Doc 10011
AN/506

Manual on Aeroplane Upset Prevention and Recovery Training

Approved by the Secretary General
and published under his authority

First Edition — 2014

International Civil Aviation Organization

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AMENDMENTS

Amendments are announced in the supplements to the *Publications Catalogue;* the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

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FOREWORD

Between 2001 and 2011, aeroplane accidents resulting from a loss of control in flight (LOC-I) event were the leading cause of fatalities in commercial aviation. LOC-I accidents often have catastrophic results with very few, if any, survivors.

Following a conference in June 2009 on aeroplane upsets and LOC-I, the Royal Aeronautical Society (RAeS) initiated a study to investigate the LOC-I phenomena and make recommendations on mitigating strategies, notably with respect to potential improvements to international civil aviation standards and guidance material. This work was undertaken by the RAeS International Committee on Aviation Training in Extended Envelopes (ICATEE), with ICAO supporting this initiative.

In 2011, the Federal Aviation Administration (FAA) of the United States commissioned an aviation rulemaking committee (ARC) to develop effective upset prevention and recovery training methodologies. In 2012, ICAO, the European Aviation Safety Agency (EASA) and the FAA decided to combine efforts to identify and establish an acceptable approach to reduce such occurrences. ICAO sponsored seven meetings in 2012 during which civil aviation authorities (CAAs), the FAA ARC and subject matter experts (SMEs) were encouraged to participate in focused discussions. Also, as several initiatives were underway simultaneously that sought to reduce the number of LOC-I events, ICAO brought many of the groups involved with these efforts into the ensuing discussions under what became known as the loss of control avoidance and recovery training (LOCART) initiative.

Reducing the number of LOC-I accidents is an ICAO priority, and ICAO has developed harmonized training requirements for flight crews that address and mitigate LOC-I events. Supported by ICATEE and the FAA ARC, ICAO has introduced improvements to existing Standards and Recommended Practices (SARPs) and corresponding guidance material. Both on-aeroplane training at the commercial pilot and multi-crew pilot level and training in a flight simulation training device at the airline transport pilot and type rating level are now promulgated in Annexes 1 — *Personnel Licensing* and 6 — *Operation of Aircraft*, Part I — *International Commercial Air Transport — Aeroplanes,* as well as in the *Procedures for Air Navigation Services — Training* (PANS-TRG, Doc 9868), with an applicability date of 13 November 2014. This manual provides guidance to support these new provisions and is only applicable to the training of aeroplane pilots.

This manual was developed over three years with input from many groups of experts such as aircraft and flight simulation training device manufacturers, pilot representative organizations, airlines, training organizations, accident investigation bureaus, human performance specialists and was thereafter submitted for an extensive peer review to take into account comments from the expert community. It is based upon the latest forms of technology available at the time of publication. As such, it will be subject to revision that will be governed in large part by changing dynamics within the industry. Comments on this manual, particularly with respect to its application, usefulness and scope of coverage, would be appreciated and will be taken into consideration in the preparation of subsequent editions. Comments should be addressed to:

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TABLE OF CONTENTS

PUBLICATIONS

(referred to in this manual)

Convention on International Civil Aviation (Doc 7300)

Annex 1 — *Personnel Licensing*

Annex 6 — *Operation of Aircraft* , Part I — *International Commercial Air Transport — Aeroplanes*

Annex 19 — *Safety Management*

Procedures for Air Navigation Services — Training (PANS-TRG, Doc 9868)

Manual of Procedures for Establishment and Management of a State's Personnel Licensing System (Doc 9379)

Manual of Criteria for the Qualification of Flight Simulation Training Devices (Doc 9625), Volume I — *Aeroplanes*

Manual on the Approval of Training Organizations (Doc 9841)

Safety Management Manual (SMM) (Doc 9859)

Manual of Evidenced-Based Training (Doc 9995)

Airplane Upset Recovery Training Aid (AURTA) — Revision 2 (by an industry and government working group) or any future revision (references to sections of the AURTA are to Revision 2)

RAeS ICATEE *Research and Technology Report*

Flight Simulation Training Device Design and Performance Data Requirements (International Air Transport Association (IATA))

FAA Advisory Circular, AC 120-109 — *Stall and Stick Pusher Training*

ABBREVIATIONS AND ACRONYMS

ADI	Attitude director indicator
AOA	Angle of attack
A/P	Autopilot
ARC	Aviation rulemaking committee
A/T	Autothrottle (equivalent to A/THR depending on the aeroplane manufacturer)
ATC	Air traffic control
A/THR	Autothrust
ATO	Approved training organization
ATR	Avions de transport régional
AURTA	Airplane upset recovery training aid
CAA	Civil aviation authority
CBT	Competency-based training
CG	Centre of gravity
CPL(A)	Commercial pilot licence — aeroplane
CRM	Crew resource management
EASA	European Aviation Safety Agency
EBT	Evidence-based training
FAA	Federal Aviation Administration
FBW	Fly-by-wire
FSTD	Flight simulation training device
ft	Feet
IAS	Indicated airspeed
IATA	International Air Transport Association
ICATEE	International Committee for Aviation Training in Extended Envelopes
IOS	Instructor operating station
ISD	Instructional systems design
KSA	Knowledge, skills and attitudes
lb	Pound
LMS	Learning management system
LOCART	Loss of control avoidance and recovery training
LOC-I	Loss of control in flight
LOFT	Line-oriented flight training
LOS	Line-operational simulation
m	Metre
M_{mo}	Maximum operating Mach number
MOFT	Manoeuvre-oriented flight training
MPL	Multi-crew pilot licence
MTOM	Maximum take-off mass
OEM	Original equipment manufacturer(s)
PF	Pilot flying
PIO	Pilot-induced oscillation
PM	Pilot monitoring (equivalent to pilot not flying)
QA	Quality assurance
RAeS	Royal Aeronautical Society
SARPs	Standards and Recommended Practices
SME	Subject matter expert

SMS	Safety management system
SOP	Standard operating procedure
SSP	State safety programme
TEM	Threat and error management
TOGA	Take-off/go-around
UPRT	Upset prevention and recovery training
V_c	Cruising speed
V_{mo}	Maximum operating speed
V_{ref}	Reference speed in the landing configuration
V_s	Vstall
vs.	Versus
VTE	Valid training envelope

GLOSSARY

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

Academic training. Training that places an emphasis on studying and reasoning designed to enhance knowledge levels of a particular subject, rather than to develop specific technical or practical skills.

Accountable executive**.** The individual who has corporate authority for ensuring that all training commitments can be financed and carried out to the standard required by the civil aviation authority (CAA), and any additional requirements defined by the approved training organization.

Aerodynamic stall. An aerodynamic loss of lift caused by exceeding the critical angle of attack (synonymous with the term “stall”).

Aeroplane upset. An aeroplane in flight unintentionally exceeding the parameters normally experienced in line operations or training, normally defined by the existence of at least one of the following parameters:

a) pitch attitude greater than 25 degrees, nose up; or

b) pitch attitude greater than 10 degrees, nose down; or

c) bank angle greater than 45 degrees; or

d) within the above parameters, but flying at airspeeds inappropriate for the conditions.

Airmanship**.** The consistent use of good judgement and well-developed knowledge, skills and attitudes to accomplish flight objectives.

Angle of attack (AOA). Angle of attack is the angle between the oncoming air, or relative wind, and a defined reference line on the aeroplane or wing.

Approach-to-stall. Flight conditions bordered by stall warning and aerodynamic stall.

Approved training organization (ATO). An organization approved by and operating under the supervision of a Contracting State in accordance with the requirements of Annex 1 to perform approved training.

Assessment. The determination as to whether a candidate meets the requirements of the expected performance standard.

Autoflight systems. The autopilot, autothrottle (or autothrust), and all related systems that perform automatic flight management and guidance.

Behaviour. The way a person responds, either overtly or covertly, to a specific set of conditions, which is capable of being measured.

Behavioural indicator. An overt action performed or statement made by any flight crew member that indicates how an individual or the crew is handling an event.

Bridge training. Additional training designed to address shortfalls in knowledge and skill levels so that all trainees possess the prerequisite levels upon which the approved training programme was designed.

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

Competency-based training. 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.

Contributing factor. A reported condition that contributed to the development of an aircraft accident or incident.

Core competencies. A group of related behaviours, based on job requirements, which describe how to effectively perform a job and what proficient performance looks like. They include the name of the competency, a description, and a list of behavioural indicators.

Critical angle of attack**.** The angle of attack that produces the maximum coefficient of lift beyond which an aerodynamic stall occurs.

Critical system malfunctions. Aeroplane system malfunctions that place significant demand on a proficient crew. These malfunctions should be determined in isolation from any environmental or operational context.

Developed upset. A condition meeting the definition of an aeroplane upset.

Developing upset. Anytime the aeroplane begins to unintentionally diverge from the intended flight path or airspeed.

Energy. The capacity to do work.

Energy state. How much of each kind of energy (kinetic, potential or chemical) the aeroplane has available at any given time.

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 consequences of errors and mitigate the probability of further errors or undesired aeroplane states.

Evidence-based training (EBT). Training and assessment based on operational data that is characterized by developing and assessing the overall capability of a trainee across a range of core competencies rather than by measuring the performance of individual events or manoeuvres.

Note.— Guidance on EBT is contained in the Procedures for Air Navigation Services — Training (*PANS-TRG, Doc 9868) and the* Manual of Evidence-based Training *(Doc 9995). EBT is competency-based and is applicable, as an option, to the recurrent training of flight crew members engaged in commercial air transport operations that is conducted in a flight simulation training device (FSTD).*

Fidelity level**.** The level of realism assigned to each of the defined FSTD features.

First indication of a stall. The initial aural, tactile or visual sign of an impending stall, which can be either naturally or synthetically induced.

Flight crew member. A licensed crew member charged with duties essential to the operation of an aeroplane during a flight duty period.

Flight management system. An aeroplane computer system that uses a large database to permit routes to be pre-programmed and fed into the system by means of a data loader. The system is constantly updated with respect to position accuracy by reference to the most appropriate navigation aids available, which are automatically selected during the information update cycle.

Flight path. The trajectory or path of an object (aeroplane) travelling through the air over a given space of time.

Flight simulation training device (FSTD). A synthetic training device that is in compliance with the minimum requirements for FSTD qualification as described in Doc 9625.

Instructional systems design (ISD). A formal process for designing training which includes analysis, design and production, and evaluation phases.

Instructor. A person authorized to provide academic or practical training to a trainee or trainees for an aviation licence, rating or endorsement.

Line-orientated flight training. Training and assessment involving a realistic, "real time", full mission simulation of scenarios that are representative of line operations.

Load factor. The ratio of a specified load to the weight of the aeroplane, the former being expressed in terms of aerodynamic forces, propulsive forces or ground reactions.

Manoeuvres. A sequence of deliberate actions to achieve a desired flight path. Flight path control may be accomplished by a variety of means including manual aeroplane control and the use of autoflight systems.

Manoeuvre-based training. Training that focuses on a single event or manoeuvre in isolation.

Motion turnaround bumps. A phenomenon associated with FSTD motion actuators when their direction of travel reverses, which results in acceleration spikes that can be felt by the pilot, thus giving a false motion cue.

Negative training. Training which unintentionally introduces incorrect information or invalid concepts, which could actually decrease rather than increase safety.

On-aeroplane training. A component of an upset prevention and recovery training (UPRT) programme designed to develop skill sets in employing effective upset prevention and recovery strategies utilizing only suitably-capable light aeroplanes.

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

Phase of flight. A defined period within a flight, for example, take-off, climb, cruise, descent, approach and landing.

Post-stall regime**.** Flight conditions at an angle of attack greater than the critical angle of attack.

Practical training. Describes training that places an emphasis on the development of specific technical or practical skills, which is normally preceded by academic training.

Quality assurance (QA). All the planned and systematic actions necessary to provide adequate confidence that all activities satisfy given standards and requirements, including the ones specified by the approved training organization in relevant manuals.

