do things that they want to do; so telling people that they are wrong and need to change is rarely effective. People generally do not behave in a way that *they* think is wrong. They are aware that others might disapprove, but they will rationalise their behaviour as being appropriate under the circumstances. Telling them that you think they are wrong gives them no new information and often motivates them to continue their current behaviour. The key is for them to understand why others disapprove and the consequences of continuing as they are.
- 3/4 When instructing, the trainer knows the subject and has the experience, otherwise it would be a pointless exercise. When facilitating both parties know the subject and have the experience, particularly when discussing behaviour. In fact, very competent facilitators are quite capable of being effective without knowing the subject or having any experience of it. In many respects this can be a useful pointer to know when to change hats from being an instructor to a facilitator. If you are certain that only you have the relevant knowledge, and the student would find it difficult to work it out for themselves in the time available, then instructing is probably the most appropriate technique to employ.
- 5 The relationship when instructing can be perceived as being top down in that the instructor knows more than the student, whereas when facilitating it must be apparently equal. A common mistake by inexperienced trainers when facilitating is to create the impression that they are in some way superior, by implying they know more or have a better attitude.
- 6 The agenda when facilitating must be set by both parties if the process of buy-in is to get the right start. Agreeing what you are going to talk about and how you will go about it is an important first step. The trainer can greatly assist the learning of the session by summarising and giving meaning to the students' discussions. It is still the trainer's responsibility to ensure that all the training requirements are included in the facilitative session.
- 7 One of the best measures of identifying which technique you are using, whether it is instructing or facilitating, is to note who is doing most of the talking. When facilitating, students need to be clear in their own minds and be able to self assess what they are doing and the benefits of changing. It is difficult to do this whilst trying to listen to a trainer passing multiple messages.
- 8 The time taken to cover a subject when instructing tends to be finite and consistent; whereas with facilitation the timescale is indefinite. This does not mean that it takes forever, but that the process of facilitation must be given sufficient time to achieve its aim. The CRMI should not be worried about longer debrief or exercise times, because the student's concentration period is much longer when they are actively involved in the thinking and discussion rather than passively listening. In a limited time period

such as a debrief, the process may need to continue afterwards, while students try out new options back at work. Conversely, if the aim is achieved in a few minutes, the job is done and there is no point dragging out the discussion.

- 9 The focus when instructing is often on the task and the instructor – how well they are doing, did they get things in order, are they being clear, is the equipment working, are they on time. With facilitation the focus must be solely on the student, their attitudes and behaviour, and whether they are learning and are comfortable with the process that is being used. The focus should also be on the student demonstrating an understanding and willingness to change.
- 10 Because each student is different and it is difficult to read people’s minds, the workload whilst facilitating is intense, and more so in a group. The facilitator in this respect is having several conversations simultaneously, both verbally and non verbally, and having to think on their feet in reaction to what is being said. With instructing the workload is high in preparation and initial delivery, but then reduces over time as the instructor becomes more familiar with the material.
- 11 Although the trainer’s observations and training objectives are inevitably judgemental; in order to prompt a student’s self analysis, the attitude of the trainer when facilitating a debrief should be non-judgemental. In other words, he or she must be prepared to accept that the opinion of the student is valid and not necessarily wrong, even though the trainer’s own experience dictates otherwise. This attitude is the most difficult to genuinely achieve, particularly for trainers who have spent many years instructing and ensuring things are right.
- 12 The evaluation of an instructing session is relatively simple and measured by test, where a judgement is made whether the standard has been achieved. When facilitating evaluation is made by observation only and the student’s self assessment.

2 Facilitation Skills

The skills required to use facilitation as a technique are as follows:

2.1 Questioning

Asking the right questions at the right time is a fundamental skill of facilitation and these are the type of questions that can be used.

Type	Purpose	Response	Example
Open	To get a more accurate and fuller response.	Unknown but they will say more than a few words.	‘What, when, why, where, who, how...’
Closed	To check understanding and to control the discussion.	Can be ‘Yes’, ‘No’ or specific data.	‘Did you, were you, had you’....
Probing/building	To obtain further information.	More in depth response.	‘Tell me more, why was that, explain...’
Summarising	To confirm agreement.	Yes.	‘Is what you mean, have you agreed ...’

Avoid:

- a) Leading:- 'You did do that didn't you, wouldn't you agree that.....'
- b) Multiple.
- c) Rhetorical:- 'Who cares?'
- d) Ambiguous.

2.2 Listening

It has often been said that hearing is done with your ears whereas listening is done with your mind. In this respect the term active listening means that a person is concentrating carefully on what is being said, so that they can really understand the other person. This mnemonic helps to capture some key points:

Look interested;

Inquire with questions;

Stay on target;

Test understanding;

Evaluate the message;

Neutralise your thoughts, feelings and opinions.

2.3 Body language

Reading body language and managing your own are essential when facilitating. A trainer should be able to know when a student is uncomfortable, confused, interested, distracted or bored. Furthermore it is important that a trainer is able to manage their own body language so that the messages they are giving are accurate and consistent.

2.4 Observation of behaviour

The ability to observe and discuss behaviour and attitudes rather than technical issues is an important skill that trainers need to develop to become effective at facilitation. Also trainers should have the ability to observe behaviour objectively against established standards.

2.5 Role modelling

As attitude is an imprecise part of competency, there is no better way of demonstrating appropriate behaviour than role modelling. This is because the student can observe at first hand what this behaviour is and experience the positive effects on themselves. Furthermore, in order to maintain credibility as a trainer in human factors, it is important that you behave to the highest level of CRM standards.

2.6 Giving and receiving criticism

A trainer should be able to receive criticism well in order to develop and be approachable. Furthermore, there may be occasions when it is appropriate and constructive to give students direct criticism and this must be carefully handled.

3 Continuous development

In order to ensure that you are able to continuously improve your facilitation skills, the recommended method is to seek feedback from those you are training. This must be done regularly and genuinely, otherwise you may not be given anything useful - and a measure of whether you are doing this well is whether you do in fact get any criticism. If you find that people are not giving you any criticism then the following may be occurring:

- a) You are perfect;
- b) You have developed a reputation as someone who has difficulty receiving criticism;
- c) You are not respected enough to deserve being told.

4 Trainer Checklist for Facilitation Skills

Do:
<p>Give an introduction</p> <ul style="list-style-type: none"> • Purpose - to encourage self analysis (research says that it is the best form of learning) • Participation from them is needed • Allow pilots to set the agenda order by asking: <ul style="list-style-type: none"> • Which bits of the session they want to discuss • What went well <p>Use open questions (who, where, when, what, why, how) Deepen the discussion with supplementary questions - let them analyse.</p> <ul style="list-style-type: none"> • What happened/why it happened/what could we improve on? <p>Listen and encourage</p> <ul style="list-style-type: none"> • use names, nod, smiles, eye contact • sit forward to show interest <p>Use silence/pauses (sit back and allow them time to think for several seconds) Mix instruction with facilitation for issues on which they don't have the knowledge themselves Summarise discussion to meet training aims</p>

Don't:
<p>Miss the introduction - it is the most common way to spoil facilitative training Lecture Use your chronological agenda Short change high performing crews with quick debrief Interrupt Don't train them not to discuss by:</p> <ul style="list-style-type: none"> • Answering your own questions (better to reword the question) • Just use question and answer <p>Do the thinking for them</p>

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 behaviour been reinforced?

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Appendix 10 Examination Skills

1 Introduction

Examining any person on any subject for any skill or level of knowledge is an extension of the basic Instructional and Teaching skills. There are really few new skills for the competent Instructor who has had the correct level of education and practice across the spectrum of teaching. Given this adequate Teaching background, the emphasis for the Examiner is to know how to behave appropriately, and is therefore a modification to the management of his or her appropriate teaching behaviour.

It is also necessary to understand the need for a good examining procedure to ensure consistency which helps to promote fairness and good control of minimum standards.

Simultaneously the Examiner must be proficient in teaching skills, be able to set a good example, but above all be able to employ a good facilitative style wherever possible to set the highest example to candidate CRMI and the Trainees.

The purpose of this Appendix is to explore the CRMI test criteria, give guidance in the three areas of CRMI teaching, and to suggest a checklist for the conduct of a CRMI Accreditation Test.

2 CRM Instructor Performance Assessment

2.1 General considerations for all CRMI tests

Good administration is essential for the conduct of all Tests and Examinations to ensure that both the Examiner and the Candidate are perfectly clear as to what is required of each person.

Whereas it is the Candidate's responsibility to ensure that he or she has the necessary knowledge and skill for instructing, teaching and facilitating, it is the Examiner's duty to ensure that the Candidate is given every opportunity to demonstrate that skill and knowledge at the appropriate time without experiencing undue pressure.

If the Examiner is disorganised and unprepared in any way, it will have a negative effect upon the Candidate's performance, detracting from the efficacy of the lesson which is being presented and thus disadvantaging the students. Therefore the test must be conducted in a calm, organised but professional manner.

It is essential that the Examiner is quite clear as to the purpose of the test, the context of the teaching lesson used during the assessment, the general background and experience of the CRMI under test, the general background and experience of the students, the precise criteria against which the candidate is being assessed, where the test is to be conducted and any associated operational constraints, such as time available, time of day and number of students and how the Examiner will conduct the test given dissemination of the above criteria and formulation of a plan.

Apart from knowledge of the obvious details of the booking and venue, the Examiner should contact the CRMI and/or the company prior to the test date to establish the above criteria and also to provide the candidate with as much information as possible, particularly if the Examiner has any special test requirements, although nothing beyond the normal lesson plan should be required, save for the special case where

the Candidate can only be assessed using a simulated training environment due to a CRM course not being available upon which to mount the test.

The Examiner should prepare the necessary forms and paperwork in advance of the test, and make available copies of any general teaching material relevant to the lesson scenario (e.g. Course CRM Manual) and copies of relevant Regulatory Requirements.

When everything is prepared the Examiner should consider selection of the appropriate style that is relevant to the age and experience of both candidate and trainee, and consider the content of the lesson and the environment in which it is being delivered.

The following is a suggested Examiner's Preparation Checklist for use prior to the test.

- Contact the School/Provider/Instructor;
- Agree date and time allowing for extra opportunity for briefing and debriefing of the candidate;
- Establish type of course;
- Establish type of test (Classroom, Sim, Aircraft, Initial, Renewal);
- Syllabus items for the lesson, and the timetable;
- Background of the Trainees and Instructor;
- Special requirements;
- Review Course Manual;
- Review Short Guide to CRMI Performance Criteria;
- Review relevant items of CRM CAP;
- Obtain Test Report Forms.

The Examiner must be conversant with The CRM Instructor Performance Guide, and in particular "The Short Guide" (Appendix 12) which specifies precisely the performance required of a CRMI in the three main settings of Classroom, Simulator and Line Training in Aircraft.

The following sections describe criteria relevant to the three main sections covering the teaching of CRM. It is recommended that those who will examine Simulator and Aircraft CRM Instructors should be familiar with the examining criteria described in the "Classroom" Section because many of the principles relevant to Simulator and Aircraft are common with the "Classroom" case and reference is continually made to this section.

2.2 **Classroom Teaching Assessments**

As already indicated in the preamble, it is absolutely essential for the Examiner to set the correct tone for the CRMI assessment. It is obvious that anyone under assessment will suffer from some degree of tension, even on occasion some visible nervousness. In the classroom environment this can be most readily translated to the student group, and in the case of CRM education, a tense atmosphere will readily detract from the interactive flow between the CRMI and the working group.

The Examiner must always realise that the purpose of the observed session is primarily for the benefit of the trainees and to this end the Examiner must do everything possible to preserve an open atmosphere during the session. Indeed it is this very "openness" which is one of the main points upon which the CRMI will be assessed in his conduct of the session. It would be unacceptable for the Examiner by

his presence or intervention to inhibit open discussion and facilitative learning processes.

There are various opinions as to the role that the Examiner should take during the assessment in the classroom. Some believe that the Examiner should take no part and should sit behind the group and unobtrusively observe and take notes, whereas others believe that the obvious isolation of one individual who is nevertheless present can have a damaging effect on group dynamics.

It is most important, therefore, for the CRMIE to discuss classroom tactics with the CRMI before the session begins, and the CRMI should be given the choice. Notwithstanding this preparation, if the Examiner finds that anyone present is focussing on him during the session, or that the CRMI or the group appear to be inhibited by his presence, the CRMIE should take immediate steps to communicate and gently steer real control of the proceedings back to the Instructor.

The CRMIE should brief the CRMI at least an hour before the start of the session and arrange for an extra ten minutes at the start of the session so that he may introduce himself, explain publicly why he is there, that the students are not under check or assessment and that the session is for their benefit, with anything said in the room remaining confidential. The Examiner should also validate himself by explaining his background. Of greatest importance the Examiner should use his own instructional and facilitative skills to ensure that full control of the session is visibly given to the CRMI.

During the session the Examiner should make discreet notes. Taking notes without drawing attention is a very personal skill, but a general rule is to try to observe by "theme" or "heading groups" such that the CRMIE is not writing throughout. Also a personal "shorthand" should be developed which is succinct, ordered and above all legible and comprehensible to the CRMIE afterwards.

The CRMI must not be debriefed in the presence of the student group. Indeed it is particularly important for the Examiner, especially if inexperienced, to withdraw quietly to consider the overall assessment. In coming to a conclusion, examiners should avoid becoming lost or even deflected by trivia in their notes.

It is essential to prioritise both "good points" and "bad points", discarding trivia at every opportunity. This will ensure that the Debrief, when delivered will be understood, and above all accepted by the CRMI candidate. When experiencing difficulty in coming to a conclusion as to the outcome of any Instructor Test, it is useful to apply the following broad measurements;

Was the lesson Objective achieved and did the trainees learn from the session?

Were the trainees treated with respect and did the CRMI set a good CRM role model?

Before delivering the Debrief, the Examiner may wish to ask some questions of the candidate, for example to gain an explanation of why a particular technique was used, or to test an area of knowledge. For whatever reason questioning becomes necessary, it must not be conducted in a courtroom atmosphere, and should be kept to a minimum, the candidate having already endured a stressful session and having delivered sufficient for the Examiner to make an assessment.

When delivering the Debrief, the CRMIE's manner must continue to be friendly and professional. If the candidate has passed, then he or she should be told immediately and congratulated, followed by notification of areas for further improvement and areas which were of a good standard.

If the candidate has not made the required standard then the Examiner must inform the CRMI at the outset, and then give the MAIN reasons, in descending order of importance, each with a brief main justification, followed by the consequences (e.g. “unfortunately you will not be able to exercise the privileges of a CRMI until your reassessment is successful”). The Examiner should then seek to support the candidate by praising any areas which were of a good standard to encourage the candidate to build upon those strengths. There then should ensue a facilitative discussion on the important areas of the CRMI’s performance, with the main theme selected from the Examiner’s notes as the objective of the facilitation.

Although the power of the Examiner to decide upon the acceptability of CRMI performance is undisputed, it is important not to use continually a “telling” style during the Debrief, other than the initial portion when delivering “the verdict”. The aim must be to gain the candidate’s acceptance of the verdict and, more importantly agree upon a series of remedies of which he or she can recognise ownership.

In many ways assessing CRMI performance is the same as assessing any instructor performance. Perhaps the main emphasis differs by the very nature of the subject matter. Therefore examining CRM Instructor performance requires that the Examiner displays the best examples of CRM skill in handling the CRMI throughout the test, without losing any of the objectivity required to ensure a minimum standard.

2.3 **Assessment of CRM Instructors in Simulators**

The general principles covering Examiner Preparation, Test conduct, Briefing and Debriefing of the Candidate in the Classroom environment apply equally to the Simulator Scenarios.

The same time allowances and associated care should be taken to ensure that all parties are adequately briefed and that each person is absolutely certain as to what is required of them. This is particularly important if the assessment of the CRMI is combined with a licence or operational check (LPC/OPC). The trainees should understand that they are not under formal assessment by the CRMI(E) and the Examiner’s duty is to ensure that they do not suffer any unnecessary pressures.

The main difference which exists between the Classroom and the Simulator environment is the absence of almost all visual communication. It is necessary therefore, for the Examiner to be as alert as the SFI/TRI in the observation of the crew communication throughout the exercise. It is essential for the discipline of note taking to be rigorously applied in the darkened environment of the Simulator because of the difficulties of writing, observing and listening to crew interaction coupled with the many technical and piloting skill distractions which may or may not have a bearing on the CRM aspects.

In teaching CRM, and indeed its assessment for the benefit of crew development, the Examiner should expect the TRI/SFI to use the “Flight Freeze” facility in the early stages of the training to highlight CRM issues in addition to technical issues.

However the sooner the Instructor permits the crew to operate in “whole scenarios” from beginning to end without interruption, the sooner the crew will benefit from experiencing the outcome of their procedures, consultative processes and actions the better will be their autonomous learning development. It is this management of student CRM skill development towards the autonomy of the “LOFT” scenario which the Examiner will require of the Instructor.

Although all the principles of the Classroom environment apply to the Debriefing of the candidate after the LOFT, the main difference with regard to CRM Debriefing of the Flight Crew by the Instructor lies in the expectation of almost a totally Facilitative

style by the Instructor under examination. The Instructor should exhibit the skills of Facilitation whilst maintaining the clear objectives to which the crew's path of discovery will lead. For the Examiner to know what those objectives are, he must first question the Instructor what those objectives and conclusions are *before* the Instructor delivers the Debrief.

Otherwise Examiner behaviour must mirror that described in the Classroom scenario with regard to Debriefing and delivering the verdict on the Instructor's performance.

2.4 Assessment of CRM Instructors in the Aircraft Environment

When teaching in the aircraft, whether it be on any empty sector or during a revenue flight, SAFETY is of prime importance. At no time should the Instructor or Line Trainer or Examiner permit any situation to arise which would jeopardise the safety of the aircraft and its occupants. Neither should the Examiner or Instructor under Check act in any way as "agent provocateur" in order to stimulate a potentially dangerous situation.

Clearly, whereas much of the Examiner activity in an aircraft mirrors that in the Simulator, the Examiner must be prepared to interject at any time safety is threatened, even only with advice should he not be designated as Aircraft Commander.

Otherwise the guidelines given for Examining Conduct are common to the three CRM Instructor examining scenarios.

3 Instructor and Examiner Appropriate Behaviours Comparison

Hereafter is a simplified list of appropriate behaviours for an Instructor conducting a teaching session compared with one conducting a test of skill and/or knowledge.

Those wishing to be assessed as competent in the Examining Role will be assessed against the appropriate behaviours and criteria as listed below.

A CRMI(E), when conducting accreditation on a CRMI should expect the CRMI to exhibit the teaching skills summarised in the left hand column as a demonstration of the skills listed in the CRM instructor Short Guide.

Table 1 Skills Required – Instructor Versus Examiner

Teaching/the Lesson		Examining/the Test	
The Briefing			
TELL	What to do and How to do it.	TELL	WHAT but NOT how.
PARTICIPATE	Student practices, receives coaching and guidance; Teacher receives feedback.	PARTICIPATE	Candidate only participates to answer questions.
SELL	The method of doing the task and the "need" to know and achieve.	SELL	The need for the test; Need for success.
DELEGATE	Some of the deduction and student preparation.	DELEGATE	All preparation and deduction.

Table 1 Skills Required – Instructor Versus Examiner

Teaching/the Lesson		Examining/the Test	
The Skill/Knowledge Activity			
TELL	Demonstrate/show how, prompt.	TELL	Minimal Assessor input.
PARTICIPATE	Student/Teacher work in collaboration to improve student knowledge and skill and Student experiences under guidance.	PARTICIPATE	No collaboration other than to run the Test.
SELL	Teacher sells/Student buys "method"	SELL	Very little trading occurs other than student selling own prowess.
DELEGATE	Little delegation at start of lesson, increasing as Student proficiency grows.	DELEGATION	Very high, candidate does it all.

The Debriefing			
TELL	Teacher tells more at the start and less as Student competency grows at each session.	TELL	The Result and Consequence.
PARTICIPATE	Student participates under guidance of Teacher to diagnose own remedy via Facilitation.	PARTICIPATE	Candidate answers questions and gets some facilitation.
SELL	Obtain agreement on the facts of student performance, and agree the remedies, agree the strengths.	SELL	Why it was good or bad.
DELEGATE	Student given tasks to complete by way of "homework"/practise.	DELEGATE	Candidate may be given remedial self-study/practice.

3.1 CRMI Accreditation Test Checklist

The Examiner will show the same awareness of, and ability to manage time as expected of the Teacher/Instructor.

As for the Instructor/Teacher, the Examiner will show the same sensitivity to the personal style of Candidate, whether the candidate be Activist (Get on and do), Theorist (I need to know all the background), Reflector (I need a little time to consider), or Pragmatist (Just tell me what I need to know).

The Examiner will apply the appropriate style as shown in the comparison table above.

The Examiner will demonstrate an orderly plan and an orderly management of the Examination/Test.

The Assessment will be made against recognised criteria such as set out in the JAA NOTECHS FRAMEWORK (Appendix 11).

The Assessment will be conducted as an OVERALL measurement of the criteria as appropriate to the scenario, and not as an Activity Survey to reach a score of events under each Category and Element of the Framework unless such scoring is rationalised as being suitable for the particular test scenario.

The Examiner will be expected to make notes of Candidate Performance and to deliver a logical verdict and Debriefing at the close of the session.

3.2 **Debrief and assessment**

The Examiner will indicate the Result, whether Pass or Fail, at the start of the debrief.

If a Fail, the Fail Points will be given in Descending Order of Importance.

The remaining instructional part of the Debrief will embody only major points selected from the performance of the candidate, and will last no longer than fifteen minutes per candidate.

Following the Result, the Examiner will embark upon a sequence which embodies Sell, Tell, Participate and Delegation styles to fully involve the candidate in his/her self preparation for future improvement IF NECESSARY.

The Debrief will be balanced, and not merely a litany of faults, with suitable and appropriate reinforcement. Use Facilitation to obtain diagnosis and remedy, but NOT to reach the verdict.

