Trinidad and Tobago
Civil Aviation Authority

TTCAA Advisory Circular

Subject: CREW RESOURCE MANAGEMENT TRAINING
TTCAA Advisory Circular TAC- 010A
Date: 05/02/25

PURPOSE

1. (1) The purpose of this TTCAA Advisory Circular (TAC) is to present guidelines for developing, implementing, reinforcing, and assessing Crew Resource Management (CRM) training programmes for flight crewmembers and other personnel essential to flight safety. These programmes are designed to become an integral part of training and operations. Guidelines are primarily for those operators subject to Trinidad and Tobago Civil Aviation Regulations (TTCARs) No.2 and No.3. All TTCAR No.2 operators are required by regulations to provide CRM training for pilots, cabin crew and flight operations officers. These guidelines are also for use by other Trinidad and Tobago aircraft operators electing to train in accordance with TTCAR No.3 requirements. Certificate holders and individuals operating apart from air operator requirements, should find these guidelines useful in addressing human performance issues. This TAC presents one way, but not necessarily the only way, that CRM training may be addressed. CRM training focuses on situation awareness, communication skills, teamwork, task allocation, and decision making within a comprehensive framework of standard operating procedures (SOPs).

(2) This TAC is based on FAA Advisory Circular AC 120-51E.

(3) TAC-010A replaces and supercedes TAC-010 which is now cancelled and should be destroyed.

DEFINITIONS

2. (1) The human factors safety challenge and the CRM training response may be defined as follows:

(a) **Human Factors**. Human factors is a multidisciplinary field devoted to optimising human performance and reducing human error. It incorporates the methods and principles of the behavioural and social sciences, engineering, and physiology. Human factors is the applied science that studies people working together in concert with machines. Human factors embraces variables that influence individual performance and variables that influence team or crew performance. It is recognized that inadequate system design or inadequate operator training can contribute to individual human error that leads to system performance degradation. Further, it is recognized that inadequate design and management of crew tasks can contribute to group errors that lead to system performance degradation;

(b) **Crew Resource Management (CRM) Training**. The application of team management concepts in the cockpit environment was initially known as Cockpit Resource Management. As CRM training programmes evolved to include cabin crew, maintenance personnel and others, the phrase Crew Resource Management has been adopted and refers to the effective use of all available human resources, hardware and information. Other groups routinely working with the cockpit crew, who are involved in decisions required to operate a flight safely, are also essential participants in an effective CRM process. These groups include but are not limited to:

(i) Flight Operations Officers;

(ii) Cabin Crew;

(iii) Maintenance personnel;

(iv) Air traffic controllers.

(2) CRM training is one way of addressing the challenge of optimising the human/machine interface and accompanying interpersonal activities. These activities include team building and maintenance, information transfer, problem solving, decision making, maintaining situation awareness, and dealing with automated systems.

(3) CRM training is comprised of three components: initial indoctrination/awareness, recurrent practice and feedback, and continual reinforcement.

BACKGROUND

3. (1) Investigations into the causes of air operator accidents have shown that human error is a contributing factor in 60 to 80 percent of all air operator incidents and accidents. Research has demonstrated that these events share common characteristics. Many problems encountered by flightcrews have very little to do with the technical aspects of operating in a multi-person cockpit. Instead, problems are associated with poor group decision making, ineffective communication, inadequate leadership, and poor task or resource management. Pilot training programmes historically focused almost exclusively on the technical aspects of flying and on an individual pilot's performance; they did not effectively address crew management issues that are also fundamental to safe flight.

(2) Investigative research have identified SOPs as a persistent element in these problems, which sometimes have led to accidents. SOPs define the shared mental model upon which good crew performance depends. Too often well-established SOPs have been unconsciously ignored by pilots and others; in other cases they have been consciously ignored. In still other cases SOPs have been inadequately developed by the operator for use by his pilots, cabin crews, or flight operations officers, or a significant SOP has been omitted altogether from an operator's training programme, a coalition of industry and government organizations called “The Commercial Aviation Safety Team (CAST)”, has undertaken to reduce the air operator accident rate by 80% by the year 2007. Initiatives to improve SOPs and adherence to those SOPs are among the top-priority safety initiatives now being implemented by CAST.

(3) Industry and government have come to consensus that training programmes should place emphasis on the factors that influence crew coordination and the management of crew resources. The need for additional training in communication between cockpit crewmembers and cabin crews has been specifically identified.

(4) Coordinated efforts by representatives from the aviation community have produced valuable recommendations for CRM training programmes.

(5) This TAC is based on FAA AC 120-51E which is one product that has come from one of the working groups. While compliance with this TAC is not mandatory, the recommendations which it contains provide a useful reference for understanding and applying the critical elements of CRM training.

(6) Measurements of the impact of CRM training by research centers show that after initial indoctrination, significant improvement in attitudes occur regarding crew coordination and cockpit management. In programmes that also provide recurrent training and practice in CRM concepts, significant changes have been recorded in flightcrew performance during Line Oriented Flight Training (LOFT) and during actual flight. CRM-trained crews operate more effectively as teams and cope more effectively with nonroutine situations.

(7) Research also shows that when there is no effective reinforcement of CRM concepts by way of recurrent training, improvements in attitudes observed after initial indoctrination tend to disappear, and individuals' attitudes tend to revert to former levels.

THE OBJECTIVE OF CRM TRAINING

4. CRM training has been conceived to prevent aviation accidents by improving crew performance through better crew coordination.

BASIC CONCEPTS OF CRM

5. (1) CRM training is based on an awareness that a high degree of technical proficiency is essential for safe and efficient operations. Demonstrated mastery of CRM concepts cannot overcome a lack of proficiency. Similarly, high technical proficiency cannot guarantee safe operations in the absence of effective crew coordination.

(2) Experience has shown that lasting behaviour changes in any environment cannot be achieved in a short time, even if the training is very well designed. Trainees need awareness, practice and feedback, and continuing reinforcement: in brief, time to learn attitudes and behaviours that will endure. In order to be effective, CRM concepts must be permanently integrated into all aspects of training and operations.

