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Procedures for
Air Navigation Services

Training

First Edition — 2006

International Civil Aviation Organization

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the supplements to the *Catalogue of ICAO Publications and Audio-visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

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FOREWORD

1. Introduction

1.1 This edition of the *Procedures for Air Navigation Services — Training* (PANS-TRG) was prepared by the Flight Crew Licensing and Training Panel (FCLTP) and contains material that provides for the uniform implementation of the training required for the pilot licences and ratings found in Annex 1, including the multi-crew pilot licence (MPL).

1.2 The FCLTP, at its first meeting (Montreal, 8 to 19 December 2003), identified a clear need for licensing and training material that, although too detailed to take the form of Standards, was of sufficient importance to provide universal benefit to States. The need called for material that had to be harmonized and subjected to a formal consultation and approval process and that called for a higher level of adherence on the part of States than that required of guidance material. The FCLTP determined that the establishment of the PANS-TRG would be the appropriate document for use by all States.

2. Scope and purpose

2.1 The *Procedures for Air Navigation Services — Training* (PANS-TRG) are complementary to the Standards and Recommended Practices (SARPs) contained in Annex 1 — Personnel Licensing.

2.2 The PANS-TRG specifies, in greater detail than in the SARPs, the actual procedures to be applied by training organizations in providing training for aeronautical personnel. The current edition contains, in particular, procedures for the development and implementation of a competency-based training programme for the MPL to support Annex 1 requirements.

3. Status

3.1 The Procedures for Air Navigation Services (PANS) do not have the same status as SARPs. While the latter are *adopted* by Council in pursuance of Article 37 of the Convention on International Civil Aviation and subject to the full procedure of Article 90, the PANS are *approved* by the Council and recommended to Contracting States for worldwide application.

3.2 While the PANS may contain material that may eventually become SARPs when it has reached the maturity and stability necessary for adoption as such, it may also comprise material prepared as an amplification of the basic principles in the corresponding SARPs and designed particularly to assist the user in the application of those SARPs.

4. Implementation

The implementation of procedures is the responsibility of Contracting States; they are applied in actual training only after, and in so far as, States have enforced them.

However, with a view to facilitating their processing towards implementation by States, they have been prepared in language that will permit direct use by the personnel of approved training organizations and others associated with the development and implementation of a training programme for the multi-crew pilot licence.

5. Publication of differences

5.1 The PANS do not carry the status afforded to Standards adopted by the Council as Annexes to the Convention and, therefore, do not fall under the obligation imposed by Article 38 of the Convention to notify differences in the event of non-implementation. Attention of States is drawn, however, to the provision in Annex 15 related to the publication, in their Aeronautical Information Publications, of lists of significant differences between their procedures and the related ICAO procedures.

5.2 The ICAO course development methodology is based on the Instructional Systems Design (ISD) model used for much of the competency-based training material in this document. It is, however, acknowledged that there are a variety of ISD models that may be equally appropriate and that States may wish to apply in the development of competency-based training. It might also be the case that no single methodology has all the elements needed and that a number of methodologies will have to be drawn upon for the design of a particular course. In addition, methodological prescriptions are counter-productive, as all training methodologies should display the flexibility and adaptability needed to accommodate changes in training circumstances, goals and technology. For this reason, differences in the systems approach methodologies and models used for the design of competency-based training need not be published, so long as the methodologies contain the ISD elements that govern the three basic procedural steps of a needs analysis, design and production, and evaluation.

6. Contents of the document

6.1 Chapter 1 — Definitions

This chapter contains a list of terms and their technical meanings as used in this document. In some cases, the terms are defined in other ICAO documents.

6.2 Chapter 2 — General provisions for competency-based training and assessment

6.2.1 This chapter outlines the general principles and procedures to be followed in the design and implementation of a competency-based approach to training and assessment. It outlines its key features and describes how the competency-based approach is to be used by course developers, instructors, and examiners.

6.2.2 Developments in the late 1950s and 1960s in the application of systems engineering methodologies, such as ISD and the Systems Approach to Training (SAT), to the design of training curricula resulted in the implementation of structured, performance-based training programmes. Competency-based training also evolved from later developments in mastery learning and criterion-referenced testing, whereby knowledge and skills had to be demonstrated at levels that met the entry-level occupational requirements and

assessments had to be based on observable behaviours or outcomes. The 1970s saw the widespread use of competency-based principles in both vocational and technical education and training in the United States which, by the 1980s and 1990s, had spread to Europe and to other parts of the world.

6.2.3 A description of the ICAO course development methodology is provided in the Attachment to Chapter 2. Since, as mentioned in 5.3, several other ISD methodologies are available, the purpose of this document is not to prescribe the specific methodology to be used. Instead, it outlines the elements to be included in the procedural steps that constitute ISD methodology in general and how to apply them to the design of a competency-based flight training programme.

6.3 Chapter 3 — Competency-based training and licensing for the Multi-Crew Pilot Licence (MPL)

This chapter outlines the principles and procedures that are applicable to the development and implementation of an MPL course and that shall be followed in addition to those outlined in Chapter 2. Chapter 3 also contains the competency units, competency elements and performance criteria developed for the MPL. Attachment A to Chapter 3 contains guidance material on the design and development of an MPL training programme; Attachment B contains examples of training objectives.

6.4 Chapter 4 — Instructor, examiner, inspector and course developer competencies

Annex 1 contains Standards for the issuance of the flight instructor rating and for granting authorizations to simulator instructors. Chapter 4 of this document and its Attachment contain the qualifications to be held, and the competencies to be demonstrated, by those instructors, examiners, inspectors and course developers employed in a competency-based MPL training programme. In competency-based programmes, instructor competencies are made explicit, and instructors have to demonstrate their instructional skills and their knowledge of the subject matter and training course content. Instructor competencies relative to flight simulation and the delivery of simulator-based training are also essential where extensive use is made of flight simulation training devices. Examiners and inspectors must demonstrate competencies in competency-based assessment techniques.

Table A. Amendments to the PANS-TRG

Amendment	*Source(s)*	*Subject(s)*	*Approved* *Applicable*
1st Edition (2006)	Flight Crew Licensing and Training Panel (2005)	*Procedures for Air Navigation Services — Training* (PANS-TRG)	19 July 2006 23 November 2006

Chapter 1. DEFINITIONS

When the following terms are used in this document, they have the following meanings:

Assessment (Evidence) guide. A guide that provides detailed information (e.g. tolerances) in the form of evidence that an instructor or an evaluator can use to determine whether a candidate meets the requirements of the competency standard.

Competency. A combination of skills, knowledge and attitudes required to perform a task to the prescribed standard.

Competency-based training and assessment. Training and assessment that are characterized by a performance orientation, emphasis on standards of performance and their measurement, and the development of training to the specified performance standards.

Competency element. An action that constitutes a task that has a triggering event and a terminating event that clearly defines its limits, and an observable outcome.

Competency unit. A discrete function consisting of a number of competency elements.

Criterion-referenced test. A test, the measurement of which is compared with an objective standard (and not against another measurement).

Error. An action or inaction by the flight crew that leads to deviations from organizational or flight crew intentions or expectations.

Error management. The process of detecting and responding to errors with countermeasures that reduce or eliminate the consequence of errors and mitigate the probability of further errors or undesired aircraft states.

Note.— See Attachment C to Chapter 3 for a description of undesired aircraft states.

Event. A combination of a task or a sub-task and the conditions under which the task or sub-task is to be performed.

Material-dependent training. A well-documented and repeatable training package that has been tested and proven to be effective.

Performance criteria. Simple, evaluative statements on the required outcome of the competency element and a description of the criteria used to judge whether the required level of performance has been achieved.

Range of variables (conditions). The conditions under which the competency units must be performed.

Scenario (event-set). Relatively independent segment of training made up of several events.

Threat. Events or errors that occur beyond the influence of the flight crew, increase operational complexity and must be managed to maintain the margin of safety.

Threat management. The process of detecting and responding to threats with countermeasures that reduce or eliminate the consequences of threats and mitigate the probability of errors or undesired aircraft states.

Note.— See Attachment C to Chapter 3 for a description of undesired aircraft states.

Training objective. A clear statement that is comprised of three parts, i.e. the *desired performance* or what the trainee is expected to be able to do at the end of training (or at the end of particular stages of training), the *performance standard* that must be attained to confirm the trainee's level of competence, and the *conditions* under which the trainee will demonstrate competence.

Chapter 2. GENERAL PROVISIONS FOR COMPETENCY-BASED TRAINING AND ASSESSMENT

2.1 Introduction

Chapter 2 outlines the requirements that training organizations and Licensing Authorities need to comply with in order to implement competency-based training and assessment.

2.2 Competency-based approach to training and assessment

2.2.1 The development of competency-based training and assessment shall be based on a systematic approach whereby competencies and their standards are defined, training is based on the competencies identified, and assessments are developed to determine whether these competencies have been achieved.

2.2.2 Competency-based approaches to training and assessment shall include at least the following features:

a) the justification of a training need through a systematic analysis and the identification of indicators for evaluation;

b) the use of a job and task analysis to determine performance standards, the conditions under which the job is carried out, the criticality of tasks, and the inventory of skills, knowledge and attitudes;

c) the identification of the characteristics of the trainee population;

d) the derivation of training objectives from the task analysis and their formulation in an observable and measurable fashion;

e) the development of ***criterion-referenced***, valid, reliable and performance-oriented tests;

f) the development of a curriculum based on adult learning principles and with a view to achieving an optimal path to the attainment of competencies;

g) the development of ***material-dependent*** training; and

h) the use of a continuous evaluation process to ensure the effectiveness of training and its relevance to line operations.

Note.— A detailed description of the ICAO course development methodology, a competency-based approach to training and assessment and an example of an ISD methodology, can be found in the Attachment to Chapter 2.

2.2.3 Licensing Authorities shall develop general requirements concerning the management of examiners and provide guidance on:

a) the selection of examiners and description of competency-based assessment training;

b) the performance criteria to be considered by the examiner when assessing each competency; and

c) the tolerances applicable to all competency-based tests.

2.3 The competency framework

2.3.1 The competency framework consists of ***competency units***, ***competency elements***, ***performance criteria***, ***evidence and assessment guide*** and ***range of variables***. The competency framework for flight crew shall be based on the following competency units:

1. Apply threat and error management principles
2. Perform ground and pre-flight operation
3. Perform take-off
4. Perform climb
5. Perform cruise
6. Perform descent
7. Perform approach
8. Perform landing
9. Perform after-landing and post-flight operation

2.3.2 Competency units, competency elements and performance criteria shall be derived from job and tasks analysis of flight crew and shall describe observable outcomes.

Note.— Definitions of competency units, competency elements and performance criteria are provided in Chapter 1.

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Attachment to Chapter 2
AN EXAMPLE OF AN ISD METHODOLOGY: THE ICAO COURSE DEVELOPMENT METHODOLOGY

1. Introduction

1.1 The ICAO course development methodology, like any other ISD methodology, uses a systematic approach to training development. It therefore constitutes a quality assurance tool for ATOs that supports compliance with requirements and the development of appropriate training activities. It does so by identifying the key competencies that need to be achieved, determining the most effective way of achieving them and establishing valid and reliable assessment tools to evaluate their achievement.

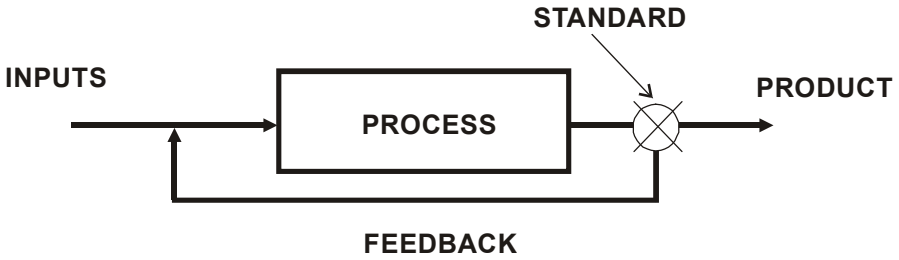
1.2 Such a tool, however, cannot be effectively implemented without the support of all stakeholders. Stakeholders include personnel involved in management, instruction design, instruction delivery, instruction assessment, licensing, operations and, of course, trainees. Successful implementation of competency-based training and assessment depends to a large extent on the support of this systematic approach at all levels of an organization.

1.3 The ICAO course development methodology has three broad categories — analysis, design and production, and evaluation — which can be subdivided into nine phases. A brief description of the specific outputs of the nine phases is summarized in the following table and a more detailed description of each phase's process is provided below.

Category	*Phases*	*Outputs*
ANALYSIS	Phase 1 — Preliminary study	Training proposals, their justification and proposed course of action
	Phase 2 — Job analysis	Task description and performance standards
	Phase 3 — Population analysis	Trainees' characteristics and their existing skills and knowledge
DESIGN AND PRODUCTION	Phase 4 — Design of curriculum	Training objectives, mastery tests and sequence of modules
	Phase 5 — Design of modules	Mode of delivery, training techniques and media, draft training material
	Phase 6 — Production and developmental testing	Production of all trainee materials
EVALUATION	Phase 7 — Validation and revision	Try-out of course and revision as required
	Phase 8 — Implementation	Human resources trained
	Phase 9 — Post-training evaluation	Evaluation of training effectiveness; plans for remedial action

2. Phase 1 — Preliminary study

2.1 The purpose of this phase is to provide management with the information needed to make a decision whether training is required and, if so, what training strategy to use. It consists of two sets of related activities: a problem analysis and a training requirement analysis. Often a job performance problem is detected. In order to accurately define a problem, a systems approach is used whereby symptoms, system or systems affected, and causes are identified.



2.2 A problem is defined by its symptoms and symptoms can be defined as differences between desired and actual performance. Before a symptom can be meaningfully described, it is necessary to determine the “desired standard of performance”. The “desired standard of performance” should be interpreted as the product standard or process standard of a system against which we compare the actual product/process. It follows that a symptom is generated when the users/customers of the product/process of a system, or other interested persons, recognize this difference and send a message of disagreement or alert (feedback component of the system). Therefore, a symptom is a consequence of a performance problem affecting the product/process of the system.

2.3 Causes of performance problems are directly linked to the *inputs* and *processes* of the system under analysis. Causes may be external; inputs that come from other systems or sub-systems are not appropriate. Causes may also be internal, a part of the process itself.

2.4 Identifying the system affected is key to clearly defining performance problems. It not only points to training solutions but also non-training solutions that could be applied. Usually, the system affected is linked to other systems or sub-systems that have to be considered in the analysis.

2.5 The systems approach is also very useful when designing a new system. The selection of an appropriate location for the new system in the overall organizational structure is very important in terms of its interrelation with other systems/sub-systems.

2.6 Once the problem is clearly defined, it may be deemed necessary to develop new competency-based training, arrange for alternative training or proceed with non-training approaches. If new competency-based training is to be developed, then a training development plan should be established that includes the details of the resources required. Often, the preliminary analysis will show that there is not a single solution to a problem but that a combination of several solutions is preferable.

