BỘ GIAO THÔNG VẬN TẢI
CỤC HÀNG KHÔNG VIỆT NAM

CỘNG HOÀ XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc

Số: 1127 /QĐ-CHK

Hà Nội, ngày 08 tháng 06 năm 2021

QUYẾT ĐỊNH
Về việc ban hành tài liệu hướng dẫn tuân thủ Bộ quy chế an toàn hàng không dân dụng lĩnh vực tàu bay và khai thác tàu bay

CỤC TRƯỞNG CỤC HÀNG KHÔNG VIỆT NAM

Căn cứ Luật Hàng không dân dụng Việt Nam năm 2006 và Luật sửa đổi, bổ sung một số điều Luật Hàng không dân dụng Việt Nam năm 2014;

Căn cứ Thông tư số 01/2011/TT-BGTVT ngày 27/01/2011 của Bộ trưởng Bộ Giao thông vận tải ban hành Bộ quy chế an toàn hàng không dân dụng lĩnh vực tàu bay và khai thác tàu bay và căn cứ các Thông tư số 03/2016/TT-BGTVT ngày 31/03/2016, Thông tư số 21/2017/TT-BGTVT ngày 30/06/2017, Thông tư số 56/2018/TT-BGTVT ngày 11/12/2018, Thông tư số 42/2020/TT-BGTVT ngày 31/12/2021 về việc sửa đổi, bổ sung một số điều của Bộ quy chế an toàn hàng không dân dụng lĩnh vực tàu bay và khai thác tàu bay được ban hành kèm theo Thông tư số 01/2011/TT-BGTVT ngày 27/01/2011.

Căn cứ Quyết định số 2606/QĐ-BGTVT của Bộ Giao thông vận tải ngày 07/09/2017 quy định chức năng, nhiệm vụ, quyền hạn và cơ cấu tổ chức của Cục Hàng không Việt Nam và quyết định số 1055/QĐ-BGTVT của Bộ Giao thông vận tải ngày 31/05/2019 về việc sửa đổ, bổ sung Quyết định số 2606/QĐ-BGTVT của Bộ Giao thông vận tải ngày 07/09/2017 quy định chức năng, nhiệm vụ, quyền hạn và cơ cấu tổ chức của Cục Hàng không Việt Nam;

Theo đề nghị của Trưởng phòng Tiêu chuẩn An toàn bay - Cục Hàng không Việt Nam.

QUYẾT ĐỊNH:

Điều 1. Ban hành bằng tiếng Anh tài liệu hướng dẫn tuân thủ Bộ quy chế an toàn hàng không dân dụng lĩnh vực tàu bay và khai thác tàu bay về khóa huấn luyện người lái máy bay tổ lái nhiều thành viên (AC07-020 Competency-based multi-crew pilot license (MPL) training course).

Điều 2. Quyết định này có hiệu lực kể từ ngày ký.

Điều 3. Trưởng phòng Tiêu chuẩn an toàn bay - Cục Hàng không Việt Nam; Thủ trưởng các cơ quan, đơn vị có liên quan và các nhân có liên quan chịu trách nhiệm thi hành quyết định này.

Nơi nhận:
- Như Điều 3;
- Cục trưởng (để báo cáo);
- TCTHK-CTCP,VJC, PA, BAV, VSA, HTX, HAA, VNHS, VNHN, BAA, FTC, VTC.
- Lưu: VT, TCATB (Quyenx 15b).

KT. CỤC TRƯỞNG
PHÓ CỤC TRƯỞNG

Võ Huy Cường

CIVIL AVIATION AUTHORITY OF VIET NAM	ADVISORY CIRCULAR AC 07 - 020

APPROVAL COMPETENCY - BASED MULTI - CREW PILOT LICENSE (MPL) TRAINING COURSE

SECTION 1 GENERAL

1.1 PURPOSE

a) This Advisory Circular (AC) provides individuals, organizations with guidance to development and implementation of competency-based MPL training course.

b) This AC provides guidance to implement the regulatory requirement of Subpart F, Section V of Part 7 - Aviation Personnel License of VARs.

1.2 STATUS OF THIS ADVISORY CIRCULAR

This is an original issuance of this AC.

1.3 BACKGROUND

a) ICAO Standards in Annex 1, Personnel Licensing.

b) ICAO's Doc 9868, Procedure for Air Navigation Services: Training (Third Editions, 2020).

c) Part 7 of VARs establishes the specific requirements for MPL.

d) EASA requirements for MPL.

1.4 APPLICABILITY

a) This AC is applicable to all individuals, organizations desiring to develope, implement the MPL training and get MPL license required by the Part 7 of VARs.

b) Applicants for the issue of an MPL shall have completed a MPL training course of theoretical knowledge and flight instruction at an ATO in accordance with this AC.

1.5 RELATED REGULATIONS

The regulations are directly applicable to the guidance contained in this advisory circular: VAR Part 7, Aviation Personnel License: Subpart F, Section V.

1.6 RELATED PUBLICATIONS

a) For further information on this topic, individuals, instructors and examiners are invited to consult the following publications:

1) International Civil Aviation Organization (ICAO)

i) ICAO Annex 1- Personnel Licensing;

ii) ICAO's Doc 9868, Procedure for Air Navigation Services: Training (Third Editions, 2020);

2) CAAV Guidance

i) AC 07-011,12 Commercial Pilot Practical Test Standards for Airplane (Single-Engine Land (SEL), Multiengine Land (MEL), Single-Engine Sea (SES), Multiengine Sea (MES)).

ii) AC 07-013 Airline Transport Pilot and Aircraft Type Rating Practical Test Standards for Airplane.

iii) AC 14-001 Training Curriculums;

iv) AC 07-004 FTSD Approvals;

v) AC 09-001 ATO Approvals.

3) Other publication

i) EASA's Annex 1, Subpart E: Multi-crew Pilot Licence and Appendix 5: Integrated MPL training course.