Note.— This definition is specific to this manual.

Quality management. A management approach focused on the means to achieve product or service quality objectives through the use of its four key components: quality planning, quality control, quality assurance, and quality improvement.

Note.— This definition is specific to this manual.

Quality system. The aggregate of all the organization's activities, plans, policies, processes, procedures, resources, incentives and infrastructure working in unison towards a total quality management approach. It requires an organizational construct complete with documented policies, processes, procedures and resources that underpin a commitment by all employees to achieve excellence in product and service delivery through the implementation of best practices in quality management.

Note.— This definition is specific to this manual.

Scenario. Part of a training module plan that consists of predetermined manoeuvres and training events.

Scenario-based training. Training that incorporates manoeuvres into real-world experiences to cultivate practical flying skills in an operational environment.

Stall**.** An aerodynamic loss of lift caused by exceeding the critical angle of attack.

Note.— A stalled condition can exist at any attitude and airspeed, and may be recognized by continuous stall warning activation accompanied by at least one of the following:

a) buffeting, which could be heavy at times;

b) lack of pitch authority and/or roll control; and

c) inability to arrest the descent rate.

Stall event. An occurrence whereby the aeroplane experiences conditions associated with an approach-to-stall or an aerodynamic stall.

Stall recovery procedure**.** This refers to the manufacturer-approved aeroplane-specific stall recovery procedure. If a manufacturer-approved recovery procedure does not exist, the aeroplane-specific stall recovery procedure developed by the operator based on the stall recovery template contained in the FAA Advisory Circular, AC 120-109, *Stall and Stick Pusher Training,* could be referred to.

Stall warning**.** A natural or synthetic indication provided when approaching a stall that may include one or more of the following indications:

a) aerodynamic buffeting (some aeroplanes will buffet more than others);

b) reduced roll stability and aileron effectiveness;

c) visual or aural cues and warnings;

d) reduced elevator (pitch) authority;

e) inability to maintain altitude or arrest rate of descent; and

f) stick shaker activation (if installed).

Note.— A stall warning indicates an immediate need to reduce the angle of attack.

Startle. The initial short-term, involuntary physiological and cognitive reactions to an unexpected event that commence the normal human stress response.

***Stick shaker*.** A device that automatically vibrates the control column to warn the pilot of an approaching stall.

Note.— A stick shaker is not installed on all aeroplane types.

Stick pusher. A device that, automatically applies a nose down movement and pitch force to an aeroplane's control columns, to attempt to decrease the aeroplane's angle of attack. Device activation may occur before or after aerodynamic stall, depending on the aeroplane type.

Note.— A stick pusher is not installed on all aeroplane types.

Stress (response). The response to a threatening event that includes physiological, psychological and cognitive effects. These effects may range from positive to negative and can either enhance or degrade performance.

***Surprise*.** The emotionally-based recognition of a difference in what was expected and what is actual.

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 aeroplane states.

***Train to proficiency*.** Approved training designed to achieve end-state performance objectives, providing sufficient assurances that the trained individual is capable to consistently carry out specific tasks safely and effectively.

Note.— In the context of this definition, the words train to proficiency can be replaced by training to proficiency.

Training event. Part of a training scenario that enables a set of competencies to be exercised.

Training objective. A clear statement that is comprised of three parts, i.e.:

a) 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);

b) the conditions under which the trainee will demonstrate competence; and

c) the performance standard to be attained to confirm the trainee's level of competence.

Transport category aeroplane. A category of airworthiness applicable to large civil aeroplanes, which are either:

a) turbojet aeroplanes with ten or more seats or having a maximum take-off mass (MTOM) greater than 5 700 kg (12 566 lb); or

b) propeller-driven aeroplanes with greater than 19 seats or having an MTOM greater than 8 618 kg (19 000 lb).

Unsafe situation. A situation, which has led to an unacceptable reduction in safety margin.

Wake encounter. An event characterized by the aeroplane experiencing the effects of wake turbulence brought about by wingtip vortices or engine exhaust.

Chapter 1

INTRODUCTION

1.1 AEROPLANE UPSET DEFINED

1.1.1 The term "aeroplane upset" is defined in the Glossary as an in-flight condition by which an aeroplane unintentionally exceeds the parameters normally experienced in normal line operations or training. An upset is generally recognized as a condition of flight during which the pitch of the aeroplane unintentionally exceeds either 25 degrees nose up or 10 degrees nose down, or a bank angle exceeding 45 degrees, or flight within the aforementioned parameters but at inappropriate airspeeds.

1.1.2 For the purposes of continuity, "aeroplane upset" will be the term used throughout this manual recognizing that there are several other terms in use within the aviation industry referring to this particular type of occurrence. It is important to be clear on two points about aeroplane upsets. First is the notion of *unintentional*, in other words, the aeroplane is not doing what it was intended to do by the flight crew and is approaching unsafe parameters. Second is the fact that a pilot must not wait until the aeroplane is in a fully developed upset before taking recovery action to return to stabilized flight path parameters. In this regard, the term "loss of control in flight" (LOC-I) is a categorization of an accident or incident resulting from a deviation from the intended flight path.

1.1.3 Finally, it is important to understand that there is a relationship to the definitions of "stall" and "upset". Although not all aeroplane upset occurrences involve an aerodynamic stall, an unintentional stall is indeed a form of upset even though it may not meet the pitch and bank attitude upset parameters. This is because during a stall the aeroplane meets the upset criteria of being at an inappropriate airspeed for the conditions. In all instances of an aeroplane upset involving a stall, it is stressed in this manual that the aeroplane must first be recovered from the stall condition before any other upset recovery action can become effective. Therefore, since upset and stall events are closely related, it is highly desirable to ensure that any comprehensive training programme for the prevention and recovery from a stall be closely linked with training for the prevention and recovery of aeroplane upsets.

1.2 UPSET PREVENTION AND RECOVERY TRAINING (UPRT) — ORIGIN

1.2.1 The number of fatalities resulting from LOC-I events involving commercial air transport aeroplanes has led to an examination by several organizations regarding current training practices.

1.2.2 As mentioned in the Foreword, by 2012 several initiatives were underway each seeking to reduce the number of LOC-I events. Committees and working groups had been formed to study industry trends, advancements in simulation technologies, training requirements, aeroplane equipment design, and human performance. These initiatives included an Aviation Rulemaking Committee (ARC) set up in 2011 by the Federal Aviation Administration (FAA) of the United States. In 2012, ICAO and the FAA brought many of the groups involved with these initiatives into the ensuing discussions under what became known as the loss of control avoidance and recovery training (LOCART) initiative through which civil aviation authorities (CAAs), pilot representatives, aeroplane manufacturers and subject matter experts were encouraged to participate in focused discussions.

1.2.3 This initiative revealed that some existing practices were found to be not only ineffective but were also considered a contributory factor in inappropriate responses by some flight crews. For example, in certain cases, the methodologies being applied in training and checking a recovery from an approach-to-stall condition of flight were based on the pilot being able to achieve recovery with a minimal loss of altitude. This resulted in training practices emphasizing the importance of a rapid application of power with the least amount of reduction in angle of attack (AOA) to minimize the loss of altitude rather than appreciating the importance of reducing the angle of attack to effectively restore the ability of the wing to generate lift. Action has now been taken by both regulators and training providers to amend such procedures with new training and testing standards emphasizing that effective recovery from an approach to stall requires, foremost, an immediate and deliberate reduction in the angle of attack. Crews must also be made aware that this required reduction in AOA, whenever the aeroplane is encountering low energy states while operating at high altitudes, might even necessitate a substantial loss in altitude to ensure that an effective recovery from an impending or actual aerodynamic stall condition is achieved.

1.2.4 Analysis of LOC-I accident data indicated that contributory factors can be categorized as being either aeroplane systems-induced, environmentally induced, pilot/human-induced, or any combination of these three. Of the three, pilot-induced accidents represented the most frequently identified cause of the event, principally resulting from one or more of the following reasons:

a) application of improper procedures, including inappropriate flight control inputs;

b) one or more flight crew members becoming spatially disoriented;

c) poor aeroplane energy management;

d) one or more flight crew members being distracted; or

e) improper training.

1.2.5 There are also several recorded incidents of aeroplane upsets from which there was a successful recovery and many other occurrences where an impending upset was avoided. The determinant factor for recovery to a safe state in most of those incidents was either the flight crew's accurate analysis of the occurrence and the timely and correct application of preventive/recovery techniques, or the aeroplane's inherent stability combined with its envelope protection system that provided an added measure of time, or an auto-flight system input that marginalized the seriousness of the incident.

1.2.6 The LOCART initiative resulted in the following recommendations for implementing improvements to existing training practices by integrating a comprehensive upset prevention and recovery training (UPRT) programme:

a) provide comprehensive academic training that covers the broad spectrum of issues surrounding aeroplane upsets at the earliest stages of commercial pilot development, during type rating training, and continued throughout the professional career at scheduled recurrent training intervals;

b) provide UPRT-specific training in actual flight at the commercial pilot licence — aeroplane (CPL(A)) and multi-crew pilot licence (MPL) licensing levels on light aeroplanes which are capable of performing the recommended manoeuvres whilst maintaining acceptable margins of safety;

c) provide UPRT that is conducted in non-type-specific FSTDs when introducing multi-crew operations at the CPL(A) or MPL licensing level;

d) provide training scenarios involving conditions likely to result in upsets as part of the regular initial type rating and recurrent training exercises in type-specific FSTDs;

e) implement standards that demand UPRT be delivered by appropriately qualified and competent instructors;

f) implement standards that require that UPRT in FSTDs be conducted in an appropriately qualified device using the highest level of fidelity available; and

g) provide conditions, whenever feasible, under which FSTD instructors are trained and able to provide feedback in real time using UPRT-specific debriefing tools of the instructor operating station (IOS).

1.3 MANUAL — APPLICABILITY

1.3.1 Based upon the determinations of the LOCART initiative, an effective countermeasure to a LOC-I event was deemed to reside in improvements to current flight crew training programmes with the emphasis on providing pilots with the skill sets to prevent conditions from developing that could lead to such an occurrence. The objective of this manual, therefore, is to support PANS-TRG procedures for UPRT and provide guidance to CAAs, operators and approved training organizations (ATOs) for instituting best practices into those training programmes, which are required to comply with the UPRT requirements in Annexes 1 and 6. In order to implement such programmes, this manual is designed to be used in conjunction with the documents referenced in the Publications section.

1.3.2 The focus of this material is to better prepare flight crew members to recognize and avoid situations that are conducive to encountering an in-flight upset, in other words, “prevention”. Notwithstanding, any risk mitigation effort would be incomplete without including recovery training. The guidance on recovery training and techniques provided herein has been influenced by the recommendations of the major original equipment manufacturers (OEMs) of transport category aeroplanes. Overall, the manual has been carefully developed by an international team of subject matter experts (SMEs) and flight instructors from
major aeroplane manufacturers, civil aviation authorities, commercial air transport operators, FSTD manufacturers, ATOs, pilot associations, international aviation industry associations, aviation accident investigation bureaus and scientific institutions in aerospace.

1.3.3 The training programme framework supports ICAO’s contention that CAAs require UPRT efforts to be conducted in an integrated manner, commencing with the preparatory training of those individuals qualifying to hold a professional standard of pilot licence in order to operate commercial aeroplanes. Therefore, the Standards and Recommended Practices (SARPs) in Annex 1 — *Personnel Licensing* were amended to include on-aeroplane UPRT in the licensing requirements for the MPL and in a new Recommended Practice for the issuance of a CPL(A).