(3) While there are various useful methods in use in CRM training today, the following essentials are universal:

(a) CRM training is most effective within a training programme centered on clear, comprehensive standard operating procedures;

(b) CRM training should focus on the functioning of crewmembers as teams, not as a collection of technically competent individuals;

(c) CRM training should instruct crewmembers how to behave in ways that foster crew effectiveness;

(d) CRM training should provide opportunities for crewmembers to practice the skills necessary to be effective team leaders and team members;

(e) CRM training exercises should include all crewmembers functioning in the same roles (e.g., captain, first officer, and/or flight engineer, cabin crews) that they normally perform in flight;

(f) CRM training should include effective team behaviours during normal, routine operations.

(4) Good training for routine operations can have a strong positive effect on how well individuals function during times of high workload or high stress. During emergency situations, it is highly unlikely (and probably undesirable) that any crewmember would take the time to reflect

upon his or her CRM training in order to choose the appropriate behaviour. But practice of desirable behaviours during times of low stress increases the likelihood that emergencies will be handled effectively.

(5) Effective CRM has the following characteristics:

(a) CRM is a comprehensive system of applying human factors concepts to improve crew performance;

(b) CRM embraces all operational personnel;

(c) CRM can be blended into all forms of aircrew training;

(d) CRM concentrates on crewmembers' attitudes and behaviours and their impact on safety;

(e) CRM uses the crew as the unit of training;

(f) CRM is training that requires the active participation of all crewmembers. It provides an opportunity for individuals and crews to examine their own behaviour, and to make decisions on how to improve cockpit teamwork.

(6) LOFT sessions provide an extremely effective means of practicing CRM skills and receiving reinforcement.

(7) Audiovisual (taped) feedback during debriefing of LOFT and other training are excellent ways for flight crewmembers to assess their skills as individuals and as team members. Bulk erasure of taped sessions is suggested to encourage candor among participants while assuring their privacy.

(8) In cases where simulators are not available, crewmembers can participate in group problem-solving activities designed to exercise CRM skills. Through taped feedback during debriefing, they can then assess the positive and negative behaviours of all crewmembers.

(9) Crewmembers may also participate in role-playing exercises. Such exercises permit practice in developing strategies for dealing with events or event sets, and enable analysis of behaviours shown while dealing with them. Again, taping the role-playing exercises is useful for assessment and feedback during debriefing. Crewmembers' abilities can be clearly observed in such areas as adherence to SOPs, decision making, teamwork, and leadership.

(10) Attitude and/or personality measures can also be used to provide feedback to participants, allowing them to assess their own strengths and weaknesses.

(11) Success of a CRM training programme depends upon check airmen, instructors, and supervisors who are highly qualified in the operator's SOPs and specially trained in CRM.

FUNDAMENTALS OF CRM TRAINING IMPLEMENTATION

6. Research programmes and airline operational experience suggest that the greatest benefits are achieved by adhering to the following practices:

(a) **Assess the Status of the Organization Before Implementation**. It is important to know how widely CRM concepts are understood and practiced before designing specific training. Surveys of crewmembers, management, training, and standards personnel, observation of crews in line observations, and analysis of incident/accident reports can provide essential data for programme designers;

(b) **Get Commitment from All Managers, Starting with Senior Managers.** CRM programmes are received much more positively by operations personnel when senior managers, flight operations managers, and flight standards officers conspicuously support CRM concepts and provide the necessary resources for training. Flight operations manuals and training manuals should embrace CRM concepts by providing crews with necessary policy and procedures guidance centred on clear, comprehensive SOPs. A central CRM concept is communication. It is essential that every level of management support a safety culture in which communication is promoted by encouraging appropriate questioning. It should be made perfectly clear in pilots' manuals, and in every phase of pilot training, that appropriate questioning is encouraged and that there will be no negative repercussions for appropriate questioning of one pilot's decision or action by another pilot;

(c) **Customize the Training to Reflect the Nature and Needs of the Organization.** Using knowledge of the state of the organization, priorities should be established for topics to be covered including special issues, such as the effects of mergers or the introduction of advanced technology aircraft. Other special issues might include topics specific to the particular type of operation, such as the specific characteristics that exist in commuter operations, in long-haul international operations or night operations. This approach increases the relevance of training for crewmembers;

(d) **Define the Scope of the Programme and an Implementation Plan.** Institute special CRM training for key personnel including check airmen, supervisors, and instructors. It is highly beneficial to provide training for these groups before beginning training for crewmembers. CRM training may be expanded to combine pilots, cabin crews, and aircraft dispatchers. It may also be expanded to include maintenance personnel and other company team members as appropriate. It is also helpful to develop a long term strategy for programme implementation;

(e) **Communicate the Nature and Scope of the Programme Before Startup.** Training departments should provide crews, managers, training, and standards personnel with a preview of what the training will involve together with plans for initial and continuing training. These steps can prevent misunderstandings about the focus of the training or any aspect of its implementation;

(f) **Institute Quality Control Procedures.** It has proved helpful to monitor the delivery of training and to determine areas where training can be strengthened. Monitoring can be initiated by providing special training to programme instructors (often called facilitators) in using surveys to collect systematic feedback from participants in the training.

COMPONENTS OF CRM TRAINING

General

7. The topics outlined below have been identified as critical components of effective CRM training. They do not represent a fixed sequence of phases, each with a beginning and an end. Ideally, each component is continually renewed at every stage of training.

Initial Indoctrination/Awareness

8. (1) Indoctrination/awareness typically consists of classroom presentations and focuses on communications and decision making, interpersonal relations, crew coordination, leadership, and adherence to SOPs, among others. In this component of CRM training, the concepts are developed, defined, and related to the safety of line operations. This component also provides a common conceptual framework and a common vocabulary for identifying crew coordination problems.

(2) Indoctrination/awareness can be accomplished by a combination of training methods. Lectures, audiovisual presentations, discussion groups, role-playing exercises, computer-based instruction, and videotaped examples of good and poor team behaviour are commonly used methods.

(3) Initiating indoctrination/awareness training requires the development of a curriculum that addresses CRM skills that have been demonstrated to influence crew performance. To be most effective, the curriculum should define the concepts involved and relate them directly to operational issues that crews encounter. Many organizations have found it useful to survey crewmembers. Survey data have helped identify embedded attitudes regarding crew coordination and cockpit management. The data have also helped to identify operational problems and to prioritise training issues.