1.7 DEFINITIONS & ACRONYMS

a) ATPL: Air Transport Pilot License

b) ATO: Approval Training Organization

c) CAAV: Civil Aviation Authority of Vietnam

d) FNPT: Flight Navigation Procedures Trainer

e) FSTD: Full Simulator Training Device

f) FFS: Full Flight Simulator

g) IFR: Instrument Flight Rule

h) KSA: Knowledge, skills and attitudes

i) MPL: Multi-crew Pilot License

j) ME: Multi-engine.

k) MCC: Multi Crew Cooperation

l) LOFT: Line Oriented Flight Training

m) PBN: Performance-based Navigation

n) PF: Pilot Flying

o) PNF: Pilot Non-flying

p) PM: Pilot Monitoring

q) VFR: Visual Flight Rule

r) UPRT: Upset Prevention and Recovery Training

SECTION 2. TRAINING PRINCIPLES

2.1. GENERAL

a) Multi-crew pilot licence (MPL) training delivers ab initio aeroplane pilots directly for co-pilot duties. MPL courses shall be competency-based according to ICAO requirements (Annex 1) and guidances (Doc 9868). MPL training makes greater use of modern simulation and training devices. The training curriculum was traditionally conducted on an aeroplane to now can be done on flight simulation training devices.

b) The competency standards expected from the MPL holder are defined in the approved adapted competency model used by the ATO. With these competencies, the MPL holder is expected to complete the air operator's initial operational experience phase (IOE) with high probability of success and within the time frame normally allowed for this phase.

c) ATOs and operators involved in MPL programs shall assure the existence of a data collection and analysis mechanism, acceptable to the CAAV, as a basis for seamless student performance tracking and continuous course improvement. This requires the harmonization of the adapted competency models used by the ATO and the operator.

2.2. TRAINING REQUIREMENTS

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

media (classroom, various level of simulation and aeroplan) according to competency-based training requirements and guidance of ICAO.

b) The approval to conduct MPL courses should be provisional and should be confirmed only after obtaining a satisfactory result from the first courses and after incorporation of lessons learned into the curriculum.

c) Close oversight by the CAAV shall be exercised during the period of provisional approval. Regular feedback from the ATO to the CAAV on the progress and problems faced during delivery of the course is important. How this feedback is to be provided to the CAAV shall therefore be clearly stated as part of the approval.

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

e) Each phase of the MPL training scheme shall be composed of instruction in underpinning knowledge and presented 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.

f) The training course for an MPL licence shall include an ongoing evaluation of the training programme and of the students following the programme that is acceptable to the CAAV. The evaluation shall ensure that:

1) The competencies and related assessment are relevant to the task of a co-pilot of an aircraft certificated for more than one pilot, under VFR and IFR, day and night flights; and

2) The training plan is designed to enable the trainees to meet the interim (if defined) and final competency standards; and

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

g) The advanced phase of an MPL training course shall include a sufficient number of take-offs and landings in actual flight to ensure that competency standards are met and 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.

h) The CAAV may accept a reduction, from twelve to six, of the number of take-offs and landings, provided that:

1) The approved training organization has demonstrated to the satisfaction of the Licensing Authority that this does not negatively affect the achievement of the competency standards by the student; and

2) 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.

i) Applicants for the issue of an MPL shall demonstrate a level of theoretical knowledge appropriate to the holders of an ATPL(A), in accordance with VAR Part 7 and to a multi-pilot type rating.

j) An applicant for an MPL shall have demonstrated through continuous assessment the skills required for fulfilling all the competency units specified in this AC, as pilot flying and pilot not flying, in a multi-engine turbine-powered multi-pilot aeroplane, under VFR and IFR.

k) On completion of the training course, the applicant shall pass a skill test that equivalent to ATPL/Type rating in accordance with VAR Part 7 and AC 07-013, to demonstrate the ability to perform the relevant procedures and maneuvers with the competency appropriate to the privileges granted. The skill test shall be taken in the type of aeroplane used on the advanced phase of the MPL integrated training course or in an FFS representing the same type.

2.3 INSTRUCTOR STANDARDISATION

a) Instructors shall hold or have held a licence and be authorized to carry out instruction on the basis of their expertise and/or qualifications and/or ratings.

Note: The above requirement does not preclude a non-licensed technical specialist from being authorized by the appropriate authority to instruct on subject matters that deal with systems operation or procedural requirements in any training environment or media.

b) Prior to an organization authorizing the provision of instruction, instructors should undergo a selection process designed to ensure the individual's motivation and disposition are suitable for the instructor's role.

c) Prior to an organization authorizing the provision of instruction, instructors should successfully complete a formal instructor competency assessment during the conduct of practical training. During the assessment, the instructor should consistently demonstrate the required competencies according to the relevant adapted competency model.

d) All instructors should receive refresher training, and be reassessed using a documented training and assessment process acceptable to the CAAV, implemented by a certificated or approved organization and at intervals established by the

authority. Such refresher training and reassessment intervals shall not be greater than three years.

e) The instructor shall have experience, acceptable to the CAAV.

f) Qualified and authorized instructors may be assigned to carry out specific assessment, checking and/or testing duties to determine that all required performance criteria have been satisfactorily achieved. These performance criteria may have been established as a final objective or required to be met on a continuous basis. In either case, the instructor is responsible for making a determination of the level of competence achieved and any recommendation for immediate remediation, if necessary. Qualified instructors/assessors/evaluators may be assigned to determine the final level of competence of a candidate.

2.4 EXAMINER QUALIFICATIONS

MPL examiners shall meet at least the following requirements:

a) Have demonstrated that they possess the competencies required to perform the tasks described as following:

1) Gather evidence

i) Establish a working relationship with the candidate

ii) Interpret competency standards

iii) Apply assessment techniques and tools

2) Evaluate evidence

i) Ensure validity of evidence gathered

ii) Ensure reliability of evidence gathered

iii) Establish assessment decision

iv) Provide constructive feedback to the candidate

3) Report assessment decision

i) Record assessment results

ii) Provide candidate with future training plan, if applicable

iii) Review assessment process to improve validity and reliability

iv) Process relevant documentation

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

c) For each training subject, examiner is not an instructor for the training subject that instructed.

e) Meet the experience requirements of an instructor for the MPL as specified in Paragraph 2.3.

SECTION 3. TRAINING PROGRAM

3.1. STRUCTURE OF TRAINING PROGRAM

a) The structure of training program includes four phases of training as following:

1) Phase 1 - Core flying skills: Specific basic single-pilot training

2) Phase 2 - Basic: Introduction of multi-crew operations and instrument flight

3) Phase 3 - Intermediate: Application of multi-crew operations in a high-performance, ME turbine aeroplane

4) Phase 4 - Advanced: Type rating training within an airline-oriented environment

b) The training items listed under the **Core Flying Skills and Basic** phases 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 crew resource management (CRM) skills and threat and error management (TEM) is also strengthened by introducing them at the very beginning of the programme. The student shall meet the interim competency standard representative of the Core Flying Skills, Basic or Intermediate phases, as applicable. The student shall meet the final competency standards at the completion of the advanced phase of training.

c) During the **Core flying skills** phase or the **Basic** phase, training on an aeroplane includes upset prevention and recovery and instrument flight. However, starting with the Basic phase of training, use of flight simulation training devices (FSTDs) will form an integral part of the training. FSTDs range 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. Both Pilot Flying and Pilot Monitoring tasks and performance should be emphasised equally in the training conducted during the Basic, Intermediate and Advanced phases of training.

d) During the **Intermediate** phase, flight training should be conducted under IFR but need not be specific to any aeroplane type.

e) During the **Advanced** phase, the student will be required to consistently achieve the final competency standards needed for the safe operation of an applicable aeroplane type as specified in the training and assessment plans. Upon qualifying, the student will hold an MPL which includes the privileges of the type and instrument ratings, the privileges of which are to be exercised as co-pilot on a turbine-powered, commercial air transport aeroplane.