A summary will be given at the close of the Debrief.

3.3 **Report**

The written report will be concise and precise, avoiding the use of vague adjectives to describe the Candidate's performance. It will mirror the Debrief and contain no surprises for the Candidate.

It will service the needs of the Candidate, the Training Manager, the next Instructor.

4 CRMIE Assessment of CRMI (Ground)

4.1 **Introduction**

This brief is to assist the CRMIE (Ground) in their role of assessing a CRMI (Ground) in the class environment. It includes an easy to use checklist in the form of effective CRMI knowledge, skills and attitudes so that Examiners will know what to look for and a sample Examiner's record form.

The checklist and form are practical tools that reflect the reference material in The Short Guide to Performance Standards for CRM Instructors (The Short Guide). They are designed to help the CRMIE make and record an assessment of the candidate's suitability to hold a CRMI (Ground) rating. The form is also useful for the candidate to appreciate the requirements that are being observed and assessed. They are, however, not mandatory and an Examiner can use his or her own Company paperwork.

In the early stages of CRMI Accreditation the Test should also include encouragement and development of CRM teaching and assessment skills. Examiners should also

bear in mind that whilst some CRM Ground-School Training Pilots may be experienced in their role, class facilitation skills may still be new to him/her.

As the majority of validations or renewals result in a PASS, best practice demands that all CRMIEs use this opportunity to give supportive feedback that helps develop the CRMI candidate's skills.

4.2 **The Accreditation Process**

The candidate must demonstrate to the CRMI Examiner (or CAA Inspector/CRM Advisory Panel Member) that they meet the Competence Standards laid down in 'The Short Guide'.

The CRMI (ground) rating is not a Company specific qualification. The validity period of the CRMI (ground) is three years. Thereafter, re-accreditation will be at the discretion of the CAA and subject to the following:

- The instructor should have conducted at least two courses of training in every yearly period within the three-year accreditation period.
- For re-accreditation, one course of training or a part thereof, within the last 12 months of the accreditation period will be observed by a CRMIE, who may be a company examiner, an Inspector of the CAA, or a suitably qualified member of the CRM Advisory Panel.

4.3 **Documents**

In addition to any course material CRMI Examiners should also be familiar with the general content of the following documents:

- 'The Short Guide'.
- CAP 737 (available at www.caa.co.uk).
- Standards Document 29 (available at www.caa.co.uk).
- NOTECHS or Company CRM Standards.
- Form TS10 or the CRMI Assessment Form.
- CAA CRMI Application Form.

4.4 **The Test**

CRMI Examiners will need to be familiar with guidance for pre-test preparation, briefing, conducting tests and debriefing skills given in CAP 737.

Pre Test Preparation

- Not all CRMI Candidates will be aware of the requirements, and the candidate should be provided with a copy of 'The Short Guide' and any Company Examiner Checklist prior to undertaking an assessment. This is to ensure they are familiar with the performance standards required.
- The CRMIE will need to establish the type of course, review the syllabus/course material and establish the experience level and recency of the CRMI Candidate and course trainees.
- Agree a date/time, allowing for extra opportunity for briefing/debriefing of the candidate.

Briefing/Conducting the Test

The CRMIE needs to brief the CRMI candidate in plenty of time before the course starts - this ensures there is time to:

- Set an open and professional tone.
- Establish the purpose of the test is for the CRMI to demonstrate his/her competence.
- Discuss the examiner's role (including seating position and involvement with the class).
- Discuss briefing the class about the examiner.
- Establish what the training objectives are for the session.
- Allow an opportunity for the CRMI to ask questions.
- Establish how many courses the CRMI has run in the validity period.
- The examiner should maintain an unobtrusive role during the training, leaving the CRMI responsible for course conduct and timing.
- The examiner should bear in mind that the needs of the trainees take precedence over any other requirements.

The CRMI check is primarily based on observation, and it cannot be over-emphasised that the CRMIE **MUST** have **EVIDENCE** to support their final assessment of the CRMI's competence. It may be necessary to ask questions prior to delivering the result, or as part of the debrief to ascertain the candidate's knowledge level of CRM aspects not covered during the course being observed.

Debriefing/Report

- CRMIEs should adopt an appropriate relaxed but professional tone for the debrief and deliver the test result at the outset.
- The overall aim is to facilitate learning and for the CRMIE to role model an effective debriefing that ensures that the candidate makes the analysis of their own performance.
- The debriefing should focus on the CRMIs development and include an appropriate balance of positive and negative feedback.
- The written report should reflect the debrief.

In addition the CRMI Examiner should bear in mind the following points:

"Examining CRM Instructor performance requires that the Examiner displays the best examples of CRM skill in handling the CRMI throughout the test, without losing any of the objectivity required to ensure a minimum standard." CAP737.

Pass

- Congratulate the Candidate. State the result of the test.

Fail

- State the outcome, with the reasons in descending order of priority.
- State the effect on the CRMI's rating - "unfortunately you will be unable to exercise the privileges of a CRMI rating until your reassessment is successful."

Pass or Fail

- Facilitate the main debrief points and agree any retraining requirements.
- Candidate must leave the debrief knowing what their strengths are.
- Candidate must leave the debrief knowing what to change and how to change it.

Assessment Criteria

Full details of reference material for Instructor Competence are contained in 'The Short Guide'. The CRMI should explain the reasons for the training at the outset. The aim of the checklist is to provide a summary of the key knowledge, skills, and attitudes as an aid to making an assessment of the CRMI's competence. The definition of a "good role model" is open to some degree of subjectivity, but encapsulates the most significant aspect of a trainer irrespective of the other skills. 'The Short Guide' list of behaviours may not be exhaustive, but the following list of behaviour is considered sufficient to assist you to understand the concept and make an informed judgment:

- Overtly supports CRM principles in word and deed (actively role models good CRM).
- Works hard to establish a rapport with trainees.
- Is open and honest.
- Creates an atmosphere of trust and respect.
- Preserves confidentiality.
- Good listener.
- Has a sense of humour.
- Supportive of fellow trainers.
- Always patient, sensitive and respectful of others.
- Seeks feedback and responds appropriately.
- Openly strives to improve own performance.

Examiner's Checklist for CRMI (Ground):

The CRMIE may find using this simple nine point checklist of effective knowledge, skills and attitudes to be an easy way to analyse and assess the appropriate important performance elements.

Were the training objectives achieved, YES or NO?**In deciding, consider the following:**

- Did the candidate demonstrate the **knowledge** required for the role?
- Did the candidate **encourage trainees to participate, share their experience and self-analyse**?
- Did the candidate **identify and respond to the trainees' needs** relative to their expertise/experience?
- Did the candidate **integrate** practical CRM within technical training and line operations?
- Did the candidate identify **CRM reasons** involved in accidents/incidents?
- Did the candidate regularly **check for understanding** and **resolve ambiguity**?

- Did the candidate incorporate **NOTECHS** or **Company CRM Standards** when appropriate?
- Did the candidate demonstrate effective **instruction and facilitation skills**?
- Was the candidate **supportive of CRM concepts** and **role model** best CRM practice?

The CRMI Examiner may also find that asking the course trainees for feedback or checking their understanding can help in giving developmental feedback to the CRMI (Ground) candidate. Questions should be open and address positives as well as negatives. The examiner should take care not to reopen CRM training topics and focus on how the instructor delivered the training. The following examples may be useful in eliciting feedback from the trainees about skills you have observed:

- What do you think were the key messages or points that the instructor was trying to address?
- Thinking about the way the material was delivered - what do you think the instructor did well today?
- Is there anything that would have made the training more constructive for you?
- Are there any issues that you feel were not addressed or remain outstanding?
- If you had the chance to ask the instructor to clarify or expand on any areas, what would they be?
- Do you think that you will try to apply anything discussed today to your normal line operations?
- How would you sum up the course to a friend or colleague who is about to attend this training?
- In what ways did you feel involved in today's training session?
- Which aspects of the session caused you to think relevant issues through?

Administration

A record of all CRMIE checks must be kept for a period of three years.

PASS Complete TS10 Examiner's Report or CRMI (Ground) Assessment Form
Complete CRMI (Ground) Application Form.

FAIL Advise Company Training Department
Complete relevant sections of TS10 Examiner's report/CRMI Assessment Form
Complete FCL252 Notice of Failure and give candidate a copy.

Examiners should ensure any records are kept in accordance with Data Protection requirements and remember the candidate has the right of access to see them.

Were the training objectives achieved? YES/NO (Provide reasons / give examples)	
Did the Candidate demonstrate the knowledge required for the role?	
Did the Candidate encourage trainees to participate, share their experience, and self-analyse?	
Did the Candidate identify and respond to the trainees' needs relative to expertise/experience?	
Did the Candidate integrate practical CRM within technical training and line operations?	
Did the Candidate identify CRM reasons involved in accidents/incidents?	
Did the Candidate regularly check for understanding and resolve ambiguity?	
Did the Candidate incorporate NOTECHS or Company CRM Standards when appropriate?	
Did the Candidate demonstrate effective instruction and facilitation skills?	
Was the Candidate supportive of CRM concepts and role model best CRM practice?	

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Appendix 11 Assessment of CRM Skills/Behavioural Markers

1 Introduction to Behavioural Markers

1.1 Context

Chapter 7 outlines the JAR-OPS requirements concerning the use of behavioural markers. This Appendix contains details of some of the behavioural marker schemes, both formal and informal, which are available. It should not be interpreted as a definitive list. The following schemes are addressed:

- NOTECHS
- University of Texas behavioural markers
- LMQCRM standards

Further examples of behavioural markers currently used by Operators may be found on www.raes-hfg.com on the CRMAP page.

1.2 Frequently asked questions concerning behavioural markers

The following text has been extracted verbatim from the GIHRE report (Group Interaction in High Risk Environments)

- 1 What are behavioural markers?
 - Observable, non-technical behaviours that contribute to superior or substandard performance within a work environment (for example, as contributing factors enhancing safety or in accidents and incidents in aviation).
 - Observable behaviours of teams or individuals.
 - Usually structured into a set of categories.
 - The categories contain sub-components that are labelled differently in various behavioural marker systems (e.g. NOTECHS: "elements" and "markers" = UT (LOSA): "anchors").
- 2 How are behavioural markers derived?
 - From analysis of data from multiple sources regarding performance that contributes to successful and unsuccessful outcomes (e.g. accident investigation, confidential incident reporting systems, incident analysis, simulator studies, task analysis, interviews, surveys, focus groups, ethnographies).
- 3 What makes a good behavioural marker?
 - It describes a specific, observable behaviour, not an attitude or personality trait, with clear definition (enactment of skills or knowledge is shown in behaviour).
 - It has demonstrated a causal relationship to performance outcome.
 - It does not have to be present in all situations.
 - Its appropriateness depends on context.
 - It uses domain specific language that reflects the operational environment.

- It employs simple phraseology.
 - It describes a clear concept.
- 4 What are the domains of application?
- Behavioural markers can be used in any domain where behaviour relating to job performance can be observed. However, they are expensive to develop and utilise given the level of training and calibration required for users. At present, they tend to be found in occupations where safety is prime and high fidelity simulators are used for training and assessment, e.g. in aviation, nuclear power generation, military settings, and, to a lesser degree, in medicine (anaesthesia and surgery), where simulation is less widely employed.
- 5 What are the uses of behavioural markers?
- To enable performance measurement for training and assessment, evaluation of training, safety management, and research.
 - To highlight positive examples of performance.
 - To provide a common vocabulary for training, briefing and debriefing, communication, regulation, research, and to connect different domains of safety (e.g. incident analysis and performance tracking).
 - To build performance databases to identify norms and prioritise training needs.
 - To compare sub-groups in organisations (e.g. aircraft fleets, etc.).
 - To give feedback on performance at individual, team, organisational, and system levels.
 - To establish co-operation between safety/quality, training, and operations.
- 6 What are characteristics of good behavioural marker systems?
- Validity: in relation to performance outcome.
 - Reliability: inter-rater reliability, internal consistency.
 - Sensitivity: in relation to levels of performance.
 - Transparency: the observed understand the performance criteria against which they are being rated; availability of reliability and validity data.
 - Usability: easy to train, simple framework, easy to understand, domain appropriate language, sensitive to rater workload, easy to observe.
 - Can provide a focus for training goals and needs.
 - Baselines for performance criteria are used appropriately for experience level of ratee (i.e. ab initio vs. experienced ratees).
 - Minimal overlap between components.
- 7 What are the limitations of behavioural marker systems?
- Cannot capture every aspect of performance and behaviour due to:
- Limited occurrence of some behaviours;
 - These are important but infrequent behaviours, such as conflict resolution.
 - Limitations of human observers – distraction, overload (e.g. in complex situations, large teams).

- 8 What considerations must be made when using a behavioural marker system?
- Raters require extensive training (initial and recurrent) and calibration.
 - Behavioural marker systems do not transfer across domains and cultures without adaptation (e.g. western markers in eastern cultures, or from aviation to medicine).
 - Behavioural marker systems need proper implementation into an organisation, and need management and workforce support.
 - phased introduction of behavioural marker systems required to build confidence and expertise in raters and ratees.
 - Application of the behavioural marker system must be sensitive to the stage of professional development of the individual, and to the maturity of the organisational and professional culture (e.g. whether used as a diagnostic, training, and/or assessment tool).
 - Use must consider context (e.g. crew experience, workload, operating environment, operational complexity).

- 9 What are special considerations when using a behavioural marker system for assessment?

The use of a behavioural marker system in a formal assessment of non-technical aspects of performance presents significant challenges. The behavioural marker system must capture the context in which the assessment is made (e.g. crew dynamics and experience, operating environment, operational complexity). For example, in a team endeavour, the behaviour of one crew member can be adversely or positively impacted by another, resulting in a substandard or inflated performance rating. Behavioural marker systems should be designed to detect and record such effects.

- 10 What are prerequisites to be a trainer for a behavioural marker course?

Qualifications required of the persons who will deliver a formal course to train, calibrate, and qualify raters (evaluators) using the behavioural marker system:

- Commitment to human factor's principles;
- Domain knowledge;
- Formal training in applicable aspects of human factors or non-technical skills (e.g. Crew Resource Management);
- Formal training in the use and limitations of performance rating systems;
- Formal training in the use of the specific behavioural marker system.

- 11 What are prerequisites for evaluators using a behavioural marker system?

Entry requirements for personnel who will serve as evaluators:

- Commitment to human factors' principles;
- Domain knowledge;
- Formal training in applicable aspects of human factors or non-technical skills (e.g. Crew Resource Management).

- 12 What are necessary qualifications of evaluators?

- Complete initial training in behavioural marker systems;

- Formal assessment as competent and calibrated following behavioural marker system-training in classroom;
 - Calibration in operational environment (e.g. training, simulator, work environment);
 - Periodic re-calibration for continuing use of the behavioural marker system.
- 13 What should the content of behavioural marker system training be?
- Make explicit goals for use of the behavioural marker system;
 - Explain the design of the behavioural marker system, as well as content and guidelines for its use;
 - Review main sources of rater biases (e.g. hindsight, halo, recency, primacy) with techniques to be used for minimisation;
 - Present the concept of inter-rater reliability and the methods to be used to maximise it;
 - Illustrate and define each point of the rating scale and different levels of situational complexity with video examples, discussions, and hands-on exercises;
 - Provide practical training with multiple examples;
 - Include calibration with iterative feedback on inter-rater reliability score;
 - Teach debriefing skills as appropriate;
 - Conclude with a formal assessment of rater competence.
- 14 How should a behavioural marker system training be structured?
- Minimum two consecutive days training;¹
 - An ideal group size of 8-12 people;
 - Training follow-up (e.g. meetings, feedback via telephone) after use of behavioural marker system in operational setting;
 - Training ideally utilises video examples from the organisation.
- 15 What training and calibration materials should be used?
- Videotapes of scenarios with professional sound and visual quality;
 - Demonstrating various levels of performance;
 - Showing all behavioural markers in scenarios illustrating various environmental conditions and complexity;
 - Depicting increasing lengths of segments with training progress (e.g. from 2 minute vignettes of a specific behavioural marker to an entire flight/surgical procedure).
 - Information about the background of the behavioural marker system with full reference documentation.
- 16 What are regulatory issues regarding the use of behavioural marker systems?
- The rationale for employing a behavioural marker system in any domain is to improve levels of safety and to facilitate attainment of the highest possible levels of performance;

1. Note: This is a recommendation from the GIHRE report and not a CAP 737 recommendation.

- A partnership between the operators and regulatory authorities is needed to achieve equitable assessment of non-technical skills, especially when a pass/fail criterion is mandated;
- Regulators should move cautiously when initiating formal assessment of non-technical skills.

17 What are research issues regarding the use of behavioural marker systems?

By nature, behavioural marker systems are not static, but must be continually evolved or refined in response to changing operational circumstances (e.g. development of equipment) and increased understanding of human factors issues in the domain. The following list, which is not exhaustive, specifies research topics where empirical evidence is either lacking or incomplete and systematic research should prove highly beneficial:

- Developing empirical evidence for the relative merits of global vs. phase or event-specific ratings and individual vs. team ratings;
- Defining context effects on crew behaviour and developing a systematic system of integrating these measures with behavioural markers to provide a more comprehensive system;
- Investigating the distribution of ratings of markers taken in different data collection environments (i.e. training including technical and non-jeopardy, full mission simulation (LOFT), non-jeopardy assessment of system performance (LOSA), formal evaluations in both line operations, and recurrent proficiency checks);
- Integrating knowledge from incident analyses, especially coping/recovery strategies and translating them into behavioural markers;
- Providing practical guidance for the transfer of behavioural marker systems and/or their components across domains and cultures (national, professional, and organisational).

Conclusion

- Behavioural marker systems have demonstrated value for training, understanding of performance in high risk environments, and research into safety and human factors.
- Behavioural marker systems can contribute to safety and quality in other work environments, as well as in high risk settings.
- Concepts are continuously evolving as a result of co-operation between practitioners and researchers.
- Researchers, practitioners, and regulatory authorities must work congruently in order to realise the ultimate goal of improved safety.

2 The Development of the NOTECHS Behavioural Markers

The following text has been extracted from the GIHRE report

The European Joint Aviation Requirements (JAR) require the training and assessment of pilots' CRM skills. JAR OPS NPA 16 [now JAR OPS amendment 2] states: *"The flight crew must be assessed on their CRM skills in accordance with a methodology acceptable to the Authority and published in the Operations Manual. The purpose of such an assessment is to: Provide feedback to the individual and serve to identify retraining; and be used to improve the CRM training system"*. CRM skills can also be

called non-technical skills. These refer to a flight crew member's behaviours in the cockpit not directly related to aircraft control, system management, and standard operating procedures.

In 1996, the JAA Research Committee on Human Factors initiated a project that was sponsored by four European Civil Aviation Authorities (Germany, France, Netherlands, UK). A research consortium, consisting of members from DLR (Germany), IMASSA (France), NLR (Netherlands), and University of Aberdeen (UK), was established to work on what was called the NOTECHS (Non-Technical Skills) project. This group was required to identify or develop a feasible and efficient methodology for assessing pilots' non-technical skills. The design requirements were (i) that the system was to be used to assess the skills of an individual pilot, rather than a crew, and (ii) it was to be suitable for use across Europe, by both large and small operators. After reviewing existing methods it became apparent, for various reasons (e.g. crew-based, fleet specific, or too complex), that none of these systems met the design requirements and therefore they could not be taken as an Acceptable Means of Compliance (AMC) under the scope of the JAR. Moreover, none of them provided a suitable basis for simple amendment, although particular attention was paid to two of the principal frameworks, namely the KLM WILSC/SHAPE systems and the NASA UT Line/LOS Checklist system (LLC version 4). Therefore, the research group, with the assistance of training captains from KLM, designed a prototype behavioural marker system for rating non-technical skills, which was called NOTECHS.

The development of the NOTECHS system consisted of: (i) the review of existing systems to evaluate proficiency in non-technical skills; (ii) a literature search for relevant research findings relating to key categories of non-technical skills; (iii) extended discussions with subject matter experts at NOTECHS working group meetings. The following design criteria were used to guide the final choice of components and descriptor terms:

- a) the system should contain the minimum number of categories and elements in order to encompass the critical behaviours;
- b) the basic categories and elements should be formulated with minimum overlap;
- c) the terminology should reflect everyday language for behaviour, rather than psychological jargon;
- d) the skills listed at the behavioural level should be directly observable in the case of social skills or inferable from crew interaction in the case of cognitive skills.

The resulting structure of NOTECHS comprises four categories: *Co-operation, Leadership and Managerial Skills, Situation Awareness, Decision Making*. These four primary categories effectively subdivide into two social skills categories (Co-operation; Leadership and Managerial) and two cognitive skills categories (Situation Awareness; Decision Making). In relation to the four categories, 15 elements were identified. For each element, a number of positive and negative exemplar behaviours were included. These were phrased as generic behaviours (e.g. closes loop for communications) rather than specific behaviours (e.g. reads back to ATC) to give an indication of type, and to avoid designating particular actions that should be observed.

Finally, a set of NOTECHS Principles was established, which should be adhered to when the system is used.

- Evaluations based on observable behaviours;
- Need for technical consequences;
- Evaluations based on repeatedly shown behaviour patterns;

- Scale should allow for ratings of acceptable to unacceptable behaviours;
- Explanation required if unacceptable category rating is given.

The NOTECHS system requires a minimum of two full days of specialist training and this should meet the recommendations in the guidelines above. Further information on the development and evaluation of the NOTECHS system can be found in the Joint Aviation Requirements – Translation and Elaboration of Legislation (JARTEL) project reports.