2.7 If a decision is made that competency-based training should be developed, decisions are then made on potential modes of delivery; for example, should training be based on validated competency-based training materials or be left to the judgement of the instructor? Should the instruction be individualized or given in a group?

2.8 Validated competency-based training material takes the form of a well-documented and repeatable package that has been tested and shown to be effective. A validated course is said to be material-dependent as opposed to instructor-dependent**.** The former is the predominant form used in ICAO course development, but instructor-dependent training should not be ruled out in certain specific and limited areas (such as training a very small number of specialist technicians on new equipment). Usually this decision is made once for the whole course of training.

2.9 In some circumstances, organizations may find it useful to evaluate the effectiveness of a proposed solution. This can be done by using cost benefit or risk management analysis. If a training course or programme is to be developed, a plan for subsequently evaluating the actual benefits resulting from the training after it has been implemented should also be foreseen.

3. Phase 2 — Job analysis

3.1 Training should be designed so that it enables all qualified trainees to perform their tasks at acceptable levels of competence. Job analysis can define these levels. It is important that the focus of training courses be towards enabling employees to competently perform tasks, and not only “learn about” or “understand” the subject matter. The purpose of job and task analysis is twofold: to gather information on how, where and with what information a job is done in order to define the skills, knowledge and attitudes (SKAs) required, and to determine the job performance objectives.

3.2 The main steps of a job and task analysis consist of :

1) collecting and analysing existing relevant documentation and information from the field;

2) obtaining a consensus among subject matter experts regarding job performance standards;

3) checking the validity of the analysis; and

4) reviewing the information. The most appropriate subject matter experts are master performers.

In Step 2), a technique that has been found particularly successful is known as a DACUM session (develop a curriculum). This is a form of controlled brainstorming between two or three subject matter experts guided by the course development team. By systematically extracting a consensus of opinion on the job, errors and omissions are avoided. During Step 3), direct observations and interviews on the job complement the results of the DACUM session in Step 2. In Step 4, the holders of the job may discover alternative ways of carrying out certain tasks, which may prove more effective. If so, the task analysis should be revised and reviewed by subject matter experts.

3.3 A job can be broken down into a number of functions. A function represents a major subdivision of a job with a distinct identity. One function may be common to several jobs. Each function can be broken down into a number of operations which, depending on the level of detail, are called tasks, sub-tasks or task elements. The result of a function is observed and measured through the results of the tasks that constitute it.

3.4 A task can be considered as a system with inputs, process, standards, outputs/products and feedback. The characteristics of a task are listed below against system components:

System component	***Task characteristics***
Inputs	A triggering event Equipment, tools, job aids, documentation, references
Process	Perform all necessary steps (i.e. sub-tasks) to achieve the output/product. It should be worded with an active verb.
Output/product	A measurable and observable result of the process A terminating event
Product standard	A specification of what the output should look like
Feedback	Result of the comparison between product and standard. If the result is compliant with the standard, the terminating event of the task has been reached. If not, the task process has to be started again until the product meets the standard.

3.5 A sub-task is a single step in the process of a task; it is measurable and observable and requires the use of several SKAs. The process standard is the sequence and correct performance of each sub-task. The validity of each task process (sequence of sub-tasks) is established with a subject matter expert.

3.6 It is often difficult to tell whether an activity should be called a function or a task, a sub-task or a task element. Frequently, the same activity would be labelled differently depending on the context. The main objective of this phase is to describe operations in a way that will be helpful when carrying out the subsequent phases of course development.

3.7 The SKAs are what a performer requires to perform a sub-task i.e. underlying knowledge (recall), underlying cognitive skills (classifying, problem-solving, rule-using, etc.), psycho-motor skills and attitudes.

3.8 Task analysis is not necessarily required for all tasks. It is required, however, for all tasks that are critical. The criticality of a task can be determined through consideration of the following factors:

a) Importance: can be determined by asking the question: How serious are the consequences if the tasks are performed incorrectly or not performed at all?

b) Difficulty: can be determined by asking the question: How frequently do employees make performance errors?

c) Frequency: can be described through the specification of a mean time between execution of the task.

Tasks that are found critical will be emphasized during training; therefore, all relevant information is required for them.

3.9 Other data are also gathered during task analysis for a given task, such as the triggering and terminating event, a description of how the task should be carried out, the SKAs that are needed, any special difficulty in performing the task, the inputs needed to carry out the task (environmental conditions, equipment, documentation, etc.), and the standard required to evaluate job performance. A performance standard clearly distinguishes between correct or acceptable performance and incorrect or unacceptable performance. If it can be observed and measured, the product standard describes the expected output of a task. A process standard specifies the way a task should be performed and provides a means to evaluate performance even if there is no output.

3.10 The method described above for task analysis is widely and commonly used but other methods do exist. Two such methods are:

a) *Cognitive task analysis* — This method was developed to address the increasing shift to cognitive skills in job performance. The job of flight crews can be considered to have strong cognitive components. The purpose of cognitive task analysis is to outline the mental processes and skills needed to perform a task at a high proficiency level. While cognitive task analysis methods are resource-intensive, they can supplement generic task analysis methods. As a detailed description of the methods and techniques involved in cognitive task analysis is beyond the scope of this document, readers may wish to consult the reference list provided at the end of this attachment.

b) *Team task analysis* — While generic task analysis focuses on an individual's performance, work in more sophisticated and complex environments is increasingly carried out in teams. Team task analysis methods are used to identify critical teamwork behaviours. A detailed description of the methods and techniques developed to date for team task analysis is beyond the scope of this document. Readers may consult the reference list for additional material.

4. Phase 3 — Population analysis

4.1 The purpose of this phase is to study the target population (future trainees) with a view to identifying the SKAs that they already have and to collecting information on preferred learning styles and on the social and linguistic environments of prospective trainees, all of which could have an impact on the training design.

4.2 The target population may be a mixture of experienced and newly recruited personnel, groups differing in age, etc. All this information is important for determining the SKAs already possessed by the target population and for designing the most appropriate programme of instruction.

4.3 This mixture of experience may be accommodated through a modular training design, which is more flexible than a "traditional system". In a modular system, each major task would require a module containing clear performance objectives, exercises, handouts and tests. The modular system would be designed in such a way that trainees would enter the course at the level where they cannot pass the exercises and tests.

4.4 Population analysis is also an opportunity to initiate a dialogue with members of the target population so they can voice attitudes to be taken into account in the design of the

training. This dialogue should be maintained throughout training to ensure that due regard is taken of the learning problems, reactions and attitudes of those receiving the instruction. This dialogue is valuable not only for the information it provides but also for the positive attitudes that it helps to create among the trainees because they are being consulted and know that their needs are being considered.

5. Phase 4 — Design of curriculum

5.1 Steps for curriculum development

The steps to carry out curriculum development are to:

a) determine the use of job aids;
b) restate the aim of the training;
c) derive terminal objectives from tasks identified in Phase 2;
d) outline a competency-based mastery test for each terminal objective;
e) list relevant enabling objectives for each terminal objective;
f) check that all skills, knowledge and attitude requirements for the job are covered by the objectives;
g) determine possible similarities in enabling objectives;
h) sequence all objectives; and
i) group the objectives into training modules and sequence the modules.

5.2 Job aids or training as solutions

5.2.1 The first step of this phase is to determine whether the skills, knowledge or attitudes needed are best provided by the development of job aids, or training, or both. A job aid is any device made available on the job and designed to facilitate correct performance of the task by extending the performer's capability to retain and utilize information (e.g. numerical tables, checklists, guidelines, and forms). A job aid is less costly to develop than training, and implementation costs are usually very small. Sometimes a job aid is preferable to training, not on grounds of costs but in terms of effectiveness. The focus should be on providing only that training for which job aids cannot be substituted.

5.2.2 The preparation of job aids is a particularly good solution for tasks involving many simple operations or procedures that can be completely described. Job aids are also useful for tasks that are performed infrequently, require a high degree of accuracy but not speed, comprise many decision points which must be performed in a definite sequence, and are subject to frequent changes.

5.3 Definition of training objectives

5.3.1 The main purpose of Phase 4 is to provide detailed information on what the training is intended to achieve, i.e. the training objectives, and how this achievement will be tested. The objectives will describe what the trainees must be able to do after training. Objectives should be expressed in terms of measurable performance (what specific concrete results are to be achieved).

5.3.2 Every training objective should include descriptions of the desired performance or behaviour of the trainee after training, the conditions under which the trainee is to perform the task, and the standards that describe how the trainee should perform the task.

5.3.3 The overall purpose of the training already specified in Phase 1 will require several types of objectives. A given course will have several terminal objectives, each one corresponding to a task. Each terminal objective, in turn, will have several enabling objectives, which describe the desired performance for sub-tasks. Finally, post-training objectives describe what the trainee should be able to do after a defined period of practice on the job.

5.4 Design of competency-based assessments

5.4.1 Another purpose of Phase 4 is to prepare valid and reliable tests that will measure whether or not the training objectives have been achieved. In order for tests to be effective, they must be valid and reliable. A test is valid when it measures what it sets out to measure. The more closely a test matches a performance objective, the more valid it is. A reliable test is one that will obtain consistent results when administered by different instructors. More precisely, a reliable test will allow several instructors to come up with the same evaluation on trainees' performances. This implies that instructors have clear instructions on how to administer the test, and precise and unambiguous evaluation instruments (score key).

5.4.2 The use of criterion-referenced tests is advocated in the ICAO course development methodology. When the performance of a trainee is compared to other trainees, and a judgement is made based on this comparison, this is a norm-referenced test. When, for example, students are ranked based on their performance in reference to each other, this is in fact a norm-referenced evaluation. When a measurement is compared with an objective standard (not against another measurement), this is a criterion-referenced evaluation.

5.4.3 In the ICAO course development methodology, mastery tests are used to determine if a trainee meets the standard of performance established in the terminal objectives. This training standard should be as closely related as possible to the corresponding standard established during job and task analysis. The conditions, behavior and standards assessed during the test should reproduce as closely as possible what was described in the training objective for a given task or sub-task. If a trainee demonstrates in a mastery test that the standard has been met or surpassed, the trainee passes, independent of a comparison to the scores of other trainees. This is what is meant by the "pass or fail" concept.

5.4.4 Designing tests prior to designing modules, handouts and training manuals (Phase 5) may seem a departure from most conventional training. However, designing the mastery test at this point has two important functions: it ensures that the test is designed to focus on how trainees meet the training objective and it curbs the natural tendency of designing tests that focus on training materials rather than job performance.

5.4.5 Trainees' attitudes towards a test will be influenced by the way it is administered. This attitude can range from cooperative to extremely hostile. Proper test administration can help create an attitude that is positive and cooperative.

5.4.6 Feedback to trainees and discussion of test results should be standard practice. Test results should be used as diagnostic tools to help the instructor and trainees take remedial steps to ensure mastery and should be analysed in terms of performance relating to specific objectives. There should only be two grades — pass and fail. If they do not meet the criterion, they would be reported as having failed the course. In addition, one of two options would be noted: either that they had attended the course but had not completed it satisfactorily, or that arrangements would be made for further training on the modules that they had failed. When determining whether trainees should undergo additional training, consideration should be given to whether the modules that the trainee failed are related to tasks that have been assessed as critical.

6. Phase 5 — Design of modules

6.1 A training strategy makes the most effective use of available resources, techniques, needs and constraints to ensure that trainees accomplish their training objective. The overall strategy must consider the number and characteristics of the target population, the resources required (e.g. equipment, financial, and facilities), organizational issues, and repeatability of the course. The above considerations will determine the choice of instructional techniques, amount of practice, modes of delivery, media selection, tests and sequence.

6.2 The grouping of objectives into modules and the sequencing of these modules will have been decided in Phase 4. Modules are designed once the training strategy is established. Each module should be designed to ensure that trainees are capable of performing the module objective to the standard required at the end of the module. This will usually require that the module follow the sequence below:

a) gaining attention and motivating the learner;
b) demonstrating what the trainee will be able to accomplish after learning (the objective);
c) explaining how the accomplishment will be tested;
d) stimulating the recall of prerequisite learning;
e) presenting the subject matter content to be learnt, piece by piece;
f) providing opportunities for the trainee activity (partial practice; global practice);
g) reinforcing learning by providing feedback on the trainee's practice;
h) assessing the performance of the trainee (mastery test); and
i) enhancing retention of what has been learnt so that it can be transferred to other situations.

6.3 Selecting a mode of delivery for each module and each instructional event within each module depends on many factors. The importance of the factors may vary according to the objective. Individual modules (and, by extension, a complete training course) may consist of both individualized and group training.

6.4 The most creative decisions in course development are the selection of training techniques. Optimal learning will occur when the training technique is enjoyable and allows the trainee to be active. However, the enjoyment of a training technique will fade if it is used too often; thus, it is necessary to look for variety. Just as within a course or module there is scope to vary the mode of delivery, so there is scope to vary the training technique. Training techniques include lectures, demonstrations, guided group discussions, role play, case studies/projects, games, laboratory exercise, supervised

practice, leaderless groups, field visits, self-paced learning, independent study, tutorials, supervised practice, and on-the-job practice.

6.5 For each training technique, there are usually several alternative media for presenting information to the trainees, and these should be selected to suit the training objective. For example, if the information includes motion, such as interpretation of movement on a radar display, then some form of medium that can represent movement should be used. The options include live demonstration, e-learning, simulation, multimedia projection, text, and the instructor, according to the learning requirements. Sometimes special effects, such as stop-action or slow motion, are required.

6.6 Four main factors govern the choice of media: instructional appropriateness, economy, simplicity and availability. To meet the requirement of instructional appropriateness, media selection should take into account the mode of delivery, the objectives of instruction, and the type of capabilities to be learned, e.g. verbal and motor skills. Since certain media items represent a considerable investment, it may be necessary to plan ahead and strike a compromise which will limit future decisions. The objective should be to select the hardware in order to keep options as flexible as possible.

7. Phase 6 — Production and developmental testing

7.1 The ICAO course development methodology is designed to prepare a comprehensive and standardized training package (STP) for each course. Each package contains all of the material required for that particular course, presented in such a manner that any competent instructor will be able to readily deliver the course. In Phase 6, all necessary training material required to achieve each module's training objective is prepared, i.e. detailed lesson plans, instructor's notes, students' handbooks and handout material, and audio-visual or other training material.

7.2 To ensure that the training material is effective and suitable to the target population, it is essential that it be tried out as it is being developed and be revised as necessary. Mastery tests, in particular, should be tried out. Each test should be validated by ensuring that the test reflects the conditions, performance and standards of the objectives; it is technically accurate based on the review of a subject matter expert; and it is administered to a sample of skilled and unskilled performers of the target population. A high proportion of the skilled should pass the test, and a high proportion of the unskilled should fail. If "Master performers" do not score well on a test, the course developer should ensure that the course objective to which the test refers is really valid, i.e. that the task is actually part of the job.