(4) Effective indoctrination/awareness training increases understanding of CRM concepts. That understanding, in turn, often influences individual attitudes favourably regarding human factors issues. Often the training also suggests more effective communication practices.

(5) It is important to recognize that classroom instruction alone does not fundamentally alter crewmember attitudes over the long term. The indoctrination/awareness training should be regarded as a necessary first step towards effective crew performance training.

Recurrent Practice and Feedback

9. (1) CRM training must be included as a regular part of the recurrent training requirement. Recurrent CRM training should include classroom or briefing room refresher training to review and amplify CRM components, followed by practice and feedback exercises such as LOFT, preferably with taped feedback; or a suitable substitute such as role-playing in a flight training device and taped feedback. It is recommended that these recurrent CRM exercises take place with a full crew, each member operating in his or her normal crew position. A complete crew should always be scheduled, and every attempt should be made to maintain crew integrity. Recurrent training LOFT which includes CRM should be conducted with current line crews, and preferably not with instructors or check airmen as stand-ins.

(2) Recurrent training with performance feedback allows participants to practice newly improved CRM skills and to receive feedback on their effectiveness. Feedback has its greatest impact when it comes from self-critique and from peers, together with guidance from a facilitator with special training in assessment and debriefing techniques.

(3) The most effective feedback refers to the coordination concepts identified in Indoctrination/Awareness training or in recurrent training. Effective feedback relates to specific behaviours. Practice and feedback are best accomplished through the use of simulators or training devices and videotape. Taped feedback, with the guidance of a facilitator, is particularly effective because it allows participants to view themselves from a third person perspective. This view is especially compelling in that strengths and weaknesses are captured on tape and vividly displayed. Stop action, replay, and slow motion are some of the playback features available during debriefing. Behavioural patterns and individual work styles are easily seen, and appropriate adjustments are often self-evident.

Continuing Reinforcement

10. (1) No matter how effective each curriculum segment is (the classroom, the role-playing exercises, the LOFT, or the feedback), one-time exposures are simply not sufficient. The attitudes and norms that contribute to ineffective crew coordination may have developed over a crewmember's lifetime. It is unrealistic to expect a short training programme to reverse years of habits. To be maximally effective, CRM should be embedded in every stage of training, and CRM concepts should be stressed in line operations as well.

(2) CRM should become an inseparable part of the organization's culture.

(3) There is a common tendency to think of CRM as training only for captains. this notion misses the essence of the CRM training mission: the prevention of crew-related accidents. CRM training works best in the context of the entire crew. Training exercises are most effective if all crewmembers work together and learn together. In the past, much of the flightcrew training has been segmented by crew position. This segmentation has been effective for meeting certain training needs such as seat dependent technical training and upgrade training, but segmentation is not appropriate for most CRM training.

(4) Reinforcement can be accomplished in many areas. Training such as joint cabin and cockpit crew training in security can deal with many human factors issues. Joint training with aircraft dispatchers, maintenance personnel, and gate agents can also reinforce CRM concepts and is recommended.

SUGGESTED CURRICULUM TOPICS

11. The topics outlined below have been included in many current CRM programmes. Specific content of training and organization of topics should reflect an organization's unique culture and specific needs. Appendix1 offers a set of behavioural markers fitting subtopics within each topic cluster. Sometimes overlapping, these markers may be helpful in curriculum development and in LOFT design. Appendix 3 gives additional CRM training topics.

COMMUNICATIONS PROCESSES AND DECISION BEHAVIOR

12. This topic includes internal and external influences on interpersonal communications. External factors include communication barriers such as rank, age, gender, and organizational culture, including the identification of inadequate SOPs. Internal factors include speaking skills, listening skills and decision making skills, conflict resolution techniques, and the use of appropriate assertiveness and advocacy. The importance of clear and unambiguous communication must be stressed in all training activities involving pilots, cabin crews, and aircraft dispatchers. The greater one's concern in flight-related matters, the greater is the need for clear communication. More specific subtopics include the following:

(a) **Briefings**. Training in addressing both operational and interpersonal issues, and training in establishing and maintaining open communications. Briefings should reaffirm established SOPs, and should address the most threatening safety and security situations as follows:

(i) **Safety.** A captain’s briefing should address emergencies that might require an airplane evacuation (e.g., cabin fire or engine fire) and should highlight the functions of flightcrew and cabin crews during an evacuation. A captain’s briefing should stress to cabin crew the importance of identifying able-bodied passengers and briefing them, in turn. Passengers in exit rows are particularly resources, and cabin crew should brief them on what to do during an evacuation;

(ii) **Security.** A captain’s briefing should address general security topics, especially hijack, and any known or suspected specific threat pertaining to the flight. Flight attendants should identify able-bodied passengers, including exit row seat occupants, and may enroll them as resources who might be called upon to help contain a disruption caused by a passenger(s);

(b) **Inquiry/Advocacy/Assertion**. Training in the potential benefits of crewmembers advocating the course of action that they feel is best, even though it may involve conflict with others;

(c) **Crew Self-Critique (Decisions and Actions)**. Illustrating the value of review, feedback, and critique focusing on the process and the people involved. One of the best techniques for reinforcing effective human factors practices is careful debriefing

of activities, highlighting the processes that were followed. Additionally, it is essential that each crewmember be able to recognize good and bad communications, and effective and ineffective team behaviour;

(d) **Conflict Resolution**. Demonstrating effective techniques of resolving disagreements among crewmembers in interpreting information or in proposing courses of action. Demonstrating effective techniques for maintaining open communication while dealing with conflict;

(e) **Communications and Decision making.** Demonstrating effective techniques of seeking and evaluating information. Showing the influence of biases and other cognitive factors on decision quality. There are benefits in providing crews with operational models of this group decision process. Crews may refer to these models to make good choices in situations when information is incomplete or contradictory.