1.3.4 Correspondingly, it is well understood within the aviation community that experience acquired at the early stages of a pilot’s development not only shape a pilot’s approach to operating aeroplanes, but the lessons learned are perishable. Hence, the application of prevention and recovery skills always needs to be reinforced throughout a pilot’s career and framed within the appropriate context. Clearly, in-flight UPRT situations experienced in a propeller-driven light aeroplane (that may be fully aerobatic) might pose a very different set of challenges than similar conditions in a large transport category turbojet passenger aeroplane. Consequently, a requirement for UPRT conducted in an FSTD is included in commercial air transport flight crew member training programmes (Annex 6) and in the multi-crew aeroplane type rating training for pilots (Annex 1). These SARPs are also supported by provisions appearing in PANS-TRG (Doc 9868).

1.3.5 At the outset of UPRT implementation, CAAs may find that a significant number of those air operators under their oversight programme will have numerous pilots who have never received formalized UPRT, and bridge training may be required (see 3.2.5). The regulatory oversight guidance material in Chapter 6 contains additional recommendations for bridge training.

1.3.6 The UPRT programme guidance represents a means of compliance, but not the only means by which States can fulfil the UPRT requirements of Annexes 1 and 6.

This manual is developed upon the premise that UPRT will be focused upon the trainee being “trained to proficiency” based upon achieving predetermined knowledge and skill performance levels.

Implementation of UPRT within an existing **MPL** or **EBT** recurrent programme **requires** that it be integrated as a competency-based training (CBT) programme. The appendix provides guidance on the competency-based approach to UPRT.

Chapter 2

TRAINING PROGRAMME REQUIREMENTS

> The recommendations herein provide a comprehensive training programme framework to mitigate the risk of LOC-I accidents. However, the material may include training elements which could be affected or invalidated by future aircraft-specific technology or other developments of an operational nature. Although consulted throughout development of this manual, aeroplane OEMs may at some point develop differing guidance regarding procedures to address these areas of training. In such instances, OEM's recommendations take precedence over any differing information contained within. Whenever practical, organizations are encouraged to notify ICAO of the existence of conditions that significantly impact the relevancy of the material provided herein.

2.1 APPROACH AND COMPONENTS OF UPRT DESIGN

2.1.1 The LOCART initiative determined that the approach in mapping out such a programme should focus its design into satisfying three distinct areas/objectives:

a) *heightened awareness* — of the potential threats from events, conditions or situations;

b) *effective avoidance* — at early indication of a potential upset-causing condition; and

} *Prevention* (a and b)

c) *effective and timely recovery* — from an upset to restore the aeroplane to safe flight parameters.

2.1.2 Effective UPRT programme development and supporting regulatory frameworks require an integrated comprehensive approach to ensure standardization in the levels of knowledge and skill sets within the pilot community. This integration effort should comprise the following UPRT components:

a) *academic training* — designed to equip pilots with the knowledge and awareness needed to understand the threats to safe flight and the employment of mitigating strategies; and

b) *practical training* — designed to equip pilots with the required skill sets to effectively employ upset avoidance strategies and, when necessary, effectively recover the aeroplane to the originally intended flight path. The practical training component is further broken down into two distinct subcomponents involving:

   1) *on-aeroplane training* — during CPL(A) or MPL training in suitably capable light aeroplanes to be conducted by appropriately qualified instructors to develop the knowledge, awareness and experience of aeroplane upsets and unusual attitudes, and how to effectively analyse the event and then apply correct recovery techniques; and

2) *FSTD training* — on specific or generic aeroplane types to build on knowledge and experience, and apply these to the multi-crew crew resource management (CRM) environment, at all stages of flight, and in representative conditions, with appropriate aeroplane and system performance, functionality and response. Once again, this instruction should only be provided by appropriately qualified instructors.

2.1.3 Each component of the integrated effort should be carefully constructed and delivered to **ensure that the correct lessons are learned and that the necessary levels of pilot proficiency are acquired**. Particularly, if UPRT is not developed as a CBT programme, all stakeholders should exercise caution in determining what performance benchmarks constitute "acceptable" proficiency levels. The determination of an acceptable level of performance should in all instances be based upon the trainee demonstrating the ability to consistently employ effective strategies in a timely manner to prevent or, if not reasonably foreseen, recover from an aeroplane upset during which the safety of the aeroplane and its crew was not unnecessarily imperilled.

2.2 TRAINING ELEMENTS OF UPRT

2.2.1 The two major components of UPRT programmes were previously identified in 2.1.2 as being the "academic" and the "practical" components, with the latter being broken down into two subcomponents. Those two subcomponents of practical training involve the utilization of either an aeroplane or an FSTD as the primary training platform.

2.2.2 Table 2-1 provides a comprehensive UPRT programme blueprint by dividing all the recommended training elements under 11 separate subjects and indicating under which UPRT component each training element needs to be addressed (see A to K in Table 2-1). For instance, in the first column of the table the subjects and their associated training elements are listed, while the second, third, fourth and fifth columns indicate the training elements and platforms most appropriate for effective learning.

2.2.3 For detailed information on academic syllabi, the sixth column of Table 2-1 refers to the *Airplane Upset Recovery Training Aid* (AURTA), Revision 2,[1] which details each associated topic that could be very helpful during the development of a UPRT programme. However, the AURTA generally was developed to deal with topics pertaining to swept-wing aeroplanes with more than 100 passenger seats. Nonetheless, it still contains valuable guidance which often applies to smaller propeller-driven and turbojet aeroplanes.

Note 1.— For UPRT to be effective, it is important to recognize that the subject areas and their associated training elements described in Table 2-1 are simply a means to develop the appropriate proficiencies and assist in developing training programmes and should not lead to a "tick box" approach to completing a training syllabus.

Note 2.— Some of the training elements of Table 2-1 are linked to specific equipment and are only to be trained if the aeroplane type carries that equipment (e.g. stick pusher, fly-by-wire controls). However, the academic training for such elements should be covered during the CPL(A), MPL and bridge training.

[1] Electronic copies of the AURTA can be obtained free of charge at the following website address: http://flightsafety.org/archives-and-resources/airplane-upset-recovery-training-aid. An effort, led by ICAO and industry, aims at updating and reformatting the AURTA, and including information on turbo propeller and smaller swept-wing aeroplanes. When available, the updated document will be published by ICAO (during 2015) and made available for free, resulting in an amendment to this manual.

Table 2-1. UPRT training elements, components and platforms

Subjects and training elements	*Academic training*	*On-aeroplane training — CPL(A)/MPL*	*Non-type-specific FSTD training — (CPL(A)/MPL)*	*Type-specific FSTD training*	*AURTA, Revision 2, references*
A. *Aerodynamics*					section 2.5
1) general aerodynamic characteristics	•	•	•		
2) advanced aerodynamics	•	•	•	•	
3) aeroplane certification and limitations	•	•		•	
4) aerodynamics (high and low altitudes)	•	•	•	•	
5) aeroplane performance (high and low altitudes)	•	•	•	•	
6) angle of attack (AOA) and stall awareness	•	•	•	•	
7) stick shaker activation	•		•	•	
i) stick pusher activation	•		•	•	
ii) Mach effects — if applicable to aeroplane type	•		•	•	
8) aeroplane stability	•	•	•	•	
9) control surface fundamentals	•	•	•	•	
i) trims	•			•	
10) icing and contamination effects					
11) propeller slipstream (as applicable)	•		•	•	Nil
B. *Causes and contributing factors of upsets*					section 2.4
1) environmental	•			•	
2) pilot-induced	•			•	
3) mechanical	•			•	
C. *Safety review of accidents and incidents relating to aeroplane upsets*	•	•		•	
D. *G-awareness*					sections 2.5.3 and 2.6.2.2
1) positive/negative/ increasing/decreasing g-loads	•	•	•	•	
2) lateral g-awareness (sideslip)	•	•	•	•	
3) G-load management	•	•	•	•	

Subjects and training elements	*Academic training*	*On-aeroplane training — CPL(A)/MPL*	*Non-type-specific FSTD training — (CPL(A)/MPL)*	*Type-specific FSTD training*	*AURTA, Revision 2, references*
E. *Energy management*					section 2.5.2
1) kinetic energy vs. potential energy vs. chemical energy (power)	•	•	•	•	
2) relationship between pitch and power and performance	•	•	•	•	
3) performance and effects of differing engines	•	•	•	•	
F. *Flight path management*					
1) automation inputs for guidance and control	•		•	•	
2) type‑specific characteristics	•	•		•	
3) automation management	•		•	•	
4) manual handling skills	•	•	•	•	
G. *Recognition*					
1) type‑specific examples of instrumentation during developing and developed upset	•	•		•	
2) pitch/power/roll/yaw	•	•	•	•	section 2.5.5.5–2.5.5.9
3) effective scanning (effective monitoring)	•	•	•	•	
4) stall protection systems and cues	•		•	•	
5) criteria for identifying stalls and upset	•	•	•	•	
H. *Upset prevention and recovery techniques*					
1) timely and appropriate intervention	•	•	•	•	section 2.6.1
2) nose-high/wings-level recovery	•	•	•	•	
3) nose-low/wings-level recovery	•	•	•	•	sections 2.6.3.2–2.6.3.5
4) high bank angle recovery techniques	•	•	•	•	
5) consolidated summary of aeroplane recovery techniques	•	•	•	•	

Subjects and training elements	*Academic training*	*On-aeroplane training — CPL(A)/MPL*	*Non-type-specific FSTD training — (CPL(A)/MPL)*	*Type-specific FSTD training*	*AURTA, Revision 2, references*
I. *System malfunction*					section 2.4.2
1) flight control anomalies	•	•	•	•	
2) power failure (partial or full)	•	•	•	•	
3) instrument failures	•	•	•	•	
4) automation failures	•		•	•	
5) fly-by-wire protection degradations	•		•	•	
6) stall protection system failures, including icing alerting systems	•		•	•	
J. *Specialized training elements*					sections 2.6.3.2–2.6.3.5 and section 3
1) spiral dive (graveyard spiral)	•	•	•	•	section 2.5.5.7
2) slow flight		•	•	•	
3) steep turns		•	•	•	
4) recovery from approach to stall		•	•	•	
5) recovery from stall, including uncoordinated stalls (aggravating yaw)		•	•	•	
6) recovery from stick pusher activation (as applicable)	•		•	•	
7) nose-high/high-speed recovery		•	•	•	
8) nose-high/low-speed recovery		•	•	•	
9) nose-low /high-speed recovery		•	•	•	
10) nose-low/low-speed recovery		•	•	•	
11) high bank angle recovery		•	•	•	
12) line-oriented flight training (LOFT) or line-operational simulation (LOS)			•	•	
K. *Human Factors*					section 2.5.5.11.10
1) situation awareness					
i) human information processing	•	•	•	•	

Subjects and training elements	*Academic training*	*On-aeroplane training — CPL(A)/MPL*	*Non-type-specific FSTD training — (CPL(A)/MPL)*	*Type-specific FSTD training*	*AURTA, Revision 2, references*
ii) inattention, fixation, distraction	•	•	•	•	
iii) perceptual illusions (visual or physiological) and spatial disorientation	•	•	•	•	
iv) instrument interpretation	•	•	•	•	
2) startle and stress response					
i) physiological, psychological, and cognitive effects	•	•	•	•	
ii) management strategies	•	•	•	•	
3) threat and error management (TEM)					
i) TEM framework	•	•	•	•	
ii) active monitoring, checking	•	•	•	•	
iii) fatigue management	•	•	•	•	
iv) workload management	•	•	•	•	
v) crew resource management (CRM)	•	•	•	•	

Chapter 3

TRAINING

3.1 OVERVIEW

3.1.1 UPRT is collated into an integrated approach which identifies the training resources — academic, on-aeroplane, and FSTD-based — and the associated elements of training required to provide pilots with the necessary knowledge, skills and attitudes (KSA) to reduce the probability of an upset encounter and to maximize their ability to recover from such an event. This results in a comprehensive application of UPRT through the full spectrum of flight training during a professional pilot's career in order to equip the pilot with the ability to maintain and, if necessary, regain aeroplane flight path control in all normal and abnormal (recoverable) situations. The recommendations which follow suggest an approach utilizing existing training infrastructures to efficiently deliver integrated UPRT for those pilots entering the professional pilot pool, which continues to be reinforced throughout a pilot's career (see Figure 3-1).