Note: The TEM requirements and guidance is specified in Appendix 3 of this AC.

3.2. TRAINING SCHEME

a) The specific arrangement, between an approved training organisation (ATO) and an operator for the MPL training should cover at least the following points:

1) Pre-entry requirements (including screening and selection);

2) Provision of the relevant documentation (operations manuals (OMs) and training manuals);

3) Design of the training program;

4) Content of the operator conversion course;

5) Training effectiveness (e.g. continuous monitoring system, progress checks, etc.);

6) Provision of base training;

7) Graduate performance data feedback from the operator to the ATO;

8) Course evaluation and improvement; and

9) Alignment of the grading and assessment criteria.

b) The ATO and operator may use their OMs and training manuals to identify additional areas to be covered by the specific arrangement.

c) The following scheme shall be applied:

MPL training scheme Training including PF and PNF/PM					
	Phase of training	*Training items*	*Flight and simulated flight training media — Minimum level requirement*		*Ground training media*
Adapted Competency Model	Advanced Type rating training within an airline-oriented environment	i) TEM and CRM ii) Landing training iii) All weather scenarios iv) LOFT v) Abnormal procedures vi) Normal procedures vii) Upset prevention and recovery*	Aeroplane: Turbine Multi-engine Multi-crew certified	12 take-offs and landings as PF One go-around with all engines operating	• E-learning • Part-task trainer • Classroom
			FSTD: i) Type VII (ICAO Standard), or ii) FS Level D or C + ATC Simulation (EASA Standard)	PF/PM	
	Intermediate Application of multi-crew operations in a high-performance, multi-engine turbine aeroplane	i) TEM and CRM ii) LOFT iii) Abnormal procedures iv) Normal procedures v) Multi-crew vi) Instrument flight	FSTD: i) Type VI (ICAO Standard), or ii) Representing on ME turbine-powered aeroplane to be operated with a co-pilot and qualified to an equipvalent standard to level B + ATC simulation (EASA Standard)	PF/PM	
	Basic Introduction of multi-crew operations and instrument flight	i) TEM and CRM ii) PF/PM complement iii) IFR cross-country iv) Upset prevention and recovery* v) Night flight** vi) Instrument flight	Aeroplane: single or multi-engine	PF/PM	
			FSTD: i) Type IV or V (ICAO Standard), or ii) FNPT II + MCC (EASA Standard)		
	Core flying skills Specific basic single pilot training	i) TEM and CRM ii) VFR cross-country iii) Upset prevention and recovery* iv) Solo flight v) Night flight** vi) Basic instrument flight vii) Principles of flight viii) Cockpit procedures	Aeroplane: single engine (or multi-engine as appropriate)	PF	
			FSTD: i) Type I or III – Type II may be used for certain basic instrument flight training task (ICAO Standard), or ii) FNPT I/BITD (EASA Standard)		

*UPRT is provided in modules starting with an on-aeroplane module in the Core flying skills phase or in the Basic phase depending on the individual course design and equipment, and completed with at least one FSTD training module during the type rating training.

** Night flying experience should be gained on-airplane, which could be in the Core flying skills phase or in the Basic phase.

3.3. TRAINING COURSE

3.3.1 GENERAL REQUIREMENTS

a) The aim of the MPL integrated course is to train pilots to the level of proficiency necessary to enable them to operate as co-pilot of a multi-engine multi-pilot turbine-powered air transport aeroplane under VFR and IFR and to obtain an MPL.

b) An applicant wishing to undertake an MPL integrated course shall complete all the instructional stages in one continuous course of training at an ATO. The training shall be competency based and conducted in a multi-crew operational environment.

c) Only ab-initio applicants shall be admitted to the course.

d) The course shall comprise:

1) Theoretical knowledge instruction to the ATPL(A) knowledge level;

2) Visual and instrument flying training;

3) Training in MCC for the operation of multi-pilot aeroplanes;

4) Type rating training.

e) An applicant failing or unable to complete the entire MPL course may apply to the CAAV for the theoretical knowledge examination and skill test for a licence with lower privileges and an IR, if the applicable requirements are met.

3.3.2 THEORETICAL KNOWLEDGE

a) An approved MPL theoretical knowledge course shall comprise at least 750 hours of instruction for the ATPL(A) knowledge level, as well as the hours required for:

1) Theoretical knowledge instruction for the relevant type rating; and

2) UPRT theoretical knowledge instruction in accordance AC 14-003.

Note: The detail requirements for theoretical knowledge instruction are specified in Appendix 1 of AC.

3.3.3 FLYING TRAINING

a) The flying training shall comprise a total of at least 240 hours, composed of hours as PF and PM, in actual and simulated flight, and covering the four phases of training.

b) MCC requirements shall be incorporated into the relevant phases.

c) Training in asymmetric flight shall be given either in an aeroplane or an FFS.

d) Flight experience in actual flight shall include:

1) All the experience requirements of class and type ratings;

2) UPRT flight instruction in accordance with AC14-003;

3) Aeroplane UPRT exercises related to the specificities of the relevant type in accordance with AC 14-003;

4) Night flying;

5) Flight solely by reference to instruments; and

6) The experience required to achieve the relevant airmanship.

e) Each phase of training in the flight instruction syllabus shall be composed of both instruction in the underpinning knowledge and in practical training segments.

f) The training course shall include a continuous evaluation process of the training syllabus and a continuous assessment of the students following the syllabus. Evaluation shall ensure that:

1) The competencies and related assessment are relevant to the task of a co-pilot of a multi-pilot aeroplane; and

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

g) The training course shall include at least 12 take-offs and landings to ensure competency. Those take-offs and landings may be reduced to at least six, provided that prior to delivering the training, the ATO and the operator ensure that:

1) A procedure is in place to assess the required level of competency of the student pilot; and

2) A process is in place to ensure that corrective action is taken if in-training evaluation indicates the need to do so.

h) Those take-offs and landings shall be performed under the supervision of an instructor in an aeroplane for which the type rating shall be issued.