TEAM BUILDING AND MAINTENANCE

13. This topic includes interpersonal relationships and practices. Effective leadership /followership and interpersonal relationships are key concepts to be stressed. Curricula can also include recognizing and dealing with diverse personalities and operating styles. Subtopics include:

(a) **Leadership/Followership/Concern for Task.** Showing the benefits of the practice of effective leadership through coordinating activities and maintaining proper balance between respecting authority and practicing assertiveness. Staying centered on the goals of safe and efficient operations;

(b) **Interpersonal Relationships/Group Climate**. Demonstrating the usefulness of showing sensitivity to other crewmembers' personalities and styles. Emphasizing the value of maintaining a friendly, relaxed, and supportive yet task oriented tone in the cockpit and aircraft cabin. The importance of recognizing symptoms of fatigue and stress, and taking appropriate action;

(c) **Workload Management and Situation Awareness.** Stressing the importance of maintaining awareness of the operational environment and anticipating contingencies. Instruction may address practices (for example, vigilance, planning and time management, prioritising tasks, and avoiding distractions) that result in higher levels of situation awareness. The following operational practices may be included:

(i) **Preparation/Planning/Vigilance.** Issues include methods to improve monitoring and accomplishing required tasks, asking for and responding to new information, and preparing in advance for required activities;

(ii) **Workload Distribution/Distraction Avoidance.** Issues involve proper allocation of tasks to individuals, avoidance of work overloads in self and in others, prioritisation of tasks during periods of high workload, and preventing nonessential factors from distracting attention from adherence to SOPs, particularly those relating to critical tasks.

(d) **Individual Factors/Stress Reduction**. Training in this area may include describing and demonstrating individual characteristics that can influence crew effectiveness. Research has shown that many crewmembers are unfamiliar with the negative effects of stress and fatigue on individual cognitive functions and team performance. Training may include a review of scientific evidence on fatigue and stress and their effects on performance. The content may include specific effects of fatigue and stress in potential emergency situations. The effects of personal and interpersonal problems and the increased importance of effective interpersonal communications under stressful conditions may also be addressed. Training may also include familiarization with various countermeasures for coping with stressors. Additional curriculum topics

may include examination of personality and motivation characteristics, self-assessment of personal style, and identifying cognitive factors that influence perception and decision making.

SPECIALIZED TRAINING IN CRM CONCEPTS

14. (1) As CRM programmes have matured, some organizations have found it beneficial to develop and implement additional courses dealing with issues specific to their operations.

(2) After all current crewmembers have completed the Initial Indoctrination /Awareness component of CRM training, arrangements are needed to provide newly hired crewmembers with the same material. A number of organizations have modified their CRM initial courses for inclusion as part of the initial training and qualification for new hire crewmembers.

(3) Training for upgrading to captain provides an opportunity for specialized training that deals with the human factors aspects of command. Such training can be incorporated in the upgrade process.

(4) Training involving communications and the use of automation can be developed for crews operating aircraft with advanced technology cockpits, or for crews transitioning into them.

ASSESSMENT OF CRM TRAINING PROGRAMMES

15. (1) It is vital that each programme be assessed to determine if it is achieving its goals. Each organization should have a systematic assessment programme. Assessment should track the effects of the training programme so that critical topics for recurrent training may be identified and continuous improvements may be made in all other respects. Assessment of the training programme should include observation of the training process by programme administrators and self-reports by participants using standard survey methods.

(2) The emphasis in this assessment process should be on crew performance. The essential areas of CRM-related assessment include communications processes, decision making, team building and maintenance, workload management, and situation awareness, always in balance with traditional technical proficiency. An additional function of such assessment is to determine the impact of CRM training and organization-wide trends in crew performance.

(3) For optimal assessment, data on crewmembers' attitudes and behaviour should be collected before CRM indoctrination and again at intervals after the last component of CRM training, to determine both initial and enduring effects of the programme. The goal should be to obtain an accurate picture of the organization's significant corporate personality traits before formal adoption of CRM training, and to continue to monitor those traits after implementation.

(4) Reinforcement and feedback are essential to effective CRM training programmes. Crewmembers must receive continual reinforcement to sustain CRM concepts. Effective reinforcement depends upon usable feedback to crewmembers on their CRM practices and on their technical performance.

(5) Usable feedback requires consistent assessment. Crewmembers and those involved in training and evaluation should be able to recognize effective and ineffective CRM behaviours. CRM concepts should be critiqued during briefing/debriefing phases of all training and checking events.

(6) To summarize, the assessment programme should-

(a) Measure and track the organization's corporate culture as it is reflected in attitudes and norms;

(b) Identify topics needing emphasis within the CRM programme;

(c) Ensure that all check airmen, supervisors, and instructors are well prepared and standardized.

THE CRITICAL ROLE OF CHECK AIRMEN AND INSTRUCTORS

16. (1) The success of any CRM training programme ultimately depends on the skills of the people who administer the training and measure its effects. CRM instructors, check pilots, supervisors, and course designers must be skilled in all areas related to the practice and assessment of CRM. These skills comprise an additional level to those associated with traditional flight instruction and checking.

(2) Gaining proficiency and confidence in CRM instruction, observation, and measurement requires special training for instructors, supervisors, and check pilots in many CRM training processes. Among those processes are role-playing simulations, systematic crew-centered observation, administering LOFT programmes, and providing usable feedback to crews.

(3) Instructors, supervisors, and check pilots also require special training in order to calibrate and standardize their own skills.

(4) Instructors, supervisors, and check airmen should use every available opportunity to emphasize the importance of crew coordination skills. The best results occur when the crews examine their own behaviour with the assistance of a trained instructor who can point out both positive and negative CRM performance. Whenever highly effective examples of crew coordination are observed, it is vital that these positive behaviours be discussed and reinforced. Debriefing and critiquing skills are important tools for instructors, supervisors, and check pilots. (Behavioural markers of effective LOFT debriefings are shown in Appendix 2.)

(5) Feedback from instructors, supervisors, and check airmen is most effective when it refers to the concepts that are covered in the initial indoctrination/awareness training. The best feedback refers to instances of specific behaviour, rather than behaviour in general.