Table 1 The NOTECHS Behavioural Markers The NOTECHS Rating Scale

Categories	Elements	Example Behaviours
CO-OPERATION	Team building and maintaining	Establishes atmosphere for open communication and participation
	Considering others	Takes condition of other crew members into account
	Supporting others	Helps other crew members in demanding situation
	Conflict solving	Concentrates on what is right rather than who is right
LEADERSHIP AND MANAGERIAL SKILLS	Use of authority and assertiveness	Takes initiative to ensure involvement and task completion
	Maintaining standards	Intervenes if task completion deviates from standards
	Planning and co-ordinating	Clearly states intentions and goals
	Workload management	Allocates enough time to complete tasks
SITUATION AWARENESS	System awareness	Monitors and reports changes in system's states
	Environmental awareness	Collects information about the environment
	Anticipation	Identifies possible future problems
DECISION MAKING	Problem definition/ diagnosis	Reviews causal factors with other crew members
	Option generation	States alternative courses of action Asks other crew member for options
	Risk assessment/ Option choice	Considers and shares risks of alternative courses of action
	Outcome review	Checks outcome against plan

Very Poor	Poor	Acceptable	Good	Very Good
Observed behaviour directly endangers flight safety	Observed behaviour in other conditions could endanger flight safety	Observed behaviour does not endanger flight safety but needs improvement	Observed behaviour enhances flight safety	Observed behaviour optimally enhances flight safety and could serve as an example for other pilots

3 University of Texas Behavioural Markers

The following text has been extracted from the GIHRE report

The original behavioural marker system in the U.S. originated in the University of Texas Human Factors Research Project (then called the NASA/UT Project) in the late 1980s. There were two goals associated with the effort: the first was to evaluate the effectiveness of CRM training as measured by observable behaviours, while the second was to aid in defining the scope of CRM programmes. The first manual to assist check airmen and evaluators in assessing the interpersonal component of flying was issued by NASA/UT in 1987. Originally, ratings of crew performance were made by observers assessing a complete flight from initial briefing to landing, taxi-in, and shutdown of engines.

The first set of behavioural markers was included by the Federal Aviation Administration as an Appendix to its Advisory Circular on CRM (AC-150A). Development of the markers was supported by a grant from the FAA. Systematic use of the markers grew as airlines enhanced assessment of crew performance and as the University of Texas project began collecting systematic data on all aspects of an airline's operations in a programme known as the Line Operations Safety Audit (LOSA). The markers themselves were incorporated in a form for systematic observations known as the Line/LOS Checklist (LOS refers to line operational or full mission simulation). As experience and the database of observations grew, it became apparent that there was significant variability in crew behaviour during flights that needed to be captured. Accordingly, the form was modified to assess the markers for each phase of flight.

In 1995, a validation of the markers was undertaken by classifying their impact (positive and negative) in analyses of aviation accidents and incidents. The results of the analysis provided strong support for the utility of the markers as indicators of crew performance and their value as components of CRM training.

LOSA evolved over time from a sole assessment of the behavioural markers to a focus on threat and error management. In this iteration (now reflected in the 9th generation of the data collection instrument), threats and errors are classified and their management assessed along with a greatly reduced set of behavioural markers. The new focus on threat and error management provided hard, empirical criteria against which to pit the markers. In this process, a number of overlapping markers were dropped to yield a smaller, but highly influential list. These are shown, along with the phase of flight in which collected, in the following section.

Training for LOSA, including the behavioural markers as well as classification of threats and errors, takes two full days and is similar to that recommended for using the markers alone.

The markers listed below in Table 2 are used in Line Operations Safety Audits, non-jeopardy observations of crews conducting normal line flights. Each of these markers has been validated as relating to either threat and error avoidance or management. With the exception of two global ratings, specific markers are rated (if observed) during particular phases of flight. Following is a list of currently used markers showing phase where rated, followed by the ratings for each phase of flight:

Table 2 University of Texas (UT) Behavioural markers Rating Scale

SOP BRIEFING	The required briefing was interactive and operationally thorough	Concise, not rushed, and met SOP requirements Bottom lines were established	P-D
PLANS STATED	Operational plans and decisions were communicated and acknowledged	Shared understanding about plans "Everybody on the same page"	P-D
WORKLOAD ASSIGNMENT	Roles and responsibilities were defined for normal and non-normal situations	Workload assignments were communicated and acknowledged	P-D
CONTINGENCY MANAGEMENT	Crew members developed effective strategies to manage threats to safety	Threats and their consequences were anticipated Used all available resources to manage threats	P-D
MONITOR/ CROSSCHECK	Crew members actively monitored and crosschecked systems and other crew members	Aircraft position, settings, and crew actions were verified	P-T-D
WORKLOAD MANAGEMENT	Operational tasks were prioritised and properly managed to handle primary flight duties	Avoided task fixation Did not allow work overload	P-T-D
VIGILANCE	Crew members remained alert of the environment and position of the aircraft	Crew members maintained situational awareness	P-T-D
AUTOMATION MANAGEMENT	Automation was properly managed to balance situational and/or workload requirements	Automation setup was briefed to other members Effective recovery techniques from automation anomalies	P-T-D
EVALUATION OF PLANS	Existing plans were reviewed and modified when necessary	Crew decisions and actions were openly analyzed to make sure the existing plan was the best plan	P-T
INQUIRY	Crew members asked questions to investigate and/or clarify current plans of action	Crew members not afraid to express a lack of knowledge "Nothing taken for granted" attitude	P-T
Key to Phase: P =Pre-departure/Taxi; T =Takeoff /Climb; D =Descent/Approach/Land; G =Global			

Table 2 University of Texas (UT) Behavioural markers Rating Scale

ASSERTIVENESS	Crew members stated critical information and/or solutions with appropriate persistence	Crew members spoke up without hesitation	P-T
COMMUNICATION ENVIRONMENT	Environment for open communication was established and maintained	Good cross talk – flow of information was fluid, clear, and direct	G
LEADERSHIP	Captain showed leadership and co-ordinated flight deck activities	In command, decisive, and encouraged crew participation	G
Key to Phase: P =Pre-departure/Taxi; T =Takeoff /Climb; D =Descent/Approach/Land; G =Global			

1=poor	2=marginal	3=good	4=outstanding
Observed performance had safety implications	Observed performance was barely adequate	Observed performance was effective	Observed performance was truly noteworthy

4 The JARTEL project (Joint Aviation Requirements – Translation and Elaboration of Legislation)

The following text has been extracted from the GIHRE report

In 1998, a European project team was established to work on the JARTEL project. This team was funded by the European Commission (DG TREN) and consisted of the following partners: Alitalia, British Airways, Airbus, DERA (UK), DLR (G), IMASSA (F), NLR (N), Sofreavia (F) and University of Aberdeen (UK), several of whom had been involved in the NOTECHS project. The basic aim of the JARTEL project was to conduct initial tests of the NOTECHS behavioural marker system to ascertain whether it was a) reliable, b) usable, and c) culturally robust across European operators. This project began with a literature review to determine the main cultural clusters relating to flight deck crews' behaviour patterns in Europe. This was followed by an experimental study with 105 training captains from larger and smaller operators located in the five main cultural clusters using the NOTECHS system. An operational study involving a number of airlines has been completed.

JARTEL WP5 gives a general overview of the NOTECHS method and answers practical questions in relation to the implementation of the method within airlines.

5 LMQ CRM Standards

The following information has been provided by LMQ, specialists in CRM training, and, offers an informal method of distinguishing between good and poor CRM.

The list in Table 3 is a compilation of the views of several hundred training captains in response to the following questions:

- Can you recall flying with a person who you regarded as professional and why did you think that?
- Can you recall flying with a person who you felt was a liability and why did you think that?

An observation of this 5 year research was that the lists generated by the groups interviewed were uncannily similar and took little time to recall. This has led therefore to the conclusion that the majority of training captains and probably line pilots already have a consistent knowledge about what CRM standards should be, and are also able to recognise these standards.

Table 3 Qualities of a Professional Operator

As well as having a good knowledge of operations, procedures and technical subjects and good handling skills - a professional operator is a person who:
<ul style="list-style-type: none"> • Is calm, relaxed and unflustered • Has control of the situation and can see the big picture • Is flexible and sensible with procedures • Is clear and precise • Is open and honest • Is patient and forgiving • Debriefs directly but fairly, and focuses criticism on how to improve • Is reliable and consistent • Is approachable and open to ideas • Is conscientious and enjoys their work • Listens well and demonstrates an understanding of other people's positions • Is confident, modest and reserved • Plans well, is aware of what is going on and thinks ahead • Lets others know what they are thinking and planning • Makes good decisions and involves others in the process • Sets an open climate by offering to both give and receive criticism • Admits to things that they don't know • Treats everyone equally and part of the team • Reviews their own performance candidly • Is friendly and has a sense of humour • Delegates, trusts and recognises work • Motivates by example and giving praise

Table 3 Qualities of a Professional Operator

and not someone who as well as being incompetent:
<ul style="list-style-type: none"> • Is insensitive, pompous and aggressive • Is impulsive, unprepared and unpredictable • Is confrontational and deliberately obtuse • Demoralises others by nitpicking and blaming them • Is selfish, individualistic and self centered • Is judgmental and critical • Is disloyal, devious and rude • Says little • Has little respect for others • Is unaware • Has a closed mind and rigid views • Is overconfident, arrogant and autocratic

However in order to give crews and operators a more comprehensive and specific set of standards, LMQ have produced the following CRM Standards which are now being used by several UK airlines, and are freely available to any operator.

These standards were developed not only from the above research but also from accident and incident analysis, as well as experience from exercises undertaken by crews when practising their CRM skills.

The Standards are founded on Observable Actions which Trainers and Examiners should be able to use during their assessments of line crews. They were validated from October 2003 to July 2004 using a four phase validation programme involving 55 training captains plus 8 first officers, cabin crew members and CRMIs.

Table 4 LMQ CRM Standards

	Observable Actions
Communications	<p>Crew members:</p> <ul style="list-style-type: none"> • Know when, what, how much and to whom they need to communicate. • Ensure the recipient is ready and able to receive the information. • Pass messages and information clearly, accurately, timely and adequately. • Check the other person has the correct understanding when passing important information. • Listen actively, patiently and demonstrate understanding when receiving information. • Ask relevant and effective questions and offer suggestions. • Use appropriate body language, eye contact and tone. • Are open and receptive to other people's views.

Table 4 LMQ CRM Standards

Teamworking	<p>Crew members:</p> <ul style="list-style-type: none"> • Agree and are clear on the team's objectives and members' roles. • Are friendly, enthusiastic, motivating and considerate of others. • Use initiative, give direction and take responsibility when required. • Are open and honest about thoughts, feelings and intentions. • Give and receive criticism and praise well. • Confidently do and say what is important to them. • Demonstrate respect and tolerance for other people. • Involve others in the planning and implementation.
Workload Management	<p>Crew members:</p> <ul style="list-style-type: none"> • Are calm, relaxed and careful. • Prioritise and schedule tasks effectively. • Use time available efficiently to complete tasks. • Offer and accept assistance, and delegate when necessary. • Review, monitor and cross-check actions conscientiously. • Follow procedures appropriately and consistently. • Only concentrate on one thing at a time, and ensure tasks complete.
Situation Awareness	<p>Crew members:</p> <ul style="list-style-type: none"> • Are aware of what the aircraft and its systems are doing. • Are aware of where the aircraft is and its environment. • Are aware of the condition of the people involved in the operation including passengers. • Are able to recognise what is likely to happen, to plan and stay ahead of the game. • Keep track of time. • Are able to identify threats to the safety of the aircraft and people. • Develop what if scenarios and make pre-decisions.
Problem Solving and Decision Making	<p>Crew members:</p> <ul style="list-style-type: none"> • Identify and verify why things have gone wrong and do not jump to conclusions or make assumptions • Seek accurate and adequate information from appropriate resources. • Persevere working through a problem. • Use and agree the most effective decision making process. • Agree decision criteria and prioritise. • Consider as many options as practicable. • Make decisions when they need to and are not impulsive. • Consider risks but do not take unnecessary risks.

6 References and Useful Additional Reading

- a) GIHRE. Enhancing Performance in High Risk Environments: recommendations for the use of Behavioural Markers. July 2001. <http://www2.hu-berlin.de/GIHRE>.
- b) O'Connor, Flin, Fletcher and Hemsley. Methods Used to Evaluate the Effectiveness of Flightcrew CRM Training in the UK Aviation Industry. 2002.
- c) O'Connor, Flin, Fletcher and Hemsley. Literature Review. Methods Used to Evaluate the Effectiveness of Flightcrew CRM Training in the UK Aviation Industry. 2002.
- d) Behavioural Markers for Crew Resource Management. CAA Paper 98005. 1998 Printed by Documedia www.documedia.co.uk.
- e) Joint Aviation Requirements: Translation and Elaboration of Legislation (JARTEL). www.sofreavia.com/jartel/.
- f) Examples of company behavioural markers. www.raes-hfg.com (on CRMAP page).

Appendix 12 The "Short Guide"

This Appendix includes a copy of "The Short Guide to Performance Standards for CRM Instructors" - v.4 (Jan/03).

The purpose of this Short Guide is to establish industry standards for CRM Instructors (CRMIs). It gives guidance and information to operators, providers of CRM training and CRM Instructors, on the necessary standards of competence.

Further information is provided in the 'Guide to Performance Standards for Instructors of Crew Resource Management Training in Commercial Aviation' dated September 1998. However, the contexts in that document differ from those here, which are aligned with those in CAA Standards Document 29 Version 1 dated 18 September 2001.

This Short Guide is a significant revision of the 1998 Guide and should therefore be considered as the reference document for CRM instructor accreditation. In due course, the 1998 Guide will be revised to reflect industry experience of instructor accreditation, and the changes in this document.

This Short Guide details what instructors need to be considered competent in, in each of 3 different contexts: (a) Simulator and Base Training, (b) Line Training, (c) Ground School Training. Material in these 3 contexts is naturally similar, but is laid out separately to avoid the need to cross-refer between contexts.

In each of the contexts there are 4 main Areas of Competence:

- a) Designs training;
- b) Delivers training;
- c) Assesses trainee progress;
- d) Continuously improves the effectiveness of the training.

The Areas are subdivided into 12 Units of Competence, each of which contains a number of Performance Elements and Background Knowledge. Those elements marked in bold are essential and the rest are options. To meet the requirements of a CRMI, trainers must be able to demonstrate competence in all the essential elements plus 5 option elements.

Table 1 Simulator and Base Training

Unit	Performance Element	Knowledge
A1 Designs CRM training sessions	Identifies training requirements Selects CRM standards Builds in methods of evaluating training effectiveness	Understanding objectives Company and industry requirements Training techniques Relevant regulatory requirements CRM standards
A2 Prepares resources	Ensures activities are practical and realistic Ensures facilities meet requirements Assists in the preparation of briefing materials	Simulator procedures and resources Available equipment
B1 Integrates CRM training	Makes CRM links with technical training and Standard Operating Procedures (SOPs) where appropriate. Makes links with flight safety, customer service, company policy.	Company technical and operational training procedures and requirements Human Factors knowledge
B2 Creates a climate conducive to learning	Establishes CRM credentials and rapport with trainees, and clarifies roles. Clarifies training objectives and methods. Ascertain and supports trainees' needs.	Potential barriers to learning, including awareness of cross-cultural issues How to put trainees at ease
B3 Presents knowledge	Communicates clearly, accurately and adequately. Creates and sustains realism in the detail.	Distinguish between process and content outcomes Ways to elicit participation. Methods of giving information/adult learning styles
B4 Facilitates learning and coaches individuals	Encourages trainees to get involved. Focus is on trainees not themselves. Overtly supportive of CRM principles in word and deed (i.e., role models good CRM). Motivating, patient, confident and assertive manner. Conducts one-to-one coaching/debrief of crew members as appropriate. Encourages mutual support, teamwork and sharing of individual learning experiences.	Facilitation How to give constructive debriefing and feedback The difference between coaching and demonstration/instruction Group dynamics
C1 Monitors and reviews progress	Continuously monitors and responds flexibly to the training session Ensures objectives are achieved Reviews progress with trainees.	Methods of tracking performance in the simulator Methods of tracking performance Principles and purpose of reviews What constitutes valid and reliable information
C2 Assesses trainees performance	Assists trainees to assess own individual and team performance against CRM standards. Sets new/additional learning objectives. Observes CRM behaviours.	Uses of video playback and debriefing to facilitate learning

Table 1 Simulator and Base Training

Unit	Performance Element	Knowledge
D1 Evaluates CRM training sessions	Elicits feedback from trainees. Tracks training session processes against agreed criteria Keeps appropriate records.	Methods of assessing and improving session effectiveness
D2 Evaluates and develops own practice	Regularly reviews own performance, strengths and development needs. Collects feedback about performance from others. Keeps abreast of developments from Regulator, trade press, etc. Maintains a written development record against a development plan.	Methods of assessing own performance Methods of improving own performance

Table 2 Line Training

Unit	Performance Element	Knowledge
A1 Designs CRM training sessions	Identifies training requirements Selects CRM components of line check. Provides opportunities for demonstrating CRM competency.	Company and industry requirements Training techniques Relevant regulatory requirements CRM standards
A2 Prepares resources	Not applicable	Not applicable
B1 Integrates CRM training	Makes CRM links with technical training and Standard Operating Procedures (SOPs) where appropriate. Makes links with flight safety, customer service, company policy.	Company technical and operational training procedures and requirements Human Factors knowledge
B2 Creates a climate conducive to learning	Establishes CRM credentials and rapport with learners, and clarifies roles. Clarifies training objectives and consequences. Ascertains and supports trainees' needs.	Potential barriers to learning, including awareness of cross-cultural issues How to put trainees at ease Trainees experience level and expectations Adult learning styles
B3 Presents knowledge	Communicates clearly, accurately and adequately. Looks for training opportunities.	Ways to elicit participation in debrief Methods of giving information
B4 Facilitates learning and coaches individuals	Encourages trainees to get involved. Focus is on trainees not themselves. Overtly supportive of CRM principles in word and deed (i.e., role models good CRM). Motivating, patient, confident and assertive manner. Conducts one-to-one coaching/debrief of crew members as appropriate. Encourages mutual support, teamwork and sharing of individual learning experiences. Debriefs on practical application of CRM skills.	Facilitation How to give constructive debriefing and feedback The difference between coaching and demonstration/instruction How to encourage trainees to ask questions and seek advice

Table 2 Line Training

Unit	Performance Element	Knowledge
C1 Monitors and reviews progress	Continuously monitors and responds flexibly to the training session. Ensures objectives are achieved Reviews progress with trainees.	Methods of tracking performance Principles and purpose of reviews What constitutes valid and reliable information
C2 Assesses trainees' performance	Assists trainees to assess own individual and team performance against CRM standards. Conducts formative assessments. Makes assessment decision and provides clear feedback. Sets new/additional learning objectives. Keeps appropriate records. Observes CRM Behaviours.	Observation techniques Methods of collecting evidence
D1 Evaluates CRM training sessions	Elicits feedback from trainees. Tracks training session processes against agreed criteria Keeps appropriate records.	Methods of assessing and improving session effectiveness
D2 Evaluates and develops own practice	Regularly reviews own performance, strengths and development needs. Collects feedback about performance from others. Keeps abreast of developments from Regulator, trade press, etc. Maintains a written development record against a development plan	Methods of assessing own performance Methods of improving own performance

Table 3 Ground School Training

Unit	Performance Element	Knowledge
A1 Designs CRM training sessions	Identifies training requirements and delivery resources. Sets Objectives Builds in methods of evaluating training effectiveness Incorporates a variety of activities in design.	Understanding objectives Company and industry requirements Training techniques Relevant regulatory requirements CRM standards
A2 Prepares resources	Ensures activities are practical and realistic Ensures facilities meet requirements Assists in the preparation of briefing materials Ensures materials are adequate and clear	Existing materials Copyright and intellectual property Company training standards
B1 Integrates CRM training	Makes CRM links with technical training and Standard Operating Procedures (SOPs) where appropriate. Makes links with flight safety, customer service, company policy.	Company technical and operational training procedures and requirements Human Factors knowledge
B2 Creates a climate conducive to learning	Establishes CRM credentials and rapport with trainees, and clarifies roles and confidentiality. Clarifies training objectives and methods. Ascertains and supports trainees' needs.	Potential barriers to learning, including awareness of cross-cultural issues How to put trainees at ease

Table 3 Ground School Training

Unit	Performance Element	Knowledge
B3 Presents knowledge	Communicates clearly, accurately and adequately. Creates and sustains realism in the detail. Maintains interest.	Distinguish between process and content outcomes Ways to elicit participation. Methods of giving information/adult learning styles Presentation techniques and visual aids
B4 Facilitates learning and coaches individuals	Encourages trainees to get involved. Focus is on trainees not themselves. Overtly supportive of CRM principles in word and deed (ie, role models good CRM). Motivating, patient, confident and assertive manner. Uses exercises and activities to maximise learning. Recognises and responds to individuals needs. Encourages mutual support, teamwork and sharing of individual learning experiences.	Facilitation How to give constructive debriefing and feedback The difference between coaching and demonstration/instruction Group dynamics Group facilitation techniques
C1 Monitors and reviews progress	Continuously monitors and responds to flexibly to the training session. Ensures objectives are achieved Reviews progress with trainees against formal benchmarks.	Methods of tracking performance
C2 Assesses trainees performance	Assists trainees to assess own individual and team performance against CRM standards. Sets new/additional learning objectives.	Uses of video playback and debriefing to facilitate learning Methods of assessing knowledge and skills
D1 Evaluates CRM training sessions	Elicits feedback from trainees. Tracks training session processes against agreed criteria Elicits formal course evaluation from trainees Keeps appropriate records.	Methods of assessing and improving session effectiveness Evaluation techniques
D2 Evaluates and develops own practice	Regularly reviews own performance, strengths and development needs. Collects feedback about performance from others. Keeps abreast of developments from Regulator, trade press, etc. Maintains a written development record against a development plan	Methods of assessing own performance Methods of improving own performance

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Appendix 13 Miscellaneous CRM Topics

1 Line Operations Safety Audit (LOSA)

LOSA and CRM are two different things. However, due to the fact that LOSA is often discussed in conjunction with CRM, it was considered appropriate to include a short section describing LOSA and how it relates to CRM, in order to help dispel any misconceptions. Further information on LOSA may be obtained from ICAO. The following text is extracted from the ICAO Line Operations Safety Audit (LOSA) manual (Doc 9803 AN/761).