3.3.4 ASSESSMENT LEVEL

The applicant for the MPL shall have demonstrated performance in all 9 competency units specified below, at the advanced level of competency required to operate and interact as a co-pilot in a turbine-powered multi-pilot aeroplane, under visual and instrument conditions. Assessment shall confirm that control of the aeroplane or situation is maintained at all times, to ensure the successful outcome of a procedure or manoeuvre. The applicant shall consistently demonstrate the knowledge, skills and attitudes required for the safe operation of the applicable aeroplane type, in accordance with the MPL performance criteria.

a) COMPETENCY UNITS

The applicant shall demonstrate competency in the following 9 competency units:

1) Apply human performance principles, including principles of threat and error management;

2) Perform aeroplane ground operations;

3) Perform take-off;

4) Perform climb;

5) Perform cruise;

6) Perform descent;

7) Perform approach;

8) Perform landing; and

9) Perform after landing and aeroplane post-flight operations.

Note:

1) Detailed requirements for all competency units are specified in Appendix 2 of AC.

2) Assessment of student competency during take-off and landing training is specified in Appendix 4 of AC.

b) SIMULATED FLIGHT

Minimum requirements for FSTDs:

1) Phase 1 - Core flying skills: E-training and part tasking devices approved by the CAAV that have the following characteristics:

i) Involve accessories beyond those normally associated with desktop computers, such as functional replicas of a throttle quadrant, a side-stick controller, or an FMS keypad; and

ii) Involve psychomotor activity with appropriate application of force and timing of responses.

2) Phase 2 - Basic: An simulator type IV or V (ICAO Standard) or FNPT II + MCC (EASA Standard) that represents a generic multi-engine turbine-powered aeroplane.

3) Phase 3 - Intermediate: An FSTD that represents a multi-engine turbine-powered aeroplane required to be operated with a co-pilot and qualified to an

equivalent standard to type VI (ICAO Standard), or to level B + ATC simulation (EASA Standard), additionally including:

i) A daylight/twilight/night visual system continuous cross-cockpit minimum collimated visual field of view providing each pilot with 180° horizontal and 40° vertical field of view, and

ii) ATC environment simulation.

4) Phase 4 - Advanced: An FFS which is fully equivalent to type VII (ICAO Standard), or level D or C + ATC Simulation (EASA Standard) with an enhanced daylight visual system, including ATC environment simulation.

APPENDIX 1

THEORETICAL KNOWLEDGE INSTRUCTION

a) The 750 hours of instruction, which also cover the Area 100 KSA, may include in suitable proportions:

1) Classroom work;

2) Lessons;

3) Tutorials;

4) Demonstrations, including those supported by demonstration equipment;

5) Exercises carried out as groups or individuals and based on pre-flight and en-route planning, communications, presentations and projects;

6) Exercises that use demonstration equipment or training devices;

7) Directed study including workbook exercises or assignments;

8) Aerodrome or aviation industry field trips;

9) Computer-based training and e-learning elements;

10) Progress tests, Area 100 KSA assessments and mental maths test(s); and

11) Other training methods, media and tools approved by the competent authority.

APPENDIX 2

COMPETENCY UNITS, COMPETENCY ELEMENTS AND PERFORMANCE CRITERIA

a) Apply human performance principles, including principles of threat and error management:

1) Cooperation;
2) Leadership and managerial skills;
3) Situation awareness;
4) Decision making.

b) Perform Aircraft Ground and Pre-Flight Operations

List of competency elements and performance criteria	**Duty**	**Observation and assessment** *Satisfactory (S) Unsatisfactory (U)*
1) Demonstrate attitudes and behaviors appropriate to the safe conduct of flight, including recognising and managing potential threats and errors;		
2) Perform dispatch duties:		(S) or (U)
i) Verifies technical condition of the a/c, including adequate use of MEL;	PF/PNF	
ii) Checks technical bulletins and notices;	PF/PNF	
iii) Determines operational environment and pertinent weather;	PF/PNF	
(iv) Determines impact of weather on aircraft performance;	PF/PNF	
v) Applies flight planning and load procedures;	PF/PNF	
vi) Determines fuel requirement;	PF/PNF	
vii) Files an ATS flight plan (if required)	PF/PNF	
3) Provide flight crew and cabin crew briefings;		(S) or (U)
i) Briefed flight crew in all relevant matters;	PF	
ii) Briefed cabin crew in all relevant matters.	PF	
4) Perform pre-flight checks and cockpit preparation:		
i) Ensures the airworthiness of the aircraft;	PF	
ii) Performs the cockpit preparation and briefings;	PF/PNF	
iii) Performs FMS initialisation, data insertion and confirmation;	PF/PNF	

iv) Optimises and checks take-off performance and take-off data calculation.	PF/PNF	
5) Perform engine start:		(S) or (U)
i) Asks for, receives acknowledges and checks ATC clearance;	PNF	
ii) Performs engine start procedure;	PF/PNF	
iii) Uses standard communication procedures with ground crew and ATC.	PF/PNF	
6) Perform taxi out:		(S) or (U)
i) Receives, checks and adheres to taxi clearance;	PNF	
ii) Taxis the aircraft, including use of exterior lighting;	PF	
iii) Complies to taxi clearance;	PF/PNF	
iv) Maintains look-out for conflicting traffic and obstacles;	PF/PNF	
v) Operates thrust, brakes and steering;	PF	
vi) Conducts relevant briefings;	PF	
vii) Uses standard communication procedures with crew and ATC;	PNF	
viii) Completes standard operating procedures and checklists;	PF/PNF	
ix) Updates and confirms FMS data;	PF/PNF	
x) Manages changes in performance and departure route;	PF/PNF	
xi) Completes de or anti-ice procedures.	PF/PNF	
7) Manage abnormal and emergency situations:		(S) or (U)
i) Identifies the abnormal condition;	PF/PNF	
ii) Interprets the abnormal condition;	PF/PNF	
iii) Performs the procedure for the abnormal condition.	PF/PNF	
8) Communicate with cabin crew, passengers and company:		(S) or (U)
i) Communicates relevant information with cabin crew;	PF	
ii) Communicates relevant information with company;	PF/PNF	
iii) Makes passenger announcements when appropriate.	PF/PNF	