EVOLVING CONCEPTS OF CRM

17. (1) **Crew Monitoring and Cross-Checking.** Several studies of crew performance, incidents, and accidents have identified inadequate flightcrew monitoring and cross-checking as a problem for aviation security. Therefore, to ensure the highest level of safety, each flight crewmember must carefully monitor the aircraft's flight path and systems and actively cross-check the actions of other crewmembers. Effective monitoring and cross-checking can be the last line of defence that prevents an accident because detecting an error or unsafe situation may break the chain of events leading to an accident. This monitoring function is always essential, and particularly so during approach and landing when controlled flight into terrain (CFIT) accidents are most common. (For more information on SOPs that promote effective monitoring, see AC 120-71, as revised, appendix 19.)

(2) **Joint CRM Training**. More and more operators are discovering the value of expanding CRM training to reach various employee groups beyond the flight crew and cabin crew. Such groups are being brought together in CRM training and other activities. The objective is to improve the effectiveness and safety of the entire operations team as a working system.

(a) The attacks of September 11, 2001, have caused many restrictions on flightdeck access. Among those affected are air traffic controllers, for whom revised access procedures are being studied. Pilots may observe operations in

air traffic facilities under certain conditions, and are encouraged to do so. Using real air traffic controllers during LOFT sessions has also proven beneficial to pilots and participating controllers;

(b) Aircraft dispatchers and flight operations officers have functioned jointly with flight captains for years. They have been allowed, indeed required to observe cockpit operations from the cockpit jumpseat as part of their initial and recurrent qualification. Some operators have included day trips to their aircraft dispatchers' offices to provide the pilot insight into the other side of the joint function scheme. Those trips have commonly been part of the special training offered to first-time captains. Now, real-life aircraft dispatchers and flight operations officers are increasingly being used in LOFT sessions. The training experience gained by the pilot and the dispatcher during LOFT is considered the logical extension of earlier training methods, providing interactivity where CRM principles are applied and discussed;

(c) Under certain conditions, maintenance personnel have also had access to the cockpit jumpseat in air operator’s operations but that access has come under scrutiny because of security concerns following the attacks of 9/11. Training of first-time captains has often included day trips to a operator's operations control or maintenance control centre where a pilot and a maintenance supervisor can meet face to face and discuss issues of mutual interest in a thrumming, real-life setting. Some operators have included maintenance personnel in LOFT sessions. Dedicated CRM training courses for maintenance personnel have been operating since 1991;

(d) Even broader cross-pollination of CRM concepts has been considered, using other groups such as passenger service agents, mid- and upper-level managers and special crisis teams like hijack and bomb-threat teams;

(e) Cabin crew are probably the most obvious of the groups other than pilots who may profit from CRM training. Joint CRM training for pilots and cabin crews has been practiced for years. One fruitful activity in joint training has been that each group learns of the other group's training in shared issues. The joint training has revealed inconsistencies between training for one group and training on the same topic for another group. Examples of shared issues include delays, the use of personal electronic devices in the cabin, and evacuation and ditching. When inconsistencies are identified between the contents of pilots' manuals and cabin crews' manuals, for instance, or between widely-held ideas or attitudes in those two populations, those inconsistencies are brought out into the open and often resolved. Other specific topics for joint training include:

(i) Pre-flight briefings;

(ii) Post incident/accident procedures;

(iii) Sterile cockpit procedures;

(iv) Notification procedures pre-takeoff and pre-landing;

(v) Procedures for turbulence and other weather;

(vi) Security procedures;

(vii) Passenger-handling procedures;

(viii) In-flight medical problems;

(ix) Smoke/fire procedures;

(x) Passenger-related regulations such as those relating to smoking (TTCAR No.2:213), exit row seating (TTCAR No.2:208), and carry-on baggage (TTCAR No.2:211);

(xi) Authority of the pilot in command.

(f) CRM principles are made more relevant for pilots, cabin crews, and other groups by treating those principles in a familiar job-related context. Furthermore, each group should benefit from concurrent training in CRM that is complemented by usable knowledge of the other's job;

(h) Communication and coordination problems between cockpit crewmembers and cabin crews continue to challenge air operators and Regulatory Agencies. Other measures with positive CRM training value for flightcrews are being considered, such as:

(i) Including cabin crew as participants during LOFT;

(ii) Scheduling month-long pairings of pilots and cabin crew; and

(iii) Providing experienced flight crewmembers to teach newly-hired cabin crew orientation classes.

(3) **Error Management**. It is now understood that pilot errors cannot be entirely eliminated. It is important, therefore, that pilots develop appropriate error management skills and procedures. It is certainly desirable to prevent as many errors as possible, but since they cannot all be prevented, detection and recovery from errors should be addressed in training. Evaluation of pilots should also consider error management (error prevention, detection, and recovery). Evaluation should recognize that since not all errors can be prevented, it is important that errors be managed properly.

(4) **Advanced Crew Resource Management**. CRM performance requirements or procedures are being integrated into the SOPs of certain air operators. Specific callouts, checks, and guidance have been included in normal checklists, the quick-reference handbook, abnormal/emergency procedures, manuals, and job aids. This integration captures CRM principles into explicit procedures used by flightcrews.

(5) **Culture Issues**. While individuals and even teams of individuals may perform well under many conditions, they are subject to the influence of at least three cultures--the professional cultures of the individuals themselves, the cultures of their organizations, and the national cultures surrounding the individuals and their organizations. If not recognized and addressed, factors related to culture may degrade crew performance. Hence, effective CRM training must address culture issues as appropriate in each training population.

SUMMARY

18. Effective Crew Resource Management begins in initial training; it is strengthened by recurrent practice and feedback, and it is sustained by continuing reinforcement that is part of the corporate culture and embedded in every stage of training.

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Ramesh Lutchmedial
Director General of Civil Aviation

APPENDIX 1 CREW PERFORMANCE MARKER CLUSTERS

1. Italicised Markers apply to Advanced Technology Cockpit. These behavioural markers are provided to assist organizations in programme and curriculum development and to serve as guidelines for feedback. They are not presented as a checklist for evaluating individual crewmembers.

COMMUNICATIONS PROCESSES AND DECISION BEHAVIOR CLUSTER

Briefings

2. (1) An effective briefing is interesting and thorough. It addresses coordination, planning, and problems. Although briefings are primarily a captain's responsibility, other crewmembers may add significantly to planning and should be encouraged to do so.