1.1 Introduction to LOSA

LOSA is a critical organisational strategy aimed at developing countermeasures to operational errors. It is an organisational tool used to identify threats to aviation safety, minimise the risk such threats may generate and implement measures to manage human error in operational contexts. LOSA enables operators to assess their level of resilience to systemic threats, operational risks, and front-line personnel errors, thus providing a principled, data-driven approach to prioritise and implement actions to enhance safety.

LOSA uses expert and highly trained observers to collect data about flight crew behaviour and situational factors on "normal" flights. The audits are conducted under strict no-jeopardy conditions; therefore flight crews are not held accountable for their actions and errors that are observed. During flights that are being audited, observers record and code potential threats to safety; how the threats are addressed; the errors such threats generate; how flight crews manage these errors; and specific behaviours that have been known to be associated with accidents and incidents.

LOSA is closely linked with CRM training. Since CRM is essentially error management training for operational personnel, data from LOSA form the basis for contemporary CRM training refocus and/or design known as Threat and Error Management training (TREM). Data from LOSA also provide a real-time picture of system operations that can guide organisational strategies in regard to safety, training and operations. A particular strength of LOSA is that it identifies examples of superior performance that can be reinforced and used as models for training. In this way, training interventions can be reshaped and reinforced based on successful performance, that is to say, positive feedback.

1.2 LOSA References and Useful Additional Reading

- a) Line Operations Safety Audit (LOSA). ICAO Doc 9803 AN/761. 2002.
- b) The LOSA Experience; Safety Audits on the Flight Deck. ICAO Journal V 57, no 4. 2002.
- c) Proceedings of the First LOSA Week; Cathay City, Hong Kong. March 2001. ICAO
- d) Proceedings of the Second LOSA Week; Panama City, Panama. November 2001. ICAO.
- e) Proceedings of the First TREM workshop. San Salvador, El Salvador. May 2002. ICAO.

2 Advanced CRM (ACRM)

The information in this Section has been extracted directly from the FAA document: Developing Advanced Crew Resource Management (ACRM) Training: a Training

Manual 1998. Seamster T., Boehm-Davis, D., Holt, R., Schulz, K.

A copy may be downloaded from www.hf.faa.gov/docs/DACRMT.pdf (size 2.5 MB).

2.1 Definition

Advanced Crew Resource Management - a comprehensive implementation package including CRM procedures, training of the instructor/evaluators, training of the crews, a standardised assessment of crew performance, and an ongoing implementation process providing an integrated form of CRM by incorporating CRM practices with normal and emergency SOPs.

2.2 Introduction

Part 1 of the ACRM Manual explains the background of ACRM training and describes the main elements for developing an ACRM training program. The last section in this part outlines the major benefits of developing and implementing ACRM training. That section should be particularly useful for those needing justification for implementing ACRM.

Part 1 was written for those not familiar with ACRM training and its elements. Those with knowledge of or experience with ACRM can jump to Part 2, Guiding the Organisation, or Part 3, Developing CRM Procedures.

Most airlines emphasise CRM principles in the form of topics or markers. These principles include topics such as crew co-ordination, decision making, and situation awareness. These principles are in the form of recommended practices, and crews are encouraged to implement these practices when and how they see fit. The resulting behavior is not always predictable, and most airlines have found it difficult to specify standards of performance for CRM principles.

Some operationally relevant CRM principles can be translated into airline-specific procedures that will benefit crew performance in certain situations. These CRM-based procedures can be integrated with existing normal or non-normal procedures, or they can be designed into new procedures.

The identification of CRM procedures normally starts with existing principles and moves to forming preliminary procedures. This process includes:

- Reviewing existing CRM principles;
- Identifying crew performance problem areas;
- Reviewing procedures at other airlines;
- Identifying possible procedural changes or additions.

The identification of CRM procedures should first address the most important crew performance problems. Once ACRM training has been developed and implemented, additional CRM procedures can be developed. CRM procedure identification should be treated as an ongoing process involving the entire organisation in constantly looking for ways to improve crew performance.

2.3 How CRM Procedures Work

ACRM is directed to the training and assessment of CRM skills within crew training programs. CRM procedures become a focal point in CRM training, and those procedures allow crews to practice specific CRM behaviors both in normal and non-normal situations. The procedures help crew members develop a consistent pattern of crew co-ordination allowing crews to know what to expect from each other. The CRM procedures also serve as a constant reminder to the importance of CRM within the operational environment.

CRM procedures are an integral part of SOP. CRM procedures may be integrated within briefings, checklists, and emergency or abnormal procedures, such as those found in a QRH, the FSM, or the FOM. These procedures promote good CRM in consistent ways during appropriate times for normal and non-normal flight situations.

For example, crew communication and situation awareness can be improved by requiring specific items in briefings prior to take-off. A take-off brief that requires the crew to address situationally relevant items critical to that particular take-off can be inserted during times with lower levels of workload. By having the take-off brief address important conditions related to the airport, weather, and performance, the crew discusses those conditions that affect the take-off. The brief should include specific plans for abnormals that may occur during take-off. Having the briefing scheduled for the lower workload period prior to taxi helps improve situation awareness and decision making during a critical phase of flight.

2.4 **Example of a CRM Procedure**

CRM procedures may be embedded in a range of crew activities. Some CRM procedures, as the one shown in this example, are inserted into required crew briefings prior to critical times of flight such as approach/landing.

There are a number of cases where an airline may notice a pattern or crews are being rushed during the approach that results in the following type of incident (from ASRS Reports):

Due to the proximity of the airport, the high indicated airspeed, the excess alt and the flight crew's anticipation of the ILS 34 approach, the workload of the flight crew was quite high. The PF descended from the published segment alt (3500' MSL) at the 18 DME position to the published straight in landing MDA of 2000' MSL. The FAF for the procedure was at the 13 DME position and the PF's premature descent put the aircraft 1500' below the published segment alt.

The following Arrival Brief was designed to help crews address the main conditions relevant to each arrival. The brief was placed at the end of cruise phase.

Table 1 Arrival Brief:

ATIS/NOTAMS
Brief Descent Profile
Statement of Conditions
Select and Prioritise:
Fuel status/delays
Runway conditions
Low visibility procedures
Terrain/MSA
Convective activity
Crosswinds/windshear
Hydroplaning
Aircraft performance
GPWS/TCAS alerts
Bottom Lines for arrival, approach and landing
Backup Plan for arrival, approach and landing
Overview of CRM Procedures

2.5 **Overview of CRM Procedures**

CRM procedures, instructor/evaluator training, crew training and assessment, and the ongoing implementation of ACRM form the essential elements of ACRM. CRM procedures are the basis of ACRM training. They are SOPs that contain significant CRM elements. These Procedures can be used to add required CRM to an airline's briefings, calls, and checklists for normal and non-normal conditions.

It has been demonstrated that CRM procedures can be successfully developed and fully implemented within a regional airline's SOP helping to integrate the technical with the CRM performance in training, assessment, and, most importantly, in the operation of aircraft. CRM procedures are designed to integrate CRM with standard aircraft operation and provide structure to crew management training and assessment. During training, the procedures become a major focus in CRM skill development. These procedures help crews form a set of beneficial and predictable CRM behaviors that increase crew co-ordination, communication, awareness, planning, and decision making.

During crew assessment, CRM procedures help instructor/evaluators brief and debrief the technical and CRM performance more objectively. The assessment of a crew's procedural performance is more focused than the traditional evaluation of general CRM markers. This permits a more accurate understanding of crew performance leading to the identification and development of better targeted CRM training.

Part 3 of the ACRM Manual provides guidance in developing CRM procedures, starting with the identification of general industry and own airline needs and moving on to the development and finalising of CRM procedures.

2.6 **Overview of Instructor/Evaluator Training**

Training of the instructor/evaluators is the key to combining ACRM training and assessment into a well-structured training system. For airlines implementing this approach to crew training and assessment for the first time, the new methods can seem complicated and difficult to assimilate. Therefore, it is important to identify a few basic training areas that can serve to organise instructor/evaluator training. For the first year, the main focus of the instructor/evaluator training can be the CRM procedures, the LOE or other forms of assessment, and the use of a gradesheet (such as the LOE Worksheet).

The first part of instructor/evaluator training should provide instructor/evaluators with an understanding of ACRM. Next, training can be developed to provide instructor/evaluators with the knowledge and preliminary skills required to train the CRM procedures and how to brief, administer, assess, and debrief the LOE or other forms of ACRM assessment. Then, instructor/evaluators should be given ample practice to build up their skills in standardising the assessment process using some form of Inter rater reliability (IRR). This practice can be provided initially during the final part of the basic instructor/evaluator training. Thereafter, IRR should be refined on a regular basis throughout standardisation training in order to maintain quality control and encourage ongoing instructor/evaluator participation in the ACRM process.

The evaluator part of the training can be organised around the primary IRR tools allowing the instructors to practice developing assessment skills by working with real grading sheets, observing the actual scenarios they will be using, and rating tapes of real crew performance. Assessment skills should be trained in a task specific context providing the instructor/evaluators with multiple observations of the range of crew performance that they will likely encounter.

Part 4 of the ACRM Manual provides guidelines for developing instructor/evaluator training, including the development of the introductory modules, instructional skills development modules, the ACRM assessment modules, and modules on instructor/evaluator standardisation.

2.7 **Overview of Crew Training**

Crew training under ACRM should be viewed as an extension of existing CRM training with emphasis on the new CRM procedures. ACRM can provide a number of training improvements. First, the CRM procedures provide a new focus for the training emphasizing the most critical aspects of crew co-ordination and communication. By merging CRM with SOP, ACRM training integrates CRM with the technical training, giving both aspects equal importance.

A thorough crew training program should be based on specific behavioral objectives such as those developed under an AQP. Objectives are essential for training development and ultimately direct crew performance assessment. Crew training should present the new CRM procedures in a clear and compelling manner, and demonstrate how the procedures improve crew performance. This part of crew training can be based on the concept of crew effectiveness where individual pilots improve their co-ordination by developing CRM skills that lead to overall improved crew effectiveness.

Part 5 of the Manual provides guidance in developing crew training including how to develop the introductory modules, modules that explain crew effectiveness in relation to CRM skills and procedures, and modules about how crew performance will be assessed.

2.8 **Overview of Crew Assessment**

Two forms of crew assessment can provide resource management performance data within the constraints of an operational setting. First, an LOE-based assessment allows for the collection of a wide range of crew performance data within the carefully designed and controlled event set environment. This precise method of crew assessment should be augmented with a second type of assessment, the Line Checks. Line Checks provide valuable data about the state of the CRM procedures and overall crew performance on the line. Line Checks, although not as controlled as LOEs, provide an efficient method for collecting more general crew performance data.

Crew assessment techniques are an essential part of instructor/evaluator training and should be based on the collection of reliable data. The IRR analysis tools (discussed in Part 4 and in Appendix D) are designed to increase that reliability. Computer-based IRR analysis tools can be used to inform one or a group of instructors on how they are rating crew performance in relation to the other raters. The IRR analysis tools focus on rater standardisation by addressing Agreement, Congruency, and Consistency. Agreement allows instructor/evaluators to determine how close the ratings are for each item being rated. Congruency helps individual raters understand how their use of the rating scale compares with the total group of raters, and Consistency shows how individual raters correlate with the group.

Crew assessment is discussed in Part 4, dealing with the development of instructor/evaluator training. ACRM crew assessment is based on clear standards and the ongoing process of collecting reliable crew performance data.

2.9 **ACRM Implementation**

Once CRM procedures and training have been developed, there are a number of activities that will help ensure that ACRM is implemented throughout the organisation. From experience at one airline it is evident that ACRM should be implemented as an ongoing process and not as a one-shot training and SOP package. ACRM provides a set of steps for improving crew performance that can be reused to develop additional CRM procedures and requires the involvement of the entire organisation, not just the training department.

To help ensure successful ACRM implementation, an airline should make sure the organisation, instructor/evaluators, and crews are ready for the new training process. Prior to ACRM implementation, the organisation should be involved with training scheduling an announcement of ACRM, and setting a date when ACRM will become company SOP. From an organisational perspective, key personnel should be kept informed of the development progress. Review sessions with those key personnel can help to ensure that the organisation is informed and supportive of the effort.

Instructor/evaluators represent the front line of ACRM implementation, and steps should be taken to make sure they are informed, practiced, and comfortable with the new training. Experience has shown that certain activities will help develop instructor/evaluators into a training and assessment team. These activities include having training sessions where the instructor/evaluators establish a good level of agreement in their assessment of CRM performance. Accurate and timely feedback should be given to instructors prior to and throughout ACRM implementation. In addition, standardisation meetings should be planned to allow the instructors to voice problems and to work as a team to identify solutions to those problems.

A key to ongoing successful implementation is the reporting and use of crew performance data. Once an airline has established that they are collecting reliable and stable data, they should start reporting crew performance data and trends to appropriate departments within the organisation. Different types of data and formats should be used when reporting to the crew, the instructors, fleets, or management. When properly reported, that data will direct changes or additions to the CRM procedures and modifications to ACRM training.

Part 6 of the Manual provides guidance on how to implement ACRM within the organisation, discusses the important implementation requirements, and presents considerations for keeping a standard assessment and collecting usable performance data.

2.10 **Promoting a Standard CRM for Crews**

Both training and flight operations should benefit from ACRM. The crews are a major beneficiary in that they are provided with a standard, proceduralised form of CRM. CRM procedures promote a predictable form of crew co-ordination that is shared and understood by all crew members. This results in a more standard crew performance that helps crew members participate in planning, decision making, and situation awareness.

Research has shown that predictable patterns of interaction, especially in the area of crew communication (Kanki, Lozito, and Foushee, 1989) are associated with better performing flight crews. It has been suggested that when communication is more predictable it tends to be more reliable and more likely to succeed. CRM procedures promote that standard crew communication and co-ordination which should result in improved crew decision making and situation awareness.

2.11 **Standardising CRM Training and Assessment**

The airline benefits from ACRM through the development of a standard CRM training and assessment process. CRM procedures allow instructors to focus their training on key areas of the operation and allow the evaluators to concentrate on well specified areas of crew performance. This promotes a standard training and assessment environment.

One complaint about CRM training has been the lack of objective standards leading to a range of performance and, ultimately, to substantial variability in the effectiveness of CRM. ACRM addresses this problem on two critical fronts by 1) providing clear procedures for the crews to follow, and 2) giving airlines a set of unambiguous standards for the assessment of crew performance.

A complaint about CRM assessment has been that instructors are provided with insufficient training and given too high a workload during LOFT or LOE sessions. ACRM training ensures that instructor/evaluators are given ample practice to build up their skills in standardising the assessment process. This can be done initially during the final part of the basic instructor/evaluator training, and should be done on a regular basis thereafter under some form of standardisation training. With the standard and focused approach that ACRM gives to the assessment process, instructors are able to manage their workload by concentrating on the essential elements rather than trying to assess many poorly defined concepts.

2.12 **Expanding CRM Skill Practice**

Once ACRM is implemented, the crews are provided with focused opportunities to practice CRM procedures under normal, non-normal, and training conditions. Crews, through the normal CRM procedures, are provided with the opportunity to practice specific CRM behaviors every time they fly. This frequent practice of learned behaviors promotes the development of CRM skills, skills that an airline has identified as essential to good performance within its operational environment.

In addition, crews are provided with the opportunity to practice good CRM behaviors under emergency and abnormal conditions when training in flight simulators. By inserting CRM procedures into an airline's Quick Reference Handbook or emergency procedures, crews are given CRM skill practice every time they follow one of those procedures. As an example, one airline inserted a preparation and planning cycle into certain emergency procedures where the malfunction has a significant impact on future phases of flight. That preparation and planning cycle provides crews with practice in discussing the critical conditions and stating a detailed plan for their specific situation. This focused CRM skills practice under normal and training conditions is designed to improve crew performance, and to help them manage real emergency or other non-normal situations.

2.13 **Focusing on Airline-Critical Procedures**

The ACRM development process is airline-specific, because there is not a single set of CRM procedures that will address the crew co-ordination needs of all airlines. This approach to ACRM development is aware that one size does not fit all organisations. Airlines have different missions, philosophies, and SOP, and ACRM development helps an airline refine its procedures to best meet its unique operational needs. ACRM development is a process, and that process helps the entire organisation focus on the procedures that will most improve crew performance in the airline's operational environment.

This operational focus should be used to involve training and flight operations in the process of improving CRM. Traditionally, CRM training has been the responsibility of

a relatively small group, or in some cases an individual, within the training department. ACRM training, by addressing procedures and fundamental issues of crew performance, extends involvement to the entire flight operations, involving those in standards, training, and operations. Raising CRM to the level of SOP magnifies the importance of crew co-ordination and activates all critical parts of the operation in the development, training, and assessment process.

2.14 **CRM Procedures Development Guidelines**

2.14.1 Guidelines for Identifying Own Carrier Needs

- 1 The identification of CRM problem areas is ongoing, and to ensure the long-term success of the ACRM program, an airline should identify a few operationally significant CRM problems at the beginning of the development process.
- 2 Airlines that do not have detailed CRM performance data should use industry accident reports and incident summaries to identify general problem areas, and then the airline should use specific aircraft accident and incident reports to obtain the details.
- 3 When existing airline data or reports do not point to a clear CRM cause, the development team should consider interviewing one or more individuals from the department that collected the data or produced the report.
- 4 The needs survey should be designed primarily for instructors, evaluators, and checkairmen and should investigate at least two areas: 1) CRM performance problems by phase or subphase of flight, and 2) performance problems by CRM topic or element.
- 5 The CRM procedures development team should be aware of the benefits and possible liabilities of each procedure they plan to add. The team's mandate to identify areas for new or modified procedures should be tempered with the realisation that too many procedures, or ones in the wrong place, can be as problematic as not adding any new procedures.

2.14.2 Guidelines for Specifying CRM Procedures

- 1 For initial procedure development, an airline should first identify weaknesses in existing procedures and then review airline philosophy and policy to clarify those needs. Based on that information, an airline should then identify possible locations for the new procedure as different forms (e.g. briefs, checklists, etc.) are being considered. Once that is done, the airline should work on the procedure's content.
- 2 When reviewing existing SOP and documentation, look for problems with existing procedures, lack of consistency, as well as gaps, where the performance problem is not being addressed.
- 3 In many cases, crew performance problems become apparent at times of relatively high workload, and adding a procedure at that point could further increase workload. The CRM procedures development team should consider times prior to the buildup in workload to identify periods of lower workload where a procedure would be more effective.
- 4 The main forms of CRM procedures include briefs, calls, checklist items, guides, flows, non-normal procedures, and quick reference items. One of these forms should be sufficient to address most problems, but there may be cases where the integration of two forms is less intrusive and provides a better fit with the airline's SOP.

2.14.3 Guidelines for Refining CRM Procedures and Media

- 1 The procedure prototype development (working with a mock-up of the procedure) is an important part of the refining process where the development team interacts with a range of users to determine the best form and content for the CRM procedures. The refinement step should be iterative with the feedback from each review being incorporated into the design to achieve one or more CRM procedures that will be adopted by the users and will contribute to performance improvements.
- 2 User feedback sessions should include five to ten individuals who work well together. Working with too small a group (less than five) is less efficient and the individuals are less likely to be stimulated by a wider range of comments. Working with too large a group (substantially more than ten) is more difficult to manage, and the feedback will likely cover a broad range of topics but not in depth.
- 3 If formal user feedback sessions are not possible, consider holding informal small group or individual sessions as pilots and instructors are available in the training centre or flight operations. Meaningful feedback should be obtained from a cross section of pilots and instructors either formally or informally.
- 4 Organisational presentations, generally made after user feedback sessions, are similar to those made to the users, but with fewer operational details and more information about the ACRM program. Emphasis should be on the need for the CRM procedures, the development process, and the feedback process.

2.15 **Instructor/Evaluator Training Development Guidelines**

2.15.1 Guidelines for Planning and Developing Introductory ACRM Modules

- 1 When planning for the development of instructor/evaluator training, consider not only the development process but also the actual implementation of the training. Try to plan so that the ACRM training will be ready at a point where instructors receive scheduled recurrent training. ACRM instructor training should be as integrated as possible with the rest of their training and should be treated as a minor expansion of existing training rather than a substantial addition.
- 2 One initial instructor/evaluator training module should explain that the procedure development process has translated CRM principles into operational procedures, providing the airline with an opportunity to emphasise important CRM actions that should be practised by all crews.
- 3 When presenting CRM procedures to instructors it should be explained how each procedure was developed based on airline needs and incident data. The procedure, in its actual form, should then be presented, highlighting each of its main features. Finally, consider including a set of questions or other form of instructor activity to ensure that the instructors understand the main elements of the new CRM procedure.
- 4 Each new CRM procedure has implications for crew training because it places an emphasis on the crew's development of specific CRM behaviours in the operational context. Because of this emphasis on CRM skills, instructor/evaluators should have an understanding of the nature of skill development and its implications for the training of these new CRM procedures.

2.15.2 Guidelines for Developing LOFT/LOE Modules

- 1 The effectiveness of LOFT/LOE sessions depends in good part on script detail and proper administration of that script during the simulator session. The scenario should be carefully scripted with ATC communications using correct terminology, timing, and routing. Precise ATC communication scripting will also enhance session realism.

- 2 LOFT/LOE briefings are an important part of the session, and instructor/evaluators should brief crews to act as they would in line operations dealing with everyone, including the Flight Attendant, as if they were actually present throughout the LOFT/LOE.
- 3 Event sets should be used in the development of LOFT/LOS scenarios under an ACRM program to help instructor/evaluators pinpoint key aspects of crew performance for each segment of the flight. Instructor/evaluators should be trained in the functions and use of event sets.