c) Perform take-off

List of competency elements and performance criteria	**Duty**	**Observation and assessment** *Satisfactory (S) Unsatisfactory (U)*
1) Demonstrate attitudes and behaviors appropriate to the safe conduct of including recognising flight, and managing potential threats and errors;		
2) Derform pre-take-off and predeparture preparation:		(S) or (U)
i) Checks and acknowledges line up clearance;	PF/PNF	
ii) Checks correct runway selection;	PF/PNF	
iii) Confirms validity of performance data;	PF/PNF	
iv) Checks approach sector and runway are clear;	PF/PNF	
v) Confirms all checklists and take-off preparations completed;	PF/PNF	
vi) Lines up the aircraft on centerline without losing distance;	PF	
vii) Checks weather on departure sector;	PF/PNF	
viii) Checks runway status and wind.	PF/PNF	
3) Perform take-off roll:		(S) or (U)
i) Applies take-off thrust;	PF	
ii) Checks engine parameters;	PNF	
iii) Checks air speed indicators;	PF/PNF	
iv) Stays on runway centerline.	PF	
4) Perform transition to instrument flight rules:		(S) or (U)
i) Applies v1 procedures;	PF/PNF	
ii) Rotates at vr to initial pitch attitude;	PF	
iii) Establishes initial wings level attitude;	PF	
iv) Retracts landing gear;	PNF	
v) Maintains climb out speed.	PF	
5) Perform initial climb to flap retraction altitude:		(S) or (U)
i) Sets climb power;	PF	
ii) Adjusts attitude for acceleration;	PF	
iii) Selects flaps according flap speed schedule;	PF/PNF	
iv) Observes speed restrictions;	PF	
v) Completes relevant checklists.	PF/PNF	
6) Perform rejected take-off:		(S) or (U)
i) Recognises the requirement to abort the take-off;	PF	
ii) Applies the rejected take-off procedure;	PF	

iii) Assesses the need to evacuate the aircraft.	PF/PNF	
7) Perform navigation:		(S) or (U)
i) Complies to departure clearance;	PF	
ii) Complies with published departure procedures, for example speeds;	PF	
iii) Monitors navigation accuracy;	PF/PNF	
iv) Communicates and coordinates with ATC.	PF	
8) Manage abnormal and emergency situations:		(S) or (U)
i) Tdentifies the abnormal condition;	PF/PNF	
ii) Interprets the abnormal condition;	PF/PNF	
iii) Performs the procedure for the abnormal condition.	PF/PNF	

d) Perform climb

List of competency elements and performance criteria	**Duty**	**Observation and assessment** *Satisfactory (S) Unsatisfactory (U)*
1) Demonstrate attitudes and behaviors appropriate to the safe conduct of flight, including recognising and managing potential threats and errors;		
2) Perform SID or en-route navigation:		(S) or (U)
i) Complies with departure clearance and procedures;	PF	
ii) Demonstrates terrain awareness;	PF/PNF	
iii) Monitors navigation accuracy;	PF/PNF	
iv) Adjusts flight to weather and traffic conditions;	PF	
v) Communicates and coordinates with ATC;	PNF	
vi) Observes minimum altitudes;	PF/PNF	
vii) Selects appropriate level of automation;	PF	
(viii) complies with altimeter setting procedures.	PF/PNF	
3) Complete climb procedures and checklists:		(S) or (U)
i) Performs the after take-off items;	PF/PNF	
ii) Confirms and checks according checklists.	PF/PNF	
4) Modify climb speeds, rate of climb and cruise altitude:		(S) or (U)
i) Recognizes the need to change speed, Rate of climb or cruise altitude;	PF	
ii) Selects and maintains the appropriate climb speed or rate of climb;	PF	

iii) Selects optimum cruise flight level.	PF/PNF	
5) Perform systems operations and procedures:		(S) or (U)
i) Monitors operation of all systems;	PF/PNF	
ii) Operates systems as required.	PF/PNF	
6) Manage abnormal and emergency situations:		(S) or (U)
i) Identifies the abnormal condition;	PF/PNF	
ii) Interprets the abnormal condition;	PF/PNF	
iii) Performs the procedure for the abnormal condition.	PF/PNF	
7) Communicate with cabin crew, passengers and company:		(S) or (U)
i) Communicates relevant information with cabin crew;	PF	
ii) Communicates relevant information with company;	PF/PNF	
iii) Makes passenger announcements when appropriate.	PF	

e) Perform cruise

List of competency elements and performance criteria	**Duty**	**Observation and assessment** *Satisfactory (S) Unsatisfactory (U)*
1) Demonstrate attitudes and behaviors appropriate to the safe conduct of flight, including recognizing and managing potential threats and errors;		
2) Monitor navigation accuracy:		(S) or (U)
i) Demonstrates adequate area knowledge;	PF/PNF	
ii) Demonstrates adequate route knowledge;	PF/PNF	
iii) Navigates according to flight plan and clearance;	PF	
iv) Adjusts flight to weather and traffic conditions;	PF	
v) Communicates and coordinates with ATC;	PNF	
vi) Observes minimum altitudes;	PF/PNF	
vii) Uses all means of automation.	PF	
3) Monitor flight progress:		(S) or (U)
i) Selects optimum speed;	PF	
ii) Selects optimum cruise flight level;	PF	
iii) Monitors and controls fuel status;	PNF	
iv) Recognises the need for a possible diversion;	PF/PNF	

v) Creates a diversion contingency plan if required.	PF/PNF	
4) Perform descent and approach planning:		(S) or (U)
i) Checks weather of destination and alternate airport;	PF/PNF	
ii) Checks runway in use and approach procedure;	PF/PNF	
iii) Sets the FMS accordingly;	PF	
iv) Checks landing weight and landing distance required;	PF	
v) Checks MEA, MGA and MSA;	PF/PNF	
vi) Identifies top of descent point.	PF	
5) Perform systems operations and procedures:		(S) or (U)
i) Monitors operation of all systems;	PF/PNF	
ii) Operates systems as required.	PF	
6) Manage abnormal and emergency situations:		(S) or (U)
i) Identifies the abnormal condition;	PF/PNF	
ii) Interprets the abnormal condition;	PF/PNF	
iii) Performs the procedure for the abnormal condition.	PF/PNF	
7) Communicate with cabin crew, passengers and company:		(S) or (U)
i) Communicates relevant information with cabin crew;	PF	
ii) Communicates relevant information with company;	PF/PNF	

f) Perform descent

List of competency elements and performance criteria	**Duty**	**Observation and assessment** *Satisfactory (S) Unsatisfactory (U)*
1) Demonstrate attitudes and behaviours appropriate to the safe conduct of flight, including recognising and managing potential threats and errors;		
2) Initiate and manage descent:		(S) or (U)
i) Starts descent according to ATC clearance or optimum descent point;	PF	
ii) Selects optimum speed and descent rate;	PF	
iii) Adjusts speed to existing environmental conditions;	PF	