7.3 Once training materials have been developmentally tested and then revised sufficiently, the next step is to refine and package the training materials in a form suitable for validation and later use. All material should be checked for technical content and accuracy by a subject matter expert. There should be standardization of format and presentation, which will facilitate production. The training material must be attractive, well formatted, and faithful to the course design.

8. Phase 7 — Validation and revision

8.1 During Phase 7, the capability of the competency-based instructional materials to effectively guide trainees to successful performance on the mastery tests is assessed.

Test results usually do not show that 100 per cent of the experimental trainee group have achieved 100 per cent of the objectives. This may be due to the fact that the training materials may still have some problems at this stage; the tests themselves, even after developmental testing, may not be a perfect measuring device; or the trainees may not be representative of the target population. To allow for these shortcomings, a validity criterion, which states that 80 per cent of the trainees should achieve 80 per cent of the objectives, is commonly used. The validity criterion should be determined based on the criticality of the tasks to be carried out on the job.

8.2 During validation delivery of a course, a representative sample of the target population should be given the course and their answers and reactions carefully recorded. To ensure accurate validation results, large samples of trainees are required. Instructors should administer the training while Course Developers observe and take notes. Data from the validation delivery should be analysed and required revisions determined. The data of greatest interest concern the objectives that are not met at the end of training, and why they are not met. Revisions should be made to any module that does not satisfy the validation criterion. If the revision is extensive, another validation should be conducted.

8.3 If training material is ineffective, it may cause a number of reactions: low test results, adverse comments by the participants and instructors, inability to perform the tasks once assigned to the field, too many errors, or excessive dependence on supervisors.

9. Phase 8 — Implementation

9.1 After validation, the revised training material should be used for regular delivery of the course. Training delivery, in its broadest sense, includes forecasting of delivery volumes, scheduling of classes, enrolment of trainees, preparation for and conducting of course sessions, and evaluation of effectiveness, including follow-up of trainees back on the job.

9.2 The quality of implementation of a training programme depends not only on the quality of the material but also on the qualifications of the instructors and on the effectiveness of administrative support.

10. Phase 9 — Post-training evaluation

10.1 Evaluation of training takes place at several points in the development approach — notably in the developmental testing and in validation. The higher levels of evaluation, however, cannot be done until a substantial number of trainees have followed the course; it is this latter post-course evaluation which is the final phase — Phase 9. The purpose of post-course evaluation is to determine the extent to which the training programme fulfilled the purpose for which it was designed and if corrective actions are required.

10.2 There are four levels of evaluation:

Level 1: Trainee reactions to the training process
Level 2: Trainee mastery of the end-of-course objectives
Level 3: Resulting job performance of ex-trainees
Level 4: Resulting effect on the organization’s operational objectives such as quality of service and productivity

10.3 In each of the four levels of evaluation, a comparison needs to be done of the actual effects of the training with those which were intended when the objectives were set.

- At Level 1: an evaluation of whether the classroom reactions of the trainees are the same as the reactions hoped for when the training techniques were chosen in Phase 5.
- At Level 2: an evaluation of whether the trainees actually learned the task stated as training objectives in Phase 4.
- At Level 3: in-depth look at whether, when back at their jobs, the trainees' performance improved to the required standard, which was defined in Phase 2.
- At Level 4: an evaluation of whether the training achieved the improvement in the organization's operational performance, which was the stated objective of the whole training programme in Phase 1.

10.4 The measurement of objectives at Level 3 and particularly Level 4 is complicated by the reality that training generally is not the only solution to an operational problem or to an individual performance problem. The training could be excellent but may not produce the predicted improvements at Levels 3 and 4 if management fails to implement other solutions identified as necessary to solve the problem, e.g. changes in the job environment, tools, and supervisory practices. Moreover, it is likely to be very difficult to single out the contribution of training, particularly if other solutions are not implemented.

10.5 The extent of evaluation to be undertaken for a given course depends on the importance of the training and on the time and resources available. It is suggested that, at the very least, evaluation at Levels 1 and 2 should be done routinely. Generally, some effort should be directed toward evaluating the impact of courses on job performance (Level 3). This could take the form of written feedback from supervisors of former trainees, or of reporting performance deficiencies within a few months after training — a relatively modest undertaking. If conditions warrant, more extensive study could be undertaken of the impact of courses on job performance. Level 4 evaluation might be done in cases where the operational problem was not solved and it is necessary to determine how training or other solutions would have to be modified to solve the problem. Sometimes this would be done in order to establish the credibility of the training organization.

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Chapter 3. COMPETENCY-BASED TRAINING AND LICENSING FOR THE MULTI-CREW PILOT LICENCE (MPL)

3.1 Introduction

This chapter provides the elements for a competency-based multi-crew pilot licence (MPL), with which approved training organizations (ATOs) and Licensing Authorities shall comply.

3.2 Assessment

3.2.1 Licensing Authorities and ATOs shall use the competency units, competency elements and performance criteria in approving and developing their own licensing and training programmes for the MPL, as contained in the competency-based framework at Appendix 2 to this chapter. Licensing Authorities shall develop or approve the range of variables and the evidence and assessment guide and/or practical test standards required for assessing applicants for the MPL.

3.2.2 The MPL holder shall meet the requirements of an operator's structured initial operating experience (IOE) programme, evaluation of which shall be conducted on completion of IOE by means of an operator's line check or equivalent means accepted by the Licensing Authority.

3.2.3 Licensing Authorities shall ensure that TEM competency elements are assessed as an integral part of each of the other eight phase-of-flight competency units established for the MPL.

Note.— Refer to Attachment C to this chapter and Chapter 2 of the Human Factors Training Manual (Doc 9683) for guidance material on TEM.

3.3 Training

3.3.1 All MPL training programmes shall be developed with the use of an ISD methodology.

Note.— A detailed description of the ICAO course development methodology, a competency-based approach to training and assessment and an example of an ISD methodology, can be found in the Attachment to Chapter 2.

3.3.2 Each phase of the MPL Training Scheme (see Appendix 1 to this chapter) shall be composed of instruction in underpinning knowledge and in practical training segments. Training in the underpinning knowledge requirements for the MPL shall therefore be fully integrated with the training of the skill requirements.

Note.— Refer to "Guidelines for the Implementation of the MPL" in Appendix 3 to this chapter.

3.3.3 The training course for an MPL licence shall include continuous evaluation of the training programme and of the students following the programme that is acceptable to the Licensing Authority. Evaluation shall ensure that:

a) the competencies and related assessment are relevant to the task of a co-pilot of an aircraft certificated for more than one pilot; and

b) the students acquire the necessary competencies in a progressive and satisfactory manner.

Corrective action shall be taken if in-training or post-training evaluation indicates a need to do so.

3.3.4 The advanced phase of an MPL training course shall include a sufficient number of take-offs and landings to ensure competency, which shall not be less than twelve. These take-offs and landings shall be performed under the supervision of an authorized instructor in an aeroplane for which the type rating shall be issued.

3.3.5 The Licensing Authority may accept a reduction, from twelve to six, of the number of take-offs and landings required for the advanced phase of training, provided that:

a) the approved training organization has demonstrated to the satisfaction of the Licensing Authority that it does not negatively affect the acquisition of the required skill by the student; and

b) a process is in place to ensure that corrective action can be made if in-training or post-training evaluation indicates a need to do so.

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Appendix 1 to Chapter 3
MULTI-CREW PILOT LICENCE TRAINING SCHEME

<table>
<tr><th colspan="5">MPL Training Scheme
Minimum 240 hours of training including PF and PNF*</th></tr>
<tr><th colspan="2">Phase of training</th><th>Training items</th><th colspan="2">Flight and simulated flight training media — Minimum level requirement</th><th>Ground training media</th></tr>
<tr><td rowspan="4">Integrated TEM principles</td><td>Advanced

Type rating training within an airline-oriented environment</td><td>• CRM
• Landing training
• All weather scenarios
• LOFT
• Abnormal procedures
• Normal procedures</td><td>Aeroplane:
Turbine
Multi-engine
Multi-crew certified</td><td>12 take-offs and landings as PF**</td><td rowspan="4">• CBT
• E-learning
• Part-task trainer
• Classroom</td></tr>
<tr><td></td><td></td><td>FSTD:
Type IV</td><td>PF/PNF</td></tr>
<tr><td>Intermediate

Application of multi-crew operations in a high-performance, multi-engine turbine aeroplane</td><td>• CRM
• LOFT
• Abnormal procedures
• Normal procedures
• Multi-crew
• Instrument flight</td><td>FSTD:
Type III</td><td>PF/PNF</td></tr>
<tr><td>Basic

Introduction of multi-crew operations and instrument flight</td><td>• CRM
• PF/PNF complement
• IFR cross-country
• Upset recovery
• Night flight
• Instrument flight</td><td>Aeroplane:
Single or multi-engine

FSTD:
Type II</td><td>PF/PNF</td></tr>
<tr><td></td><td>Core Flying Skills

Specific basic single pilot training</td><td>• CRM
• VFR cross-country
• Solo flight
• Basic instrument flight
• Principles of flight
• Cockpit procedures</td><td>Aeroplane:
Single or multi-engine

FSTD:
Type I</td><td>PF</td></tr>
</table>

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* PF — Pilot Flying; PNF — Pilot Not Flying.

** Limited credit may be granted in accordance with 3.3.4 and 3.3.5 of Chapter 3.

Appendix 2 to Chapter 3
MULTI-CREW PILOT LICENCE COMPETENCY UNITS — COMPETENCY ELEMENTS AND PERFORMANCE CRITERIA

		Reference	*Duty*	*Observation & assessment*
1.	**APPLY THREAT AND ERROR MANAGEMENT PRINCIPLES**			
1.1	Recognize Threat			
1.2	Manage Threat			
1.3	Recognize Error			
1.4	Manage Error			
1.5	Recognize Undesired Aircraft State			
1.6	Manage Undesired Aircraft State			
Note.— Refer to Attachment C to this chapter and to Chapter 2 of the Human Factors Training Manual *(Doc 9683) for guidance material on TEM.*				
2.	**PERFORM AIRCRAFT GROUND AND PRE-FLIGHT OPERATIONS** List of competency elements and performance criteria			
2.0	**Recognize and manage potential threats and errors**			
2.1	**Perform dispatch duties**			satisfactory/unsatisfactory
2.1.1	verifies technical condition of the aircraft, including adequate use of MEL	Ops. Manual	PF/PNF	
2.1.2	checks technical bulletins and notices	Ops. Manual	PF/PNF	
2.1.3	determines operational environment and pertinent weather	Ops. Manual	PF/PNF	
2.1.4	determines impact of weather on aircraft performance	Ops. Manual	PF/PNF	
2.1.5	applies flight planning and load procedures	Ops. Manual	PF/PNF	
2.1.6	determines fuel requirement	Ops. Manual	PF/PNF	
2.1.7	files an ATS flight plan (if required)	Ops. Manual	PF/PNF	
2.2	**Provide flight crew and cabin crew briefings**			satisfactory/unsatisfactory
2.2.1	briefs flight crew in all relevant matters	Ops. Manual	PF	
2.2.2	briefs cabin crew in all relevant matters	Ops. Manual	PF	

		Reference	Duty	Observation & assessment
2.3	**Perform pre-flight checks and cockpit preparation**			satisfactory/unsatisfactory
2.3.1	ensures the airworthiness of the aircraft	Ops. Manual	PF	
2.3.2	performs the cockpit preparation & briefings	Ops. Manual	PF/PNF	
2.3.3	performs FMS initialization, data insertion and confirmation	Ops. Manual	PF/PNF	
2.3.4	optimizes and checks take-off performance and take-off data calculation	Ops. Manual	PF/PNF	
2.3.5	conducts relevant briefings	Ops. Manual	PF	
2.4	**Perform engine start**			satisfactory/unsatisfactory
2.4.1	asks for, receives, acknowledges and checks ATC clearance	Ops. Manual	PNF	
2.4.2	performs engine start procedure	Ops. Manual	PF/PNF	
2.4.3	uses standard communication procedures with ground crew and ATC	Ops. Manual	PF/PNF	
2.5	**Perform taxi**			satisfactory/unsatisfactory
2.5.1	receives, checks and adheres to taxi clearance	Ops. Manual	PNF	
2.5.2	taxis the aircraft including use of exterior lighting	Ops. Manual	PF	
2.5.3	complies to taxi clearance	Ops. Manual	PF/PNF	
2.5.4	maintains lookout for conflicting traffic and obstacles	Ops. Manual	PF/PNF	
2.5.5	operates thrust, brakes and steering	Ops. Manual	PF	
2.5.6	conducts relevant briefings	Ops. Manual	PF	
2.5.7	uses standard communication procedures with crew and ATC	Ops. Manual	PNF	
2.5.8	completes standard operating procedures and checklists	Ops. Manual	PF/PNF	
2.5.9	updates and confirms FMS data	Ops. Manual	PF/PNF	
2.5.10	manages changes in performance and departure route	Ops. Manual	PF/PNF	
2.5.11	completes de-icing/anti-icing procedures	Ops. Manual	PF/PNF	
2.6	**Manage abnormal and emergency situations**			satisfactory/unsatisfactory
2.6.1	identifies the abnormal condition	Ops. Manual	PF/PNF	
2.6.2	interprets the abnormal condition	Ops. Manual	PF/PNF	
2.6.3	performs the procedure for the abnormal condition	Ops. Manual	PF/PNF	

		Reference	*Duty*	*Observation & assessment*
2.7	**Communicate with cabin crew, passengers and company**			satisfactory/unsatisfactory
2.7.1	communicates relevant information to cabin crew	Ops. Manual	PF	
2.7.2	communicates relevant information to company	Ops. Manual	PF/PNF	
2.7.3	makes passenger announcements when appropriate	Ops. Manual	PF/PNF	
3.	**PERFORM TAKE-OFF** List of competency elements and performance criteria			
3.0	**Recognize and manage potential threats and errors**			
3.1	**Perform pre-take-off and pre-departure preparation**			satisfactory/unsatisfactory
3.1.1	checks and acknowledges line-up clearance	Ops. Manual	PF/PNF	
3.1.2	checks correct runway selection	Ops. Manual	PF/PNF	
3.1.3	confirms validity of performance data	Ops. Manual	PF/PNF	
3.1.4	checks approach sector and runway are clear	Ops. Manual	PF/PNF	
3.1.5	confirms all checklists and take-off preparations completed	Ops. Manual	PF/PNF	
3.1.6	lines up the aircraft on centre line without loosing distance	Ops. Manual	PF	
3.1.7	checks weather on departure sector	Ops. Manual	PF/PNF	
3.1.8	checks runway status and wind	Ops. Manual	PF/PNF	
3.2	**Perform take-off roll**			satisfactory/unsatisfactory
3.2.1	applies take-off thrust	Ops. Manual	PF	
3.2.2	checks engine parameters	Ops. Manual	PNF	
3.2.3	checks airspeed indicators	Ops. Manual	PF/PNF	
3.2.4	stays on runway centre line	Ops. Manual	PF	
3.3	**Perform transition to instrument flight rules**			satisfactory/unsatisfactory
3.3.1	applies V 1 procedures	Ops. Manual	PF/PNF	
3.3.2	rotates at VR to initial pitch attitude	Ops. Manual	PF	
3.3.3	establishes initial wings level attitude	Ops. Manual	PF	
3.3.4	retracts landing gear	Ops. Manual	PNF	
3.3.5	maintains climb-out speed	Ops. Manual	PF	
3.4	**Perform initial climb to flap retraction altitude**			satisfactory/unsatisfactory
3.4.1	sets climb power	Ops. Manual	PF	
3.4.2	adjusts attitude for acceleration	Ops. Manual	PF	
3.4.3	selects flaps according to flap speed schedule	Ops. Manual	PF/PNF	