(2) Behavioural Markers. The following are charactertics of behavioural markers in briefings:

(a) The briefing establishes an environment for open/interactive communications (for example, the captain calls for questions or comments, answers questions directly, listens with patience, does not interrupt or "talk over," does not rush through the briefing, and makes eye contact as appropriate);

(b) The briefing is interactive and emphasizes the importance of questions, critique and the offering of information;

(c) The briefing establishes a "team concept" (for example, the captain uses "we" language, encourages all to participate and to help with the flight);

(d) The briefing covers pertinent safety and operational issues;

(e) The briefing identifies potential problems such as weather, delays, and abnormal system operations;

(f) The briefing provides guidelines for crew actions centered on SOPs; division of labour and crew workload is addressed;

(g) The briefing includes the cabin crew as part of the team;

(h) The briefing sets expectations for handling deviations from SOPs;

[i] The briefing establishes guidelines for the operation of automated systems (for example, when systems will be disabled; which programming actions must be verbalized and acknowledged);

[j] The briefing specifies duties and responsibilities with regard to automated systems for the pilot flying and pilot monitoring.

Inquiry/Advocacy/Assertion

3. (1) These behaviours relate to crewmembers' promoting the course of action that they feel is best, even when it involves conflict with others.

(2) Behavioural Markers. The following are charactertics of behavioural markers for Inquiry/Advocacy/Assertion;

(a) Crewmembers speak up and state their information with appropriate persistence until there is some clear resolution;

(b) "Challenge and response" environment is developed;

(c) Questions are encouraged and are answered openly and nondefensively;

(d) Crewmembers are encouraged to question the actions and decisions of others;

(e) Crewmembers seek help from others when necessary;

(f) Crewmembers question status and programming of automated systems to confirm situation awareness.

Crew Self-Critique Regarding Decisions and Actions

4. (1) These behaviours relate to the effectiveness of a group and/or an individual crewmember in critique and debriefing. Areas covered should include the product, the process, and the people involved. Critique may occur during an activity, and/or after completing it.

(2) Behavioural Marker. The following are charactertics of behavioural markers for Crew Self-Critique Regarding Decisions and Actions

(a) Critique occurs at appropriate times, which may be times of low or high workload;

(b) Critique deals with positive as well as negative aspects of crew performance;

(c) Critique involves the whole crew interactively;

(d) Critique makes a positive learning experience. Feedback is specific, objective, usable, and constructively given;

(e) Critique is accepted objectively and nondefensively.

Communications/Decisions

5. (1) These behaviours relate to free and open communication. They reflect the extent to which crewmembers provide necessary information at the appropriate time (for example, initiating checklists and alerting others to developing problems). Active participation in the decision making process is encouraged. Decisions are clearly communicated and acknowledged. Questioning of actions and decisions is considered routine.

(2) Behavioural Markers. The following are charactertics of behavioural markers for Communications/Decisions:

(a) Operational decisions are clearly stated to other crewmembers;

(b) Crewmembers acknowledge their understanding of decisions;

(c) "Bottom lines" for safety are established and communicated;

(d) The "big picture" and the game plan are shared within the team, including cabin crew and others as appropriate;

(e) Crewmembers are encouraged to state their own ideas, opinions, and recommendations.

(f) Efforts are made to provide an atmosphere that invites open and free communications;

[g] Initial entries and changed entries to automated systems are verbalized and acknowledged.

TEAM BUILDING AND MAINTENANCE CLUSTER

Leadership Followership/Concern for Tasks

6. (1) These behaviours relate to appropriate leadership and followership. They reflect the extent to which the crew is concerned with the effective accomplishment of tasks.

(2) Behavioural Markers. The following are charactertics of behavioural markers for Leadership Followership/Concern for Tasks:

(a) All available resources are used to accomplish the job at hand;

(b) Cockpit activities are coordinated to establish an acceptable balance between respect for authority and the appropriate practice of assertiveness;

(c) Actions are decisive when the situation requires;

(d) A desire to achieve the most effective operation possible is clearly demonstrated;

(e) The need to adhere to standard operating practices is recognized;

(f) Group climate appropriate to the operational situation is continually monitored and adjusted (for example, social conversation may occur during low workload, but not high);

(g) Effects of stress and fatigue on performance are recognized;

(h) Time available for the task is well managed;

[i] Demands on resources posed by operation of automated systems are recognized and managed;

[j] When programming demands could reduce situation awareness or create work overloads, levels of automation are reduced appropriately.

Interpersonal Relationships/Group Climate

7. (1) These behaviours relate to the quality of interpersonal relationships and the pervasive climate of the cockpit.

(2) Behavioural Markers. The following are charactertics of behavioural markers for Interpersonal Relationships/Group Climate

(a) Crewmembers remain calm under stressful conditions;

(b) Crewmembers show sensitivity and ability to adapt to the personalities of others;

(c) Crewmembers recognize symptoms of psychological stress and fatigue in self and in others (for example, recognizes when he/she is experiencing "tunnel vision" and seeks help from the team; or notes when a crewmember is not communicating and draws him/her back into the team);

(d) "Tone" in the cockpit is friendly, relaxed, and supportive;

(e) During times of low communication, crewmembers check in with others to see how they are doing.

WORKLOAD MANAGEMENT AND SITUATION AWARENESS CLUSTER

Preparation/Planning/Vigilance

8. (1) These behaviours relate to crews' anticipating contingencies and the various actions that may be required. Excellent crews are always "ahead of the curve" and generally seem relaxed. They devote appropriate attention to required tasks and respond without undue delay to new developments. (They may engage in casual social conversation during periods of low workload and not necessarily diminish their vigilance.)

(2) Behavioural Markers. The following are charactertics of behavioural markers for Preparation/Planning/Vigilance:

(a) Demonstrating and expressing situation awareness; (for example, the "model" of what is happening is shared within the crew);

(b) Active monitoring of all instruments and communications and sharing relevant information with the rest of the crew;

(c) Monitoring weather and traffic and sharing relevant information with the rest of the crew;

(d) Avoiding "tunnel vision" caused by stress; (for example, stating or asking for the "big picture);"

(e) Being aware of factors such as stress that can degrade vigilance and watching for performance degradation in other crewmembers;

(f) Staying "ahead of the curve" in preparing for planned situations or contingencies, so that situation awareness and adherence to SOPs are assured;

(g) Ensuring that cockpit and cabin crewmembers are aware of plans;

(h) Including all appropriate crewmembers in the planning process;

(i) Allowing enough time before manoeuvres for programming of the flight management computer;

(j) Ensuring that all crewmembers are aware of initial entries and changed entries in the flight management system.