iv) Recognises the need to adjust the descent path;	PF	
v) Adjusts the flight path as required;	PF	
vi) Utilises all means of FMS descent information.	PF	
3) Monitor and perform en route and descent navigation:		(S) or (U)
i) Complies with arrival clearance and procedures;	PF	
ii) Demonstrates terrain awareness;	PF/PNF	
iii) Donitors navigation accuracy;	PF/PNF	
iv) Adjusts flight to weather and traffic conditions;	PF	
v) Communicates and coordinates with ATC;	PNF	
vi) Observes minimum altitudes;	PF/PNF	
vii) Selects appropriate level or mode of automation;	PF	
viii) Complies with altimeter setting procedures.	PF/PNF	
4) Re-planning and update of approach briefing:		(S) or (U)
i) Re-checks destination weather and runway in use;	PNF	
ii) Briefs or re-briefs about instrument approach and landing as required;	PF	
iii) Reprograms the FMS as required;	PNF	
iv) Re-checks fuel status.	PF/PNF	
5) Perform holding:		(S) or (U)
i) Identifies holding requirement;	PF/PNF	
ii) Programs FMS for holding pattern;	PNF	
iii) Enters and monitors holding pattern;	PF	
iv) Assesses fuel requirements and determines max holding time;	PF/PNF	
v) Reviews the need for a diversion;	PF/PNF	
vi) Initiates diversion.	PF	
6) Perform systems operations and procedures:		(S) or (U)
i) Monitors operation of all systems;	PF/PNF	
ii) Operates systems as required.	PF/PNF	
7) Manage abnormal and emergency situations:		(S) or (U)
i) Identifies the abnormal condition;	PF/PNF	
ii) Interprets the abnormal condition;	PF/PNF	
iii) Performs the procedure for the abnormal condition.	PF/PNF	
8) Communicate with cabin crew, passengers and company:		(S) or (U)
i) Communicates relevant information with cabin crew;	PF	

ii) Communicates relevant information with company;	PF/PNF	
iii) Makes passenger announcements when appropriate;	PF	

g) Perform approach

List of competency elements and performance criteria	**Duty**	**Observation and assessment** *Satisfactory (S) Unsatisfactory (U)*
1) Demonstrate attitudes and behaviours appropriate to the safe conduct of flight, including recognising and managing potential threats and errors;		
2) Perform approach in general:		(S) or (U)
i) Executes approach according to procedures and situation;	PF	
ii) Selects appropriate level or mode of automation;	PF	
iii) Selects optimum approach path;	PF	
iv) Operates controls smooth and coordinated;	PF	
v) Performs speed reduction and flap extension;	PF/PNF	
vi) Performs relevant checklists;	PF/PNF	
vii) Initiates final descent;	PF	
viii) Achieves stablished approach criteria;	PF	
ix) Ensures adherence to minima;	PF/PNF	
x) Initiates go-around if required;	PF	
xi) Masters transition to visual segment.	PF	
3) Perform precision approach:		(S) or (U)
i) Performs ILS approach;	PF	
ii) Performs MLS approach.	PF	
4) Perform non-precision approach:		(S) or (U)
i) Performs VOR approach;	PF	
ii) Performs NDB approach;	PF	
iii) Performs SRE approach;	PF	
iv) Performs GNSS approach;	PF	
v) Performs ILS loc approach;	PF	
vi) Performs ILS back beam approach.	PF	
5) Perform approach with visual reference to ground:		(S) or (U)
i) Performs standard visual approach;	PF	

ii) Performs circling approach.	PF	
6) Monitor the flight progress:		(S) or (U)
i) Insures navigation accuracy;	PF/PNF	
ii) Communicates with ATC and crew members;	PF	
iii) Monitors fuel status.	PF/PNF	
7) Perform systems operations and procedures:		(S) or (U)
i) Monitors operation of all systems;	PF	
ii) Operates systems as required.	PF	
8) Manage abnormal and emergency situations:		(S) or (U)
i) Identifies the abnormal condition;	PF/PNF	
ii) Interprets the abnormal condition;	PF/PNF	
iii) Performs the procedure for the abnormal condition.	PF/PNF	
9) Perform missed approach and goaround:		(S) or (U)
i) Initiates go-around procedure;	PF	
ii) Navigates according to missed approach procedure;	PF	
iii) Completes the relevant checklists;	PF/PNF	
iv) Initiates approach or diversion after the go-around;	PF	
v) Communicates with ATC and crew members.	PNF	
10) Communicate with cabin crew, passengers and company:		(S) or (U)
i) Communicates relevant information with cabin crew;	PF	
ii) Communicates relevant information with company;	PF/ PNF	
iii) Makes passenger announcements when appropriate;	PF	
iv) Initiates go-around procedure.	PF	

h) Perform landing

List of competency elements and performance criteria	**Duty**	**Observation and assessment** *Satisfactory (S) Unsatisfactory (U)*
1) Demonstrate attitudes and behaviours appropriate to the safe conduct of flight, including recognising and managing potential threats and errors;		
2) Land the aircraft;		(S) or (U)

i) Maintains a stabilised approach path during visual segment;	PF	
ii) Recognises and acts on changing conditions for windshift or wind shear segment;	PF	
iii) Initiates flare;	PF	
iv) Controls thrust;	PF	
v) Achieves touchdown in touchdown zone on centreline;	PF	
vi) Lowers nose wheel;	PF	
vii) Maintains centreline;	PF	
viii) Performs after-touchdown procedures;	PF	
ix) Makes use of appropriate braking and reverse thrust;	PF	
x) Vacates runway with taxi speed.	PF	
3) Perform systems operations and procedures:		(S) or (U)
i) Monitors operation of all systems;	PF	
ii) Operates systems as required.	PF	
4) Manage abnormal and emergency situations:		(S) or (U)
i) Identifies the abnormal condition;	PF/PNF	
ii) Interprets the abnormal condition;	PF/PNF	
iii) Performs the procedure for the abnormal condition.	PF/PNF	

i) Perform after landing and post flight operations

List of competency elements and performance criteria	**Duty**	**Observation and assessment** *Satisfactory (S) Unsatisfactory (U)*
1) Demonstrate attitudes and behaviours appropriate to the safe conduct of flight, including recognising and managing potential threats and errors;		
2) Perform taxiing and parking:		(S) or (U)
i) Receives, checks and adheres to taxi clearance;	PNF	
ii) Taxies the aircraft including use of exterior lighting;	PF	
iii) Controls taxi speed;	PF/PNF	
iv) Maintains centreline;	PF	
v) Maintains look-out for conflicting traffic and obstacles;	PF	

vi) Identifies parking position;	PF/PNF	
vii) Complies with marshalling or stand guidance;	PF/PNF	
viii) Applies parking and engine shut down procedures;	PF	
ix) Completes with relevant checklists.	PF/PNF	
3) Perform aircraft post-flight operations:		(S) or (U)
i) Communicates to ground personnel and crew;	PF	
ii) Completes all required flight documentation;	PF/PNF	
iii) Ensures securing of the aircraft;	PF	
iv) Conducts the debriefings.	PF	
4) Perform systems operations and procedures:		(S) or (U)
i) Monitors operation of all systems;	PF/PNF	
ii) Operates systems as required.	PF/PNF	
5) Manage abnormal and emergency situations:		(S) or (U)
i) Identifies the abnormal condition;	PF/PNF	
ii) Interprets the abnormal condition;	PF/PNF	
iii) Performs the procedure for the abnormal condition.	PF/PNF	
6) Communicate with cabin crew, passengers and company:		(S) or (U)
i) Communicates relevant information with cabin crew;	PF	
ii) Communicates relevant information with company;	PF/PNF	
iii) Makes passenger announcements when appropriate.	PF	