		Reference	Duty	Observation & assessment
3.4.4	observes speed restrictions	Ops. Manual	PF	
3.4.5	completes relevant checklists	Ops. Manual	PF/PNF	
3.5	**Perform rejected take-off**			satisfactory/unsatisfactory
3.5.1	recognizes the requirement to abort the take-off	Ops. Manual	PF	
3.5.2	applies the rejected take-off procedure	Ops. Manual	PF	
3.5.3	assesses the need to evacuate the aircraft	Ops. Manual	PF/PNF	
3.6	**Perform navigation**			satisfactory/unsatisfactory
3.6.1	complies with departure clearance	Ops. Manual	PF	
3.6.2	complies with published departure procedures, e.g. speeds	Ops. Manual	PF	
3.6.3	monitors navigation accuracy	Ops. Manual	PF/PNF	
3.6.4	communicates and coordinates with ATC	Ops. Manual	PNF	
3.7	**Manage abnormal and emergency situations**			satisfactory/unsatisfactory
3.7.1	identifies the abnormal condition	Ops. Manual	PF/PNF	
3.7.2	interprets the abnormal condition	Ops. Manual	PF/PNF	
3.7.3	performs the procedure for the abnormal condition	Ops. Manual	PF/PNF	
4.	**PERFORM CLIMB** List of competency elements and performance criteria			
4.0	**Recognize and manage potential threats and errors**			
4.1	**Perform standard instrument departure/en-route navigation**			satisfactory/unsatisfactory
4.1.1	complies with departure clearance and procedures	Ops. Manual	PF	
4.1.2	demonstrates terrain awareness	Ops. Manual	PF/PNF	
4.1.3	monitors navigation accuracy	Ops. Manual	PF/PNF	
4.1.4	adjusts flight to weather and traffic conditions	Ops. Manual	PF	
4.1.5	communicates and coordinates with ATC	Ops. Manual	PNF	
4.1.6	observes minimum altitudes	Ops. Manual	PF/PNF	
4.1.7	selects appropriate level of automation	Ops. Manual	PF	
4.1.8	complies with altimeter setting procedures	Ops. Manual	PF/PNF	
4.2	**Complete climb procedures and checklists**			satisfactory/unsatisfactory
4.2.1	performs the after-take-off items	Ops. Manual	PF/PNF	
4.2.2	confirms and checks according to checklists	Ops. Manual	PF/PNF	

		Reference	*Duty*	*Observation & assessment*
4.3	**Modify climb speeds, rate of climb and cruise altitude**			satisfactory/unsatisfactory
4.3.1	recognizes the need to change speed/rate of climb/cruise altitude	Ops. Manual	PF	
4.3.2	selects and maintains the appropriate climb speed/rate of climb	Ops. Manual	PF	
4.3.3	selects optimum cruise flight level	Ops. Manual	PF/PNF	
4.4	**Perform systems operations and procedures**			satisfactory/unsatisfactory
4.4.1	monitors operation of all systems	Ops. Manual	PF/PNF	
4.4.2	operates systems as required	Ops. Manual	PF/PNF	
4.5	**Manage abnormal and emergency situations**			
4.5.1	identifies the abnormal condition	Ops. Manual	PF/PNF	satisfactory/unsatisfactory
4.5.2	interprets the abnormal condition	Ops. Manual	PF/PNF	
4.5.3	performs the procedure for the abnormal condition	Ops. Manual	PF/PNF	
4.6	**Communicate with cabin crew, passengers and company**			satisfactory/unsatisfactory
4.6.1	communicates relevant information to cabin crew	Ops. Manual	PF	
4.6.2	communicates relevant information to company	Ops. Manual	PF/PNF	
4.6.3	makes passenger announcements when appropriate	Ops. Manual	PF	
5.	**PERFORM CRUISE** List of competency elements and performance criteria			
5.0	**Recognize and manage potential threats and errors**			
5.1	**Monitor navigation accuracy**			satisfactory/unsatisfactory
5.1.1	demonstrates adequate area knowledge	Ops. Manual	PF/PNF	
5.1.2	demonstrates adequate route knowledge	Ops. Manual	PF/PNF	
5.1.3	navigates according to flight plan and clearance	Ops. Manual	PF	
5.1.4	adjusts flight to weather and traffic conditions	Ops. Manual	PF	
5.1.5	communicates and coordinates with ATC	Ops. Manual	PNF	
5.1.6	observes minimum altitudes	Ops. Manual	PF/PNF	
5.1.7	uses all means of automation	Ops. Manual	PF	
5.2	**Monitor flight progress**			satisfactory/unsatisfactory
5.2.1	selects optimum speed	Ops. Manual	PF	
5.2.2	selects optimum cruise flight level	Ops. Manual	PF	

		Reference	Duty	Observation & assessment
5.2.3	monitors and controls fuel status	Ops. Manual	PF/PNF	
5.2.4	recognizes the need for a possible diversion	Ops. Manual	PF/PNF	
5.2.5	creates a diversion contingency plan if required	Ops. Manual	PF/PNF	
5.3	**Perform descent and approach planning**			satisfactory/unsatisfactory
5.3.1	checks weather of destination and alternate airport	Ops. Manual	PF/PNF	
5.3.2	checks runway in use and approach procedure	Ops. Manual	PF/PNF	
5.3.3	sets the FMS accordingly	Ops. Manual	PNF	
5.3.4	checks landing weight and landing distance required	Ops. Manual	PNF	
5.3.5	checks MEA, MGA and MSA	Ops. Manual	PF/PNF	
5.3.6	identifies top of descent point	Ops. Manual	PF	
5.3.7	conducts relevant briefings	Ops. Manual	PF	
5.4	**Perform systems operations and procedures**			satisfactory/unsatisfactory
5.4.1	monitors operation of all systems	Ops. Manual	PF/PNF	
5.4.2	operates systems as required	Ops. Manual	PNF	
5.5	**Manage abnormal and emergency situations**			satisfactory/unsatisfactory
5.5.1	identifies the abnormal condition	Ops. Manual	PF/PNF	
5.5.2	interprets the abnormal condition	Ops. Manual	PF/PNF	
5.5.3	performs the procedure for the abnormal condition	Ops. Manual	PF/PNF	
5.6	**Communicate with cabin crew, passengers and company**			satisfactory/unsatisfactory
5.6.1	communicates relevant information to cabin crew	Ops. Manual	PF	
5.6.2	communicates relevant information to company	Ops. Manual	PF/PNF	
5.6.3	makes passenger announcements when appropriate	Ops. Manual	PF	
6.	**PERFORM DESCENT** List of competency elements and performance criteria			
6.0	**Recognize and manage potential threats and errors**			
6.1	**Initiate and manage descent**			satisfactory/unsatisfactory
6.1.1	starts descent according to ATC clearance or optimum descent point	Ops. Manual	PF	
6.1.2	selects optimum speed and descent rate	Ops. Manual	PF	

		Reference	*Duty*	*Observation & assessment*
6.1.3	adjusts speed to existing environmental conditions	Ops. Manual	PF	
6.1.4	recognizes the need to adjust the descent path	Ops. Manual	PF	
6.1.5	adjusts the flight path as required	Ops. Manual	PF	
6.1.6	utilizes all means of FMS descent information	Ops. Manual	PF	
6.2	**Monitor and perform en-route and descent navigation**			satisfactory/unsatisfactory
6.2.1	complies with arrival clearance and procedures	Ops. Manual	PF	
6.2.2	demonstrates terrain awareness	Ops. Manual	PF/PNF	
6.2.3	monitors navigation accuracy	Ops. Manual	PF/PNF	
6.2.4	adjusts flight to weather and traffic conditions	Ops. Manual	PF	
6.2.5	communicates and coordinates with ATC	Ops. Manual	PNF	
6.2.6	observes minimum altitudes	Ops. Manual	PF/PNF	
6.2.7	selects appropriate level/mode of automation	Ops. Manual	PF	
6.2.8	complies with altimeter setting procedures	Ops. Manual	PF/PNF	
6.3	**Replanning and update of approach briefing**			satisfactory/unsatisfactory
6.3.1	rechecks destination weather and runway in use	Ops. Manual	PNF	
6.3.2	briefs/rebriefs about instrument approach and landing as required	Ops. Manual	PF	
6.3.3	reprogrammes the FMS as required	Ops. Manual	PNF	
6.3.4	rechecks fuel status	Ops. Manual	PF/PNF	
6.4	**Perform holding**			satisfactory/unsatisfactory
6.4.1	identifies holding requirement	Ops. Manual	PF/PNF	
6.4.2	programmes FMS for holding pattern	Ops. Manual	PNF	
6.4.3	enters and monitors holding pattern	Ops. Manual	PF	
6.4.4	assesses fuel requirements and determines max. holding time	Ops. Manual	PF/PNF	
6.4.5	reviews the need for a diversion	Ops. Manual	PF/PNF	
6.4.6	initiates diversion	Ops. Manual	PF	
6.5	**Perform systems operations and procedures**			satisfactory/unsatisfactory
6.5.1	monitors operation of all systems	Ops. Manual	PF/PNF	
6.5.2	operates systems as required	Ops. Manual	PF/PNF	
6.6	**Manage abnormal and emergency situations**			satisfactory/unsatisfactory
6.6.1	identifies the abnormal condition	Ops. Manual	PF/PNF	
6.6.2	interprets the abnormal condition	Ops. Manual	PF/PNF	

		Reference	Duty	Observation & assessment
6.6.3	performs the procedure for the abnormal condition	Ops. Manual	PF/PNF	
6.7	**Communicate with cabin crew, passengers and company**			satisfactory/unsatisfactory
6.7.1	communicates relevant information to cabin crew	Ops. Manual	PF	
6.7.2	communicates relevant information to company	Ops. Manual	PF/PNF	
6.7.3	makes passenger announcements when appropriate	Ops. Manual	PF	
7.	**PERFORM APPROACH** List of competency elements and performance criteria			
7.0	**Recognize and manage potential threats and errors**			
7.1	**Perform approach in general**			satisfactory/unsatisfactory
7.1.1	executes approach according to procedures and situation	Ops. Manual	PF	
7.1.2	selects appropriate level/mode of automation	Ops. Manual	PF	
7.1.3	selects optimum approach path	Ops. Manual	PF	
7.1.4	operates controls smoothly and with coordination	Ops. Manual	PF	
7.1.5	performs speed reduction and flap extension	Ops. Manual	PF/PNF	
7.1.6	performs relevant checklists	Ops. Manual	PF/PNF	
7.1.7	initiates final descent	Ops. Manual	PF	
7.1.8	achieves stabilized approach criteria	Ops. Manual	PF	
7.1.9	ensures adherence to minima	Ops. Manual	PF/PNF	
7.1.10	initiates go-around if required	Ops. Manual	PF	
7.1.11	masters transition to visual segment	Ops. Manual	PF	
7.2	**Perform precision approach**			satisfactory/unsatisfactory
7.2.1	performs ILS approach	Ops. Manual	PF	
7.2.2	performs low visibility ILS CAT II/III approach	Ops. Manual	PF	
7.2.3	performs PAR approach	Ops. Manual	PF	
7.2.4	performs GPS/GNSS approach	Ops. Manual	PF	
7.2.5	performs MLS approach	Ops. Manual	PF	
7.3	**Perform non-precision approach**			satisfactory/unsatisfactory
7.3.1	performs VOR approach	Ops. Manual	PF	
7.3.2	performs NDB approach	Ops. Manual	PF	
7.3.3	performs SRE approach	Ops. Manual	PF	
7.3.4	performs GPS/GNSS approach	Ops. Manual	PF	

		Reference	*Duty*	*Observation & assessment*
7.3.5	performs ILS loc approach	Ops. Manual	PF	
7.3.6	performs ILS back beam approach	Ops. Manual	PF	
7.4	**Perform approach with visual reference to ground**			satisfactory/unsatisfactory
7.4.1	performs standard visual approach	Ops. Manual	PF	
7.4.2	performs circling approach	Ops. Manual	PF	
7.5	**Monitor the flight progress**			satisfactory/unsatisfactory
7.5.1	ensures navigation accuracy	Ops. Manual	PF/PNF	
7.5.2	communicates with ATC and crew members	Ops. Manual	PNF	
7.5.3	monitors fuel status	Ops. Manual	PF/PNF	
7.6	**Perform systems operations and procedures**			satisfactory/unsatisfactory
7.6.1	monitors operation of all systems	Ops. Manual	PF	
7.6.2	operates systems as required	Ops. Manual	PF	
7.7	**Manage abnormal and emergency situations**			satisfactory/unsatisfactory
7.7.1	identifies the abnormal condition	Ops. Manual	PF/PNF	
7.7.2	interprets the abnormal condition	Ops. Manual	PF/PNF	
7.7.3	performs the procedure for the abnormal condition	Ops. Manual	PF/PNF	
7.8	**Perform go-around/missed approach**			satisfactory/unsatisfactory
7.8.1	initiates go-around procedure	Ops. Manual	PF	
7.8.2	navigates according to missed approach procedure	Ops. Manual	PF	
7.8.3	completes the relevant checklists	Ops. Manual	PF/PNF	
7.8.4	initiates approach or diversion after the go-around	Ops. Manual	PF	
7.8.5	communicates with ATC and crew members	Ops. Manual	PNF	
7.9	**Communicate with cabin crew, passengers and company**			satisfactory/unsatisfactory
7.9.1	communicates relevant information to cabin crew	Ops. Manual	PF	
7.9.2	communicates relevant information to company	Ops. Manual	PF/PNF	
7.9.3	makes passenger announcements when appropriate	Ops. Manual	PF	