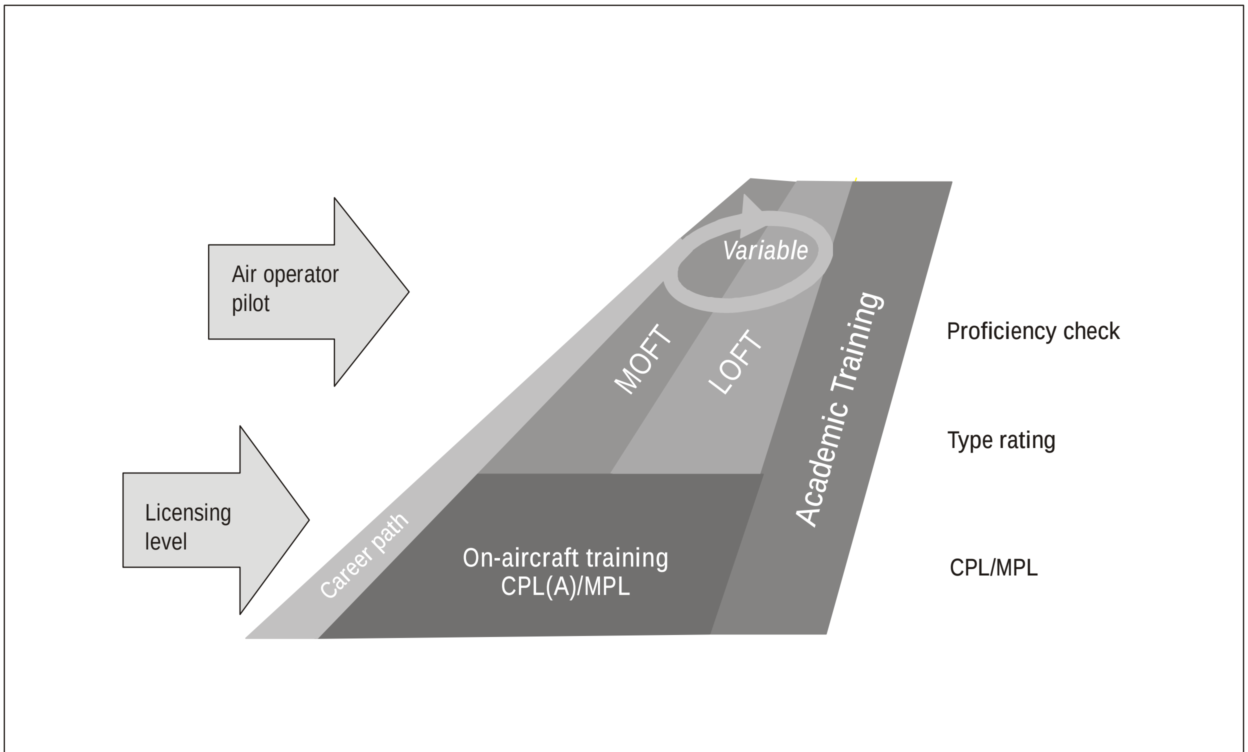

Figure 3-1. Integrated training concept

3.1.2 Of particular importance in UPRT programmes is that ATOs are required to include the provisions of such training within their mandated quality assurance (QA) processes. The objective of QA, as defined in Appendix 2 to Annex 1, is to ensure the achievement of results that conform to the standards set out in the ATO's manuals and in those requirements and documents issued by the Licensing Authority. The *Manual on the Approval of Training Organizations* (Doc 9841) describes proactive processes, provides guidance on how to institutionalize QA and assists ATOs in reaching their full potential in a safe and effective manner.

3.2 ACADEMIC TRAINING

3.2.1 Knowledge plays a fundamental role in the UPRT framework. The foundation of avoiding, or recovering from, aeroplane upsets can be taught in a theoretical manner. Essential to the prevention of upsets is a pilot's knowledge of aerodynamics, flight dynamics and aeroplane design principles as it applies to aeroplane handling and upset recovery. Equally essential is a comprehensive understanding of human limitations and how these can affect a pilot's ability to avoid, recognize and recover from upsets. When combined with practical training, theory can be further enhanced and reinforced.

3.2.2 Theoretical material used in academic training should indicate to pilots that upsets are a natural threat to operating aeroplanes and, especially, that automation alone may not help to prevent such occurrences. Course material that delineates the various causes of upsets from an evidence-based perspective helps to generate a deeper understanding of the areas of threat. Theoretical recovery strategies should be taught prior to practical training as a helpful way of maximizing resources, in both FSTD and on-aeroplane training.

3.2.3 Academic training sessions should be taught by a qualified UPRT ground or flight instructor in a classroom setting or through distance learning with a qualified instructor available to answer questions and supplement the presentation as well as to ensure an accurate understanding of the material. It is recommended that the academic training elements directly related to a scheduled flight or FSTD training session be briefed before commencing practical training. Care should be taken to minimize delays between delivering preflight briefings and conducting the practical training.

3.2.4 UPRT academic training should

not exclusively be developed for and administered to those pilots undergoing licence-qualifying training. Type rating and recurrent UPRT programmes directed towards pilots already operating transport category aeroplanes should also include comprehensive refresher training in the core subjects as well as providing type-specific knowledge that can be applied during the FSTD sessions.

3.2.5 In cases involving initial implementation of UPRT in existing type rating and recurrent training programmes, care should be taken to ensure that an assumption regarding preconceived knowledge levels based upon previous flying experience does not negatively affect the comprehensiveness of the UPRT programme. It is, therefore, recommended that CAAs, operators, and ATOs consider administering a threshold knowledge test to determine the necessary starting point for instituting bridge training to address any knowledge deficiencies amongst current transport category aeroplane pilots.

3.2.6 As essential as theoretical instruction is to fostering an academic approach to upset prevention and recovery, a solely theoretical approach without practical skill development has limited effectiveness. In high threat situations such as aeroplane upsets, mental ability can be severely diminished by fear. Practical exposure under controlled conditions is essential to complement theoretical training and improve the pilot's ability to manage threatening events. A recognized source of UPRT knowledge is the AURTA (see Table 2-1 for a non-exhaustive list of topics to cover in academic training).

3.3 PRACTICAL TRAINING

When introducing a stall event in on-aeroplane training, whenever possible, pilots should ideally be exposed to both approach-to-stall and aerodynamic stall conditions. During training, emphasis should not be unduly applied to the manner by which the event was entered. Training should, however, emphasize that recovery from either condition is carried out in the same manner and is effected immediately upon the pilot's recognition of the ensuing stall event.

The same process applies when utilizing an FSTD to conduct UPRT, except that because of fidelity limitations of these devices, aerodynamic stall training should only be conducted as a carefully managed demonstration using only devices that have the highest levels of fidelity and are qualified and approved for the training task, thereby ensuring that inappropriate understandings of the event are avoided (see Chapter 4, FSTD Fidelity Requirements for UPRT).

3.3.1 Aeroplane training

3.3.1.1 While an essential component of overall flight training and UPRT, current FSTDs have limitations that render them incapable of providing complete exposure to conditions synonymous with preventing or recovering from a LOC-I event. Limitations in FSTD motion cueing and the reduced emotional response create boundaries that prevent pilots from experiencing the full range of aeroplane attitudes, load factors and behaviour that can be present during an actual flight. These areas of missing experience provide gaps in pilots' understanding and proficiency when confronted with an actual upset. UPRT on aeroplanes provided by competent instructors should compensate these gaps by being part of the initial UPRT experience at the CPL(A) and MPL level and should then be supplemented by training in FSTDs. This on-aeroplane training, when given at the CPL(A) or MPL licensing level, provides physiological and psychological exposure geared toward upset prevention and recovery which creates a frame of reference that can be transferred to the FSTD environment later in their training. The practice and application of skills acquired during on-aeroplane UPRT provides experience and confidence that cannot be fully acquired in the simulated environment alone. Although not specifically addressed, when the two platforms are combined, the depth of coverage of the on-aeroplane UPRT elements listed in Table 3-1 can be enhanced in some instances by the integrated use of a suitable FSTD to complement the training exercises conducted on the aeroplane. Therefore, ATOs are encouraged to deliver the on-aeroplane phase of their UPRT programmes for CPL(A) and MPL trainees utilizing appropriate ground-based simulation whenever possible to optimize the exposure of the trainees to the upset phenomena.

Table 3-1. On-aeroplane UPRT elements

On-aeroplane UPRT	
Training element	*Description*
A. *Aerodynamics*	The flight training should expose trainees to the limits of the aeroplane flight envelope to develop situation awareness and prevention capability, while keeping an appropriate safety margin. Training should enable pilots to understand basic aerodynamics and flight dynamics to mentally integrate an understanding of the aeroplane AOA and energy state throughout the part of the flight envelope used in normal operations. (Ref. AURTA — 2.5)

On-aeroplane UPRT	
Training element	*Description*
B. *Causes and contributing factors of upsets*	Development and training on procedures for normal operations and deviation recovery should focus on upset prevention. Training should emphasize what to monitor during normal operations and during an upset recovery, how to identify deviations and effect recovery. Train pilots what to and when to monitor, including cross-checking and verification, during all phases of flight to prevent an upset event. Trainees should apply their academic training to prevent, and recover from, environmentally induced, aeroplane system-induced and pilot-induced upsets. (Ref. AURTA — 2.4)
C. *Safety review of accidents and incidents relating to aeroplane upsets*	Demonstration of some of the actual upsets covered in academic training, with training of the prevention and proper recovery techniques.
D. *G-awareness*	Training of g-awareness is required to expose the trainee to the physiological aspects of g-loading (positive/negative/lateral g) events to provide experience with the effects of sensory illusions. Positive and negative g-loading should be completed with pull-ups, various bank angles, and pushover(s) to develop awareness and manual handling skills to apply various levels of g-loading at various aeroplane attitudes, bank angles, and energy states within the aeroplane's flight envelope. Lateral g-loading should be demonstrated with steady state sideslip manoeuvring. Trainees need to develop the manual handling skills to be able to apply the appropriate amount of g-loading for a given situation to maintain the aeroplane performance within its designed certification envelope.
E. *Energy management*	In order to fully understand the concepts discussed in the related academic training, trainees should practice and understand acceleration performance when on the back side of the power curve and how to use pitch/power to achieve best performance results.
F. *Flight path management*	Flight path management training should be developed with regard to manual handling skills.
1) Manual control inputs	The training objective with regard to manual control inputs addresses correct pilot control inputs to avoid or recover from undesired flight path deviations. This training objective should include the control strategies pilots should use in both developing and developed upset events. This should include primary/alternate control strategies and be in accordance with the recovery techniques of 3.5, as applicable.
2) Manual handling skills	The objectives with regard to manual handling skills are to address correct pilot control inputs to avoid undesired flight path deviations. Refer to section G 2) Pitch/power/roll/yaw on how to develop pilot skills for making the correct control inputs to arrest the divergence or recover from the upset. UPRT improves manual handling skills for avoidance of, and recovery from, the edges of the flight envelope. These manual handling skills should be developed during the specialized training elements of section J below. Training should include the practice of manual handling at the operational edges. Pilots need to know the common errors to avoid and why they occur, as well as the importance of cross-checking and verification of inputs. One outcome is for pilots to know how the aeroplane responds to inputs