APPENDIX 3

PRINCIPLES OF THREAT AND ERROR MANAGEMENT

One model that explains the principles of threat and error management is the TEM model:

a) 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. Undesired aircraft state management largely represents the last opportunity to avoid an unsafe outcome and thus maintain safety margins in flight operations.

b) Threats:

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

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 prepare for a congested airport by making sure they keep a watchful eye on other aircraft as they execute the approach;

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

4) Lastly, 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 of latent threats include equipment design issues, optical illusions, or shortened turnaround schedules;

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 are detected with the necessary anticipation to enable the flight crew to respond to them through deployment of appropriate countermeasures;

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

7) Table 1 presents examples of threats, grouped under two basic categories derived from the TEM Model. Environmental threats occur due to the environment in which flight operations take place. 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. Organisational threats, on the other hand, can be controlled (for example removed or, at least, minimised) at source by aviation organisations. Organisational threats 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 organisations themselves.

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

Table 1: Example of threats (list is not exhaustive)

c) Errors:

1) Errors are defined actions or inactions by the flight crew that lead to deviations from organisational or flight crew intentions or expectations. Unmanaged 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;
2) Errors can be spontaneous (for example 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 stabilised approach parameters, executing a wrong automation mode, failing to give a required callout, or misinterpreting an ATC clearance;
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 (for example

detection and response), rather than to solely focus on error causality (for example causation and commission). From the safety perspective, operational errors that are timely detected and promptly responded to (for example properly managed), errors that do not lead to undesired aircraft states, do not reduce margins of safety in flight operations, and thus become operationally inconsequential. In addition to its safety value, proper error management represents an example of successful human performance, presenting both learning and training value;

4) Capturing how errors are managed is then as important, if not more, as 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) 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' and therefore, the TEM model uses the 'primary interaction' as the point of reference for defining the error categories;

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 aircraft handling error, the pilot or flight crew must be interacting with the aircraft (for example through its controls, automation or systems). In order to be classified as procedural error, the pilot or flight crew must be interacting with a procedure (for example checklists; SOPs; etc.). In order to be classified as communication error, the pilot or flight crew must be interacting with people (ATC, ground crew, other crewmembers, etc.);

7) Aircraft handling errors, procedural errors and communication errors may be unintentional or involve intentional non-compliance. Similarly, proficiency considerations (for example skill or knowledge deficiencies, 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 noncompliance and proficiency as separate categories of error, but rather as sub-sets of the three major categories of error.

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

Table 2: Examples of errors (list is not exhaustive)

d) Undesired aircraft states:

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 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;

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;
3) Undesired states can be managed effectively, restoring margins of safety, or flight crew response(s) can induce an additional error, incident, or accident;
4) Table 3 presents examples of undesired aircraft states, grouped under three basic categories derived from the TEM model;

Aircraft handling	i) Aircraft control (attitude); ii) Vertical, lateral or speed deviations; iii) Unnecessary weather penetration; iv) Unauthorised airspace penetration; v) Operation outside aircraft limitations; vi) Unstable approach; vii) Continued landing after unstable approach; viii) Long, floated, firm or off-centerline landing.
Ground	i) Proceeding towards wrong taxiway or runway; ii) Wrong taxiway, ramp, gate or hold spot.
Incorrect aircraft configurations	i) Incorrect systems configuration; ii) Incorrect flight controls configuration; iii) Incorrect automation configuration; iv) Incorrect engine configuration; v) Incorrect weight and balance configuration.

Table 3: Examples of undesired aircraft states (list is not exhaustive)

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 FMC. The flight crew subsequently identifies the error during a cross-check prior to the FAF. However, instead of using a basic mode (for example heading) or manually flying the desired track, both flight crew members become involved in attempting to reprogram the correct approach prior to reaching the FAF. As a result, the aircraft 'stitches' through the localiser, 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,

the basic task of the flight crew 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) 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 (for example a stabilised approach) and an outcome. Outcomes, on the other hand, are end states, most notably, reportable occurrences (for example incidents and accidents). An example would be as follows: a stabilised approach (normal operational state) turns into an unstabilised approach (undesired aircraft state) that results in a runway excursion (outcome);

7) The training and remedial implications of this differentiation are of significance. While at the undesired aircraft state stage, the flight crew has the possibility, through appropriate TEM, of recovering the situation, 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 is not possible.

e) Countermeasures:

1) Flight crews must, as part of the normal discharge of their operational duties, 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 energies 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 % of flight crew activities may be countermeasures-related activities.

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. The following would be examples of ‘hard’ resources that flight crews employ as systemic-based countermeasures:

i) ACAS;
ii) TAWS;
iii) SOPs;
iv) Checklists;

v) Briefings;
vi) Training;
vii) etc.

3) Other of flight operations. These are personal strategies and tactics, individual and team countermeasures that typically include canvassed skills, knowledge and attitudes developed by human performance training, most notably, by CRM training. There are basically three categories of individual and team countermeasures:

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

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 (PANS-TRG, Chapter 3, Attachment B) as well as in the ICAO manual, Line Operations Safety Audit (LOSA) (Doc 9803).

Planning countermeasures		
SOP briefing	The required briefing was interactive and operationally thorough	i) Concise, not rushed, and met SOP requirements; ii) 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	i) Threats and their consequences were anticipated; ii) Used all available

		resources to manage threats
Execution countermeasures		
Monitor and 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 prioritised and properly managed to handle primary flight duties	i) Avoided task fixation; ii) Did not allow work overload
Automation management	Automation management Automation was properly managed to balance situational and workload requirements	i) Automation setup was briefed to other members ii) Effective recovery techniques from automation anomalies
Review countermeasures		
Evaluation and modification of plans	Existing plans were reviewed and modified when necessary	i) 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	i) Crew members not afraid to express a lack of knowledge: 'Nothing taken for granted' attitude
Assertiveness	Crew members stated critical information or solutions with appropriate persistence	ii) Crew members spoke up without hesitation

Table 4: Examples of individual and team countermeasures

APPENDIX 4

ASSESSMENT OF STUDENT COMPETENCY DURING TAKE-OFF AND LANDING TRAINING

a) The required level of competency of a student pilot is assessed by observing the following:

1) Application of knowledge;
2) Application of regulations and procedures;
3) Communication;
4) Aeroplane flight path management - automation;
5) Aeroplane flight path management - manual control;
6) Leadership and teamwork;
7) Problem-solving and decision-making;
8) Situational awareness (SA) and information management; and
9) Workload management.

b) The competencies referred to in points (a)(2) and (a)(5) are particularly relevant during the training. This means that the focus is on observing the student pilot performing take-offs and landings in accordance with the standard operating procedures (SOPs) and recommended techniques of the original equipment manufacturer (OEM).

c) The competency elements and sub-elements stipulated in this Appendix for take-off and landing provide additional guidance for instructors and student pilots.

d) Consistency and repeatability of all the competencies above is achieved if the student pilot is able to perform at least three successive take-offs and landings demonstrating the required observable behaviours.

e) The take-off and landing training in an aeroplane should include at least one go-around. Due consideration should be given to environmental conditions when evaluating competency.