		Reference	Duty	Observation & assessment
8.	**PERFORM LANDING** List of competency elements and performance criteria			
8.0	**Recognize and manage potential threats and errors**			
8.1	**Land the aircraft**			satisfactory/unsatisfactory
8.1.1	maintains a stabilized approach path during visual segment	Ops. Manual	PF	
8.1.2	recognizes and acts on changing conditions for wind shift/wind shear segment	Ops. Manual	PF	
8.1.3	initiates flare	Ops. Manual	PF	
8.1.4	controls thrust	Ops. Manual	PF	
8.1.5	achieves touchdown in touchdown zone on centre line	Ops. Manual	PF	
8.1.6	lowers nose wheel	Ops. Manual	PF	
8.1.7	maintains centre line	Ops. Manual	PF	
8.1.8	performs after-touchdown procedures	Ops. Manual	PF	
8.1.9	makes use of appropriate braking and reverse thrust	Ops. Manual	PF	
8.1.10	vacates runway with taxi speed	Ops. Manual	PF	
8.2	**Perform systems operations and procedures**			satisfactory/unsatisfactory
8.2.1	monitors operation of all systems	Ops. Manual	PF	
8.2.2	operates systems as required	Ops. Manual	PF	
8.3	**Manage abnormal and emergency situations**			satisfactory/unsatisfactory
8.3.1	identifies the abnormal condition	Ops. Manual	PF/PNF	
8.3.2	interprets the abnormal condition	Ops. Manual	PF/PNF	
8.3.3	performs the procedure for the abnormal condition	Ops. Manual	PF/PNF	
9.	**PERFORM AFTER-LANDING AND POST-FLIGHT OPERATIONS** List of competency elements and performance criteria			
9.0	**Recognize and manage potential threats and errors**			satisfactory/unsatisfactory
9.1	**Perform taxi-in and parking**			satisfactory/unsatisfactory
9.1.1	receives, checks and adheres to taxi clearance	Ops. Manual	PNF	
9.1.2	taxis the aircraft including use of exterior lighting	Ops. Manual	PF	
9.1.3	controls taxi speed	Ops. Manual	PF/PNF	
9.1.4	maintains centre line	Ops. Manual	PF	

		Reference	*Duty*	*Observation & assessment*
9.1.5	maintains lookout for conflicting traffic and obstacles	Ops. Manual	PF	
9.1.6	identifies parking position	Ops. Manual	PF/PNF	
9.1.7	complies with marshaller/stand guidance	Ops. Manual	PF/PNF	
9.1.8	applies parking and engine shut-down procedures	Ops. Manual	PF	
9.1.9	completes with relevant checklists	Ops. Manual	PF/PNF	
9.2	**Perform aircraft post-flight operations**			satisfactory/unsatisfactory
9.2.1	communicates with ground personnel and crew	Ops. Manual	PF	
9.2.2	completes all required flight documentation	Ops. Manual	PF/PNF	
9.2.3	ensures securing of the aircraft	Ops. Manual	PF	
9.2.4	conducts the debriefings	Ops. Manual	PF	
9.3	**Perform systems operations and procedures**			satisfactory/unsatisfactory
9.3.1	monitors operation of all systems	Ops. Manual	PF/PNF	
9.3.2	operates systems as required	Ops. Manual	PF/PNF	
9.4	**Manage abnormal and emergency situations**			satisfactory/unsatisfactory
9.4.1	identifies the abnormal condition	Ops. Manual	PF/PNF	
9.4.2	interprets the abnormal condition	Ops. Manual	PF/PNF	
9.4.3	performs the procedure for the abnormal condition	Ops. Manual	PF/PNF	
9.5	**Communicate with cabin crew, passengers and company**			satisfactory/unsatisfactory
9.5.1	communicates relevant information to cabin crew	Ops. Manual	PF	
9.5.2	communicates relevant information to company	Ops. Manual	PF/PNF	
9.5.3	makes passenger announcements when appropriate	Ops. Manual	PF	

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Appendix 3 to Chapter 3
GUIDELINES FOR THE IMPLEMENTATION OF THE MULTI-CREW PILOT LICENCE

1. Introduction

The introduction of the multi-crew pilot licence (MPL) provides for the training of pilots directly for co-pilot duties making greater use of modern training devices such as the flight simulator. The ICAO Standards for the MPL specify the minimum number of actual and simulated flight hours (240) but do not specify the breakdown between actual and simulated. This allows part of the training curriculum that was traditionally conducted on an aeroplane to now be done on flight simulation training devices. While the airline industry has acquired considerable experience in the use of flight simulation training devices, the use of such devices in the early phase of airline pilot training has been limited. These guidelines provide guidance to States and Approved Training Organizations (ATOs) on the measures that could be taken to facilitate safe and efficient implementation of the new MPL Standards.

2. General considerations

2.1 The level of competency expected from the MPL holder is defined in detail in Annex 1 and this document. In broad terms, the MPL holder is expected to complete the airline Initial Operational Experience phase (IOE) with high probability of success and within the time frame normally allowed for this phase. It is similar to what is expected today from graduates from the ab initio training programme who have completed their type rating training.

2.2 The general approach that is therefore suggested is to use the existing training programme (ab initio or equivalent) of the ATO as a reference and to progressively implement the new training programme allowed by the MPL, particularly the transfer from actual flight to simulated flight.

2.3 This transfer shall be made in a progressive manner whereby successive evolutions of the training programme progressively introduce a higher level of simulated flight and a reduction of actual flight. Change from one level to the next should only take place after enough experience has been gained and once its results, including the IOE, have been analysed and taken into account.

2.4 The exchange of information between Licensing Authorities, ATOs and airlines involved in MPL training should be encouraged.

3. Guidelines for the authority

3.1 a) The implementation of the MPL requires the development of an approved training programme that blends the various types of training (knowledge and practical) with

the media (classroom, various level of simulation and aeroplane). Only ATOs that are familiar with ab initio training or airline training should be considered, at least initially.

b) In view of the developmental nature of the first MPL course in each ATO, the approval should be provisional and should be confirmed only after obtaining a satisfactory result from the first course and after incorporation into the curriculum of lessons learned.

c) All the applicable Standards related to ATOs (Annex 1, Appendix 2) shall apply and all associated guidance material should apply, in particular those dealing with approval of the curriculum and quality assurance system.

d) MPL courses shall be competency-based. One of the attributes of competency-based training, as defined in this document, is the use of a continuous evaluation process to ensure the effectiveness of the training and its relevance to line operations. This aspect of continuous evaluation is especially important during the initial implementation of an MPL course.

e) Close oversight by the Licensing Authority shall be exercised during the initial phase. The need for regular feedback from the ATO to the Licensing Authority on the progress and problems faced during delivery of the course is important. How this feedback is to be provided to the Authority shall therefore be clearly stated as part of the approval.

f) The ATO shall furnish the Licensing Authority with de-identified information concerning each phase of evaluation for each student during and following the programme, including any corrective action found to be necessary. The Licensing Authority shall make this information available to ICAO upon request for the purpose of evaluating the MPL programme on a periodic basis.

g) The success of the implementation of the MPL depends to a large measure on the effective coordination and cooperation between the Licensing Authority, the ATO and the airlines hiring the graduates and pilot representative bodies. Licensing Authorities should encourage and facilitate such cooperation and coordination.

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Attachment A to Chapter 3
COMPETENCY-BASED TRAINING AND LICENSING FOR THE MULTI-CREW PILOT LICENCE — GUIDANCE ON THE DESIGN AND DEVELOPMENT OF A MULTI-CREW PILOT LICENCE TRAINING PROGRAMME

1. Introduction

This Attachment to Chapter 3 provides a description of the application of the principles and procedures of the ICAO course development methodology in the development of an MPL training programme. A description of the structure of the MPL training programme, as established in Annex 1, is provided, followed by a detailed description of the application of the different phases of the ICAO course development methodology in the development of an MPL training programme.

2. Structure of the MPL training programme

2.1 The MPL training scheme is contained in Appendix 1 to Chapter 3. The training items listed under the ***Core Flying Skills and Basic*** levels of training must be completed prior to entering the Intermediate phase of training. These first two phases of training are of the utmost importance as the student starts to develop core technical, interpersonal, procedural and aircraft-handling skills that underpin the competencies of an MPL. The learning of cockpit resource management (CRM) and threat and error management (TEM) skills is also strengthened by introducing them at the very beginning of the programme.

2.2 At the **Basic** level of competency, training on an aeroplane includes upset recovery and instrument flight. However, starting with this phase of training, use of flight simulation training devices (FSTDs), ranging from part-task training devices, through generic systems to full-motion, full-visual, high-fidelity, type-specific flight simulators that also permit the introduction of interactive air traffic control environments, will begin to dominate the training. Emphasis should be placed equally on both Pilot Flying and Pilot Not Flying tasks and performance in the training conducted during the Basic, Intermediate and Advanced phases of training.

2.3 The flight training received in the **Intermediate** phase should be conducted under IFR but need not be specific to any aeroplane type. Upon completion of this phase of training, the student should meet the competency standards representative of the Intermediate level.

2.4 At the **Advanced** level of competency, the student will be required to consistently demonstrate the knowledge, skills and attitudes needed for the safe operation of an applicable aeroplane type as specified in the terminal training objectives of the course and their corresponding performance criteria. Upon qualifying, the student will hold an MPL and integral type and instrument ratings, the privileges of which are to be exercised on a turbine-powered, commercial air transport aeroplane.

2.5 The nine competency units for the MPL are listed in Annex 1, Appendix 3, paragraph 3.1. The competency elements into which the units have been broken down and the performance criteria, which have been established against each of the competency elements, are contained in Appendix 2 to Chapter 3. For the purpose of the Standard, TEM is established as a competency unit independent of the other eight units that each correspond to a phase of flight. For the purpose of training and testing, however, the TEM competency should be considered an integral feature of all the other phase-of-flight competencies.

3. Design and development of an MPL training programme through ICAO course development methodology

3.1 Methodological principles

There are three principal activities in the ICAO course development methodology process: analysis, design and production and evaluation; each activity is broken down into three phases (Attachment to Chapter 2 refers).

3.2 Preliminary study

3.2.1 At a meeting between the aviation industry and the ICAO Air Navigation Commission (ANC) in 1997, a problem with the levels of competency of flight crew members was identified. In addition, the safety oversight audits conducted by ICAO had shown that very few States had formalized criteria for judging performance in licensing examinations or for demonstrating maintenance of competency as required by Annex 6. As a result, the ANC agreed that a ***preliminary study*** of current systems of training and an evaluation of the practicability of developing criterion-referenced training and performance standards for the licensing of flight crew should be carried out.

3.2.2 The preliminary study, which was conducted in 2000, confirmed that ICAO licensing and training Standards and associated national regulations had not kept up with developments in training methodologies and new training and aircraft technologies. Among the proposed solutions was the development of a new airline-oriented, multi-crew pilot licence and the development of competency-based licensing and training requirements for inclusion in Annex 1.

3.3 Functional/task analysis

3.3.1 The MPL training programme aims to qualify a candidate for the *job* of co-pilot on a turbine-engined commercial air transport aeroplane. The qualifications needed to perform the job of a co-pilot and the duties and responsibilities are contained in an operator's Operations Manual. Jobs can be broken down into *functions* and, in turn, functions into *tasks* and *sub-tasks*. Each sub-task might be further broken down into *task elements* (*steps*), i.e. activities that must be done in order to complete the sub-task.

3.3.2 The functional/task analysis conducted for the purpose of developing the Standards for the MPL identified nine functions (competency units) that were further broken down into a

number of tasks (competency elements). For example, the competency unit — *perform take-off* — qualifies as a function and the competency element — *perform take-off roll* — can be defined as a task. Performance criteria established against each of the competency elements contain the sub-tasks that must be carried out in order to perform the competency element, e.g. advancing the thrust levers.

3.3.3 The functional/task analysis carried out in the development of the Annex 1 Standards for the MPL provides much of the information needed by States and flight training organizations for the design and approval of training curricula. There will, however, be a need to amplify the analysis in order to provide for training in and assessment of the Core Flying Skills, Basic, Intermediate and Advanced phases of training. In addition, in order to design training around a specific task step (e.g. the operation of the flight management computer), a more in-depth analysis may need to be conducted on the sub-task in question.

3.4 Population analysis

Training for the MPL is designed for a target population of ab initio candidates who need not have had any flying experience prior to being selected for the course. Contracting States should define the qualifications, in terms of the skills, knowledge and attitudes, required for meeting the entry levels for the course and should ensure that an appropriate corresponding selection method is in place. If training is to be effective, it will also be necessary to identify and cater for the different learning modes that are prevalent in the target population.

3.5 Curriculum design

3.5.1 Training for the MPL passes through four phases of training and levels of competency (i.e. Core Flying Skills, Basic, Intermediate, and Advanced levels of competency), during which the student's training progresses from single-engine aeroplane to multi-engine turbine aeroplane and multi-crew operations and the issuance of a type rating. Prior to passing from one level to the next, the student must have demonstrably met the training objectives established for each phase of training. Upon exit from the Advanced phase of training and qualification for the MPL, the student must have met the required levels of performance needed to complete all nine of the competency units developed for the MPL.

3.5.2 The competency units and elements that comprise the Annex 1 Standards provide the overall competency-based training framework and are reflected in the training objectives developed for each phase of training and level of competency.

3.5.3 Curriculum design starts with the formulation of performance objectives. Since, in the case of the MPL, the objectives are to evaluate the effectiveness of training, they should be referred to as ***training*** objectives. In the design of a training curriculum, the overall ***goals*** of the training programme and the ***training objectives*** correspond, respectively, to the functions and tasks identified by the MPL functional/task analysis.

3.5.4 In the MPL training course, the terminal objectives should define what the student needs to demonstrate, in terms of skills, knowledge and attitudes (SKAs), at the Core Flying Skills, Basic, Intermediate and Advanced levels of competency. For these levels of training, the student must successfully achieve all the relevant mastery tests in order to

meet the objectives and reach the corresponding level of competency. Since, at the Advanced level of competency, the terminal objectives define what must be accomplished at the end of the entire course of training, they therefore reflect the performance criteria established against each of the competency elements for the licence.

3.5.5 There will be a need to administer key progress tests to ensure that the student has acquired the necessary SKAs. Students who fail a progress test should receive remedial training until such time as they have mastered that particular module.

3.6 Developing MPL training objectives

3.6.1 As described in Chapter 2, a training objective states the (observable) ***desired action*** or ***behaviours***, the (measurable) ***standard*** and the ***conditions*** relevant to what must be accomplished by the student during each phase of training prior to reaching the desired level of competency. Sample training objectives are contained in Attachment B to Chapter 3. Included with each sample objective is a sample assessment guide and an example of the application of threat and error management.

3.6.2 The ***action statement*** or the ***statement of behaviours***, the most important part of the training objective, should always be expressed with a verb that specifies definite, observable actions. The competency elements and performance criteria found in Appendix 2 to Chapter 3 provide useful sources of suitable action verbs. Action verbs have also been developed in other learning/training objective taxonomies (Bloom, B.S (1956); Harrow, A. (1972) and Simpson, E. (1972)). Since these classifications were developed for general education purposes, however, they should only be used when a more domain-specific verb, from either the MPL functional/task analysis or other similar flight training task analysis, is not available.

3.6.3 Action verbs can be classified according to the different tasks or skills, knowledge and attitudes they represent, which facilitates the development of an effective and efficient learning path. Training organizations should choose or develop the classification that best suits their own circumstances. As described in Chapter 2, the ICAO course development methodology proposes two basic categories, i.e. *intellectual* and *physical (motor)* skills; intellectual skills can be further broken down into *classifying, discriminating*, *rule-using* and *problem-solving* sub-skills.