Workload Distributed/Distractions Avoided

9. (1) These behaviours relate to time and workload management. They reflect how well the crew manages to prioritise tasks, share the workload, and avoid being distracted from essential activities.

(2) Behavioural Markers. The following are charactertics of behavioural markers for Workload Distributed /Distractions Avoided

(a) Crewmembers speak up when they recognize work overloads in themselves or in others;

(b) Tasks are distributed in ways that maximize efficiency;

(c) Workload distribution is clearly communicated and acknowledged;

(d) Nonoperational factors such as social interaction are not allowed to interfere with duties;

(e) Task priorities are clearly communicated;

(f) Secondary operational tasks (for example, dealing with passenger needs and communications with the company) are prioritised so as to allow sufficient resources for primary flight duties;

[g] Potential distractions posed by automated systems are anticipated, and appropriate preventive action is taken, including reducing or disengaging automated features as appropriate.

APPENDIX 2 LOFT DEBRIEFING PERFORMANCE INDICATORS

1. (1) The effective Line-Oriented Flight Training (LOFT) facilitator leads the flightcrew through a self-critique of their own behaviour and of their crew performance during the simulation. The debriefing and crew analysis include both technical and CRM discussion topics. Positive points of crew performance are discussed, as well as those needing improvement. At the conclusion of the session, key learning points are summarized covering all participants, including the instructor. A strong sense of training accomplishment and learning is taken away from the session.

(2) The following performance markers may be used to evaluate the LOFT facilitator's performance in the debrief/critique phase of LOFT.

(a) Actively states the debriefing and critique agenda and solicits topics from the crew on items that they would like to cover; sets time limits;

(b) Asks the crew for their appraisal of the mission overall;

(c) States his/her own perceptions of the LOFT while guarding against making the crew defensive. Comments are as objective as possible and focus on performance;

(d) Shows appropriate incidents using videotape of the LOFT session, including examples of technical and CRM performance, and selects tape segments for discussion illustrating behaviours that feature the crew performance markers;

(e) Effectively blends technical and CRM feedback in the debriefing; does not preach to the crew, but does not omit items worthy of crew discussion;

(f) Is patient, and is constructive in probing into key areas where improvement is needed;

(g) Ensures that all crewmembers participate in the discussion, and effectively draws out quiet or hostile crewmembers;

(h) Provides a clear summary of key learning points;

(i) Asks the crew for specific feedback on his/her performance;

(j) Is effective in both technical and CRM debriefing.

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APPENDIX 3 APPROPRIATE CRM TRAINING TOPICS --

1. BACKGROUND INFORMATION.

(a) Findings coming from accident investigations have consistently pointed to the fact that human errors contribute to most aviation accidents;

(b) Research findings suggest that CRM training can result in significant improvements in flightcrew performance. CRM training is seen as an effective approach to reducing human errors and increasing aviation safety;

(c) Aviation safety information is readily available through the World Wide Web. Many websites contain valuable source materials and reference materials that may be helpful in developing CRM training. Websites commonly link to other websites containing related material. Aviation related websites maintained by U. S. Government agencies include the following:

(i) National Aeronautics and Space Administration (NASA), http://www.nasa.gov.;

(ii) National Transportation Safety Board (NTSB), http://www.ntsb.gov.;

(iii) Federal Aviation Administration (FAA), http://www.faa.gov.;

2. TRAINING TOPICS, PRINCIPLES, AND TECHNIQUES. It is recommended that CRM training include the curriculum topics described in paragraph 11 of the TAC and the following topics, principles, and techniques:

(a) Theory and practice in using communication, decision making, and team building techniques and skills;

(b) Theory and practice in using proper supervision techniques, i.e., captains working with first officers;

(c) Theory and practice in selecting and using interventions needed to correct flying errors made by either pilot, especially during critical phases of flight. These interventions may include, but not be limited to, communication, assertion, decision making, risk assessment, and situation awareness skills;

(d) During Line Operational Simulation training, information, and practice of nonflying pilot functions, i.e., monitoring and challenging pilot functions, and monitoring and challenging errors made by other crewmembers for flight engineers, first officers, and captains. Training will alert flightcrews of hazards caused by tactical decision errors which are actually errors of omission. Practice in monitoring, challenging, and mitigating errors, especially during taxi operations, should be included. These skills are important to minimize procedural errors that may occur as a result of inadequately performed checklists;

(e) Training for check airmen in methods which can be used to enhance the monitoring and challenging functions of both captains and first officers. The check airmen training should include the message that appropriate questioning among pilots is a desirable CRM behaviour and part of the corporate safety culture; further, that such questioning is encouraged, and that there will be no negative repercussions for appropriate questioning of one pilot's decision or action by another pilot;

(f) Training for new first officers in performing the nonflying pilot role to establish a positive attitude toward monitoring and challenging errors made by the flying pilot. Training should stress that appropriate questioning is encouraged as a desirable CRM behaviour, and that there will be no negative repercussions for appropriate questioning of one pilot's decision or action by another pilot;

(g) Training for captains in giving and receiving challenges of errors. Training should stress that appropriate questioning is encouraged as a desirable CRM behaviour, and that there will be no negative repercussions for appropriate questioning of one pilot's decision or action by another pilot;

(h) Factual information about the detrimental effects of fatigue and strategies for avoiding and countering its effects;

(i) Training for crewmembers which identifies conditions in which additional vigilance is required, such as holding in icing or near convective activity. Training should emphasize the need for maximum situation awareness and the appropriateness of sterile cockpit discipline, regardless of altitude;

(j) Training that identifies appropriate levels of automation to promote situation awareness and effective management of workload;

(k) Use of autopilot in in-flight icing. All flightcrew members should clearly understand their aircraft's susceptibility to in-flight icing and should monitor in-flight ice accretion by all means available. One effective means of monitoring ice accretion might be to disconnect the autopilot at intervals, if doing so is consistent with the approved procedures contained in the airplane flight manual;