2.15.3 Guidelines for Establishing Assessment Standards

- 1 When an instructor/evaluator group shows low inter-rater reliability, in addition to more training, there may be a need for a better rating form or clearer rater standards to help the group work together on the basic parameters of the assessment process.
- 2 The instructor/evaluator group should establish specific standards for elements to be rated. This is especially true for elements that may cause problems or are new to the instructor/evaluators. In most cases the new CRM procedures should have explicit standards to reduce rating difficulties.
- 3 When making crew performance assessments there is a high probability of rater bias, and the common forms of bias that should be addressed through instructor/evaluator training include central tendency, halo error, and leniency error.
- 4 If the airline has not already implemented some form of IRR training, IRR should be presented as a group process beginning with an overview of IRR, followed by the critical nature of crew assessment, the IRR measures, the gradesheet, rating scales, and examples of the criteria for each point on the scale.

2.15.4 Guidelines for Developing Standardisation and Training Modules

- 1 Under ACRM, a substantial departure from a scripted and acted videotape is required. Consideration should be given to preparing standardisation tapes working with real crews flying the actual LOFT/LOE for that year in a representative simulator without the benefit of coaching or preparation.
- 2 Instructor/evaluators should be provided with accurate and immediate rating feedback from the start of their assessment training through standardisation sessions. The first rating sessions may take place in a larger group using spreadsheets and charts showing individual and group data along with appropriate benchmarks that the group is trying to meet.
- 3 After individual and group feedback is provided and explained, instructor/evaluators should be encouraged to develop new rating rules and strategies. This cycle of practice, feedback, and discussion allows the participants to improve their reliability, and should continue until group benchmarks have been met.
- 4 Under ACRM assessment there should be ongoing training and standardisation to establish confidence in the crew performance data, its indications about CRM procedures, and the procedures' effects on overall crew performance.
- 5 Instructor/evaluators should be encouraged to take an active team approach to standardisation sessions. Instructor/evaluators should see these sessions as an essential part of maintaining their assessment standards. One way to ensure team involvement is to encourage instructor/evaluators to control the standardisation sessions, and ultimately to determine their own schedule and length of cycle between sessions based on their rating performance.

2.16 **ACRM Crew Training Development Guidelines**

2.16.1 Guidelines for Planning ACRM Crew Training

- 1 Crew training can be the largest cost of the ACRM program, so the development team should use the planning stage to determine ways for reducing the cost of that training. The team should consider integrating ACRM with existing CRM training (see Guideline 2 below) and co-ordinating ACRM training with other training cycles (see Guideline 3 below).
- 2 The development team should consider extending or modifying existing crew training to meet ACRM training needs. Much of the existing CRM recurrent training can be modified from an emphasis on general CRM principles to a concentration on the specific CRM procedures.
- 3 The development of ACRM crew training should be co-ordinated not only with crew training cycles but also with instructor/evaluator training and the implementation of the new CRM procedures.
- 4 ACRM crew training development and implementation should include a review process by scheduling ACRM crew training curriculum reviews that involve key organisational personnel who control the future of the ACRM program.

2.16.2 Guidelines for Developing CRM Procedures Crew Modules

- 1 When training crews about the need for CRM procedures, it should be emphasised that the crews have been an essential part of the development process with crew representatives involved in developing the current training. In the future, crew members should stay involved and help identify new CRM procedural needs as they become apparent.
- 2 A key component of new CRM procedures is the degree to which they support the development of CRM skills. To help crews practice and master the appropriate skills, crews should be informed of the relationship between the CRM procedures and their CRM skill development.
- 3 It should be explained that the new CRM procedures have profound implications on the way crew performance is assessed. For example, if it is the case, crews should understand that a detailed simulator-based assessment has been developed to collect crew performance data after the ACRM crew training has been implemented.
- 4 It should be explained that detailed measures of crew performance were developed in the research stages of ACRM specification and analysis. These more accurate crew performance measures will help evaluators provide more standard crew assessments, and crews should expect a fair assessment from all instructor/evaluators.

2.16.3 Guidelines for Developing Crew Effectiveness Modules

- 1 Crew effectiveness is a core concept of any ACRM program, and crew training should present its main characteristics. Crew effectiveness should be enhanced by using the new CRM procedures that will help crews develop better CRM skills.
- 2 The ACRM program provides a framework that allows airlines to integrate CRM with technical at the level of SOP. ACRM crew training should emphasise this integration at the operational level as well as at the crew performance assessment level.

- 3 It should be emphasised that crews form the core of the ACRM program, and crews should be encouraged to provide feedback about the new procedures as well as additional CRM procedures that can improve crew effectiveness.

2.16.4 Guidelines for Developing Briefing/Debriefing Modules

- 1 The LOFT/LOE briefing should prepare the crew for an effective training or assessment experience. One of the first things that the LOFT/LOE briefing should do is establish the role of the instructor as well as the role of the crew throughout the session.
- 2 The LOFT/LOE briefing should emphasise specific things the crew can do to make the session realistic and a valuable training experience. The crews should act as they would under similar situations on the line, and they should not try to operate in a manner calculated to provide the ideal training department solution.
- 3 ACRM crew training should reinforce good crew practices in conducting a constructive debriefing. Crews should understand that debriefing is an essential part of the LOFT/LOE and the main way of providing crew performance feedback.
- 4 ACRM crew training should introduce the concept that briefings can also be extended to line operations and used by crews to reinforce positive performance and learn from any problems experienced during the flight.

2.16.5 Guidelines for Developing Crew LOS Assessment Modules

- 1 Crews should be presented with the LOS CRM training objectives in the context of relevant technical objectives because crews are generally more comfortable and familiar with the technical objectives.
- 2 A major step in the LOS development process is the identification of incidents that highlight the need for specific CRM procedure, and crews should understand that the LOS is related to actual incidents that have happened to pilots flying in conditions similar to theirs.
- 3 Crew training should include one or more activities that allow crews to analyse incidents used to develop the new CRM procedures. One activity that has provided valuable crew training is having crews identify the CRM causes for each incident.
- 4 Crews should be given an explanation of how the event set is used under ACRM to help focus the specific elements of crew performance in the LOFT/LOE assessment. The event set helps training and evaluation move from general CRM markers to specific crew behaviors.

2.17 **ACRM Implementation Guidelines**

2.17.1 Guidelines for Organisational Implementation

- 1 Management should be kept informed of the general trends, both crew performance and instructor standardisation, and union representatives should be provided with data that establishes the reliable and accurate qualities of the ACRM crew assessments.
- 2 Under ACRM, it is possible to collect a large amount of CRM performance data, which can result in an overwhelming amount of information. There is a tendency to try and report everything, so care should be taken not to report too much data and overloading those who need the information.
- 3 In planning for the organisational announcement, consideration should be given to a sequence where the CRM procedures are announced prior to the start of crew training and possibly before or during instructor/evaluator training. This should be planned as a relatively short sequence, where the crew training and implementation follow closely.

- 4 The announcement of CRM procedures should include a detailed specification of the new policies and procedures. With content and format of paramount importance, the announcement should be carefully co-ordinated with flight standards and documents departments.
- 5 As part of co-ordinating the release of new CRM procedures with document updates, a formal review of the camera-ready material should be scheduled because there will be errors, and having a number of informed people review the material increases the chances of catching those mistakes.

2.17.2 Guidelines for Implementing ACRM for Instructor/Evaluator

- 1 The gradesheet should be used as a focal point in establishing reliable crew assessment. Instructor/evaluators should be encouraged to work on the refinement of the LOFT/LOE gradesheet as an effective way to develop an assessment team.
- 2 The airline should work with the instructor/evaluators to establish a specified level of rater reliability prior to conducting the LOFT/LOE portion of crew training. One way to ensure that the instructor/evaluators reach that level is to work with a realistic set of benchmarks.
- 3 Individual instructors with specific assessment problems should be encouraged to work with the group in resolving the issues. ACRM assessment should be approached as a group effort where the team, and not just one individual, needs to resolve any outstanding problems.
- 4 The airline should treat assessment standardisation as a long-term development process giving the instructor/evaluators the organisational support that will allow them to direct the process.

2.17.3 Guidelines for Maintaining Standards and IRR

- 1 When LOFT/LOE crew performance data shows a drop in ratings, the airline should consider a range of causes from properties of the LOE scenario to lack of crew training in specific areas. The IRR process allows the airlines to isolate probable causes with a greater degree of accuracy than has been possible up to this point.
- 2 Once instructor/evaluators start administering LOFT/LOE sessions, the data may show a pattern of lower ratings for certain items with some of the instructor-group IRR benchmarks not being met. In such cases, the airline should consider the possibility that some instructor/evaluators do not have the same interpretation of an event set or the standards of performance.
- 3 Airlines should monitor for crew performance problems in order to address minor problems before they turn into incidents or accidents. Minor problems are often identified by the rating of acceptable but "below standard."
- 4 Airlines should understand that a major payoff to establishing and maintaining a standard assessment is the ability to identify long-term trends in crew performance. Without data establishing that benchmarks have been met, airlines will find it difficult to make meaningful interpretations of performance trends because of the unknown reliability and accuracy of the data.

2.17.4 Guidelines for Improving CRM Procedures and Training

- 1 Once airlines have identified a specific performance problem, they should work to link that performance problem to one or more CRM skills. This step is needed to determine the exact training and/or CRM procedure needs to address the problem.

- 2 Airlines should recognise that the collection of reliable crew performance data is a minimum requirement for improving crew performance. Airlines should be prepared to support the training department and instructor-evaluators in their efforts to establish and maintain a reliable assessment system.
- 3 Airlines should understand that ACRM is not limited to the development and assessment of CRM procedures. ACRM is strongly linked to improving overall crew effectiveness at all levels.
- 4 The organisation should maintain key members of the original ACRM development teams to help with additional development by capitalising on the members' experience gained from the initial program effort.

Appendix 14 Sources of Further Information

There are many hundreds of references on CRM and human factors. An attempt has been made to list the key documents, and where you can find them. Information has also been given on websites, and website references have been included where known; however, web-based information is liable to change, therefore some of these references may be incorrect by the time you read this document.

Training material which may be suitable for CRM, is also referenced, although some of the material, especially videos, may be proprietary and difficult to obtain. Some of the material is available via the CAA library, or from www.raes-hfg.com.

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 flight attendants 1988

FAA website - part of. Search various other parts of the website for CRM
www.hf.faa.gov
www.hf.faa.gov/docs/DACRMT.pdf

FAA. FAR Part 121 Subpart N - Training Program

FAA. Turbofan Engine Malfunction Recognition and Response. November 2000. Training video and
 notes. Also in CD form. For a free copy, write to FAA Engine and Propellor Directorate, ANE-110, 12
 New England Executive Park, Burlington, MA 01803, USA.

Text can be downloaded from <http://www.faa.gov/certification/aircraft> (click on 'Special Topics -
 Safety Resource Page') or from http://www.faa.gov/certification/aircraft/engine_malf_famil.doc

Other Areas in Human Factors
<p>FAA. Turboprop Engine Malfunction Recognition and Response. Training video and notes. In preparation - may be ready late 2002 or early 2003. For further information, write to FAA Engine and Propellor Directorate, ANE-110, 12 New England Executive Park, Burlington, MA 01803, USA</p>
<p>Flight into Terrain and Enhanced Ground Proximity Warning System CD - training material</p>
<p>FSF. Approach and Landing Accident Reduction (ALAR) Toolkit. 2000/2001. Flight Safety Foundation. CD. Free to FSF members. www.flightsafety.org/pdf/alar_flyer.pdf</p>
<p>Fuller, R., Johnston, R., McDonald, N. (Eds) Human Factors in Aviation Operations. 1995. Avebury Aviation. Proceedings of the 21st Conference of the EAAP Vol 3. ISBN 0-291-39825-1</p>
<p>GAIN. Operator's Flight Safety Handbook. Issue 2. December 2001.</p>
<p>IATA website www.iata.org www.iata.org/oi/committees/hfwg</p>
<p>ICAO Aviation Training Directory. www.icao.int/td</p>
<p>ICAO. Human Factors in Cabin Safety. ICAO Human Factors Digest No. 15. ICAO Circular 300- AN/173 (November 2003)</p>
<p>ICAO. Operational Implications of Automation in Advanced Technology Flight Decks. ICAO Human Factors Digest No.5. ICAO Circular 234-AN/142</p>
<p>ICON. The Human Factors Implications for Flight Safety of Recent Developments in the Airline Industry. August 2001. www.icon-consulting.com</p>
<p>Johnston, N., McDonald, N., Fuller, R. Aviation Psychology: Training and Selection. 1995. Avebury Aviation. Proceedings of the 21st Conference of the EAAP. Vol 1. ISBN 0-291-39819-7</p>
<p>Joint Aviation Requirements: Translation and Elaboration of Legislation (JARTEL). WP1. Synthesis of cultural aspects and their influences on crew behaviour. www.sofreavia.com,/jartel/</p>
<p>Joint Aviation Requirements: Translation and Elaboration of Legislation (JARTEL).WP2. Experimental plan. www.sofreavia.com,/jartel/</p>
<p>Joint Aviation Requirements: Translation and Elaboration of Legislation (JARTEL).WP3. Results of the experiment. www.sofreavia.com,/jartel/</p>
<p>Joint Aviation Requirements: Translation and Elaboration of Legislation (JARTEL).WP4. Complementary experimental activity - operational validation of NOTECHS. www.sofreavia.com,/jartel/</p>
<p>Joint Aviation Requirements: Translation and Elaboration of Legislation (JARTEL). WP5 Report. Guidelines for Implementation of NOTECHS. April 2002. Implementation guidelines (check www.sofreavia.com website for issue status)</p>
<p>Joint Aviation Requirements: Translation and Elaboration of Legislation (JARTEL). WP6 Report. Workshop documentation (check www.sofreavia.com website for issue status)</p>
<p>Joint Aviation Requirements: Translation and Elaboration of Legislation (JARTEL). WP7 Report. Final report: consolidation of results (check www.sofreavia.com website for issue status)</p>
<p>Dietric, R et al (eds). Teaming-up: components of safety under high risk. Ashgate (2004) ISBN 0-7546-3435-3</p>
<p>Dismukes, K and Smith, G. Facilitation and Debriefing in Aviation Training and Operations Ashgate. Oct 2000 ISBN: 0 7546 1164 7</p>

Other Areas in Human Factors	
	Last, S. Eliminating "Cockpit Caused" Accidents; error tolerant crew procedures for the year 2000. In Neil Krey's CRM developers site: www.crm-devel.org
	Lauber, J. Anatomy of a Human Error Accident. Papers presented at the 34th Corporate Aviation Safety Seminar.
	Lodge, M. Airline captain - the view from the flight deck. In: Flin, R., Arbuthnot, K., eds. Incident Command: Tales from the Hot Seat. May 2002. Ashgate. ISBN 0 7546 1341 0
	Mancuso, V. Moving from theory to practice: integrating human factors into an organisation. In www.raes-hfg.org .
	Maurino, D. Building a Bridge. Air Line Pilot, February 1997
	McDonald, N., Johnston, N., Fuller, R. Applications of Psychology to the Aviation System. 1995. Avebury Aviation. Proceedings of the 21st Conference of the EAAP. Vol 2. ISBN 0-291-39818-9
	Nevile, M. Beyond the black box: talk-in-interaction in the airline cockpit. Ashgate (2004). ISBN 0-7546-4240-2
	Straunch, B. Investigating human error: incidents, accidents and complex systems. Ashgate (2004) ISBN 0-7564-4122-8

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Appendix 15 Summaries of Key Documents on CRM

1 Introduction

This Appendix contains more detailed information on key documents, to assist the reader make a decision on whether to buy, download or otherwise acquire the document concerned. Some of the information has been taken directly from the book or web description, and does not necessarily reflect the opinion of the authors of this CAP.

Where documents are available electronically, many may be accessed from the websites www.raes-hfg.com or www.crm-devel.com. Recently published CAA documents should be available from www.caa.co.uk (publications).

2 Guide to Performance Standards for Instructors of Crew Resource Management Training in Commercial Aviation

Size 82 pages

1998. RAeS, CAA, ATA.

Copies available from:

Riverprint Ltd, Unit 9 Riverside Park, Farnham, Surrey GU8 7UG, UK tel 01252 722771
email: sales@riverprint.co.uk website: www.riverprint.co.uk

Free to download from: www.crm-devel.org/resources/misc/raesperf/perfstan.htm

This guide describes, in detail, the knowledge and skills required for competence in the instruction of CRM.

Part 1 is general background and overview. It should be read by everyone who has any reason to be aware of, and is interested in, Instructor competence in this field, whether or not they are instructors themselves (e.g. Training managers, aspiring CRM instructors, existing CRM instructors, training pilots/ground school instructors in other areas of instruction, and trainers of CRM instructors)

Part 2 describes what needs to be known (background knowledge) and what needs to be shown (performance elements) to be considered competent in each of 3 different contexts: simulator, aircraft training and LOFT; base and line checks; and ground school/classroom training. Material in each of these 3 sub-sections overlaps considerably, but is laid out separately to avoid the need to cross-refer between contexts.

3 ICAO Human Factors Training Manual

304 pages

ICAO 1st edn 1998. Doc 9683-AN/950 (incorporating amendment 1, 30/9/03).

Cost - \$77 USD

Supplier: ICAO document sales unit 999 University Street, Montréal, Quebec, Canada H3C 5H7, Tel: 514-954-8022; Fax: 514-954-6769

Internet e-mail: sales_unit@icao.int

UK supplier: Airplan Flight Equipment Ltd. 1A Ringway Trading Estate Shadowmoss Road Manchester M22 5LH England UK Telephone: +44 161-499-0023
Fax: +44 161-499-0298 E-mail: enquiries@afeonline.com

This document is an edited amalgamation and update of the ICAO Human Factors Digests.

Its target audience includes senior training, operational and safety personnel in industry and regulatory bodies. It comprises two parts:

Part 1 - General. Introduces the concept of aviation human factors, presents a systemic and contemporary view of aviation safety, outlines the basic principles of workstation design and reviews the fundamental human factors issues in the various domains, including air traffic control and maintenance.

Part 2 - Training programmes for operational personnel. Outlines human factors training issues and proposes the contents of sample training curricula for pilots, air traffic controllers and accident investigators.

Several of the original ICAO HF digests have now gone out of print so you might not be able to obtain copies, but ICAO has given permission for the CAA to republish them. So far, three have been republished as CAPs, and are free to download from the UK CAA website www.caa.co.uk. Brief details of those Digests particularly relevant to CRM are provided below:

4 Fundamental Human Factors Concepts

Size: 31 pages

ICAO Human Factors Digest No.1. ICAO Circular 216-AN/131 1989.

Also published as CAP719 (free of charge to download from: www.caa.co.uk)

Chapter 1 The Meaning of Human Factors

- Introduction
- The disciplines of Human Factors
- Human Factors and Ergonomics
- A conceptual Model of Human Factors

Chapter 2 The Industry Need for Human Factors

- Overview
- Effectiveness of the System
- Well-being of Crew Members

Chapter 3 Human Factors Applications in Flight Operations

- Control of Human Error
- Plain Talk
- Training and Evaluation
- Human Factors Training
- Motivation
- Flight Documentation
- Flight Deck Design

- Cabin Design
- Visual Performance and Collision Avoidance

Chapter 4 Education and Expertise

- Overview
- Levels of Expertise Required
- Courses Available
- Information Available

5 Flight Crew Training: Cockpit Resource Management (CRM) and Line-Oriented Flight Training (LOFT)

Size: 60 pages

ICAO Human Factors Digest No. 2. ICAO Circular 217-AN/132. 1989.

Also published as CAP 720 (free of charge to download from: www.caa.co.uk)

Chapter 1 Human Factors Highlights

- General
- Overview
- Disciplines and Application
- Accidents and Incidents
- Human Error

Chapter 2 Cockpit Resource Management (CRM) Training

- Background
- CRM Training Phases
- Curriculum Development
- Essential Curriculum Elements
- Training Techniques
- CRM Effectiveness

Chapter 3 CRM Training for Small Operators (Regional, Corporate, etc.)

- Introduction
- CRM Training Steps for Small Operators

Chapter 4 CRM - The Operator Experience

- Introduction
- Alaska Airlines
- All Nippon Airways
- American Airlines
- Delta Airlines
- KLM - Royal Dutch Airlines
- Qantas Airways

Chapter 5 Line-Oriented Flight Training (LOFT)

- Introduction
- Development of Scenario Designs
- Performance Evaluation and Assessment
- Co-ordination Training and Qualifications

Appendix A LOFT Scenario Examples

6 Training of Operational Personnel in Human Factors

Size 52 pages.

ICAO Human Factors Digest No.3. ICAO Circular 227-AN/136. 1991.

To be published as a CAP in 2003/2004 (free of charge to download from: www.caa.co.uk).

Chapter 1 Human factors training of operational personnel - introduction and overview

- background and justification
- human factors highlights
- SHELL model

Chapter 2 Human factors Training Curriculum

- general
- the knowledge requirement
- the skill requirement

Chapter 3 Considerations in Training Implementation and Curriculum development

- overview
- determination of target audience
- selection of trainers
- training philosophy and objectives
- skill development, pilot assessment and training course evaluation

Appendices: Examples of human factors courses and curricula

7 Operational Implications of Automation in Advanced Technology Flight Decks

Size: 42 pages

ICAO Human Factors Digest No.5. ICAO Circular 234-AN/142.