3.6.4 Where an action verb has to be used to define a skill to infer a non-observable process, as is often the case when assessing cockpit resource management (CRM) and threat and error management (TEM), an overt or observable synonym should be used as evidence that the process has been carried out. (See also Attachment B to Chapter 3 that describes how evidence of the application of TEM can be collected.)

3.6.5 A training objective should clearly identify the ***conditions*** under which an action must be performed. Conditions consist of the training equipment on which training or assessment is being conducted (e.g. flight simulator training device), the meteorological/environmental factors, aircraft configuration, operational factors and regulatory framework. Simulator training affords an opportunity for instructors and examiners to select and manipulate the conditions under which the training and assessment of competencies take place. Conditions relevant to particular training objectives may be selected for the training or assessment of specific skills, knowledge and attitudes. The conditions included in a training objective at the Advanced level of competency will reflect the range of variables developed by the Licensing Authority.

3.6.6 Training objectives will determine the design of the exercises and other units of training around which an MPL curriculum is constructed. They should be designed to facilitate the training and testing of CRM and TEM behaviours as integral features of each of the phase-of-flight competency units. Training with the aid of flight training devices presents opportunities for structuring training objectives so that the included activities and conditions address the behaviours to be trained and tested.

3.6.7 The training objective ***standard*** contains the criteria against which a student's performance is evaluated. In the case of the terminal objectives, these reflect the performance criteria developed against each of the MPL competency elements. Licensing Authorities should ensure that these performance criteria are used in the preparation of assessment guides or practical test standards for the MPL. The standard will reflect the level of performance expected at each of the competency levels of the MPL training schedule.

3.6.8 Training objective standards may be stated in the form of tolerances, constraints, limits, performance rates or qualitative statements. Where these criteria are contained in approved documents such as regulations, operating manuals, and checklists, only a reference to such documents in the standard section of the objective is needed.

3.6.9 In many instances, the action statement or statements of desired performance contained in training objectives established at different levels of competency can be exactly the same. The conditions under which the action is to be performed and/or the standard against which it is to be judged, however, will get increasingly more complex and difficult as the student advances through the different phases of training. This is reflected in the sample training objectives at Attachment B, which all relate to the same behaviours — perform take-off roll — but differ in terms of the conditions and standards under which and in accordance with the behaviour or action is to be demonstrated.

3.6.10 Once training objectives have been developed, they must be sequenced and grouped into the training modules that make up the different phases of the training schedule. A number of principles apply to the sequencing of training objectives. Generally speaking, a logical approach is to follow the order in which the related tasks are carried out in the operational environment. This is, in fact, reflected in the manner in which the phase-of-flight competency units for the MPL have been ordered. Other considerations, however, such as the differences or commonalities between objectives in terms of the tasks involved, their levels of difficulty and the complexity of the conditions under which the actions have to be carried out, also come into play.

3.6.11 A number of rules usually apply, e.g. objectives that are typical/standard/normal come before objectives that are atypical/non-standard/abnormal and, in the learning sequence, objectives that are simple, easy, and with low task loads come before those that are complex, difficult and with high task loads. These rules, in general, govern the design of instructional materials contained in the modules and phases of training of the MPL programme.

3.6.12 After defining the training objectives, the MPL course developer will design the tests that need to be passed by the student at different points in the programme. With respect to the MPL programme, ***mastery tests*** are those tests that correspond to terminal objectives. Additional ***progress tests*** may be developed for the purpose of providing feedback on the student's progress towards achieving both the terminal objectives and the key enabling objectives. The aim of designing the mastery tests at this stage in the

development of the programme, and prior to determining the actual content of the training, is to ensure that the test, and subsequently the content of the training, strictly correspond to the training objectives and to what the student is actually expected to do on the job.

3.6.13 All tests developed for the MPL, whether mastery or progress tests, should be *criterion-referenced* tests; the criteria used to measure competence should be published in assessment guides and/or practical test standards. All tests must be reliable and valid, both in terms of being an appropriate measure of the competency being tested and of obtaining consistent results with different raters and ratings.

3.7 Design of training modules

3.7.1 Upon sequencing and grouping the training objectives and designing the mastery and progress tests, the course developer will design the training units that constitute a training curriculum for the MPL. As defined in the ICAO course development methodology, the basic building block in this process is the ***module***. Each phase of the MPL training scheme, i.e. the Core Flying Skills, Basic, Intermediate and Advanced phases of training, will consist of a number of building blocks of instruction or modules which, in turn, contain the instructional events used for training. In line with the ICAO course development methodology, the module is structured so that the training objectives are presented at the very beginning of the module, and instructional events in respect to the presentation of content, the provision of practice and feedback and the assessment of achievement follow in logical order.

3.7.2 For the purpose of achieving the enabling objectives at the early phases of training, instructional events should be designed as varied and simplified versions of airline operational activities. During later phases of training and corresponding levels of competency, instructional events can then be designed to increasingly reflect the complexity of operational activities.

3.8 Selection of modes of delivery and training techniques

3.8.1 The training objectives will determine the modes of delivery and training techniques that are to be used in the different phases of training. The consistent delivery of training for the MPL demands the use of a mixture of validated, approved training materials. In accordance with Annex 1, 1.2.8, and Appendix 2, all MPL training should be conducted by an approved training organization, and conditions for obtaining the authorization should include having the necessary documentation, manuals and equipment for conducting the course. The approval requirements also cover the employment and training of course developers and instructors. Chapter 4 contains the competency-based requirements for instructors, examiners, inspectors and course developers.

3.8.2 In respect to training techniques, training for the MPL should require both individualized and group instruction depending on the training tasks being carried out. Classroom instruction can be delivered with the aid of group lectures and individualized learning. Practice on part-tasks can be carried out by individual students working with computerized-based training or e-learning programmes. Training activities on flight simulation training devices (FSTDs) will entail the pairing up of two students into “flight crew”, with each student alternately carrying out Pilot Flying and Pilot Not Flying activities.

3.9 Scenario-based training/Event-set-based training

3.9.1 A training technique that has in recent years gained currency in proficiency-based flight training programmes is ***scenario-*** or ***event-set***-based training. In scenario-based training, module lessons and exercises are organized into a number of scenarios. These scenarios provide the context of the lesson or exercise, in terms of a set of cues or occurrences (***events)*** and conditions, specifically designed for training or assessing the training objectives. Typically, designing a scenario takes into consideration factors such as the type of flight training device to be used and the level of its fidelity, type and length of training activity, complexity of meteorological conditions, level of workload and the nature of the events to be introduced.

3.9.2 Each change in the state of a system or in the environment can be termed an event. Events may therefore include any occurrence such as engine start-up, engine failure, a microburst on short final, erroneous steering commands by the flight management system or the sudden incapacitation of the pilot-in-command. An event may be brought about through the actions of the student or by external phenomena to which the student will have to respond. Events can also be designed as triggers that activate situations (such as an ATC clearance or an error in entering navigational coordinates into the flight management computer (FMC)) to which the student has to respond and can include distractors or conditions that deliberately divert the pilot's attention or increase workload. In the context of TEM, events may be benign or threatening and may also result from a failure to effectively manage error.

3.9.3 The use of FSTDs makes possible a wide range of options in respect to the design of the exercises, events and scenarios that go to make up the training modules included in the different phases of training for the MPL. The Course Developer should, however, always ensure that they are designed in such a manner as to effectively meet the specific training objectives that have been set. As training progresses through the different phases, it is also to be expected that scenarios will become increasingly complex and will reflect more closely actual operational conditions and activities.

3.9.4 Scenario-based training has the advantages that it provides:

a) easier and more reliable criterion-referenced evaluations;

b) more effective control over the behaviours that need to be demonstrated through the selection of occurrences and conditions against which the student has to perform; and

c) a structured design process for integrating the training and testing of both CRM and TEM competencies and the technical phase-of-flight competencies.

3.9.5 The design of training scenarios can be very labour-intensive and, as such, it may not be possible for a sufficiently wide range of them to be developed for training and testing purposes. A restricted number of scenarios used repetitively will result in ineffective training and testing. Course Developers may therefore make use of a number of software packages offering tools for the rapid development and reconfiguration of scenarios. One

such package* also allows for specific conditions relating to workload (time pressure) and distractors (e.g. radio chatter) to be programmed into the scenario. Other conditions, such as meteorological factors and runway conditions, can also be programmed.

3.10 Selection of training media

3.10.1 In general, the selection of media, as described in the ICAO course development methodology (Attachment to Chapter 2 refers) depends on its instructional appropriateness, economy, simplicity and availability. All facilities and training media should be considered by the Licensing Authority as being acceptable and appropriate for an MPL training course as part of the process of the approval of a training organization, in accordance with Annex 1, 1.2.8, and Appendix 2.

3.10.2 The range includes e-training and computer-based part-task training (Type I) devices to full motion, Level D (Type IV) flight simulators. The Type III FSTD must permit the progressive introduction of a sophisticated flight environment including ATC, flight guidance systems, EFIS, FMS and TCAS. All FSTDs should be qualified in accordance with State requirements and approved by the Licensing Authority as being appropriate to the task for which they are being used. Specifications to be used for the qualification of simulators are defined in JAR STD 1A (as amended) and in FAA AC 120-40B and the Alternate Means of Compliance (AMOC), as permitted, in AC 120-40B. Guidance on the qualification of simulators is found in the *Manual of Criteria for the Qualification of Flight Simulators* (Doc 9625).

3.10.3 A definition of the different types of FSTDs to be used for training for the MPL is contained in Annex 1, Appendix 3, paragraph 4. Their allocation to the different phases of training is indicated in the MPL training scheme contained in Appendix 1 to Chapter 3 of this document.

3.11 Production, developmental testing, validation, implementation and evaluation

3.11.1 The guidance provided up to this point has addressed the processes outlined for Phases 1 through 5 of the ICAO course development methodology and is specific to a training programme for the MPL. However, the process involved for the remaining Phases 6 through 9 in the development of an MPL training programme presents a few elements that also require attention.

3.11.2 As outlined in the Attachment to Chapter 2, the output of Phase 6 results in all training materials being produced in such a manner as to allow any competent instructor to deliver the course. Consequently, a comprehensive, well-documented and formatted MPL training programme does not differ from any other standardized training package.

3.11.3 Developmental testing is another important feature of Phase 6. In particular, mastery tests should go through developmental testing to ensure that they are valid and reliable.

* The Rapid Reconfigurable Event-Set Based Line-Oriented Evaluations (RRLOE) programme was developed by the University of Central Florida, U.S.A., for the purpose of ensuring valid and reliable flight crew evaluations under the FAA's Advanced Qualification Programme. The software enables the rapid building or reconfiguring of events and scenarios for the purposes of training and testing. Additional information on the RRLOE programme can be found at http://pegasus.cc.ucf.edu/~rrloe.

In the case of the MPL training programme, this would include developmental testing of scenario-based mastery tests to ensure that they actually match the corresponding training objective. Again, this procedure does not differ for the MPL training programme.

3.11.4 The purpose of validation (i.e. ICAO course development Phase 7) is to ensure that the MPL training materials can effectively guide trainees to the successful performance of mastery tests leading to the issuance of an MPL. In respect to the MPL training programme, this procedure does not differ from other ICAO competency-based course materials.

3.11.5 Once the course materials have been validated and revised as necessary, the MPL training programme can be implemented (Phase 8 of the ICAO course development methodology). However, successful implementation will depend on the qualifications of the instructors delivering the material. To this end, approved training organizations should ensure that instructors and examiners for the MPL training programme meet the competencies described in Chapter 4.

3.11.6 Post-training evaluation is the last phase of the ICAO course development methodology. In the Attachment to Chapter 2, four levels of evaluation are described. Trainee reactions to the MPL training programme (Level 1) and trainee mastery of objectives (Level 2) will be recorded as a matter of course, given the provisions described in the *Manual on the Approval of Flight Crew Training Organizations* (Doc 9841) and the use of the ISD approach in training development. Evaluation at Level 3 calls for the description of the on-the-job performance of trainees and how it effectively meets the standard spelled out during task analysis. This particular level of evaluation will normally be carried out during the IOE phase that MPL holders will have to go through upon completion of the MPL training programme. The purpose of evaluation at Level 4 is to determine the effects of the training programme at an organizational level. This level of evaluation could be used to determine the extent to which the adoption of an MPL training programme has actually resolved organizational issues (shortage of pilots, economies of time, cost benefits, etc.) and to determine and review an organization's strategic planning accordingly.

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Attachment B to Chapter 3
MULTI-CREW PILOT LICENCE
SAMPLE TRAINING OBJECTIVES

1. Sample Training Objective, *Perform take-off roll*, established at the Core Flying Skills Level of the MPL Training Scheme

	Condition	Behaviour	Standard
Terminal Objective	Single-engine aeroplane Single-pilot operation Normal procedures Day VFR operations below 10 000 feet AMSL VMC crosswind/headwind/tailwind within aeroplane limits	Perform take-off roll	Flight Manual/take-off charts/approved checklists HF Training Manual/ threat and error countermeasures Assessment Guide* AIP/National regulations/legislation
Enabling Objective 1	As above	Apply take-off power	As above
Enabling Objective 2		Maintain aeroplane direction	
Enabling Objective 3		Control yaw	
Enabling Objective 4		Check engine instruments	
Enabling Objective 5		Manage threats and errors	

* Sample Assessment Guides are provided for each training objective.