APPENDIX 5

EXAMPLE OF MPL TRAINING SPECIFICATIONS

The table below contains an example of a completed training specification for an initial multi-crew pilot licence course.

	Purpose
What is the purpose of the training?	To train ab initio aeroplane pilots for co-pilot duties.
State the phase(s) of training.	Core Flying Skills and Basic Phases (ab initio pilot training on single- and/or multi-pilot, and single- and/or multi-engine aeroplane) Intermediate Phase (reinforcement of multi-crew coordination and IFR operations). Advanced Phase (type rating and instrument qualification on multi-pilot, multi-engine turbine-powered aeroplane used in commercial air transport operations).
What qualification, if any, will the trainee achieve on successful completion of the training?	Multi-crew pilot licence with aircraft type rating and instrument privileges as appropriate to proceed for commercial air transport line training (initial operating experience).
	Tasks
Describe the tasks associated with the purpose of the training.	The trainee shall carry out the following tasks: 1) flight planning and preparation; 2) aeroplane checks and cockpit procedures, radio-telephony procedures, CRM and TEM; 3) basic aircraft handling in the phases of flight in both VFR and IFR conditions, with asymmetric concepts; 4) aeroplane upset prevention and recovery; 5) cross-country flying procedures and technique, including diversion procedures; 6) basic and applied instrument flying technique, including standard instrument departure (SID), standard instrument arrival (STAR), airways tracking, holding procedures, arrival and approach charts and procedures (precision and non-precision), missed approach procedures; 7) solo flight and night flying operations;

	8) multi-crew operations including pilot flying (PF)/pilot monitoring (PM) duties, abnormal and emergency procedures, CRM and TEM; 9) multi-engine turbine aeroplane operations, maximum demonstrated crosswind take-off and landing, and asymmetric handling; 10) upset prevention and recovery training and abnormal procedure handling considerations for turbine aeroplane; 11) line oriented flight training (LOFT), including IFR RNAV (PBN) international flights; and 12) take-offs and landings on aeroplane type.
Operational requirements	
Which procedures will be applied?	Air operator's operations manual, aeroplane flight manual as appropriate.
Describe the operational (or simulated) environment required to successfully achieve the purpose of the training.	Actual and simulated flight as PF and PM duties in appropriately qualified aeroplane and FSTD. On aircraft training in take-offs and landings on aeroplane type to proficiency (with at least the minimum required number of take-offs and landings to comply with PANS-TRG and national regulations). LOFT in accordance with the operator's procedures for PF and PM duties.
Describe the nature of the traffic necessary to achieve the training outcome.	Actual and simulated air traffic as applicable: a) mix of IFR and VFR traffic; b) arrivals, departures, overflights and circuit traffic; and c) heavy and medium jets, business jets, light aircraft, helicopters, ground vehicles.
Which non-routine situations are necessary for successful completion of the training?	a) aeroplane system malfunctions; b) rejected take-off; c) engine fire and failure in various phases of flight; d) missed approaches, including baulked landings;

	8) multi-crew operations including pilot flying (PF)/pilot monitoring (PM) duties, abnormal and emergency procedures, CRM and TEM; 9) multi-engine turbine aeroplane operations, maximum demonstrated crosswind take-off and landing, and asymmetric handling; 10) upset prevention and recovery training and abnormal procedure handling considerations for turbine aeroplane; 11) line oriented flight training (LOFT), including IFR RNAV (PBN) international flights; and 12) take-offs and landings on aeroplane type.
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Which non-routine situations are necessary for successful completion of the training?	a) aeroplane system malfunctions; b) rejected take-off; c) engine fire and failure in various phases of flight; d) missed approaches, including baulked landings; e) asymmetric approaches and landing; f) landing emergencies; g) pilot incapacitation on multi-crew aeroplane and medical emergencies; h) traffic alert and collision avoidance system resolution advisory (TCAS-RA);

	i) wind shear recovery and enhanced ground proximity warning system (EGPWS); j) emergency descent; k) UPRT; and l) runway incursions and excursions.
Describe the working position configuration.	Co-pilot's position in a multi-crew aeroplane type.
Technical requirements	
List any specific operational (or simulated operation) systems and/or equipment that are necessary to achieve the training outcome.	a) appropriate aeroplane type for solo flying experience; b) aeroplane or appropriately qualified FSTD for multi-crew, multi-engine turbine-powered aeroplane type including training in IFR operations; and c) aeroplane and appropriately qualified FSTD for UPRT.
Regulatory requirements	
Which rules and regulations are applicable?	a) National regulations on the provision of MPL; and b) ICAO Doc 9868 and Annexes 1 and 6, Part I, for training and licensing Standards and requirements.
Are there any regulatory requirements that will affect the following aspects of the training: • duration; • content; • assessment procedures; • course approval; • any other?	a) theoretical knowledge requirements at the airline transport pilot licence level; b) practical training in both PF and PM duties to achieve and demonstrate the competencies of the adapted competency model to the final competency standard; c) multi-crew aircraft type rating for licence endorsement; d) instrument qualification on appropriate aircraft type; e) specified minimum number of take-offs and landings on aircraft type; f) flight simulation devices approved by the CAA; and g) training programme incorporating type rating, and assessment standards approved by the CAA.
Organizational requirements	
Describe any organizational requirements that may impact the training?	Approved training organization with appropriate staff and training devices for both theoretical knowledge and practical training.

Other requirements	
Other constraints.	a) appropriately authorized instructors; b) training in UPRT to be conducted by instructors appropriately qualified and approved by the CAA; c) approved type rating programme in the Advanced Phase; and d) examiners must be appropriately qualified, and current for flight checks.
Simulation requirements	
List the simulation requirements that are necessary to achieve the training outcome, if any.	a) part-task trainer; and b) FSTD of appropriate type commensurate with MPL Phase of training (refer to Doc 9625, Volume 1 and Annex 1, Appendix 3).