Chapter 1 An introduction to automation

Chapter 2 Issues and concerns in automation

Chapter 3 Training for automation

Chapter 4 Management techniques and coping strategies

Appendices: Further information on automation

8 Human Factors, Management and Organisation

Size 45 pages

ICAO Human Factors Digest No.10. ICAO Circular 247-AN/148

Chapter 1 From individuals to organisations

Chapter 2 Safe and Unsafe organisations

Chapter 3 Management's contribution to safety

Chapter 4 Organisations accidents: a case study

9 Briefings: A Human Factors Course for Pilots - Reference Manual

Size: 248 pages

Dédale. 2nd edn 2000 Publishers Dédale, France. ISBN 2-9509979-0-2

Cost: details available on http://www.dedale.net/page_bfgs.html

Target Audience/Readership for BRIEFINGS

Ab-initio pilots wanting to prepare for the JAR-FCL exam in HP and L

Flight Academies and aviation schools wanting to deliver a course covering the JAR-FCL in HP and L

Airlines wanting to give their managers, instructors and pilots a more comprehensive Human Factors education, beyond the CRM courses

Safety organisations wanting to train their staff in Human Factors

Any other individual wanting to grasp the fundamentals of Human Factors and safety in aviation

Key-Features of BRIEFINGS

Comprehensively integrates the JAR-FCL requirements in 10 structured chapters:

Lesson 1: General introduction to BRIEFINGS

Lesson 2: Aviation Physiology and Health Maintenance

Lesson 3: The Pilot's Mental Abilities and Limitations

Lesson 4: Human Error and Human reliability

Lesson 5: Decision Making in the cockpit

Lesson 6: Communication in the cockpit

Lesson 7: Cockpit Resource Management: The individual and the team

Lesson 8: Alertness, from Sleep to Stress

Lesson 9: Cockpit Automation

Lesson 10: The Pilot: a Component in a Complex System

- Goes beyond the JAR syllabus and covers the most relevant human factors concepts in aviation safety
- Integrates the most recent aviation research studies and compiles the latest thinking on Human Factors' issues
- Presents numerous examples of aviation accidents and incidents
- Has been written by world-renowned academics, industry experts and pilots in a language adapted to aviation professionals
- Is both a stand-alone instructional book on Human Factors and a complete training course for pilots and aviation professionals

10 Developing Advanced Crew Resource Management (ACRM) Training: a Training Manual

Size: approx 200 pages

FAA. 1998. Seamster et al.

Free to download from www.hf.faa.gov/docs/DACRMT.pdf

Part 1. Introduction to ACRM Training

- Background to ACRM Training
- Elements of ACRM Training
- Benefits of ACRM Training

Part 2. Guiding the Organisation

- Developing Organisational Commitment
- Integrating ACRM within the Organisation

Part 3. Developing CRM Procedures

- Overview of CRM Procedures Development
- Procedures Development Requirements
- Identifying Industry and Own Airline Needs
- Specifying CRM Procedures
- Refining CRM Procedures and Media
- CRM Procedures Development Guidelines

Part 4. Developing Instructor/Evaluator Training

- Overview of Instructor/Evaluator Training Development

- Instructor/Evaluator Requirements
- Developing Introductory ACRM Modules
- Developing LOFT/LOE Modules
- Developing Assessment Standards and IRR Process
- Developing Standardisation and Training Modules
- Instructor/Evaluator Training Development Guidelines

Part 5. Developing ACRM Crew Training

- Overview of Crew Training Development
- Curriculum Development Requirements
- Developing CRM Procedures Crew Modules
- Developing Crew Effectiveness Modules
- Developing Briefing/Debriefing Modules
- Developing Crew LOS Assessment Modules
- ACRM Crew Training Development Guidelines

Part 6. Implementing and Evaluating ACRM

- Overview of Implementing ACRM within the Organisation
- Implementation Requirements
- Implementing ACRM for the Instructor/Evaluator
- Maintaining Standards and the IRR Process
- Using Performance Data to Improve CRM Procedures and Training
- ACRM Implementation Guidelines

References and Resources

- Appendix A. Summary of ACRM Guidelines
- Appendix B. Sample Instructor/Evaluator and Organisational Forms
- Appendix C. Sample ACRM Instructor/Evaluator Training Manual TOC
- Appendix D. Instructions for Facilitating an IRR Training Workshop
- Appendix E. Considerations for Videotaping Simulator Sessions
- Appendix F. Sample LOFT/LOE Development Materials
- Appendix G. Sample ASRS Incident Reports
- Appendix H. Sample ACRM Crew Training Manual TOC
- Appendix I. Sample Quick Reference Handbook Procedures and Briefing Guide

11 Crew Resource Management Manual

Size 76 pages

Transport Canada.

Summary document free to download from:

www.crm-devel.org/resources/misc/transcan/transcan1.htm

Course can be purchased from www.tc.gc.ca

Contents:

Introduction

- Crew Resource Management
- Course Objectives
- Crew Resource Management

Standard Operating Procedures and Line Oriented Flight Training

- Standard Operating Procedures
- Line Oriented Flight Training

Communication

- Communication
- Definitions
- Key Facts About the Way We Communicate
- Modes of Communication
- Communication Process

Behavioral Styles

- Behavioral Styles

Fatigue

Stress Management

- Attitudes

Situational Awareness

- Elements of Situational Awareness
- Clues to the Loss of Situational Awareness
- Maintaining Situational Awareness
- Summary

Leadership

- What makes a Leader?
- Leadership Skills
- Analytical Decision Making
- Intuitive Decision Making
- The Fundamentals of Crew Resource Management
- CRM Skills

Professionalism

- Definitions
- Law and Ethics
- Safety is an Attitude

12 Cockpit Resource Management

Size: 520 pages

Weiner, E., Kanki, B., Helmreich, R.

1993 San Diego, Academic Press. ISBN 0-12-750026-X

Cost: book price (paperback and hardback)

Contents:

- 1 Why Crew Resource Management? Empirical and theoretical bases of human factors training in aviation. Helmreich, R and Foushee, C
- 2 Teams, leaders and organisations: new directions for crew-oriented flight training. Hackman, R.
- 3 Crews as groups: their formation and their leadership. Ginnett, R.
- 4 Communication and Crew Resource Management. Kanki, B and Palmer, M
- 5 Decision-making in the cockpit. Orasanu, J.
- 6 Crew Resource Management training assessment. Gregorich, S and Wilhelm, J.
- 7 Crew co-ordination and training in the advanced-technology cockpit. Wiener, E.
- 8 LOFT: full mission simulation as Crew Resource Management training. Butler, R.
- 9 The regulatory perspective. Birnbach, R and Longridge, T.
- 10 The accident investigator's perspective. Kayten, P.
- 11 Critical issues for CRM training and research. Chidester, T.
- 12 Training and research for teamwork in the military aircrew. Prince, C and Salas, E.
- 13 CRM: cross-cultural perspectives. Johnston, N.
- 14 Keeping CRM is keeping the flight safe. Yamamori, H and Mito, T.
- 15 Developing and implementing CRM programs: the Delta experience. Byrnes, R and Black, R.
- 16 Airline pilot training today and tomorrow. Orlady, H.
- 17 The future of Crew resource Management in the cockpit and elsewhere. Helmreich, R., Wiener, E., Kanki, B.

13 Improving Teamwork in Organisations - Applications of Resource Management Training

Size: 356 pages

Salas, E., Bowers, C., Edens, E (Eds)

2001. Mahwah, NJ Erlbaum. ISBN 0 8058 2845 1

Chapters include:

- 1 An overview of resource management in organisations. Salas, Bowers and Edens.
- 2 Identifying resource management skills for airline pilots. Seamster and Kaempf.
- 3 Stress management: individual and team training. Driskell, Salas and Johnston.
- 4 Assertiveness and team performance; more than "just say no". Jentsch and Smith-Jentsch.
- 5 Training aviation communication skills. Kanki and Smith.
- 6 Training raters to assess resource management training. Baker, Mulqueen and Dismukes.
- 7 Aviation CRM training with low fidelity devices. Prince and Jentsch
- 8 Evaluating resource management training. Holt, Boehm-Davis, Beaubein.
- 9 Airline resource management programs. Holt, Boehm-Davis and Seamster
- 15 Culture, error and CRM. Helmreich, Wilhelm, Klinect and Merritt
- 16 Research and practices of resource management in organisations; some observations. Salas, Bowers and Edens

14 Human Factors in Multi-Crew Flight Operations

Size: 603 pages

Orlady, H., Orlady, L.

1999. Ashgate. ISBN 0-291-39839-1 (paperback)

Price: £28.50 paperback; £64.50 hardback

This book presents, from the viewpoint of a well-informed pilot, a broad approach to aviation human factors and its relationship to the safety and efficiency of air transport operations. It covers many aspects of air transport human factors: the basic physiology and psychology of aviation, its growth into a core technology, the team concept and Crew/Cockpit Resource Management, the role of human error, the changing role of the co-pilot, and the changing role of the flight attendant.

- 1 Our heritage in air transport
- 2 The industry and its safety record
- 3 A brief history of human factors and its development in aviation
- 4 The physical environment and the physiology of flight
- 5 Those magnificent flying machines and their internal environment
- 6 The social environment

- 7 Basic communication
- 8 Documentation, including checklists and information management
- 9 Man's limitations, human errors and information processing.
- 10 Workload
- 11 Automation
- 12 Situation awareness and operating in today's environment
- 13 Crew resource management (CRM) and the team approach
- 14 Fatigue and stress
- 15 Fitness to fly
- 16 Selection and training
- 17 The challenging role of the flight attendant
- 18 Non-punitive incident reporting
- 19 Some ramifications of accident analysis
- 20 The worldwide safety challenge
- 21 Current safety problems
- 22 The air transport future

15 Aviation Training: Learners, Instruction and Organisation

Size: 370 pages

Telfer, R and Moore, P (Eds)

1997. Avebury Aviation. ISBN 0 291 39837 5

Includes chapters on:

- 5 Individual differences and CRM training. Schiewe, A and Moore, P.
- 8 The flight crew member's responsibility and role in aviation training. Gebers, B.
- 11 Joint training and "the real stuff". Naef, W.
- 12 Evaluation and the instructor. Anca, J
- 13 LOFT facilitator training. Bertram, J and Dowd, N
- 14 The evaluation of Virgin Atlantic Airways' CRM training program. Bilton, T
- 15 Production of CRM programs. Holling, H

16 Human Error

Size: 296 pages

Reason, J.

1990 Cambridge University Press. ISBN 0-521-31419-4

This is generally regarded as the definitive book on human error.

Contents:

- 1 The nature of error
- 2 Studies of human error
- 3 Performance levels and error types
- 4 Cognitive underspecification and error forms
- 5 A design for a fallible machine
- 6 The detection of errors
- 7 Latent errors and systems disasters
- 8 Assessing and reducing the human error risk.

17 Facilitation and Debriefing in Aviation Training and Operations

Size: 120 pages

R. Key Dismukes and Guy M. Smith Ashgate. Oct 2000

ISBN: 0 7546 1164 7

Cost: \$69.95/£39.00

This practical guide is designed to enable individual pilots, training departments and airline managers to better understand and use the techniques of facilitation. Based on extensive field studies by the editors and invited contributors, it presents an easily accessible guide to the philosophy of facilitation combined with practical applications designed to improve training and flight operations. Illustrated with realistic examples from aviation settings, and specifically designed for aviation professionals, the applications include:

- debriefing of training sessions
- crew self-debriefing of line operations
- analysis of problematic flight incidents
- assisting crew members after traumatic events

Target readership includes: managers and instructors in airline training departments, flight training organisations, flight schools and researchers in flight training.

18 Guidelines for Situation Awareness Training

Size: 78 pages

Prince, C

NAWCTSD/UCF/FAA

Cost: free to download from www.crm-devel.com

These guidelines for training situation awareness are grouped according to the area of training they address and are presented in four sections. The sections are:

Pre-Training Considerations:

These guidelines for developing a training program for situation awareness address some elements for the training developer to consider before designing a program.

Guidelines for Training Program Content:

The guidelines in this section include information about what the crewmembers should know and do to maintain awareness as a crew. They also describe situations that pose a particular threat to maintaining awareness.

Evaluation:

These guidelines address training instructors to observe and evaluate crew members' situation awareness for de-briefing. They contain information useful for training crewmembers to observe and evaluate situation awareness actions of others and of themselves.

Specialized Training: (training for Captains and upgrade training for new Captains). This section contains guidelines that can be used in training programs for Captains, since there are certain actions that are the Captain's responsibility to initiate. These actions help maintain their crew's awareness.

Appendix A General Training Tips

- Training Tips for Scenario Based Training
- Suggested Program Design: (i) for Recurrent Training (ii) for New Hires

Appendix B Research Summaries

Appendix C Training Materials

19 Situation Awareness Analysis and Measurement

Size: 383 pages

Endsley, M., Garland, D. (eds)

(2000). Mahwah, NJ: Lawrence Erlbaum Associates ISBN 0 8058 2134 1

Chapters include:

- 1 Theoretical underpinnings of Situation Awareness: a critical review. Endsley, M.
- 2 the state of SA measurement: heading towards the next century. Pew, R.
- 12 Individual differences in SA. Gugerty and Tirre
- 13 SA and ageing. Bolstad and Hess.
- 14 SA, automaticity and training. Shebilske, Goettle and Garland.
- 15 Team SA, errors and CRM: research integration for training guidance. Prince and salas.

16 Training for SA in individuals and teams. Endsley and Robertson

20 Decision Making Under Stress; Emerging Themes and Applications

Size: 339 pages

Flin, R., Salas, E., Strub, M., Martin, L.(Eds)

1997. Ashgate. ISBN 0-291-39856-1.

Cost: £57 (hardback only)

Proceedings of a conference on Decision Making Under Stress.

The book includes chapters on "decisions on the flight deck":

- 19 Military pilot performance - dynamic decision making in its extreme. Angelborg-Thanderz, M
- 20 Understanding expert aviator judgement. Jensen, R., Guilke, J., Tigner, R.
- 21 Decision making training for aircrew. David, G.
- 22 Selection for stressful jobs: is the defence mechanism to test the solution? Sjoberg, L., Kallmen, H., Scharnberg, M.
- 23 Pilot mental workload and situational awareness - psychological models of the pilot. Svensson, E.

21 Aviation Resource Management

Lowe, A and Hayward, B (Eds)

2000. Proceedings of the 4th Australian Aviation Psychology Symposium

Ashgate. ISBN 1 84014 974 4

Chapters include:

- 8 The foundations of CRM should be laid during ab-initio flight training. Thatcher, S.
- 37 Situation awareness or metacognition? Beaumont, G
- 38 Individual differences in situational awareness and training for complex tasks. O'Hare, D and O'Brien, K.
- 39 Decision making under time constraints. Wiggins, M and Anderson, P

22 Applications of Psychology to the Aviation System

Size: 323 pages

McDonald, N., Johnston, N., Fuller, R. (Eds)

1995. Avebury Aviation. ISBN 0-291-39818-9

Proceedings of the 21st Conference of the EAAP. Vol 1.

Cost: \$60

Chapters include:

- 36 Extending Crew resource Management: an overview. Hayward, B
- 37 Assessment of non-technical skills: is it possible? Antersijn, P and Verhoef, M.

- 38 An operational model for the evaluation of Crew resource Management skills in Line Operations Simulation. Houle, T.
- 39 Work group multitasking in aviation. Waller, M

23 Aviation Psychology: Training and Selection

Size: 359 pages

Johnston, N., McDonald, N., Fuller, R. (Eds)

1995. Avebury Aviation. ISBN 0-291-39819-7

Proceedings of the 21st Conference of the EAAP. Vol 1.

Cost: \$60

Chapters include:

- 11 Aeronautical decision making: the next generation. Kaempf, G and Klein, G.
- 12 Shared problem models and flight crew performance. Orasanu, J.
- 13 Stress and crew performance: challenges for aeronautical decision making training. Prince, C., Bowers, C and Salas, E.
- 14 Crew Resource Management: achieving enhanced flight operations. Taggart, W.
- 15 Improving aviation instruction. Telfer, R.

24 Human Factors in Aviation Operations

Size: 319 pages.

Fuller, R., Johnston, R., McDonald, N. (Eds)

1995. Avebury Aviation. ISBN 0-291-39825-1

Proceedings of the 21st Conference of the EAAP Vol 3.

Cost: \$60

Chapters include:

- 3 FOR-DEC: a prescriptive model for aeronautical decision making. Hormann, H
- 4 Pilot decision making training: a Canadian application. Stewart, J.
- 5 Cockpit crises and decision making: implications for pilot training. Pettit, M.
- 42 The role of CRM in achieving situation awareness in aviation settings. Robertson, M and Endsley, M
- 43 A taxonomy of situation awareness errors. Endsley, M

25 Cockpit Resource Management Training

Orlady, H., Foushee, C. (Eds)

1987. Proceedings of a NASA/MAC workshop (NASA CP-2455). Moffat Field, CA: NASA Ames.

Contents include:

- CRM; background studies and rationale. Lauber, J
- Theory underlying CRM training; psychological issues in flight crew performance and crew co-ordination. Helmreich, R
- Group level issues in the design and training of cockpit crews. Hackman, R
- CRM; a tool for improved flight safety. Carroll, J and Taggart, W
- The development and implementation of CRM in UAL recurrent training. Shroyer, D
- CRM training at People Express. Bruce, K and Jensen, D
- CRM and SBOs. Mudge, R
- Pan-Am flight training - a new direction; flight operations resource management. Butler, R
- Crew co-ordination concepts; Continental Airlines CRM training. Christiansen, D and Morgan, A
- Optimum culture in the cockpit (Japan Airlines). Yamamori, H
- Introduction to Trans Australia Airlines CRM training. Davidson, J
- Aircrew team management program (Trans Australia). Margerison, C, McCann, D and Davies, R
- Remedial training; will CRM work for everyone? Johnston, N
- CRM training; an international survey. White, L
- Introduction to MAC CRM training. Brown, D
- The application of CRM to military operations. Cavanagh, D and Williams, K
- CRM training for Parts 91 and 135 operations. Krey, N and Rodgers, D
- The regulatory horizon, Cook, E
- CRM curriculum development
- Techniques for CRM training
- Integration into the total training curriculum
- The effectiveness of CRM training
- CRM training in corporate/ regional operations
- Military applications of CRM
- Dyads and traids at 35000 ft; factors affecting group process and aircrew performance

- Aircrew co-operation in the RAF
- CRM training and human factors training; what Air New Zealand is doing about it
- Cockpit Resource Management at USAir

26 Enhanced Safety through Situation Awareness Integration in Training (ESSAI)

Cost: Free to download from

<http://www.nlr.nl/public/hosted-sites/essai/pages/reports.html>

WP1 "Orientation on Situation Awareness and Crisis Management" (report No. NLR-TR-2000-668) is available for free download from the NLR website. This contains a fairly broad and extensive review on current literature, theory, practices and developments in both aviation as well as other domains

A paper presented at the World Airline Training Conference 2001 (WATS) in May 2001 by Aero Lloyd, one of the ESSAI consortium members, entitled Situation Awareness, can we teach this? (PDF (360KB)) is available for download from the NLR website.

WP2: "Identification of Situation Awareness and Crisis Management related problems" is available for download from the NLR website.

WP3: "Training Analysis" (PDF (509KB)) is available for download from the NLR website. The results presented in this report are two-fold. In the first place, it provides a detailed description of the skills that need to be trained in order to enhance pilots' SA and TM skills. These skills will constitute the contents of the ESSAI training. In the second place, the framework for the design and development of the training is determined.

WP4: Training Design and Development - At the beginning of June 2001, the design and development of the training had started and was still ongoing in mid 2002. The training will be based on the Training Needs Analysis carried out in WP3. The training will be CBT structured by means of a DVD, so that the training can be accompanied with a multitude of examples in the form of video, pictures, power point slides etc. Because of training- and experimental reasons, the training will not be available until after the experimental validation (Oct 2002).

WP5: Experimental Validation - started in October 2001. The design and preparation of the experiment was planned to run from February to June 2002. In the experiment, 24 crews will participate: 8 Aero Lloyd, 8 Alitalia and 8 British Airways crews. The experiment will be carried out on an A330 Research/training simulator situated at the Technical University, Berlin. The release of the results is expected in Oct 2002.

WP6: Consolidation and Dissemination - This work-package is ongoing. The report should be available late 2002 or early 2003. If you would like to know more about the ESSAI project or its results you can contact the co-ordinators of the project, Mr. Ton Nieuwpoort, nwprt@nlr.nl or Mrs. Jessy Lamers, lamers@nlr.nl.

27 **Enhancing Performance in High Risk Environments: recommendations for the use of Behavioural Markers**

Size: 33 pages

Group Interaction in High Risk Environments (GIHRE). July 2001.

Free to download from: www2.hu-berlin.de/GIHRE

Introduction

- Frequently Asked Questions about Behavioural Marker Systems

Behavioural Markers

- What are behavioural markers?
- How are behavioural markers derived?
- What makes a good behavioural marker?
- What are the domains of application?
- What are the uses of behavioural markers?

Behavioural Marker Systems

- What are characteristics of good behavioural marker systems?
- What are the limitations of behavioural marker systems?
- What consideration must be made when using a behavioural marker system?
- What are special considerations when using a behavioural marker system for assessment?

Training

- What are prerequisites to be a trainer for a behavioural marker course?
- What are prerequisites for evaluators using a behavioural marker system?
- What are necessary qualifications of evaluators?
- What should the content of behavioural marker system training be?
- How should a behavioural marker system training be structured?
- What training and calibration materials should be used?

Regulatory And Research Issues

- What are regulatory issues regarding the use of behavioural marker systems?
- What are research issues regarding the use of behavioural marker systems?

Conclusion

Bibliography

Appendix 1: The GIHRE-aviation project

Appendix 2: A brief history of the origins and evolution of ut behavioural markers

Appendix 3: The development of the NOTECHS behavioural markers

Appendix 4: Illustrative comparison of NOTECHS elements and UT markers

28 **Joint Aviation Requirements: Translation and Elaboration of Legislation (JARTEL)**

see <http://www.sofreavia.com/jartel/> for further information

There is also a link from the NLR site to a page which contains information on the original JARTEL project requirement:

www.nlr.nl/public/hosted-sites/essai/pages/links.html

WP5 Report "Guidelines for Implementation of NOTECHS" Reference:

JARTEL/SOF/WP5/D7_61 April 2002

report will be downloadable from <http://www.sofreavia.com/jartel/> once cleared for issue.

The NOTECHS method is primarily intended to assess, after CRM courses, non-technical skills (These are cognitive and social skills which have been shown to enhance performance and reduce error) and serve related training objectives. The method complies with the ICAO Annex 6 requirement calling for the evaluation of CRM skills, and its JAA translation detailed in NPA 16, proposing new CRM regulations to be included in JAR-Ops regulations by mid-2001.