(l) Training for crewmembers in appropriate responses when passengers intimidate, abuse, or interfere with crewmember performance of safety duties. Training should address crew coordination and actions, which might defuse the situation. Training should include specific communication topics, such as conflict resolution, with particular attention to the most serious passenger interference – attempted hijack;

(m) Line-oriented flight training (LOFT) or special purpose operational training (SPOT) for cockpit crewmembers, which addresses appropriate responses to the effects of pitot-static system anomalies, such as a blocked pitot tube. Emphasis should be on situation awareness, inquiry/advocacy/assertion, and crew coordination, when flight instruments act abnormally;

(n) LOFT or SPOT for cockpit crewmembers that contain a controlled flight into terrain scenario. Emphasis should be on prevention through effective communication and decision behaviour. The importance of immediate, decisive, and correct response to a ground proximity warning should also be addressed;

(o) Training for pilots in recognizing cues that indicate lack or loss of situation awareness in themselves and in others, and training in countermeasures to restore that awareness. Training should emphasize the importance of recognizing each pilot's relative experience level, experience in specific duty positions, preparation level, planning level, normal communication style and level, overload state, and fatigue state. Pilots should assess these characteristics actively and continuously, in their fellow crewmembers and in themselves. Training should also emphasize the importance that improper procedures, adverse weather, and abnormal or malfunctioning equipment may have in reducing situation awareness. "Guidelines for Situation Awareness Training" contains expanded guidance on cues and countermeasures, and may by viewed or downloaded from the FAA web page at http://www.faa.gov/avr/afs/train.htm.;

(p) Training in communication of time management information among flightcrew and cabin crewmembers during an emergency. Training should stress that the senior or lead cabin crew member can effectively brief other cabin crew and passengers and prepare the cabin only if the time available in the emergency is clearly communicated by the flightcrew. Other information elements that are vital in effective time management are the nature of the emergency and any special instructions relating to the planned course of action.

3. APPROPRIATE TRAINING INTERVENTIONS.

(1) The most effective CRM training involves active participation of all crewmembers. LOFT sessions give each crewmember opportunities to practice CRM skills through interactions with other crewmembers. If the training is videotaped, feedback based on crewmembers' actual behaviour, during the LOFT, provides valuable documentation for the LOFT debrief.

(2) CRM training can be presented using a combination of the following training interventions:

(a) Operator in-house courses;
(b) Training center courses;
(c) Special Purpose Operational Training;
(d) LOFT sessions;
(e) Computer Based Training courses.

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RELATED READING MATERIAL

a. International Civil Aviation Organization (ICAO) Annex 13 on Human Factors. This document may be obtained from ICAO Document Sales Unit, Montreal, Quebec, Canada, 514-954-8022;

b. For detailed information on the recommendations made in this TAC, the reader is encouraged to review Crew Resource Management: An Introductory Handbook published by FAA (Document No. DOT/FAA/RD-92/26). Additional background material can be found in Cockpit Resource Management Training: Proceedings of a NASA/MAC Workshop, 1987. The National Aeronautics and Space Administration (NASA) Conference Proceedings (CP) number is 2455. The National Plan for Aviation Human Factors defines research issues related to crew coordination and training. Copies of the preceding publications may be purchased from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161. The telephone numbers for National Technical Information Service are voice - (800) 553-NTIS[6847], and (703) 605-6000; fax (703) 605-6900;

c. AC 120-35B, Line Operational Simulations: Line-Oriented Flight Training, Special Purpose Operational Training, Line Operational Evaluation;

d. AC 120-48, Communication and Coordination Between Flight Crewmembers and Cabin Crew;

e. AC 120-54, Advanced Qualification Programme;

f. AC 120-71, Standard Operating for Flightdeck Crewmembers;

g. AC 121-32, Dispatch Resource Management Training;

h. Guidelines for Situation Awareness Training, NAWCTSD/FAA/UCF Partnership for Aviation Team Training. this document may be viewed, downloaded, or printed at the following website: http://www.faa.gov/avr/afs/train.htm.;

i. Controlled Flight into Terrain Education and Training Aid, Flight Safety Foundation, International Civil Aviation Organization (ICAO), and the Federal Aviation Administration (FAA). This document may be viewed, downloaded, or printed at the following website: http://www.faa.gov/avr/afs/train.htm;

j. Descriptions of relevant research findings, methodological issues, and organizational experience can be found in Helmreich, R.L., and Wilhelm, J.A., (1991) "Outcomes of CRM Training," International Journal of Aviation Psychology, 1, 287-300; in Helmreich, R.L., and Foushee, H.C., "Why Crew Resource Management: Empirical and Theoretical Bases of Human Factors Training in Aviation"; in Orasanu, J., "Decision making in the Cockpit"; and in Gregorich, S.E., and Wilhelm, J.A., "Crew Resource Management Training Assessment." Each of the preceding appears as a chapter in E.L. Wiener, B.G. Kanki, and R.L. Helmreich (Eds.), (1993), "Cockpit Resource Management," Academic Press, Orlando, FL. For more detail on certain evolving concepts of CRM:

(1) Error management, see: "Human Error," J.T. Reason. New York: Cambridge University Press, 1990. Also, "Managing the Risks of Organizational Accidents," J.T. Reason, Brookfield, VT, Ashgate Publishing, 1997;

(2) Advanced crew resource management, see: "Developing Advanced Crew Resource Management (ACRM) Training: A Training Manual," Seamster, Boehm-Davis, Holt, Schultz, 8-1-98. http://www.hf.faa.gov/products/dacrmt/dacrmt.html;

(3) Culture issues, see: "Culture, Error, and Crew Resource Management," book chapter from "Applying Resource Management in Organizations: A Guide for Professionals," in press. (Helmreich, Wilhelm, Klinect, and Merritt) http://www.psy.utexas.edu/psy/helmreich/nasaut.htm;

(4) Situation awareness, see: "Cockpit Distractions and Interruptions," Dismukes, Young, Sumwalt, December, 1998. http://asrs.arc.nasa.gov/directline_issues/dl10_distract.htm;

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