Assessment Guide

Element	Evidence	TEM Countermeasures
Perform take-off roll	➢ Line-up checks are completed ➢ Brakes are released ➢ Take-off power is smoothly and fully applied ➢ Aeroplane direction is maintained on runway ➢ Flight and engine instruments are checked and responded to during the take-off roll	➢ Aircraft position and settings are verified ➢ Airport and taxiway charts are used (if applicable) ➢ Clearances are understood and accurately read back ➢ Into wind aileron is raised (as applicable to crosswind) ➢ Excessive pressure on nose wheel is avoided ➢ Yaw is controlled ➢ Task fixation is avoided; tasks are effectively prioritized

Threat and Error Management

Example — Line-up checks completed

Threat: ATC call to give clearance interrupted checklist
Error: Pilot skipped checklist items — Line-up check is not completed
Undesired Aircraft State: Aircraft is lined up for take-off roll with pitot heat off

Examples of use of available resources (countermeasures) to manage the threat/undesired aircraft state

- Task fixation avoided (keep finger in checklist item until checklist is re-started)
- Aircraft settings verified (start checklist all over again after clearance read back)
- Effective task prioritization (request ATC to hold clearance until checklist completed)

2. Sample Training Objective, *Perform take-off roll*, established at the Basic Level of the MPL Training Scheme

	Condition	Behaviour	Standard
Terminal Objective	Single-engine aeroplane and/or approved simulator — Type II – III (as applicable to multi-crew operation) VFR operations VMC, light rain, wet runway Crosswind/headwind/tailwind within aeroplane limits Normal procedures	Perform take-off roll	Flight Manual/pilot operating handbook/take-off charts/approved checklists Aircraft Technical Log Operations Manual HF Training Manual/ threat and error countermeasures Assessment Guide AIP/National regulations/legislation NOTAMs, MET forecasts
Enabling Objective 1	As above	Apply take-off power	As above
Enabling Objective 2		Maintain aeroplane direction	
Enabling Objective 3		Control yaw	
Enabling Objective 4		Check engine instruments	
Enabling Objective 5		Manage threats and errors	

Assessment Guide

Element	Evidence	TEM Countermeasures
Perform take-off roll	➢ Line-up checks are completed ➢ Brakes are released ➢ Take-off power is smoothly and fully applied ➢ Aeroplane direction is maintained on runway ➢ Flight and engine instruments are checked and responded to during the take-off roll	➢ Aircraft position, settings and crew actions (as applicable to multi-crew operations) are verified ➢ Airport and taxiway charts are used ➢ Clearances are understood and accurately read back ➢ Into wind aileron is raised (as applicable to crosswind) ➢ Excessive pressure on nose wheel is avoided ➢ Yaw is controlled ➢ Wet runway procedures are applied (as applicable) ➢ Task fixation is avoided; tasks are effectively prioritized ➢ Briefings are concise and not rushed

		➢ Decisions and actions are analysed and openly verified (as applicable to multi-crew operations) ➢ No hesitation in making queries and in speaking up (as applicable to multi-crew operations) ➢ Communicates and acknowledges plans and decisions; good crosstalk, flow of information is fluid (as applicable to multi-crew operations)

Threat and Error Management

Example — Aeroplane direction is maintained on the runway

Threat: Crosswind take-off
Error: PF did not turn aileron into the wind
Undesired Aircraft State: Aircraft starts take-off roll with flight controls incorrectly configured

Examples of use of available resources (countermeasures) to manage the threat/undesired aircraft state

- Aircraft settings and crew actions verified
- Task fixation avoided
- Into wind aileron raised
- Crew briefed
- PNF did not hesitate to query
- Actions openly verified

3. Sample Training Objective, *Perform take-off roll*, established at the Intermediate Level of the MPL Training Scheme

	Condition	Behaviour	Standard
Terminal Objective	Approved simulator (Type III – IV) Multi-crew operation IFR operations IMC, rain, slippery runway Night/high crosswind Low visibility/low ceiling	Perform take-off roll	Flight Manual/take-off charts/approved checklists Aircraft Technical Log Operations Manual HF Training Manual/ threat and error countermeasures Assessment Guide AIP/National regulations/ legislation Departure/approach charts NOTAMs, MET forecasts ATC clearance
Enabling Objective 1	As above	Apply take-off power	As above
Enabling Objective 2		Maintain aeroplane direction	
Enabling Objective 3		Control yaw	
Enabling Objective 4		Check engine instruments	
Enabling Objective 5		Manage threats and errors	

Assessment Guide

Element	Evidence	TEM Countermeasures
Perform take-off roll	➢ Line-up checks are completed ➢ Brakes are released ➢ Take-off power is smoothly and fully applied ➢ Aeroplane direction is maintained on runway ➢ Flight and engine instruments are checked and responded to during the take-off roll ➢ Automation anomalies are effectively captured	➢ Aircraft position, settings and crew actions are verified ➢ Automation setup is briefed to other crew members ➢ Airport and taxiway charts are used ➢ Clearances are understood and accurately read back ➢ Into wind aileron is raised (as applicable to crosswind) ➢ Excessive pressure on nose wheel is avoided ➢ Yaw is controlled ➢ Wet runway procedures are applied (as applicable) ➢ Task fixation is avoided; tasks are effectively prioritized ➢ Briefings are concise and not rushed

		➢ Decisions and actions are analysed and openly verified ➢ No hesitation in making queries and in speaking up ➢ Communicates and acknowledges plans and decisions; good crosstalk, flow of information is fluid

Threat and Error Management

Example — Brakes are released

Threat: ATC instructs to taxi into position and hold due to departing traffic in intersecting runway
Error: When take-off clearance is received, PF forgets to release brakes
Undesired Aircraft State: High-engine thrust is applied before brakes are released

Examples of use of available resources (countermeasures) to manage the threat/undesired aircraft state

- Aircraft settings and crew actions verified
- Task fixation avoided
- Communicated and actions analysed and openly verified
- Decisions and actions openly verified

4. Sample Training Objective, *Perform take-off roll*, established at the Advanced Level of the MPL Training Scheme

	Condition	Behaviour	Standard
Terminal Objective	Approved simulator (Type IV) Multi-crew operation IFR operations IMC, rain, wet runway Night/high crosswind Low visibility/low ceiling Engine failure prior to V_1 Maximum gross weight	Perform take-off roll	Flight Manual/take-off charts/approved checklists Aircraft Technical Log Operations Manual HF Training Manual/ threat and error countermeasures Assessment Guide AIP/National regulations/legislation Departure/approach charts NOTAMs, MET forecasts ATC clearance
Enabling Objective 1	As above	Apply take-off power	As above
Enabling Objective 2		Maintain aeroplane direction	
Enabling Objective 3		Control yaw	
Enabling Objective 4		Check engine instruments	
Enabling Objective 5		Manage threats and errors	

Assessment Guide

Element	Evidence	TEM Countermeasures
Perform take-off roll	➢ Line-up checks are completed ➢ Brakes are released ➢ Take-off power is smoothly and fully applied ➢ Aeroplane direction is maintained on runway ➢ Flight and engine instruments are checked and responded to during the take-off roll ➢ Automation anomalies are effectively captured ➢ Required rejected take-off procedures are followed	➢ Aircraft position, settings and crew actions are verified ➢ Automation setup is briefed to other crew members ➢ Airport and taxiway charts are used ➢ Clearances are understood and accurately read back ➢ Into wind aileron is raised (as applicable to crosswind) ➢ Excessive pressure on nose wheel is avoided ➢ Yaw is controlled ➢ Wet runway procedures are applied (as applicable) ➢ Brake cooling chart is used ➢ Task fixation is avoided; tasks are effectively prioritized ➢ Briefings are concise and not rushed

		➢ Decisions and actions are analysed and openly verified ➢ No hesitation in making queries and in speaking up ➢ Communicates and acknowledges plans and decisions; good crosstalk, flow of information is fluid

Threat and Error Management

Example — Required rejected take-off procedures are followed

Threat: Heavy weight, high speed, rejected take-off
Error: Flight crew taxies into apron following the RTO without checking brake cooling chart
Undesired Aircraft State: Aircraft with overheated brakes taxiing in the vicinity of other aircraft, vehicles and ramp personnel

Examples of use of available resources (countermeasures) to manage the threat/undesired aircraft state

- Briefing
- Use of brake cooling chart
- Aircraft settings and crew actions verified
- Communicated and actions analysed and openly verified
- Decisions and actions openly verified

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Attachment C to Chapter 3
THREAT AND ERROR MANAGEMENT (TEM)

1. General

1.1 Threat and error management (TEM) is an overarching safety concept regarding aviation operations and human performance. TEM is not a revolutionary concept; it evolved gradually, as a consequence of the constant drive to improve the margins of safety in aviation operations through the practical integration of Human Factors knowledge.

1.2 TEM developed as a product of the collective industry experience. Such experience fostered the recognition that past studies and, most importantly, operational consideration of human performance in aviation had largely overlooked the most important factor influencing human performance in dynamic work environments: the interaction between people and the operational context (i.e. organizational, regulatory and environmental) within which they discharge their operational duties.

1.3 The recognition of the influence of the operational context in human performance led to the conclusion that study and consideration of human performance in aviation operations must not be an end in itself. In regard to the improvement of margins of safety in aviation operations, the study and consideration of human performance without context address only part of a larger issue. TEM therefore aims to provide a principled approach to the broad examination of the dynamic and challenging complexities of the operational context in human performance, for it is the influence of these complexities that generates consequences directly affecting safety.

2. The Threat and Error Management (TEM) Model

2.1 The Threat and Error Management (TEM) Model is a conceptual framework that assists in understanding, from an operational perspective, the interrelationship between safety and human performance in dynamic and challenging operational contexts.

2.2 The TEM Model focuses simultaneously on the operational context and the people discharging operational duties in such context. The model is descriptive and diagnostic of both human and system performance. It is descriptive because it captures human and system performance in the normal operational context, resulting in realistic descriptions. It is diagnostic because it allows quantifying complexities of the operational context in relation to the description of human performance in that context, and vice versa.

2.3 The TEM Model can be used in several ways:

a) safety analysis tool — can focus on a single event, as is the case with accident/incident analysis, or can be used to understand systemic patterns within a large set of events, as is the case with operational audits.

b) licensing tool — helps clarify human performance needs, strengths and vulnerabilities, allowing the definition of competencies from a broader safety management perspective.

c) training tool — helps an organization improve the effectiveness of its training interventions and, consequently, of its organizational safeguards.

2.4 From a training perspective, the broadest application to date of the TEM Model is in flight crew human performance training, especially in Crew Resource Management (CRM) training, a widely implemented Human Factors-based training intervention. This may lead to questions about the relationship between TEM and CRM, and it is therefore essential to clarify potential confusions from the outset. The *Human Factors Training Manual* (Doc 9683), Part II, Chapter 2, addresses this relationship in more detail.

2.5 TEM is an overarching safety concept with multiple applications in aviation, while CRM is exclusively a training intervention. The basic concepts underlying TEM (threats, errors and undesired aircraft states) have been integrated into existing CRM programmes because TEM countermeasures build in large measure — although not exclusively — upon CRM skills. The combination of TEM concepts with CRM skills thus introduces the opportunity to present the utilization of CRM skills by flight crews anchored in the operational environment and from a purely operational perspective. It is emphasized that TEM training does not replace CRM training but rather complements and enhances it.

2.6 Originally developed for flight deck operations, the TEM Model can nonetheless be used at different levels and in different sectors within an organization, and across different organizations and activities within the aviation industry. It is therefore important, when applying TEM, to keep the user's perspective in the forefront. Depending on "who" is using TEM (front-line personnel, intermediate management, senior management; flight operations, maintenance, air traffic control), slight adjustments to related definitions may be required. This document focuses on the flight crew as "user", and the discussion herein presents the perspective of flight crews' use of TEM.

3. The components of the TEM Model

There are three basic components in the TEM Model, from the perspective of flight crews: threats, errors and undesired aircraft states. The model proposes that threats and errors are part of everyday aviation operations that must be managed by flight crews, since both threats and errors carry the potential to generate undesired aircraft states. Flight crews must also manage undesired aircraft states, since they carry the potential for unsafe outcomes. Undesired state management is an essential component of the TEM Model, as important as threat and error management, because it largely represents the last opportunity to avoid an unsafe outcome and thus maintain safety margins in flight operations.

4. Threats

4.1 Threats are defined as events or errors that occur beyond the influence of the flight crew, increase operational complexity, and must be managed to maintain the margins of safety. During typical flight operations, flight crews have to manage various contextual complexities, for example, adverse meteorological conditions, airports surrounded by high mountains, congested airspace, aircraft malfunctions, and errors committed by other people outside of the cockpit, such as air traffic controllers, flight attendants or maintenance workers. The TEM Model considers these complexities as threats because they all have the potential to negatively affect flight operations by reducing margins of safety.

4.2 Some threats can be anticipated, since they are expected or known to the flight crew. For example, flight crews can anticipate the consequences of a thunderstorm by briefing their response in advance or can prepare for a congested airport, as they execute the approach, by making sure they keep a watchful eye out for other aircraft.

4.3 Some threats can occur unexpectedly and without warning, such as an in-flight aircraft malfunction. In this case, flight crews must apply skills and knowledge acquired through training and operational experience.

4.4 Some threats may not be directly obvious to, or observable by, flight crews immersed in the operational context and may need to be uncovered by safety analysis. These are considered latent threats. Examples include equipment design issues, optical illusions, or shortened turn-around schedules.

4.5 Regardless of whether threats are expected, unexpected, or latent, one measure of the effectiveness of a flight crew's ability to manage threats is whether threats can be anticipated so as to enable the flight crew to respond to them through deployment of appropriate countermeasures.

4.6 Threat management is a building block to error management and undesired aircraft state management. Although the threat-error linkage is not necessarily straightforward (i.e. it may not always be possible to establish a linear relationship or one-to-one mapping between threats, errors and undesired states), archival data demonstrate that mis-managed threats are normally linked to flight crew errors, which in turn are oftentimes linked to undesired aircraft states. Threat management provides the most proactive option to maintain margins of safety in flight operation, by avoiding safety-compromising situations at their roots. As threat managers, flight crews are the last line of defence to keep threats from impacting flight operations.

4.7 Table 1 presents examples of threats, grouped under two basic categories derived from the TEM Model. Some environmental threats can be planned for and some will arise spontaneously, but they all have to be managed by flight crews in real time. Organizational threats, on the other hand, can be controlled (i.e. removed or, at least, minimized) at source by aviation organizations and are usually latent in nature. Flight crews still remain the last line of defence, but there are earlier opportunities for these threats to be mitigated by aviation organizations themselves.

5. Errors

5.1 Errors are defined actions or inactions by the flight crew that lead to deviations from organizational or flight crew intentions or expectations. Unmanaged and/or mismanaged errors frequently lead to undesired aircraft states. Errors in the operational context thus tend to reduce the margins of safety and increase the probability of adverse events.

5.2 Errors can be spontaneous (i.e. without direct linkage to specific, obvious threats), linked to threats, or part of an error chain. Examples of errors would include the inability to maintain stabilized approach parameters, executing a wrong automation mode, failing to give a required call-out, or misinterpreting an ATC clearance.

Table 1. Examples of threats

Environmental threats	Organizational threats
➢ **Weather:** thunderstorms, turbulence, icing, wind shear, cross/tailwind, very low/high temperatures. ➢ **ATC:** traffic congestion, TCAS RA/TA, ATC command, ATC error, ATC language difficulty, ATC non-standard phraseology, ATC runway change, ATIS communication, units of measurement (QFE/meters). ➢ **Airport:** contaminated/short runway; contaminated taxiway, lack of/confusing/faded signage/markings, birds, aids U/S, complex surface navigation procedures, airport constructions. ➢ **Terrain:** High ground, slope, lack of references, “black hole”. ➢ **Other:** similar call signs.	➢ **Operational pressure**: delays, late arrivals, equipment changes. ➢ **Aircraft:** aircraft malfunction, automation event/anomaly, MEL/CDL. ➢ **Cabin:** flight attendant error, cabin event distraction, interruption, cabin door security. ➢ **Maintenance:** maintenance event/error. ➢ **Ground:** ground-handling event, de-icing, ground crew error. ➢ **Dispatch:** dispatch paperwork event/error. ➢ **Documentation:** manual error, chart error. ➢ **Other:** crew scheduling event

5.3 Regardless of the type of error, an error’s effect on safety depends on whether the flight crew detects and responds to the error before it leads to an undesired aircraft state and to a potential unsafe outcome. This is why one of the objectives of TEM is to understand error management (i.e. detection and response), rather than solely focusing on error causality (i.e. causation and commission). From a safety perspective, operational errors that are detected in a timely manner and promptly responded to (i.e. properly managed) do not lead to undesired aircraft states and do not reduce margins of safety in flight operations, thus becoming operationally inconsequential. In addition to its safety value, proper error management is an example of successful human performance, having both learning and training value.