On-aeroplane UPRT	
Training element	*Description*
	across flight regimes. Manual handling training should include training on the use of up to full control inputs. Flight control inputs become less effective when the aeroplane is at or near its critical AOA or stalled. The tendency is for pilots not to use full control authority because they rarely are required to do so in normal operations. Pilots must overcome this habit when recovering from severe upsets. It is important to guard against control reversals. To maintain structural integrity, rapid full-scale reversal of control deflections should be avoided. *Note 1.— Rudder control is still effective at a high AOA, and special care must be taken in the use of rudder during upset prevention and recovery.* *Note 2.— The objective of this manual is to reduce LOC-I accidents through training appropriate to commercial air transport aeroplanes. Consequently, manoeuvres tolerances should be tailored to the operating limitations of transport category aeroplanes.* In addition, manual handling training (pitch/power/roll/yaw) should include training on non-intuitive factors. For example, it may be counter-intuitive to use greater unloading control forces when recovering from a high AOA, especially at low altitudes. If the aeroplane is stalled while already in a nose-down attitude, the pilot still needs to push the nose down (unload) in order to reduce the AOA. Altitude cannot be maintained in a stall and should be of secondary importance.
G. *Recognition*	**Trainees should understand that anytime the aeroplane begins to diverge from the intended flight path or desired speed, they need to promptly identify and determine what, if any, action must be taken and then act accordingly.**
1) Aeroplane-specific examples of instrumentation/ visual cues during developing and developed upset	A key aspect to upset awareness, prevention, and recovery training is for trainees to recognize developing and developed upset conditions. The emphasis is on using examples of visual cues and available instrumentation to train awareness, recognition and prevention of a developing upset and recovery from a developed upset in order to acquire effective aeronautical decision-making skills.
2) Pitch/ power/roll/yaw	A key aspect of upset awareness, prevention and recovery training is for trainees to recognize developing and developed upset conditions so they can make control inputs based on desired aeroplane reaction. Control deflections at one point in the flight envelope might not be appropriate in another part of the flight envelope. Pilots need to have a fundamental understanding of instrumentation and flight dynamics in pitch/power/roll/yaw in order to recognize the current state of the aeroplane and make the correct control inputs to arrest the divergence or recover from the upset. (Ref. AURTA — 2.5.5.5 to 2.5.5.9)
3) Effective scanning (effective monitoring)	Effective instrument scanning techniques should be trained as appropriate to recognize normal states and divergence from normal flight parameters. To avoid upsets related to an inadequate monitoring of aeroplane state, pilots should be trained on what to monitor and when, during all phases of flight. Pilots need to create a mental picture of the aeroplane status and keep it updated and cross-checked. Pilots should also be aware of the effects of fatigue on their ability to monitor effectively.
4) Stall protection	Accurate and early recognition of all available aural, visual and tactile alerts to both an approaching

On-aeroplane UPRT	
Training element	*Description*
systems	stall and, with due consideration to maintaining adequate safety margins, an aerodynamic stall. Particular attention must be given to aeroplane stall characteristics in the absence of a stall warning indication. (Ref. AURTA — 2.5.5.1)
H. *Upset prevention and recovery techniques*	Upset prevention and recovery techniques should be accomplished in an aeroplane using published flight manual upset prevention and recovery procedures. The training organization should include these techniques in their training and procedures manual and use OEM recommendations for upset prevention and recovery when available. In as much as the flight manual procedures allow, these techniques should be in accordance with the recommended techniques in 3.5, where applicable. The academic portion of the training should discuss these techniques, which will be applied practically during flight training.
1) Timely and appropriate intervention	Training should emphasize the need for the pilot to recognize a divergence as early as possible and immediately take corrective action to return the aeroplane to a stabilized flight path. The corrective action should include managing the energy, arresting the flight path divergence and recovering to a stabilized flight path. The amount and rate of control input to counter a developing upset should be proportional to the amount and rate of pitch, roll and/or yaw experienced. If the aeroplane is stalled during the divergence from the intended flight path, then the training should also stress the importance of first applying and maintaining nose-down elevator until recovery from the stall is complete.
2) Nose-high/wings-level recovery	See 3.5 for OEM recommended recovery techniques. (Ref. AURTA — 2.6.3.2)
3) Nose-low/wings-level recovery	See 3.5 for OEM recommended recovery techniques. (Ref. AURTA — 2.6.3.3)
4) High bank angle recovery techniques	(Ref. AURTA — 2.6.3.4)
5) Consolidated summary of aeroplane recovery techniques	(Ref. AURTA — 2.6.3.5)
6) Stall event	Training for: awareness of the distinction between aircraft attitude and AOA; aggravating effect of side slip; energy management and trading altitude for speed; awareness of the correlation between stall speed and g-load and the capability to reduce stall speed by unloading; stall recovery technique (see 3.5).
I. *System malfunction*	Trainees should understand the systems of their aeroplane relevant to UPRT and how these systems can cause or contribute to an upset. **Simulated** system malfunctions should be introduced in flight with an emphasis on preventing an upset. Extreme care should be taken to ensure any risks associated with the simulated malfunctions are addressed and mitigated. OEMs, if available, should be consulted for possible system malfunctions that could cause or contribute to an upset. System malfunctions include flight control anomalies, power failure, icing and stall alerting system

On-aeroplane UPRT		
	Training element	*Description*
		failures, and instrument failures, as applicable to the aeroplane. (Ref. AURTA — 2.4.2)
J.	*Specialized training elements*	These are several specific elements to be incorporated into the training that teach a specific skill set to help trainees prevent, and if needed, recover from an upset.
	1) Spiral dive	In this manoeuvre, sometimes called a graveyard spiral, the aeroplane is at a high bank angle and descending. Trainees will learn in this situation that applying up‑elevator in an attempt to arrest both the increasing speed and sink rate causes the spiral to tighten. The skill learned is that it is imperative to get the wings close to level before beginning any pitching-up manoeuvre. Trainees must decrease the bank angle and then apply up‑elevator to recover. If g-loading is large the pilot will need to first unload some g to regain adequate roll control for wings levelling. (Ref. AURTA — 2.4.2)
	2) Slow flight	Slow flight exposes the trainee to flight right above the stall speed of the aeroplane and to manoeuvring the aeroplane at this speed without stalling. The purpose is to reinforce the basic stall characteristics learned in academics and allow the pilot to obtain handling experience and motion sensations when operating the aeroplane at slow speeds during the entire approach-to-stall regime in various aeroplane attitudes, configurations and bank angles.
	3) Steep turns	Steep turns provide the trainee with practical experience of load factor and manoeuvring the aeroplane at higher than normal bank angles.
	4) Recovery from approach-to-stall	Particular emphasis should be placed on the early recognition of those symptoms associated with approaching a stall as well as the recognition of stall warning system activation. Trainees should be made to understand that recovery action involving a deliberate and smooth application of nose-down pressure should be performed immediately upon recognition of the presence of stall-related symptoms or the activation of a stall alerting device.
	5) Recovery from stall	With due regard to adequate safety margins, stall recovery training should focus on developing the awareness of stall-related cues such as buffet, degradation of control responsiveness in the pitch and roll axis, as well as the inability to arrest descent. Respecting the limitations of the aeroplane, the training should also include recovery from accelerated stalls and stalled conditions involving side slip. The recovery portion of the training should constantly stress the primary importance of a smooth and deliberate reduction in the angle of attack sufficient to break the stalled condition and completing the recovery in compliance with aeroplane-specific recommended techniques.
	6) Nose high/ high speed 7) Nose high/ low speed 8) Nose low/ high speed 9) Nose low/ low speed 10) High bank angle recovery	This training will provide the trainees with the experience of conditions close to the limits of the operating envelope and high bank angles as well as demonstrate appropriate recovery techniques that should also be compliant with the guidance in 3.5. The on‑aeroplane training should include a variety of developing and developed upset conditions, with focus on pitch, power, roll, and yaw. This on‑aeroplane training should include demonstrations and practice for various upset scenarios, to include nose‑high and nose‑low scenarios with various bank angles and speeds. High bank angle recovery exercises should be practised in both nose-high and nose‑low situations. This training should be done in both visual and simulated instrument conditions to allow the trainee to practice recognition and recovery, as well as experience and recognize some of the physiological factors related to each condition. (Ref. AURTA — 2.6.3.2 to 2.6.3.5)

On-aeroplane UPRT	
Training element	*Description*
	High bank angle recovery training (for consideration by the CAA and approved training organizations): A review of transport category aeroplane major incidents and accidents shows that bank angles have exceeded 90° in some upsets. Studies show that most pilots who went into inverted flight for the first time during training incorrectly added back pressure even though they received instructions in academic training and briefings before flight not to increase back pressure. The use of an aeroplane capable of delivering inverted manoeuvre training would be helpful to meet the optimum objectives. For such on-aeroplane training, additional measures should be taken to ensure safety by only using aeroplanes suitable for the training tasks and appropriately qualified instructors. Furthermore, because type rating training should include recommended recovery training from high bank angles (beyond 90°) in an FSTD, initial skill development for those who have never been exposed to such advanced training could be further enhanced using a suitable aeroplane before conducting their type-rating training in an FSTD. Given the availability of capable aeroplanes in the State, the safety benefits, and the additional costs, the CAA should consider whether these inverted manoeuvres, providing for an optimum on-aeroplane UPRT experience, are to be required for the issue of either a CPL(A) or MPL.
K. *Human Factors*	Human Factors are an overarching, integral part of UPRT. The Human Factors in UPRT address the physiological responses in the event of a flight path divergence or a sudden upset. Integrating Human Factors into UPRT is also important to help develop airmanship, which requires perceptual, cognitive, and psychomotor knowledge and skills. Human Factors for on-aeroplane training include, but are not limited to, the cognitive process, the learning process and the ability of the trainees to recall and apply appropriate knowledge and skills at a later stage of their career.
1) Threat and error management (TEM)	TEM as it relates to upset prevention and recovery should be integrated in the UPRT. TEM training should include: threat identification, the aeroplane normal states, detection of deviations, interpretation of the meaning of the deviation, decision on how to respond, and the response. It is a crucial means of addressing Human Factors training elements. The pilots' capacity to think effectively in flight conditions to which they have not previously been exposed may be challenged during an upset event. Pilots should focus on stabilizing the aeroplane. Training should define which control inputs are appropriate and how to prioritize the tasks to avoid overloading. TEM requires effective monitoring and for that, methods and training should be provided and include appropriate assessment techniques (i.e. what to monitor and when, what to cross-check, ensuring proper verification) during all phases of flight to prevent an upset event and during recovery efforts.

On-aeroplane UPRT	
Training element	*Description*
2) Human information processing	For pilots to understand how to respond appropriately and why they sometimes fail to do the correct action, they must understand how they process information. These are the "building blocks" of knowledge that allow a better understanding of how to maintain or improve such areas as communication, decision-making, situation awareness, and team dynamics. Those areas involved in all human information processing include: i) attention — the sensing and retrieval of relevant information from the environment; ii) perception — understanding that information which has been retrieved; iii) interpretation — associating the information which is relevant and the knowledge required for the task at hand; iv) judgement — aligning the requirement for action with the correct response; v) decision-making — assessing the correct response needed for the outcome required or an alternative; vi) action — implementing the response chosen; and vii) feedback — checking that the response action meets the correct requirements of the task.
3) Crew resource management (CRM)	CRM is as much about the trainee knowing how to manage themselves when they are the only crew member (single pilot) as it is about working as part of a team. Areas of importance for on-aeroplane training include managing workload, and vocalizing the analysis of the aeroplane status and its energy state and keeping it updated and cross-checked.
4) Situation awareness	Pilots need to maintain situation awareness at all times through effective monitoring (see the training element "Recognition" in this table). Pilots do this by maintaining a mental model while creating mental pictures of developing situations. A breakdown of a pilot's mental model or picture, which can be caused by several factors, such as spatial disorientation from in-flight perceptual illusions, being startled, inattention and complacency, can lead to a loss of situation awareness. Training should include how to maintain situation awareness and what to monitor to prevent, and recover from, upsets. After a deviation, it is important that the first actions be correct and timely to avoid the recovery from one upset leading to a new upset. Troubleshooting the cause of the upset is secondary and can wait. The situation analysis process includes: i) determining the bank angle; ii) determining the pitch attitude; iii) confirming the attitude by reference to other indicators, as available; and iv) assessing the energy state.