JARTEL was the name of the research project that assessed the validity and the usability of the NOTECHS method.

Non-technical skills (NTS) usually refer to flightcrews' professional ability to demonstrate, beside their technical flying competencies, safe and satisfactory behaviour in the domains of cockpit authority, crew co-ordination and co-operation, communication and collective decision making, human error and conflict management, stress and workload management, attention, vigilance and monitoring.

The NOTECHS method is designed to be a guiding tool to look beyond a failure during recurrent checks or training, and help to diagnose possible underlying deficiencies in CRM competence in relation to technical failures. The method is based on the evaluation of four categories of behaviour: Co-operation, Leadership and Managerial Skills, Situation Awareness, and Decision Making; each of them being subdivided into elements and behavioural markers.

The NOTECHS method has been developed by a consortium of European airlines and research departments during the years 1997-2000, and subject to further operational input, is now considered mature enough to be proposed to the JAA and to the aviation industry.

The WP5 report gives a general overview of the method and answers practical questions in relation to the implementation of the method within airlines.

29 **NOTECHS: Non-technical Skill Evaluation in JAR-FCL**

Project TP 98518: 1998 Paper presented by: Avermaete, J at the Human Factors Open Day of the JAA-Project Advisory Group on Human Factors, Hoofddorp, 18 November 1998

Cost: Available for free download from:

<http://www.nlr.nl/public/library/1998/98518-dcs.html>

Upon a request from the JAA-Project Advisory Group on Human Factors, NLR, DLR, IMASSA and the University of Aberdeen conducted a study into possible ways to evaluate nontechnical skills of multi-pilot aircrew. The request was made in the light of the new requirements in JAR-FCL and JAR-OPS that make such an evaluation

mandatory. The project, named NOTECHS, was executed between March 1997 and March 1998, and resulted in a descriptive framework for non-technical skills. The project result includes guidelines on how to use the framework in the check situations referred to in JAR-FCL. The proposed assessment method incorporates safeguards that should prevent misuse or arbitrariness of the evaluation. A formal validation of the proposed method was not possible within the NOTECHS project. The European Union JAR-TEL project will, building on the NOTECHS results, extend its application to JAR-OPS and test the robustness of the method proposed here.

30 Behavioural Markers for Crew Resource Management

Size: 66 pages

Flin, R and Martin, L

CAA Paper 98005. 1998. ISBN 0 86039 735 1

Publisher: Documedia Solutions

cost: about £10. contact documedia solutions on www.documedia.co.uk for exact price.

The report examines current practice in the development and use of behavioural markers for training and assessing non-technical CRM skills both in the UK and abroad. The report covers 4 areas:

- 1 How CRM behavioural marker systems are used in practice
- 2 Comparing the principal CRM behavioural marker systems
- 3 The empirical basis for CRM marker systems
- 4 Recommending a CRM marker system (NOTECHS, once validated by the JARTEL project)

31 Methods Used to Evaluate the Effectiveness of Flightcrew CRM Training in the UK Aviation Industry

Size: literature review 50 pages; survey report 69 pages.

Survey report and literature review

O'Connor, Flin, Fletcher and Hemsley.

2002

The report contains the results of a study to identify the methods used currently by UK operators to assess the effectiveness of their CRM training programmes. A separate report contains the results of a literature survey on methods used to evaluate CRM training effectiveness, categorised according to whether the methods evaluated (i) reactions, (ii) learning, (iii) behaviour, or (iv) organisational impact.

32 Operator's Flight Safety Handbook

Size: approx 300 pages

GAIN. Issue 2. December 2001.

Free to download from:

This handbook is intended to serve as a guide for the creation and operation of a flight safety function within an operator's organisation. This handbook is specifically oriented and focused on the impact of safety considerations as they apply to air operations. It also acknowledges the importance of the development of safety practices in all areas of the organisation. The handbook also includes reference and guidance to areas that may not have been historically included in the safety department, such as Emergency Response and Crisis Management. The Working Group strongly emphasises the importance of independence and authority of the safety function in each organisation. Recognising that the final structure of the safety element will reflect the culture of the organisation, the Working Group urges that the Flight Safety Officer report directly to the Chief Executive Officer (CEO) and be empowered to positively effect safety integration throughout the organisation.

This **Operator's Flight Safety Handbook** was developed by the Aviation Operator's Safety Practices Working Group of the Global Aviation Information Network (GAIN) initiative as a derivation of the Airbus Industrie **Flight Safety Manager's Handbook**. This document has been developed by subject matter experts from the organisations listed in the Foreword of this document as necessary to be compatible with the philosophy, practices, and procedures of the organisation. Where possible, alternative practices and procedures in current use are also shown.

The important elements of an effective safety programme are:

- Senior management commitment to the company safety programme
- Appointment of a Flight Safety Officer reporting directly to the CEO
- Encouragement of a positive safety culture
- Establishment of a safety management structure
- Hazard identification and risk management
- On-going hazard reporting system
- Safety audits and assessment of quality or compliance
- Accident and incident reporting and investigation
- Documentation
- Immunity-based reporting systems
- Implementation of a Digital Flight Data Recorder information collection system
- The exchange of valuable "Lessons Learned" with manufactures and other airlines
- Safety training integration into the organisation's training syllabi
- Human factors training for all personnel
- Emergency response planning
- Regular evaluation and ongoing fine tuning of the programme

33 Websites

33.1 **Neil Krey's CRM Developers Forum** **www.crm-devel.org**

This is a useful US-based website containing many links to key CRM documents.

The forum's goal is to identify needs, co-ordinate processes, and facilitate development of Crew Resource Management (CRM) and Human Factors (HF) resources and products. Here you will find a wide variety of resources to assist you in the development and use of Crew Resource Management and Human Factors courses and training materials for aviation and other applications.

CRM-DEVEL Mailing List - CRM-DEVEL is a free Internet mailing list that provides a forum for everyone who develops, presents, or manages CRM and HF programs. An archive is also available.

Tiger Teams - Tiger Teams were a major activity of the former Industry CRM Developers Group. The first Tiger Team focused on Situation Awareness Management. Among their products was a Situation Awareness Management Workshop.

33.2 **Royal Aeronautical Society Human Factors Group, CRM pages** **www.raes-hfg**

This is a UK based website containing information on CRM, including links to documents, proceedings of RAeS CRM conferences, and a page for the Industry CRM Accreditation Panel (formerly the Accreditation Focus Group).

33.3 **Mica Endsley's Situation Awareness Technologies site** **www.satechnologies.com**

SA Technologies, Inc. provides research, design and training services for successfully integrating humans and advanced systems. SA Technologies is involved in the analysis, design and measurement of situation awareness. SA Technologies applies state of the art knowledge in cognitive engineering to a wide variety of projects centering on the design and evaluation of advanced displays and technologies. Areas of expertise include:

- Analysis Of User Requirements, Including Function Analysis, Function Allocation And Cognitive Task Analysis
- Human Information Processing And Decision Making Processes
- Integrating Human Operators With Advanced Automation And Expert Systems Technologies
- Knowledge Engineering
- Information Presentation For Overcoming Information Overload Problems
- Measurement Of Situation Awareness, Workload And Performance
- Organisational Effectiveness Considerations

The site contains many documents on Situation Awareness which are free to download.

33.4 **FAA website**
www.hf.faa.gov

The human factors elements of the FAA website are split among different parts of the site, so you will need to search for CRM requirements and documents

FAA-AAR-100 project: Developing ACRM Training
<http://www.faa.gov/avr/afs/hfactors.htm>

33.5 **UK Civil Aviation Authority**
www.caa.co.uk

Search under publications for specific CRM documents. Also search under FODCOMs for the FODCOMs relating to CRM (including 21/01, 15/01, 06/01, 13/00, 10/99)

33.6 **IATA website**
www.iata.org

The Human Factors Committee information can be found on page
www.iata.org/oi/committees/hfwg

CRM documents may be downloaded from this page, including:

CRM/LOFT manual; theme - how do I design CRM/LOFT programs?
(IATA HFWG)(9 pages)

The evolution of CRM: from managerial theory to safety tool
(IATA HFWG)(7 pages)

33.7 **University of Texas; Bob Helmreich's CRM and LOSA site www.psy.utexas.edu**
www.psy.utexas.edu/psy/helmreich/nasaut.htm

This site contains details of the Human Factors Research Project (formerly the Aerospace Crew Research Project) at The University of Texas at Austin. Under the leadership of Dr. Robert Helmreich, this project is funded to investigate individual, team, and organisational factors determining performance and safety in aviation, space, and medicine. It is also charged with developing new measures of performance in these environments and assessing the impact of human factors training on attitudes and behaviour. Another role is serving in an advisory capacity for the government and organisations in the application of research findings.

The site contains links to publications by Helmreich and his team, many of which are free to download.

The site also contains details on Line Operations safety Audit (LOSA) and Flight management Attitudes Questionnaire (FMAQ)

33.8 **Netherlands NLR site**
www.nlr.nl

Information on the ESSAI project can be found on
<http://www.nlr.nl/public/hosted-sites/essai/>

Enhanced Safety through Situation Awareness Integration in training (ESSAI)

Aims: The ESSAI project aims at training solutions for problems that occur in cockpits when pilots are confronted with extreme situations (a Crisis) for which they do not have appropriate procedures. These extreme situations may be the result of a rare chain of events, but may also occur because of lack of Situation Awareness of the crew. The aim is to develop training tools and techniques and their implementation in training programmes.

Goals: - to minimise (or recover from) loss of Situation Awareness during flight operations that could result in hazardous situations; - to provide strategies for effective Crisis Management during flight operations.

Methods: - reviewing

current training in relation to non-normal situations and emergencies at various operators; - identifying skills and procedures relating to crisis handling, error management and recovery of loss of Situation Awareness; - developing and validating training tools and techniques in support of the above.

The ESSAI report (divided into various workpackages) can be downloaded from www.nlr.nl/public/hosted-sites/essai/pages/reports.html

34 Miscellaneous (including videos)

34.1 Aviation Health and Safety Collection

BBC package of aviation videos -

available from BBC Worldwide learning email: vet@bbc.co.uk and www.bbcvet.co.uk

Total package is 17 films for £750

Videos within this package which are particularly useful for CRM purposes include:

- The Unflyable plane 1997 about Sioux City DC10
- The Wrong Stuff 1986
- Fall From Grace 1987 Tenerife 747s
- The Deadly Puzzle 1997 COPA flight 201 Panama investigation
- Aircrash Detective 1973 BEA Vanguard
- Fatal Error 1991 Kegworth
- A Major Malfunction 1998 Challenger Accident (Shuttle)
- Spiral to Disaster 1997 Piper Alpha Safety Management and Planning
- A Cut-Price Tragedy 1998 Valujet DC9
- Crash - What Happened to Flight 1008 1981 Dan Air 727 TFN
- Against the Clock 1994 jet lag exhaustion how the body copes.

Appendix 16 Standards Document 29

Guidance Notes for Accreditation Standards for CRM Instructors and CRM Instructor Examiners

1 Introduction

1.1 Origin

- 1.1.1 In the early years of aviation the main cause of accidents was attributed to technical defects. However as the reliability of aircraft improved it became apparent that the proportion of accidents attributed to non technical causes was increasing. Crew Resource Management (CRM) was developed as a result of accident analysis and information from Flight Data and Voice Recorders which indicated that many accidents were caused by the flight crew responding inappropriately to a particular situation.

CRM training has developed over the last two decades and has now reached a sufficient stage of maturity to benefit from a more formal structure. In order to formalise the training and to further enhance the effectiveness of CRM it is essential that instructors of CRM meet certain performance standards. Details of the performance criteria and instructor assessment are now given in CAP 737 "Crew Resource Management (CRM) Training". This Standards Document has been developed by the CRM Advisory Panel. The Terms of Reference of the panel and membership details are given at Annex A.

- 1.1.2 These guidance notes form part of the JAR-OPS and JAR-FCL "acceptable means of compliance".
- 1.1.3 The role of the CRM Instructor derives from JAR-OPS Subpart N. CRM instructions and, where appropriate, CRM checking of flight crew will therefore be carried out by accredited instructors.
- 1.1.4 Any advice concerning the conduct of CRM training should be obtained from Flight Operations Inspectorate (Training Standards) Section, Safety Regulation Group, Civil Aviation Authority, South Area, Gatwick Airport, West Sussex, RH6 0YR. Telephone 01293 573632.

1.2 Initial Accreditation

- 1.2.1 The accreditation process will be divided into three contexts, namely Ground School, Simulator/Base and Line.

When exercising the privileges of a CRMI in an aircraft, the individual shall hold an appropriate valid and current licence. (See paragraph 1.4.2.3)

With the exception of Line CRMIs, the qualification of CRMI may be carried forward from one operator to another, subject to suitable training being given with regard to the second and/or subsequent company's culture, practices and nature of operations.

A CRMI may be an instructor for more than one company at any one time.

All company CRMIs should be nominated in the company Operations Manual (Training).

Standardisation will be maintained by a CAA Inspector observing ground school training, LOFT training, simulator/base checks and line checks on an opportunity basis.

1.3 **Instructor Requirements**

1.3.1 **All Instructors**

1.3.1.1 A CRMI should meet the minimum standards contained in CAP 737, and should at least:

- a) Have completed a basic instructional technique course acceptable to the CAA.
- b) Have or have had commercial air transport experience as a flight crew member;
and
 - i) Have successfully passed the Human Performance and Limitations (HPL) examination whilst obtaining the ATPL; or
 - ii) If holding a Flight Crew Licence acceptable under JAR-OPS 1.940 (a)(3) prior to the introduction of HPL into the ATPL syllabus, have completed a theoretical HPL course covering the whole syllabus of that course; or
 - iii) Have theoretical experience in the subject of CRM or Human Factors training.

Notwithstanding the above, and when acceptable to the CAA:

- c) A flight crew member holding a recent qualification as a CRM Instructor may continue to be a CRM trainer after the cessation of active flying duties;
- d) An experienced non-flight crew CRM Instructor having a knowledge of HPL, may also be, and continue to be, a CRM Instructor;
- e) A former flight crew member having knowledge of HPL may become a CRM Instructor if he maintains adequate knowledge of the operation and aircraft type and meets the provisions of paragraphs (a) and (b) above;
- f) An instructor not meeting the above requirements may become a CRM Instructor at the discretion of the CAA and after an observation by a CAA Training Inspector.

1.3.2 **Instructors Ground School**

Shall have satisfied the conditions in 1.3.1.1 above, and

- a) Have completed initial CRM training; and
- b) Be supervised by a suitably qualified CRM Instructor when conducting their first initial CRM training sessions; and
- c) Have the knowledge and ability to teach the subjects detailed in Annex C.
- d) Complete the arrangements detailed in paragraph 1.4.

1.3.3 **Instructors Simulator/Base**

Shall have satisfied the conditions in 1.3.1.1 above, and

- a) Hold a TRI, TRE, CRI, CRE, SFI or SFE rating/authority.
- b) Have the knowledge detailed in Annex C.
- c) Complete the arrangements detailed in paragraph 1.4.

1.3.4 **Instructors Line**

Shall have satisfied the conditions in 1.3.1.1 above, and

- a) Have the knowledge detailed in Annex C.
- b) Complete the arrangements detailed in paragraph 1.4.

1.4 **Authorisation**

1.4.1 All instructors will need to demonstrate that:

- a) They have the knowledge specified for their relevant role, and
- b) They have the necessary instructional skills, and
- c) They are able to assess crews' CRM performance, and
- d) They are able to facilitate a constructive debrief of the above.

For Ground School Instructors the demonstration of ability should be carried out with a class of "live" trainees and be of sufficient length to confirm the CRM's depth of knowledge and ability to facilitate learning where necessary. It is unlikely, therefore, that a course of less than one day or four trainees including some flight crew would be considered adequate.

1.4.2 **CRM Instructor Examiners (CRMIE)**

- 1.4.2.1 The CAA will authorise suitably experienced and qualified people to accredit instructors as being competent to carry out CRM training. The CRMIE authorisation will remain valid subject to the examiner's continued employment with the sponsoring company. Should the examiner cease to be employed on examining duties, or leave the sponsoring company, the authorisation will automatically lapse.
- 1.4.2.2 Examiners should have at least the qualifications and experience required of a CRM Instructor in their respective roles.
- 1.4.2.3 When exercising the privileges of a CRMIE in an aircraft, the individual shall hold a valid, current and appropriate licence unless carrying out an observation from the jump seat.
- 1.4.2.4 Where no CRMIE is available, a CAA Training Inspector or suitably qualified member of the CRM Advisory Panel, may be authorised to carry out instructor accreditation checks.
- 1.4.2.5 A CRMIE may carry out accreditation checks on instructors not employed by the company sponsoring that examiner's authorisation, subject to a written agreement between the sponsoring company and the external agency. Copies of such written agreements must be forwarded to the Head of Training Standards at the CAA. The CAA reserves the right, without prejudice, to refuse to sanction any such agreements.

1.4.3 **Instructors**

- 1.4.3.1 On recommendation from a CRMIE, the CAA will accredit suitably experienced and qualified persons to conduct the necessary training. This accreditation will remain valid subject to the instructor's continued employment as a CRM Instructor. With the exception of Line CRMIs, the qualification of CRMIE will be able to be carried forward from one operator to another (given suitable training with regard to company SOPs etc.). Furthermore, a CRMIE would be able to be an instructor for more than one company. All company CRMIs and CRMIEs should be nominated in the Operations Manual.

1.5 **Revalidation Criteria**

1.5.1 **Instructors Ground School**

- 1.5.1.1 The accreditation will be for an initial period of three years. Thereafter, re-accreditation will be at the discretion of the CAA and subject to the following:
 - a) The instructor should have conducted at least two relevant courses of training in every yearly period within the three year accreditation period;

- b) For re-accreditation, one course of training, or a part thereof, within the last 12 months of the accreditation period will be observed by a CRMIE, a CAA Training Inspector, or a suitably qualified member of the CRM Advisory Panel.

1.5.2 **Examiners Ground School**

- 1.5.2.1 The authorisation will be for an initial period of three years. Thereafter re-authorisation will be at the discretion of the CAA and subject to the following:

The examiner should have conducted at least two accreditation checks in every yearly period within the three year authorisation period. For re-authorisation, one accreditation check within the last 12 months of the authorisation period will be observed by a CAA Training Inspector, or a suitably qualified member of the CRM Advisory Panel.

Re-authorisation as a CRMIE does not automatically re-accredit an Examiner as a CRMIE. Examiners must additionally comply with the requirements of paragraph 1.5.1.1 above.

1.5.3 **Simulator and Aircraft Trainers (TRI, TRE, CRI, CRE, SFI, and SFEs)**

TREs, SFEs and CREs will be accredited with CRM instructional and assessment skills when their authority is revalidated either by a CAA Training Inspector or a company Revalidation Examiner (RETRE). TRIs, SFIs, if accredited separately from any other qualification, may be revalidated by a TRI (E) or CAA Training Inspector. CRIs will be revalidated by a CAA Flight Examiner.

1.5.4 **Line Training Captains**

Line Training Captains will be accredited by a company nominated CRMIE on a three yearly renewal basis. The accreditation process may be done as a workshop or during actual line training.

1.5.5 **Record Keeping**

- 1.5.5.1 Records of all training courses conducted by instructors must be kept for a period of three years. Records of all checks conducted by examiners must also be kept for a period of three years. These records should show the instructional course dates, the type of course or check, the name(s) of the candidate(s) and the type of simulator or aircraft (if any) that was used.

2 Training Approvals

2.1 **General**

- 2.1.1 The quality and standardisation of CRM training programmes, their delivery, and CRM assessment is subject to acceptance and verification by the CAA. A nominated CRMIE or CRMIE will be responsible for each course.
- 2.1.2 It is envisaged that larger operators will carry out training and examination of their own instructors internally and that verification of that process will be carried out by or on behalf of the CAA. Smaller operators, who do not have their own internal training and examining system, may have their instructors examined by the CAA, a panel member or a nominated CRMIE.
- 2.1.3 The system of third party training carried out by dedicated organisations other than aircraft operators is expected to continue, although operators will be required to take increased "ownership" of the training carried out on their behalf. The size of the third party training organisation may dictate their ability to retain CRM instruction and examination internally, or whether they will require external training and examination.

2.1.4 JAR-OPS 1 and 3 both require that CRM course material be acceptable to the CAA. The detailed course syllabus should be laid down in Part D of the Operations Manual along with the name of the third party provider, if used (it may be a separate volume of the Operations Manual, yet still be an integral part of it).

2.2 **Company Approval**

2.2.1 The responsibility for the different contexts of CRM instruction and instructor examination may be held by different individuals within a company (or by one individual in smaller organisations). CRM training can be broadly differentiated into ground school training, simulator/base and line training.

2.2.2 The current system of the training and authorisation of aircraft TRIs and TREs by means of a company Revalidation Examiner (RETRE) specifically authorised for the purpose, is the model which will be utilised for the internal training and testing of CRMIs. It is envisaged that the role of simulator/base CRMI will be held by TRI/TREs as a part of their existing authorities. This will not prevent companies qualifying other individuals to undertake CRM instruction and instructor examination duties.

2.2.3 Revalidation of a CRMI rating for TRIs/TREs may be carried out by a company RETRE, by a TRI(E), or by a CAA Training Inspector. Ground School CRMI ratings may be revalidated by a CRMIE specifically authorised for that purpose. Revalidation of the CRMIE authorities will be carried out by the CAA or by a suitably qualified member of the CRM Advisory Panel.

2.2.4 The same criteria will apply to third party training organisations that are large enough to undertake and administer such a system.

2.2.5 Smaller companies and third party training organisations not having their own internal checking system, should liaise directly with the CAA Training Standards section, who will carry out revalidation of CRMIs. CRM Advisory Panel Members may also be authorised for this task.

2.2.6 Where an operator contracts a third party training organisation or another operator to provide CRM training and instructor examination on its behalf, it is important that such training and examination is carried out in accordance with the contracting operator's Operations Manual in order to reflect the culture, practices and nature of operations of that operator.