5.4 Capturing how errors are managed is then as important as, if not more important than, capturing the prevalence of different types of error. It is of interest to capture if and when errors are detected and by whom, the response(s) upon detecting errors, and the outcome of errors. Some errors are quickly detected and resolved, thus becoming operationally inconsequential, while others go undetected or are mismanaged. A mismanaged error is defined as an error that is linked to or induces an additional error or undesired aircraft state.

5.5 Table 2 presents examples of errors, grouped under three basic categories derived from the TEM Model. In the TEM concept, errors have to be “observable”; therefore, the TEM Model uses the "primary interaction" as the point of reference for defining the error categories.

5.6 The TEM Model classifies errors based upon the primary interaction of the pilot or flight crew at the moment the error is committed. Thus, in order to be classified as an aircraft-handling error, the pilot or flight crew must be interacting with the aircraft (e.g. through its controls, automation or systems). In order to be classified as a procedural error, the pilot or flight crew must be interacting with a procedure (e.g. checklists and SOPs). In order to be classified as a communication error, the pilot or flight crew must be interacting with people (e.g. ATC, ground crew, and other crew members).

5.7 Aircraft-handling errors, procedural errors and communication errors may be unintentional or may involve intentional non-compliance. Similarly, proficiency considerations (i.e. skill or knowledge deficiencies and training system deficiencies) may underlie all three categories of error. In order to keep the approach simple and avoid confusion, the TEM Model does not consider intentional non-compliance and proficiency as separate categories of error but rather as subsets of the three major categories of error.

6. Undesired aircraft states

6.1 Undesired aircraft states are flight crew-induced aircraft position or speed deviations, misapplication of flight controls, or incorrect systems configuration, associated with a reduction in margins of safety. Undesired aircraft states that result from ineffective threat and/or error management may lead to compromising situations and reduce margins of safety in flight operations. Often considered at the cusp of becoming an incident or accident, undesired aircraft states must be managed by flight crews.

6.2 Examples of undesired aircraft states would include lining up for the incorrect runway during approach to landing, exceeding ATC speed restrictions during an approach, or landing long on a short runway requiring maximum braking. Events such as equipment malfunctions or ATC controller errors can also reduce margins of safety in flight operations, but these would be considered threats.

Table 2. Examples of errors

Aircraft-handling errors	➢ Manual handling/flight controls: vertical/lateral and/or speed deviations, incorrect flaps/speed brakes, thrust reverser or power settings. ➢ Automation: incorrect altitude, speed, heading, autothrottle settings, incorrect mode executed, or incorrect entries. ➢ Systems/radio/instruments: incorrect packs, incorrect anti-icing, incorrect altimeter, incorrect fuel switches settings, incorrect speed bug, incorrect radio frequency dialled. ➢ Ground navigation: attempting to turn down wrong taxiway/runway, taxi too fast, failure to hold short, missed taxiway/runway.
Procedural errors	➢ SOPs: failure to cross-verify automation inputs. ➢ Checklists: wrong challenge and response; items missed, checklist performed late or at the wrong time. ➢ Call-outs: omitted/incorrect call-outs. ➢ Briefings: omitted briefings; items missed. ➢ Documentation: wrong weight and balance, fuel information, ATIS, or clearance information recorded, misinterpreted items on paperwork; incorrect logbook entries, incorrect application of MEL procedures.
Communication errors	➢ Crew to external: missed calls, misinterpretations of instructions, incorrect readback, wrong clearance, taxiway, gate or runway communicated. ➢ Pilot to pilot: within crew miscommunication or misinterpretation.

6.3 Undesired states can be managed effectively, restoring margins of safety, or flight crew response(s) can induce an additional error, incident, or accident.

6.4 Table 3 presents examples of undesired aircraft states, grouped under three basic categories derived from the TEM Model.

6.5 An important learning and training point for flight crews is the timely switching from error management to undesired aircraft state management. An example would be as follows: a flight crew selects a wrong approach in the Flight Management Computer (FMC). The flight crew subsequently identifies the error during a cross-check prior to the Final Approach Fix (FAF). However, instead of using a basic mode (e.g. heading) or manually flying the desired track, both flight crew members become involved in attempting to reprogramme the correct approach prior to reaching the FAF. As a result, the aircraft "stitches" through the localizer, descends late, and goes into an unstable approach. This would be an example of the flight crew getting "locked in" to error management, rather than switching to undesired aircraft state management. The use of the TEM Model assists in educating flight crews that, when the aircraft is in an undesired state, their basic task is undesired aircraft state management instead of error management. It also illustrates how easy it is to get locked in to the error management phase.

6.6 Also from a learning and training perspective, it is important to establish a clear differentiation between *undesired aircraft states* and *outcomes*. *Undesired aircraft states* are transitional states between a normal operational state (i.e. a stabilized approach) and an outcome. *Outcomes*, on the other hand, are end states, most notably reportable occurrences (i.e. incidents and accidents). An example would be as follows: a stabilized approach (normal operational state) turns into an unstabilized approach (undesired aircraft state) that results in a runway excursion (outcome).

Table 3. Examples of undesired aircraft states

Aircraft handling	➢ Aircraft control (attitude). ➢ Vertical, lateral or speed deviations. ➢ Unnecessary weather penetration. ➢ Unauthorized airspace penetration. ➢ Operation outside aircraft limitations. ➢ Unstable approach. ➢ Continued landing after unstable approach. ➢ Long, floated, firm or off-centre line landing.
Ground navigation	➢ Proceeding towards wrong taxiway/runway. ➢ Wrong taxiway, ramp, gate or hold spot.
Incorrect aircraft configurations	➢ Incorrect systems configuration. ➢ Incorrect flight controls configuration. ➢ Incorrect automation configuration. ➢ Incorrect engine configuration. ➢ Incorrect weight and balance configuration.

6.7 The training and remedial implications of this differentiation are significant. While at the undesired aircraft state stage, the flight crew has the possibility, through appropriate TEM, of recovering the situation and returning to a normal operational state, thus restoring margins of safety. Once the undesired aircraft state becomes an outcome, recovery of the situation, return to a normal operational state, and restoration of margins of safety are not possible.

7. Countermeasures

7.1 As part of the normal discharge of their operational duties, flight crews must employ countermeasures to keep threats, errors and undesired aircraft states from reducing margins of safety in flight operations. Examples of countermeasures would include checklists, briefings, call-outs and SOPs, as well as personal strategies and tactics. Flight crews dedicate significant amounts of time and energy to the application of countermeasures to ensure margins of safety during flight operations. Empirical observations during training and checking suggest that as much as 70 per cent of flight crew activities may be countermeasure-related activities.

7.2 All countermeasures are necessarily flight crew actions. However, some countermeasures to threats, errors and undesired aircraft states that flight crews employ build upon "hard" resources provided by the aviation system. These resources are already in place in the system before flight crews report for duty and are therefore considered as systemic-based countermeasures. These include:

- Airborne Collision Avoidance System (ACAS);
- Ground Proximity Warning System (GPWS),
- Standard Operating Procedures (SOPs);
- Checklists;
- Briefings;
- Training.

7.3 Other countermeasures are more directly related to the human contribution to the safety of flight operations. These are personal strategies and tactics, and individual and team countermeasures, that typically include canvassed skills, knowledge and attitudes developed by human performance training, most notably, by Crew Resource Management (CRM) training. There are basically three categories of individual and team countermeasures:

- Planning countermeasures: essential for managing anticipated and unexpected threats;
- Execution countermeasures: essential for error detection and error response;
- Review countermeasures: essential for managing the changing conditions of a flight.

7.4 Enhanced TEM is the product of the combined use of systemic-based and individual and team countermeasures. Table 4 presents detailed examples of individual and team countermeasures. Further guidance on countermeasures can be found in the sample assessment guides for terminal training objectives (Attachment B to Chapter 3) as well as in the manual *Line Operations Safety Audit (LOSA)* (Doc 9803).

Table 4. Examples of individual and team countermeasures

Planning countermeasures		
SOP BRIEFING	The required briefing was interactive and operationally thorough	— Concise, not rushed, and met SOP requirements — Bottom lines were established
PLANS STATED	Operational plans and decisions were communicated and acknowledged	— Shared understanding about plans – "Everybody on the same page"
WORKLOAD ASSIGNMENT	Roles and responsibilities were defined for normal and non-normal situations	— Workload assignments were communicated and acknowledged
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
Execution countermeasures		
MONITOR / CROSS-CHECK	Crew members actively monitored and cross-checked systems and other crew members	— Aircraft position, settings, and crew actions were verified
WORKLOAD MANAGEMENT	Operational tasks were prioritized and properly managed to handle primary flight duties	— Avoided task fixation — Did not allow work overload
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
Review countermeasures		
EVALUATION/ MODIFICATION OF PLANS	Existing plans were reviewed and modified when necessary	— Crew decisions and actions were openly analysed to make sure the existing plan was the best plan
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
ASSERTIVENESS	Crew members stated critical information and/or solutions with appropriate persistence	— Crew members spoke up without hesitation

Chapter 4. INSTRUCTOR, EXAMINER, INSPECTOR AND COURSE DEVELOPER COMPETENCIES FOR THE MULTI-CREW PILOT LICENCE

4.1 Instructor qualifications

4.1.1 Instructors shall have demonstrated that they possess the competencies described in the Attachment to this chapter and that they have successfully achieved the ability to deliver training in accordance with the features of a competency-based approach to training, as outlined in 2.2 of Chapter 2.

4.1.2 Instructors shall meet the requirements as specified in Annex 1, 2.1.8 and 2.8, as appropriate. In addition, for the Intermediate and Advanced phases of the MPL training programme, the instructor shall have experience, acceptable to the Licensing Authority, in multi-crew operations.

4.2 Examiner qualifications

4.2.1 Examiners shall meet at least the following requirements:

a) have demonstrated that they possess the competencies for examiners described in the Attachment to this chapter;

b) hold the qualifications to provide instruction at the Advanced phase of training; and

c) meet the experience requirements of an instructor for the MPL as specified in 4.1.

4.2.2 The Licensing Authority shall authorize an examiner for periods not exceeding three years.

4.3 Inspector qualifications

Inspectors of MPL training programmes shall have demonstrated that they possess the competencies described in the Attachment to this chapter.

4.4 Course developer qualifications

Course developers shall have demonstrated that they possess the competencies described in the Attachment to this chapter and that they have successfully achieved the ability to develop training in accordance with the features of a competency-based approach to training, as outlined in 2.2 of Chapter 2.

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Attachment to Chapter 4
COMPETENCIES OF INSTRUCTORS, EXAMINERS, INSPECTORS AND COURSE DEVELOPERS

INSTRUCTOR

Deliver competency-based training

1. Prepare for the delivery of training

1.1 Perform administrative arrangements
1.2 Perform personal preparation for delivery
1.3 Prepare facilities and equipment for group-based training
1.4 Administer entry test for group-based training
1.5 Analyse results of entry tests for group-based training
1.6 Administer entry tests for individualized training
1.7 Determine entry level of each student

2. Conduct competency-based training module

2.1 Conduct group-based training
2.2 Introduce module
2.3 Present content of the first/next intermediate objective
2.4 Clarify content of the first/next intermediate objective
2.5 Administer written exercises
2.6 Administer group discussion exercises
2.7 Administer role-play exercises
2.8 Administer e-learning/CBT/FSTD exercises
2.9 Administer key progress tests
2.10 Administer mastery tests
2.11 Administer an individualized module
2.12 Introduce training
2.13 Provide training materials to each trainee
2.14 Meet with student for consultation
2.15 Monitor student progress
2.16 Administer end-of-module test
2.17 Conduct airborne and scenario-based training
2.18 Conduct briefing
2.19 Administer airborne/scenario-based training
2.20 Conduct debriefing
2.21 Monitor student progress
2.22 Administer end-of-module test

3. Evaluate trainee's performance

3.1 Determine test results
3.2 Determine individual problems

3.3 Determine class problems
3.4 Apply corrective measures to the class/individual problems

4. Prepare course delivery report

4.1 Prepare introduction and administrative information
4.2 Summarize end-of-module test results
4.3 Summarize feedback for the course developers
4.4 Summarize trainee's opinion questionnaires

EXAMINER

Carry out competency-based assessment

1. Gather evidence

1.1 Establish a working relationship with the candidate
1.2 Interpret competency standards
1.3 Apply assessment techniques and tools

2. Evaluate evidence

2.1 Ensure validity of evidence gathered
2.2 Ensure reliability of evidence gathered
2.3 Establish assessment decision
2.4 Provide constructive feedback to the candidate

3. Report assessment decision

3.1 Record assessment results
3.2 Provide candidate with future training plan, if applicable
3.3 Review assessment process to improve validity and reliability
3.4 Process relevant documentation

INSPECTOR

Inspect competency-based training programmes

1. Assess ATO's application to conduct a competency-based training programme

1.1 Validate background data on Approved Training Organization
1.2 Review application
1.3 Evaluate quality assurance system implementation
1.4 Document findings

2. Evaluate competency-based training programme

2.1 Assess training needs analysis
2.2 Assess curriculum design
2.3 Assess courseware (ground, flight simulation training device (FSTD) and flight)
2.4 Assess evaluation procedures
2.5 Confirm required qualifications and competencies of instructors and designated/delegated examiners
2.6 Document evaluation findings

3. Inspect competency-based training programme

3.1 Inspect ground school facilities
3.2 Inspect FSTD facilities
3.3 Inspect flight training facilities
3.4 Inspect record-keeping system
3.5 Evaluate conduct of training
3.6 Document inspection findings

4. Conduct surveillance

4.1 Carry out a risk assessment
4.2 Establish initial surveillance plan
4.3 Conduct operational review of training programme
4.4 Instigate follow-up rectification/enforcement action
4.5 Document surveillance findings
4.6 Establish ongoing surveillance plan

5. Conduct trend analysis of approval/surveillance activity*

* Depending on the size of the civil aviation authority, individual inspectors may or may not be responsible for this competency unit.

COURSE DEVELOPER

Develop competency-based training and assessment

1. Conduct analysis

1.1 Conduct preliminary analysis
1.2 Conduct job and task analysis
1.3 Conduct population analysis

2. Develop training material

2.1 Design curriculum
2.2 Define training objectives
2.3 Design mastery tests
2.4 Design modules
2.5 Determine training strategy
2.6 Select training media
2.7 Produce competency-based training and assessment materials
2.8 Carry out developmental testing of competency-based training and assessment materials

3. Evaluate training material

3.1 Validate competency-based training materials
3.2 Evaluate whether job performance objectives are met
3.3 Evaluate whether organizational and operational objectives are met

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