On-aeroplane UPRT		
Training element		*Description*
5)	Decision-making	Pilots should focus on stabilizing the aeroplane. They should know the appropriate pitch and power targets for stabilization and take the appropriate corrective action. To do so, trainees should be aware of what information they need to make the optimum decision for action, as well as of those factors, such as cognitive biases, that affect decision-making.
6)	Problem-solving	Training should improve the problem-solving competency and recognize those factors that can impede a trainee's ability to solve a problem, such as fatigue, fear, work overload. In particular, UPRT should emphasize the importance of evaluating whether a solution is working and of not rushing into an action that may be detrimental.
7)	Startle and stress response	Training should include strategies to deal with the range of physiological, psychological and cognitive effects associated with the human stress response to unexpected threatening events. Pilots may be startled when an unexpected event during flight contradicts their expectations. If an unexpected event is sufficiently serious and/or arises during a critical phase of flight, the correct response to that uncertainty becomes vital for survival. UPRT is different from aerobatic training. In aerobatics training, the pilot knows what the manoeuvre is and is expecting it, so there is no threat of consequences or perception of undue risk by the pilot. While respecting the need to ensure adequate safety margins, upset training should strive to include the element of "unexpectedness" that pilots will experience in a real world application.
8)	Physiological factors	Recognizing the effects of visual and vestibular (angular and linear) illusions and responding appropriately is a key aspect of UPRT. Areas to be addressed during on-aeroplane training include: i) conditions which can lead to spatial disorientation and the use of instrument interpretation to manage spatial disorientation; ii) avoiding errors in adjusting attitude/power; iii) avoiding, and recovering from, pilot-induced oscillations (PIOs); and iv) recognizing and managing sensory illusions in flight. All of these items should be covered in academic training, but some training in the aeroplane can target some of them, especially spatial disorientation.

3.3.1.2 The delivery of UPRT in an aeroplane should not be focused on aeroplane-specific performance or features. Appropriate use of aeroplane training platforms for the delivery of UPRT should emphasize the introduction of general principles of understanding and techniques which may be applied to a wide range of aeroplanes and are not in conflict with commercial air transport aeroplane recovery techniques. Table 3-1 contains specific information on UPRT training elements for on-aeroplane training.

3.3.1.3 It is important to make the distinction that UPRT is not synonymous with aerobatic flight training. While aerobatic training improves manual handling skills and increased awareness of the results of flight path deviations, its primary objective is to achieve proficiency in precision manoeuvring. The primary objective of UPRT is effective aeroplane upset prevention and recovery. From the Human Factors aspect, aerobatics does not specifically address the element of “startle”. Nor does aerobatic flight training necessarily provide the best medium to develop the full spectrum of analytical reasoning skills required to rapidly and accurately determine the course of recovery action during periods of high stress. UPRT should address these psychological and reasoning responses, which are significant factors in most LOC-I accidents. These skills can be acquired using non-aerobatic aeroplanes, but the range of possible manoeuvres is appreciably smaller than for more capable aeroplanes. Given the resources available within the State, the additional safety benefits and costs, the CAA should consider whether the use of those more capable aeroplanes, providing for an optimum on-aeroplane UPRT experience, are to be required for the issue of either a CPL(A) or MPL.

3.3.1.4 On-aeroplane UPRT will require departures from traditional flight training parameters with recovery executed by trainees undergoing training while under the direct supervision of a qualified instructor. This form of training imposes a heightened level of risk, which should be mitigated by thorough flight planning and preflight briefings, and by only permitting UPRT-qualified aeroplane flight instructors to deliver the in-flight training. UPRT instructors should be trained to proficiency and remain current to ensure competence in aeroplane manoeuvring as well as being able to consistently employ effective intervention skills that may become necessary to maintain adequate margins of safety. Such interventions may be required with regard to aeroplane limitations, altitude, airspace, avoidance of collision, human performance and limitations of the instructor or the trainee or any other threat or error that might reduce margins of safety.

Note.— Chapter 5 details recommendations on the qualifications required for UPRT instructors.

3.3.1.5 There are several other avenues available to reduce risks associated with the manoeuvring requirements inherent in on-aeroplane UPRT. For instance, ATOs should utilize only aeroplanes that have certification and handling capabilities appropriate for the training tasks, recognizing that some recommended manoeuvres may not be able to be accomplished in certain types of aeroplanes. ATOs should also develop and enforce strict operational control procedures involving appropriate training airspace areas, minimum dispatch and weather conditions, and adherence to minimum safe altitudes. However, the most important factor affecting safety in the conduct of UPRT is a competent instructor qualified for the delivery of on-aeroplane UPRT who operates within a well-structured safety management system (SMS) environment.

Annex 19 states:

> 3.1.3 As part of its SSP, each State shall require that the following service providers under its authority implement an SMS:
>
> a) approved training organizations in accordance with Annex 1 that are exposed to safety risks related to aircraft operations during the provision of their services; …
>
> 4.1.2 The SMS of an approved training organization, in accordance with Annex 1, that is exposed to safety risks related to aircraft operations during the provision of its services shall be made acceptable to the State(s) responsible for the organization’s approval.

3.3.1.6 It is important for the Licensing Authority and ATOs to realize and understand the applicability of SMS for ATOs: the requirement to adopt SMS practices is intended to be restricted to only those training entities whose activities directly impact upon the safe operation of aircraft. The *Safety Management Manual (SMM)* (Doc 9859) provides very detailed guidance on the history of aviation safety, why SMS is so important in industry’s collective effort to reduce safety occurrences, and how to design and maintain an effective SMS.

3.3.1.7 Combined with well-structured QA policies and procedures, an ATO’s SMS programme should effectively mitigate any increased risk levels associated with conducting on-aeroplane UPRT.

> On-aeroplane UPRT is not intended to be delivered while operating transport category aeroplanes or aeroplanes requiring two or more crew members; for those operations, UPRT should not be permitted to be conducted outside the confines of a suitable FSTD.

3.3.1.8 A list of training topics and associated elements enabling pilots to recognize, avoid and recover from upset conditions during single-pilot operations while under instruction in actual flight appears in Table 3-1, which should be used in conjunction with Table 2-1. This training is applicable only for MPL courses during the core flying skills or basic phase and for CPL(A) courses. This table addresses all single-pilot UPRT objectives except aeroplane flight path management — automation and high-altitude operations; both of these objectives are covered in the type rating-specific section.

3.3.1.9 Where noted, AURTA, Revision 2, which has specific details on each associated topic that could be very helpful during the development of a UPRT programme, is referenced. Although AURTA generally was developed to deal with topics pertaining to swept-wing aeroplanes with more than 100 passenger seats, it still contains valuable guidance which often applies to smaller propeller-driven and turbojet aeroplanes (see 2.2.3).

3.3.2 FSTD training

3.3.2.1 ***Overview***

3.3.2.1.1 The use of FSTDs for the delivery of UPRT during type rating training and commercial air transport flight crew training complements the application of knowledge and techniques introduced through on-aeroplane UPRT at the CPL(A) or MPL licensing level, as applicable. FSTD capabilities permit training in operational areas that are otherwise unsafe or impractical in actual aeroplanes (such as low altitude or very high altitude upset encounters or flight during rapidly deteriorating situations involving adverse weather or icing conditions). Additionally, FSTDs can allow for practical skill development in upset prevention and recovery in a crew environment and with aeroplane-specific systems, instrument indications, control response and procedures.

3.3.2.1.2 Of major concern in the delivery of UPRT in FSTDs is adherence to the valid training envelope (VTE) for a particular device. While various levels of training devices may be appropriate for the illustration and practice of a variety of elements of UPRT, they should always be qualified appropriately for the delivery of UPRT-specific training. Use of FSTDs in regions of the flight envelope beyond the FSTD's ability to provide accurate fidelity has the potential to introduce misleading concepts or an inappropriate understanding of techniques which can result in a negative training experience.

> FSTD UPRT programme design recommendations are based upon the understanding that:
>
> a) simulation training will be conducted using the highest level of FSTD fidelity available utilizing flight test data for the design of the simulation model whenever possible;
>
> b) when flight test data simulation modelling is not available, other appropriate engineering data may be used provided the simulation is then validated using appropriately qualified personnel which may include test pilots; and
>
> c) validation of simulation modelling must be completed in context of the training curriculum for which the device is being used.

3.3.2.1.3 Tables 3-2 and 3-3 contain additional information on UPRT conducted in non-type-specific FSTDs (for introducing multi-crew operations) and type-specific FSTDs, respectively. A list of OEM recommendations for FSTD training sequences is contained in 3.4.2.

3.3.2.1.4 The highest level of FSTD is defined in Doc 9625, Volume I, as a Type VII device. The UPRT-related enhancements that should be incorporated in these devices, before some parts of the UPRT programme described herein are conducted, are now defined in the criteria for an FSTD as described in Doc 9625, Volume I, and in the RaeS ICATEE *Research & Technology Report,* and are summarized in Chapter 4.

3.3.2.2 ***Non-type-specific FSTD training***

3.3.2.2.1 Non-type-specific FSTD UPRT is applicable to MPL courses during the multi-crew phases and can also be used for CPL(A) courses that introduce trainees to multi-crew operations. It addresses all multi-crew training objectives, except high-altitude operations which are covered in the type-specific training elements listed in Table 3-3. Prior to conducting this training, the trainee should have completed the academic and on-aeroplane portions of the UPRT programme.

Table 3-2. Non-type-specific FSTD multi-crew UPRT elements

Non-type-specific FSTD multi-crew UPRT	
Training element	*Description*
A. *Aerodynamics*	Trainees should be knowledgeable about aerodynamic effects at both high and low altitudes. The FSTD training should be accomplished at high altitude (at or near max cruise level) and at low altitude (below 3 000 m (10 000 ft) above mean sea level) to reinforce the academic training described in 3.2. Trainees should also be trained with respect to the aircraft handling effects of operating at low speeds or high Mach, as applicable to the FSTD, including: i) demonstration of Mach tuck, if applicable, and Mach buffet; ii) recognition of high speed/Mach buffet and low speed buffet; and iii) awareness of control surface effectiveness at low and high speeds. Trainees should also be trained to control the energy state of the aeroplane using elevator inputs and thrust. They should understand aeroplane performance across all flight phases, including how to respond as pilot flying (PF) and pilot monitoring (PM). They should apply their basic aerodynamics and flight dynamics knowledge to mentally integrate an understanding of the aeroplane AOA and energy state throughout the normal envelope of operations and should be able to communicate that awareness to the other pilot. (Ref. AURTA — 2.5)
B. *Causes and contributing factors of upsets*	Development and training on procedures, including PF and PM roles, for normal operations and deviation recovery should focus on upset prevention. The training should emphasize what to monitor during normal operations and during an upset recovery, how to identify and communicate deviations between pilots and how to effect recovery. Train pilots in what to monitor and when, including cross-checking and verification, during all phases

Non-type-specific FSTD multi-crew UPRT	
Training element	*Description*
	of flight to prevent an upset event. Stress communication behaviour between pilots to share an understanding of aeroplane state so that both pilots recognize when either of them might be introducing a pilot-induced upset. Trainees should apply their academic training to prevent, and recover from, environmentally induced, pilot-induced and aeroplane system-induced upsets. (Ref. AURTA — 2.4)
C. *Safety review of accidents and incidents relating to aeroplane upsets*	Demonstration of some of the actual upsets of transport category aeroplanes covered in academic training, with training of the prevention and proper recovery techniques.
D. *G-awareness*	Most FSTDs cannot replicate sustained g-forces; therefore, the cockpit situation must be envisioned during flight when not under traditional 1 g environment and trainees trained accordingly. For example, in an actual upset in flight, the pilot may be floating up against the shoulder harness and seat belt making it difficult for the pilot to apply proper control inputs. Unsecured items may also be flying around the cockpit. If any practical exercise regarding g-awareness is accomplished in an FSTD, careful consideration should be taken to avoid negative training. Because there is a visual and sensory aspect associated with g-loading, the training programme will need to validate whether the g-awareness training in the FSTD will be effective and can be accomplished without negative training.
E. *Energy management*	The training should include integrated CRM training for developing crew knowledge and skills for energy management, as well as techniques for reducing pilot error, including what to monitor during an event and how the PM should coach the PF in the recovery using appropriate callouts and other verbal feedback. Training should cover accelerations from low to high speed at both low and high altitudes and develop the trainees' ability to understand and manage the difference between kinetic, potential and chemical energy and the relationship between pitch, power and performance.
F. *Flight path management*	Flight path management training should be developed with regard to which automated systems are on the FSTD being used for the specific training.
1) Manual or automation inputs for guidance and control	The training objective related to the manual or automation inputs for guidance and control addresses correct pilot control inputs to avoid or recover from undesired flight path deviations. This training objective should include the control strategies pilots should use in both developing and developed upset events. Pilots need to know the conditions under which it is best to allow automated systems to control the aeroplane and those under which manual intervention by the pilot is best. This should include primary/alternate control strategies and how to interpret instrument displays to recognize, prevent or recover from upsets. It should also include relevant considerations when disconnecting the automation. Integrated CRM training should include communication between pilots of their understanding of the current aeroplane state. Pilots should be able to work as a crew to be aware of, recognize and prevent upsets.