3 **Guidance**

3.1 **CRM Instruction**

3.1.1 The different categories of CRM instruction include: Initial CRM training; Conversion course CRM training when changing aircraft type; Conversion course CRM training when changing operator; Command course CRM training and Recurrent CRM training. Elements of all these categories of training can be carried out both in a classroom and/or in a simulator. None of the above categories requires any form of checking, although it is suggested that feedback be given to the candidate(s) during CRM training.

3.1.2 Elements of CRM training which are required in each category of training are laid down at Annex D.

3.1.3 To ensure that adequate standards are met and that CRM training is delivered in a consistent manner, it is essential that those instructors delivering CRM training meet minimum performance standards. Full guidance on performance standards for those who instruct in CRM has been produced in CAP 737. Performance Assessment

should be based on CAP 737 and the NOTECHS behavioural marker system but companies are free to develop an acceptable system which incorporates the company culture and meets the spirit of CAP 737.

3.2 **Non-Technical Skills (NTS) Assessment**

- 3.2.1 The assessment of NTS (CRM/MCC) is required by both JAR-OPS and JAR-FCL. This document is primarily concerned with the accreditation of CRM Instructors and Instructor Examiners. More detailed guidance is given in CAP 737.
- 3.2.2 The different contexts of NTS assessment include the Licence Skill Test, Operator Proficiency Check, Line Check and the sequence of checks carried out on completion of a command course. The purpose of NTS assessment is to provide feedback to individuals, thereby identifying any further training needs and to improve the CRM training system.
- 3.2.3 Until recently the assessment of NTS has lacked any formal measurement criteria resulting in subjective and extremely variable standards. Research into means of assessment has determined that acquired NTS skills are reflected in recognisable behaviours, whose characteristics are identifiable as measurable behavioural markers. This research is outlined in CAA Paper 98005 - "Behavioural Markers for Crew Resource Management".
- 3.2.4 Instructors and examiners must be thoroughly familiar with the operator's marker system (as in NOTECHS or any other similar system acceptable to the CAA) in order to enable them to deliver constructive debriefs and give guidance to crews to improve future performance. They should also make recommendations for further training where this is necessary. However, they should not use behavioural markers as a check list when making assessments. NTS assessment should not be conducted as an activity survey for each phase of flight, but should be carried out within the overall assessment of the flight check. See Annex E.
- 3.2.5 A crew member should not fail a licence or type rating revalidation check due to poor NTS unless this is associated with a technical failure. However, an Operator Proficiency Check should not be considered as being satisfactorily completed unless the performance of the pilot meets with company requirements. If the Operator Proficiency Check is combined with the Type Rating Revalidation Check, the assessment of NTS will satisfy the Multi Crew Co-operation requirements of the Type Rating renewal.
- 3.2.6 When operating in a multi-pilot role it may be difficult to make an assessment of an individual crew member. However, this should be done where possible in order that the pilot concerned gains maximum advantage from the assessment and any recommendations that the instructor may make. If it is not possible to make individual assessments then this should be done as a crew.
- 3.2.7 Operators should establish procedures to be applied in the event that flight crew members do not achieve or maintain the required standards (See JAR-OPS 1, App 1 to 1.1045, Sect D, Para 3.2).

Appendix 16, Annex A Crew Resource Management Advisory Panel - Terms Of Reference

Mission

The CRM Advisory Panel (the Panel), acting in the interests of industry, will provide cost effective, timely and high quality advice and assistance to the Civil Aviation Authority (CAA) on the accreditation and standardisation of CRM Providers Examiners and Trainers to ensure the highest standards of Human Factors and CRM education and practice.

Purpose

- a) To provide the CAA with guidance on Performance Standards for CRM Providers, individual Trainers and Examiners taking account of the need of industry.
- b) To propose amendments and updates to those standards.
- c) To promote a common understanding of accreditation processes and requirements.
- d) To advise, when requested, to assist the CAA on the assessment of the performance Providers and individual Trainers of CRM.
- e) To act as an arbitrator in the case of disputes over CRM training standards and provide the findings to interested parties.
- f) To advise and, when requested, to assist the CAA in the maintenance of Provider and Trainer verification techniques and standards.

Standards

- a) The standards required of CRM Providers and individual Trainers are those established in CAP 737 and as supplemented by current Aeronautical Information Circulars (AICs).
- b) The Panel's standards of operating and its procedures will be in direct support of the content of these documents and any relevant Legislation and amendments.
- c) Standards of Examiners are those determined by the CAA, based on National Standards.

Responsibilities

- a) The Panel will normally meet four times per year.
- b) Members will be expected to attend at least two of these meeting per year.
- c) The Panel Chairman will ensure a balanced quorum at each meeting.
- d) In relation to CRM and HF, in a cost effective, timely and effective manner:
 - i) Provide advice to CAA on all matters relating to CRM Training.
 - ii) Continually review and recommend accreditation procedures to enable the CAA to Qualify and Verify CRM Instructors and Trainers to a consistent and acceptable standard.
 - iii) Be aware and respond to all changes in Human Factors Legislation, particularly with respect to the training and accreditation of CRM Instructors/Trainers.
 - iv) Provide qualified assessors to act as advisors/arbitrators should a dispute arise which relates to CRM Training standards.

- v) Initially assist the CAA in the compiling of a register of adequately qualified/verified CRM Instructors/Trainers.

Resources

- a) Meeting venues and a measurement of administrative support will be provided by the CAA, where appropriate.
- b) Certain fee charging, where appropriate.

Personnel

Membership

- a) Chaired by a person, acceptable to the CAA, who has a recognised background in Human Factors in aviation.
- b) A deputy chairman, acceptable to the CAA, who has a recognised background in Human Factors in aviation.
- c) Head Flight Operations Inspectorate(Training Standards)
- d) A secretary acceptable to, or provided by the CAA.

Wherever possible suitable Members will be selected from the following list:

- | | |
|--|-----------|
| i) CAA Training Inspector/Specialist | nominated |
| ii) CAA PLD (FCL) member | nominated |
| iii) RAeS Human Factors Group | nominated |
| iv) Flight Crew member of a Representative Body | nominated |
| v) Instructor from a Flight Crew Representative Body | nominated |
| vi) Industry CRM Training specialists | invited |
| vii) Nationally recognised training organisations | invited |
| viii) A representative from the research community | invited |
| ix) TRI/TRE and/or RETRE | invited |
| x) CRMIE | invited |
| xi) CRMI | invited |
| xii) Cabin Crew Member | invited |
| xiii) Basic Training School Member | invited |
| xiv) Helicopter CRM specialist. | invited |

Other members from the above mentioned categories to bring total membership sufficient to meet the task.

Appointment to the Panel

- a) Members may be either nominated by organisations or invited, as indicated in "Membership" above.
- b) The chair will be nominated by the members, will hold office for three years after which an election will be held. Nothing will stop those in office offering themselves for re-election.

Membership Criteria

Any person acting as a member shall be:

- a) Actively involved, or show a proven track record, in the design, development, delivery, improvement or management of Human Factors training;
- b) Demonstrably interested in the cost-effective application of Human Factors as a major contribution to flight safety; and,
- c) Motivated to serve regularly and effectively on the CRM Advisory Panel.

Any communication for the attention of the CRM Advisory Panel should be sent to;

Training Standards

Flight Operations Inspectorate

1W Aviation House

Gatwick Airport South

West Sussex, RH6 0YR

E-mail: trainingstandards@srg.caa.co.uk

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Appendix 16, Annex B Withdrawn

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Appendix 16, Annex C Knowledge Requirements

1 Knowledge Requirements for Instructors of CRM Training

- 1.1 Human Performance and Limitations (as detailed in AMC FCL 1.470 - Theoretical knowledge requirements for the issue of a Commercial Pilot Licence).
- JAR-OPS core CRM elements (see AMC JAR-OPS 1.943/1.945/1.955/1.965)
 - Human error and reliability, error chains, error prevention and detection
 - Company safety culture, SOPs, organisational factors
 - Stress, stress management, fatigue and vigilance
 - Information acquisition and processing, situation awareness, workload management
 - Decision making
 - Communication and co-ordination inside and outside the flight deck
 - Leadership and team behaviour
 - Automation and automation philosophy (as required)
 - Specific type-related differences (as required)
- 1.2 Case based studies.
- 1.3 Knowledge of the NOTECHS behavioural marker system. See Appendix E.
- 1.4 Knowledge of the relevant parts of the "Short Guide".

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Appendix 16, Annex D CRM Training Requirements

Core Elements (a)	Initial CRM Training (b)	Operator's conversion course when changing type (c)	Operator's conversion course when changing operator (d)	Command course (e)	Recurrent training (f)
Human error and reliability, error chain, error prevention and detection	In depth	In depth	Overview	Overview	All items to be covered within a three year period
Company safety culture, SOPs, organisational factors		Not required	In depth	In depth	
Stress, stress management, fatigue and vigilance			Not required		
Information acquisition and processing, situation awareness workload management		Not required	Overview		
Decision making		Overview			
Communication and co-ordination inside and outside the cockpit					
Leadership and team behaviour synergy		As required	In depth	In depth	
Automation, philosophy of the use of automation (if relevant to the type)					
Specific type-related differences	Not required				
Case based studies	In depth	In depth	In depth	In depth	As appropriate

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Appendix 16, Annex E An Introduction to the NOTECHS Behaviour Marker System

The NOTECHS project

The NOTECHS project was sponsored by EC DGVII and the CAA's of France, Netherland, Germany and UK and ran from March 1997 until March 1998. The central goal of the NOTECHS project was to provide guidance for a feasible and efficient method for assessing an individual pilot's non-technical skills by instructor pilots and examiners during both training and check events in a multi-crew environment.

The NOTECHS behavioural marker system

The NOTECHS marker system was constructed from an inventory of existing systems. Non-technical skills (NTS) are defined as "those skills that refer to a crew member's attitudes and behaviours in the cockpit, not directly related to aircraft control, system management and Standard Operating Procedures (SOPs)".

Components of NTS

The review of existing methods exposed a large number of NTS labels and descriptors, each with their own specific meaning. A new framework was therefore created covering the whole range of NTS, based on the descriptors gathered in the review.

This framework consists of four Categories:

- Co-operation
- Leadership and managerial skills
- Situation Awareness
- Decision making

Each is subdivided into a number of Elements. Figure 1 shows the Elements in the Co-operation Category and behavioural examples for one Element. The Categories and Elements are formulated to be mutually exclusive but, given the interdependence of the various non-technical skills required in flight deck operations, this will not always be achievable. The terminology attempts to reflect everyday language for describing behaviour. Although the precise naming and positioning of the words within the framework is not that important, examiners, instructors and flight crew using the framework must all have the same understanding of the NOTECHS concepts. NOTECHS provides behavioural examples that assist in standardising assessments.¹

1. Anyone familiar with CRM or NTS will immediately spot the absence of Communication as one of the main Categories. However, good communication is crucial to the performance of all non-technical skills and thus does not receive a separate classification.

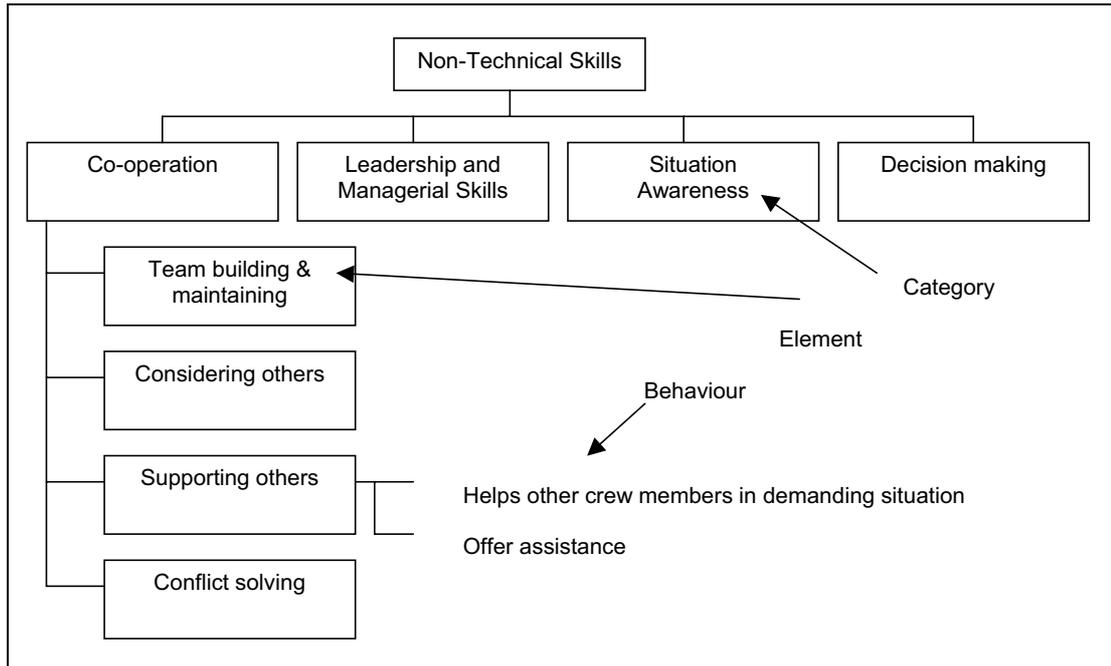


Figure 1 The NOTECHS descriptive framework consists of Categories, Elements and Behavioural examples

Within the NOTECHS framework, four Categories of non-technical skills have been identified, each Category containing 3 or 4 skill Elements. A short overview of the Categories and corresponding Elements is given in the following table.

Category	Elements
1. Co-operation	<ul style="list-style-type: none"> • Team-building and maintaining • Consideration of others • Support of others • Conflict solving
2. Leadership and/or managerial skills	<ul style="list-style-type: none"> • Use of authority and assertiveness • Providing and maintaining standards • Planning and co-ordination • Workload management
3. Situation awareness	<ul style="list-style-type: none"> • Awareness of aircraft systems • Awareness of external environment • Awareness of time
4. Decision making	<ul style="list-style-type: none"> • Problem definition and diagnosis • Option generation • Risk assessment and option selection • Outcome review

1 Co-operation

Co-operation is the ability to work effectively in a crew.

a) Team-building and maintaining

Team-building and maintaining is about the ability to establish positive interpersonal relations between crew members and their active participation in fulfilling the tasks.

Examples of **poor** practice:

- Blocks open communication.
- Keeps barriers between crew members.
- Competes with others.

Examples of **good** practice:

- Establishes atmosphere for open communication and participation.
- Encourages inputs and feedback from others.
- Does not compete with others.

b) Consideration of others

Consideration of others involves the acceptance of others and understanding their personal condition.

Examples of **poor** practice:

- Ignores suggestions of other crew members.
- Does not take account of the condition of other crew members.
- Shows no reaction to other crew members' problems.

Examples of **good** practice:

- Takes notice of the suggestions of other crew members even if s/he does not agree.
- Takes condition of other crew members into account.
- Gives appropriate personal feedback.

c) Support of others

Support of others relates to giving help to other crew members when they need assistance.

Examples of **poor** practice:

- Hesitates to help other crew members in demanding situations.
- Does not offer assistance.

Examples of **good** practice:

- Helps other crew members in demanding situations.
- Offers assistance.

d) Conflict solving

Conflict solving is about the articulation of different interpersonal positions and giving suggestions for solutions.

Examples of **poor** practice

- Overreacts in interpersonal conflicts, sticks to own position without considering a compromise.
- Accuses other crew members of making errors.

Examples of **good** practice:

- Keeps calm in conflicts.
- Suggests conflict solutions.
- Concentrates on what is right rather than who is right.

2 Leadership and Managerial Skills

Effective leadership and managerial skills help to achieve joint task completion within a motivated, fully-functioning team through co-ordination and persuasiveness.

a) Use of authority and assertiveness

The use of authority and assertiveness infers the ability to create a proper challenge and response atmosphere. The given command authority of the Captain should be adequately balanced by assertiveness and crew member participation. If a situation requires, decisive actions are expected.

Examples of **poor** practice:

- Hinders or withholds crew involvement.
- Passive, does not show initiative for decisions, own position not recognisable.
- Does not show appreciation for the crew, coaches very little or too much.

Examples of **good** practice:

- Advocates own position.
- Takes initiative to ensure involvement and task completion.
- Takes command if situation requires.
- Motivates crew by appreciation and coaches when necessary.

b) Providing and maintaining standards

Providing and maintaining standards refers to the compliance with essential standards (SOPs and others) for the task completion. Supervision and intervention in case of deviations from standards by other crew members is also part of this skill. If situation requires, non-standard procedures might be necessary. Such deviations shall be discussed and announced.

Examples of **poor** practice:

- Does not comply with SOPs, does not monitor crew for SOP compliance.
- Does not intervene in case of deviations.
- Applies non-standard procedures without announcement or consultation of crew members.

Examples of **good** practice:

- Ensures SOP compliance.

- Intervenes if task completion deviates from standards.
- Having consulted the crew, deviates from standard procedures if situation requires.

c) Planning and co-ordination

Planning and co-ordination refers to applying an appropriate concept for organised task-sharing and delegation in order to achieve top performance and to avoid workload peaks and dips. Communication of plans and intentions leads to co-ordinated activities within the whole crew.

Examples of **poor** practice:

- Plans only for self, does not involve crew.
- Intentions not stated or confirmed.
- Changes plan without informing crew or follows plans blindly.

Examples of **good** practice:

- Encourages crew participation in planning and task completion.
- Clearly states intentions and goals.
- Having consulted crew, changes plan if necessary.

d) Workload management

Workload management demands clear prioritisation of primary and secondary operational tasks. Based on sound planning, tasks should be distributed appropriately among the crew. Signs of stress and fatigue should be communicated and taken into account. Available external and internal resources (including automation) should be used to accomplish timely task completion.

Examples of **poor** practice:

- Flying solo without other crew members involved.
- Allowing secondary operational tasks to interfere with primary flight duties.
- Inadequate workload planning.
- Ignoring signs of stress and fatigue.

Examples of **good** practice:

- Distributes tasks among the crew, checks and corrects appropriately.
- Secondary operational tasks are prioritised to retain sufficient resources for primary flight duties.
- Allocates enough time to complete tasks.

3 Situation Awareness

Situation awareness relates to one's ability to accurately perceive what is in the cockpit and outside the aircraft. It is also one's ability to comprehend the meaning of different elements in the environment and the projection of their status in the near future.

a) Awareness of aircraft systems

The crew needs to be constantly aware of the state of different aircraft systems.

Examples of **poor** practice:

- Does not ask for updates.

- Does not signal awareness of changing systems.

Examples of **good** practice:

- Monitors and reports changes in system states.
- Acknowledges entries and changes to systems.

b) Awareness of external environment

The crew needs to be aware of their environment (position, weather, air traffic, terrain).

Examples of **poor** practice:

- Does not acknowledge - repeat ATC directions.
- Does not enquire about environmental changes.
- Does not comment on relevant environmental factors, or is surprised by them.

Examples of **good** practice:

- Collects information about the environment.
- Contacts outside resources when necessary.
- Shares information about the environment with others.

c) Awareness of time

The crew needs not only to be aware of the present state of the aircraft systems and environment, but must also be able to predict future states in order to anticipate future events.

Examples of **poor** practice:

- Does not set priorities with respect to time limits.
- Does not discuss relationship between past events and present - future.
- Is surprised by outcomes of past events.

Examples of **good** practice:

- Discusses contingency strategies.
- Identifies possible - future problems.

4 Decision Making

Decision making is the process of reaching a judgement or choosing an option.

a) Problem definition and diagnosis

Problem definition and diagnosis is the ability to collect the information needed to define a problem and its causal factors.

Examples of **poor** practice:

- Nature of the problem not stated or failure to diagnose.
- No discussion of probable causes.

Examples of **good** practice:

- Gathers information and identifies problem.
- Reviews causal factors with other crew members.

b) Option generation

Option generation refers to the ability of a crew member to generate multiple responses to a problem.

Examples of **poor** practice:

- Does not search for information.
- Does not ask crew for alternatives.

Examples of **good** practice:

- States alternative courses of action.
- Asks crew members for options.

c) Risk assessment and option selection

Risk assessment and option selection refers to the ability of a crew member to successfully assess risks and benefits of different responses to a problem, and to select the best response. Both should be accomplished through discussion with other crew members.

Examples of **poor** practice:

- Inadequate discussion of limiting factors with crew.
- Failing to inform crew of decision path being taken.

Examples of **good** practice:

- Considers and shares risks of alternative courses of action.
- Talks about possible risks for course of action in terms of crew limitations.
- Confirms selected course of action.

d) Outcome review

Outcome review refers to the crew member's need to check the outcome of a solution against the predefined goal.

Examples of **poor** practice:

- Fails to check selected outcome against goal.

Examples of **good** practice:

- Checks outcome against plan.

JARTEL

Joint **A**viation **R**equirements - **T**ranslation and **E**laboration of **L**egislation. The JAR-TEL project will be completed in 2001.

The introduction of NTS evaluation requirements (as a corollary to the existing Technical Skills evaluation system in the licensing process), combined with current pilot training, aims at reducing and then managing risks so that individual behaviour on the flight deck should not lead to an incident or an accident, the importance of NTS in overall flight crew performance being now largely confirmed. (NTS has been defined as referring to those flight crew attitudes and behaviours not directly related to aircraft control, system management and Standard Operating procedures (SOPs), which influence flight safety).

The JAR-TEL project was designed to assess the validity and the usability of NOTECHS, as a proposed method for the evaluation of flight crews' Non-Technical

Skills (NTS) that was developed in the NOTECHS project funded by the JAA and the DG TREN (Avermaete, J.A.G van & Kruijsen, E.A.C. (Eds), 1998).

JAR-TEL will provide implementation guidelines in the form of an Acceptable Means of Compliance (AMC) or similar instrument for the operational use of the method in check and training situations (flight - simulator) as requested by the relevant JAR codes, especially under JAR OPS.