Non-type-specific FSTD multi-crew UPRT	
Training element	*Description*
2) Automation management	The automation management training objective addresses correct pilot inputs to avoid undesired flight path deviations. Pilots need to know how to use the automation systems (if installed) during prevention and recovery from an upset event. This training should include the following: i) common errors to avoid and why they occur; ii) cross-check and verification of mode use; iii) advantages and disadvantages of using automated systems for upset prevention and recovery; and iv) the importance of ensuring correct pilot inputs to the automation systems and the consequences of failing to do so. This training objective should include the control strategies pilots should use in both developing and developed upset events. Pilots should know the common errors to avoid, why they occur, the importance of cross-checking and verification of inputs, as well as have a common understanding between them of why it may be a better practice to continue flying the aeroplane through automation in the particular circumstances. It is imperative that the PF keep the aeroplane in trim while flying with an engine inoperative on a multi-engine aeroplane. At slow speed and high thrust on the remaining engine(s), the autopilot (A/P) on some aeroplanes is generally incapable of holding the correct attitude against an adverse yaw condition, which may result in an upset.
3) Manual handling skills	The manual handling skills objectives are to address correct pilot control inputs to avoid undesired flight path deviations. Refer to the discussion in section G 2) Pitch/power/roll/yaw on how to develop pilot skills for making the correct control inputs to arrest the divergence or to recover from the upset. These manual handling skills should be developed during the specialized training elements in section J below. Pilots should know the common errors to avoid, why they occur, the importance of cross-checking and verification of inputs, as well as have a common understanding between them of why it may be a better practice to fly the aeroplane manually. Pilots should develop an understanding of how the aeroplane responds to inputs across all flight regimes. Manual handling training should include training on the use of full control inputs. Flight control inputs become less effective when the aeroplane is at or near its critical AOA or stalled. The tendency is for pilots not to use full control authority because they rarely are required to do so. Pilots need to overcome this habit when recovering from severe upsets. *Note 1.— Rudder control is still effective at a high AOA, and special care must be taken in the use of rudder during upset prevention and recovery.* *Note 2.— Excessive use of pitch trim or rudder during the recovery may aggravate the upset*

Non-type-specific FSTD multi-crew UPRT	
Training element	*Description*
	condition and/or may result in exceeding aeroplane structural limitations. It is also important to guard against control reversals. To maintain structural integrity, rapid full-scale reversal of control deflections should be avoided. In addition, manual handling training (pitch/power/roll/yaw) should include training on non-intuitive factors. For example, it may be counter-intuitive to use greater unloading control forces when recovering from a high AOA, especially at low altitude. If the aeroplane is stalled while already in a nose-down attitude, the pilot still needs to push the nose down (unload) in order to reduce the AOA. Altitude cannot be maintained in a stall and should be of secondary importance. The training should highlight when it is appropriate to fly manually versus through automation.
G. *Recognition*	**Trainees should understand that anytime the aeroplane begins to diverge from the intended flight path or speed they need to promptly identify and determine what, if any, action must be taken, and then act accordingly.**
1) Examples of instrumentation during developing and developed upset	A key aspect to UPRT is for trainees to recognize developing and developed upset conditions. The emphasis is on using examples of instrumentation and visual cues to train awareness, recognition and prevention of a developing upset and recovery from a developed upset in order to improve effective aeronautical decision-making to prevent upset events.
2) Pitch/power/roll/yaw	A key aspect of UPRT is for trainees to recognize developing and developed upset conditions so they can make control inputs based on desired aeroplane reaction. Control deflections at one point in the flight envelope might not be appropriate in another part of the flight envelope. Pilots need to have a fundamental understanding of instrumentation and flight dynamics in pitch/power/roll/yaw in order to recognize the current state of the aeroplane and make the correct control inputs to arrest the divergence or recover from the upset. The attitude director indicator (ADI) is the primary control instrument for recovery from an upset as, due to varying visibility conditions in operations, one cannot depend on having adequate outside visual references. (Ref. AURTA — 2.5.5.5 to 2.5.5.9)
3) Effective scanning (effective monitoring)	Effective instrument scanning techniques should be trained as appropriate to recognize normal states and divergence from normal flight parameters. Pilots should be trained on what to monitor and when, including cross-checking and verification, during all phases of flight, to identify the precursors and the initial development of an upset and then use that recognition to make timely and appropriate responses to bring the aeroplane back to the desired path. Pilots should also be aware of the effects of fatigue on their ability to monitor effectively. Training should also be provided on communicating the current aeroplane state between pilots, including callouts to improve situation awareness. Pilots should be able to create a mental picture of the aeroplane state and keep it updated and cross-checked with the other pilot throughout the flight. The PM should know how to assist the PF to return the aeroplane to a stable state.
4) Stall protection systems	Accurate and early recognition of all available aural, visual and tactile alerts to both an approaching stall and an aerodynamic stall. Particular attention must be given to aeroplane stall characteristics in the absence of a stall warning indication. (Ref. AURTA — 2.5.5.1)

Non-type-specific FSTD multi-crew UPRT	
Training element	*Description*
H. *Upset prevention and recovery techniques*	Upset prevention and recovery techniques should be accomplished in an FSTD qualified for the training, using the training organization's upset prevention and recovery procedures published in the training and procedures manual. These procedures should follow the OEM recommendations for upset prevention and recovery (see 3.5).
1) Timely and appropriate intervention	Training should emphasize the need for the PF or PM to recognize a divergence as early as possible and immediately ensure corrective action is taken to return the aeroplane to a stabilized flight path, including appropriate crew interaction. The corrective action should include managing the energy, arresting the flight path divergence and recovering to a stabilized flight path. If the aeroplane is stalled during the divergence from the intended flight path, then the training should also stress the importance of first applying and maintaining nose-down elevator until recovery from the stall is complete. The amount and rate of control input to counter a developing upset should be proportional to the amount and rate of pitch, roll and/or yaw experienced. The ADI is the primary control instrument for recovery from an upset, as adequate outside visual references may not be available or may be misleading.
2) Nose-high/ wings-level recovery	See 3.5 for OEM recommended recovery techniques. (Ref. AURTA — 2.6.3.2)
3) Nose-low/ wings-level recovery	See 3.5 for OEM recommended recovery techniques. (Ref. AURTA — 2.6.3.3)
4) High bank angle recovery techniques	(Ref. AURTA — 2.6.3.4)
5) Consolidated summary of aeroplane recovery techniques	(Ref. AURTA — 2.6.3.5)
6) Stall event	Awareness of the distinction between aircraft attitude and AOA. Energy management trading altitude for speed. Awareness of the correlation between stall speed and g-load and the capability to reduce stall speed by unloading. Stall recovery technique (see 3.5). Suggested training exercises are detailed in 3.4.2.
I. *System malfunction*	Trainees should understand the systems relevant to UPRT used in the FSTD and how these systems can cause or contribute to an upset. Upset-inducing failures/malfunctions related to systems, instruments, power and automation should be incorporated into training, whenever applicable. Trainees should be made particularly aware of the insidious nature of inaccurate information (e.g. unreliable airspeed, failures of stall and icing-alerting devices, degradation of envelope protection systems), so that trainees are trained to recognize the problem/error, prevent an upset and maintain control of the aeroplane.

Non-type-specific FSTD multi-crew UPRT		
	Training element	*Description*
		System malfunctions may also be used in scenarios with the aim of introducing a startle factor, either by distracting the flight crew when the simulated aeroplane encounters upset inducing conditions or by triggering an unforeseen upset condition. (Ref. AURTA — 2.4.2)
J.	*Specialized training elements*	These are several specific elements to be incorporated into the training that teach a specific skill set to help trainees prevent, and if needed, recover from an upset. *Note.— Communicating the current aeroplane state between pilots, including callouts to improve situation awareness, is essential. The PM should know how to effectively assist the PF to return the aeroplane to a stable state.*
	1) Spiral dive	In this manoeuvre, sometimes called a graveyard spiral, the aeroplane is at a high bank angle and descending. Trainees will learn in this situation that applying up‑elevator in an attempt to arrest both the increasing speed and sink rate causes the spiral to tighten. The skill learned is that it is imperative to get the wings close to level before beginning any pitching-up input. Trainees must decrease the bank angle and then apply up‑elevator to recover. If g-loading is large the pilot will need to offload some g to regain adequate roll control. (Ref. AURTA — 2.4.2)
	2) Slow flight	Slow flight exposes the trainee to flight right above the stall speed of the aeroplane and to manoeuvring the aeroplane at this speed without stalling. The purpose is to reinforce the basic stall characteristics learned in academics and allow the pilot to obtain handling experience and motion sensations (as available) when operating the aeroplane at slow speeds during the entire approach-to-stall regime in various aeroplane attitudes, configurations and bank angles.
	3) Steep turns	Steep turns provide the trainee with practical experience of manoeuvring the aeroplane at higher than normal bank angles (see section D of this table for FSTD limitations).
	4) Recovery from approach-to-stall	Particular emphasis should be placed on the early recognition of those symptoms associated with approaching a stall as well as on the recognition of stall warning system activation. Trainees should be made to understand that recovery action involving a deliberate and smooth application of nose-down pressure should be performed immediately upon recognition of the presence of stall‑related symptoms or the activation of a stall alerting device.
	5) Recovery from stall	With due regard to fidelity limitations of the FSTD in use, this portion of the training would normally be performed as a **demonstration exercise only** highlighting the following: i) recovery training from an aerodynamic stall should focus on developing the awareness of stall-related cues such as buffet, degradation of control responsiveness in the pitch and roll axis, as well as the inability to arrest descent; and ii) the recovery portion of the training should constantly stress the primary importance of a smooth and deliberate reduction in the angle of attack sufficient to break the stalled condition and completing the recovery in compliance with aeroplane specific recommended techniques, with due consideration of the effect of thrust on pitch control in aeroplanes with underslung engines. The maintenance of a wings level condition during the recovery is secondary to the reduction in the angle of attack.

Non-type-specific FSTD multi-crew UPRT		
	Training element	*Description*
	6) Recovery following stick pusher activation (if equipped)	Stick pusher activation is a sudden event that often startles the crew and is usually followed by an almost overpowering urge to pull back on the controls in an attempt to overcome the sharp nose-down movement of the elevator. Training in the FSTD should focus on developing a proper pilot response to such an occurrence recognizing that the stick pusher is a valued aid in the recovery from an aerodynamic stall.
	7) Nose high/ high speed 8) Nose high/ low speed 9) Nose low/ high speed 10) Nose low/ low speed 11) High bank angle recovery	The FSTD training should include a variety of developing and developed upset conditions with focus on pitch, power, roll and yaw. It should include demonstrations and practice recovery techniques for various upset scenarios, to include nose-high and nose-low scenarios with various bank angles and speeds, including bank angles greater than 90°. Trainees should practice high bank angle recovery exercises in both nose-high and nose-low situations. FSTD manoeuvres training should be done in both visual and instrument conditions to allow trainees to practice recognition and recovery under both conditions and to train them to recognize some of the physiological factors. Upset training in an FSTD that exceeds the VTE increases the risk of negative training. See 3.5 for OEM recommended recovery techniques. (Ref. AURTA — 2.6.3.2 to 2.6.3.5 and 3)
	12) Line-oriented flight training (LOFT) or line-operational simulation (LOS)	Training should expose trainees, through LOFT or LOS scenarios, to situations or malfunctions, which could cause an upset if not properly managed. The focus of each scenario should be awareness and prevention of the upset.
K.	*Human Factors*	Human Factors are an overarching, integral part of UPRT. The Human Factors in UPRT address the physiological and crew responses in the event of a flight path divergence or a sudden upset. Integrating Human Factors into UPRT is also important to help develop airmanship, which requires perceptual, cognitive and psychomotor knowledge and skills. Human Factors include, but are not limited to, CRM, the cognitive process, the learning process and the ability of the trainees to recall and apply appropriate knowledge and skills at a later stage of their career.
	1) Threat and error management (TEM)	TEM as it relates to upset prevention and recovery should be integrated in the UPRT. TEM training should include: communication/interaction techniques between pilots and between pilots and the aeroplane, the aeroplane normal states, identification and management of environmental threats that might induce an upset, detection of deviations, interpretation of the meaning of the deviation, decision on how to respond, and response. TEM is a crucial means of addressing Human Factors training elements. The flight crew's capacity to think effectively in flight conditions to which they have not previously been exposed may be challenged during an upset event and should be developed through UPRT. Training should define which control inputs are appropriate and how to prioritize the tasks to avoid overloading. TEM requires effective monitoring and for that, methods and training should be provided and include appropriate assessment techniques (i.e. what to monitor and when, what to cross-check, ensuring proper verification) during all phases of flight to prevent an upset event and during recovery efforts.

Non-type-specific FSTD multi-crew UPRT	
Training element	*Description*
2) Human information processing	For pilots to understand how to respond appropriately and why they sometimes fail to do the correct action, they must understand how they process information. These are the "building blocks" of knowledge that allow a better understanding of how to maintain or improve such areas as communication, decision-making, situation awareness, and team dynamics. Those areas involved in all human information processing include: i) attention — the sensing and retrieval of relevant information from the environment; ii) perception — understanding that information which has been retrieved; iii) interpretation — associating the information which is relevant and the knowledge required for the task at hand; iv) judgement — aligning the requirement for action with the correct response; v) decision-making — assessing the correct response needed for the outcome required or an alternative; vi) action — implementing the response chosen; and vii) feedback — checking that the response action meets the correct requirements of the task.
3) Crew resource management (CRM)	Pilots should focus on stabilizing the aeroplane as a team, with clearly defined PF and PM roles, especially if one pilot becomes fixated. Training should include: i) development and application of appropriate communication patterns between pilots for a shared understanding of the current aeroplane state; and ii) how to identify and communicate deviations and guide recovery in both PF and PM roles. Training should define how to distribute the tasks between the PF and the PM to avoid overloading either pilot. Pilots should be able to create a mental picture of the aeroplane and its energy state and keep it updated and cross-checked with the other pilot throughout the flight. Crew callouts according to standard operating procedures (SOPs) will assist in communication, leading the flight crew to implement a recovery strategy as necessary.
4) Situation awareness	Pilots need to maintain situation awareness at all times through effective monitoring (see the training element "Recognition" in this table). Pilots do this by maintaining a mental model while creating mental pictures of developing situations. A breakdown of a pilot's mental model or picture, which can be caused by several factors, such as spatial disorientation from in-flight perceptual illusions, being startled, inattention and complacency, can lead to a loss of situation awareness.

Non-type-specific FSTD multi-crew UPRT	
Training element	*Description*
	Training should include how to maintain situation awareness and what to monitor to prevent, and recover from, upsets. Trainees should learn how the PM should assist/coach the PF in the recovery using appropriate callouts and other verbal feedback. After a deviation, it is important that the first actions be correct to prevent the recovery effort from developing into an even more serious situation. In order to accomplish that objective, the accurate and timely determination of the actual flight condition and energy state during the upset is of paramount importance. Troubleshooting the cause of the upset is secondary and can wait. Pilots should use the primary flight instruments because darkness, weather conditions, and the limited view from the cockpit may make it difficult/impossible to effectively use the outside horizon. The ADI is the primary reference. The situation analysis process includes: i) communicating with other flight crew members; ii) locating the bank indicator on the ADI and determining the bank angle; iii) determining the pitch attitude (from the ADI primarily); iv) confirming the attitude by reference to other indicators; and v) assessing the energy state.
5) Decision-making	Training should stress the importance of the pilots effectively communicating verbally and nonverbally. Another important subject is the criteria for a PM to decide whether to take control of the aeroplane if the PF is overwhelmed and unresponsive. The pilots should use a shared decision-making process where both are engaged in the outcome. The pilots should focus on stabilizing the aeroplane. They should understand the role of the PM in coaching the PF to a stable state. They should know the generic pitch and power targets for stabilization and take the appropriate action. To do so, trainees should be aware of what information they need to make the optimum decision for action as well as of those factors, such as cognitive biases, that affect decision-making.
6) Problem-solving	Training should improve the problem-solving competency and recognize those factors that can impede a trainee's ability to solve a problem, such as fatigue, fear and work overload. In particular, UPRT should emphasize the importance of evaluating whether a solution is working and of not rushing into an action that may be detrimental. Pilots should be able to communicate verbally or nonverbally to the other pilot if stress overwhelms them. Training should include how to self-assess impending incapacitation because of stress. This includes detecting and avoiding fixation on a particular item.
7) Startle and stress response	Training should include strategies to deal with the range of physiological, psychological and cognitive effects associated with the human stress response to unexpected threatening events with the pilots applying their competencies to maintain safe flight and crew coordination.

Non-type-specific FSTD multi-crew UPRT	
Training element	*Description*
	Pilots may be startled when an unexpected event during flight contradicts their expectations. If an unexpected event is sufficiently serious and/or arises during a critical phase of flight, the correct response to that uncertainty becomes vital for survival. Upset training should strive to include the element of "unexpectedness" that pilots will experience in a real world application.
8) Physiological factors	Recognizing the effects of visual and vestibular (angular and linear) illusions and responding appropriately is a key aspect of UPRT. Areas to be addressed during on-aeroplane training include: i) conditions which can lead to spatial disorientation and the use of instrument interpretation to manage spatial disorientation; ii) avoiding errors in adjusting attitude/power; iii) avoiding, and recovering from, PIOs; and iv) recognizing and managing sensory illusions in flight. All of these items should be covered in academic training, but training in an FSTD can target some of them. Spatial disorientation has been a significant factor in many aeroplane upset accidents. The definition of spatial disorientation is the inability to correctly orient oneself with respect to the earth's surface. Pilots who are unable to resolve a perceived conflict between bodily senses and flight instruments are spatially disoriented. Allowed to continue, spatial disorientation may lead to aeroplane upset. Attention to flight instruments and a good cross-check are the keys to remaining spatially oriented. A review of aeroplane upsets reveals that inattention or neglecting to monitor the aeroplane's performance can lead to upsets. Neglecting to monitor the appropriate instruments or fixating on a certain instrument can lead to performance deviations. Distractions can be very subtle, such as warning or caution lights illuminating during critical phases of flight. Many aeroplane upsets occur while the pilot is engaged in some task that takes attention away from monitoring the aeroplane state.

Table 3-3. Type-specific FSTD training

Type-specific FSTD UPRT elements	
Training element	*Description*
A. *Aerodynamics*	Trainees should be knowledgeable about aerodynamic effects at both high and low altitudes. The FSTD training should be accomplished at both high altitude (within 1 500 m [5 000 ft] of the service ceiling of the aeroplane) and at low altitude (below 3 000 m [10 000 ft] above mean sea level) to reinforce the academic training described in 3.2. High-altitude training should be conducted at normal operational cruise altitudes.

Type-specific FSTD UPRT elements	
Training element	*Description*
	Trainees should also be trained with respect to the handling effects of operating at low speeds and high Mach, including: i) demonstration of Mach tuck and Mach buffet (if applicable to the aeroplane type); ii) understanding of the change in aeroplane stability at high altitude; iii) recognition of high speed/Mach buffet (as applicable to the aeroplane type) and low speed buffet; iv) the altitude necessary to effectively recover from a stall event at high altitudes; and v) awareness of control surface effectiveness at low and high speeds. Trainees should apply their aerodynamic knowledge by including the following in FSTD training: i) practice in manoeuvring the simulated aeroplane at high altitude at various speeds and automation levels — the pilot will apply the aerodynamic principles acquired in the academic training to prevent an upset; ii) trainees should be aware of the AOA from available data shown on the flight deck and demonstrate the use of those data to prevent an upset or recover from one; iii) practice of speed controlled by elevator inputs or speed controlled by thrust, and understanding of aeroplane energy state as it pertains to the type being flown — trainees should demonstrate use of that knowledge to avoid or recover from an upset; and iv) trainees should demonstrate knowledge of the type-specific systems that use AOA with emphasis on warning systems and the limitations of those systems; for example, recognizing an indication in the flight deck that “continuous ignition” has turned on without the system being manually selected on. They should understand aeroplane performance across all flight phases, including how to respond as PF and PM. They should apply their basic aerodynamics and flight dynamics knowledge to mentally integrate an understanding of the aeroplane AOA and energy state throughout the part of the flight envelope used in normal operations and should be able to communicate that awareness to the other pilot. (Ref. AURTA — 2.5)
B. *Causes and contributing factors of upsets*	Development and training on procedures, including PF and PM roles, for normal operations and deviation recovery should focus on upset prevention. The training should emphasize what to monitor during normal operations and during an upset recovery, how to identify and communicate deviations between pilots and how to recover. Train pilots in what to monitor and when, including cross-checking and verification, during all phases of flight to prevent an upset event. Stress communication behaviour between pilots to share an understanding of the aeroplane state so that both pilots recognize when either of them might be introducing a pilot-induced upset.

Type-specific FSTD UPRT elements	
Training element	*Description*
	Trainees should apply their type-specific academic training to prevent, and recover from, environmentally induced, pilot-induced and aeroplane system-induced upsets. (Ref. AURTA — 2.4)
C. *Safety review of accidents and incidents relating to aeroplane upsets*	Demonstration of some of the actual upsets of transport category aeroplanes covered in academic training, with training of the prevention and type-specific recovery techniques.
D. *G-awareness*	It must be emphasized that g-loading in transport category aeroplanes feels significantly more pronounced than in other aeroplanes, due specifically to the cockpit environment. Commercial air transport pilots are normally uncomfortable (for the sake of passenger comfort and safety) reacting appropriately to changing g-forces on a large aeroplane. Pilots should be trained to overcome this inhibition when faced with the necessity to promptly deal with any excess external forces. Most FSTDs cannot replicate sustained g-forces**;** hence, the limitations of the device to adequately represent the actual g-environment during upset conditions must be well understood by both the instructor and the trainee. If any practical exercise regarding g-awareness is accomplished in an FSTD, careful consideration should be taken to avoid negative training. Because there is a visual and sensory aspect associated with g-loading, the training programme will need to validate whether the g-awareness training in the FSTD will be effective and can be accomplished without negative training.
E. *Energy management*	The training should include integrated CRM training for developing crew knowledge and skills for energy management, as well as techniques for reducing pilot error, including what to monitor during an event and how the PM should coach the PF in the recovery using appropriate callouts and other verbal feedback. To fully understand the concepts discussed in academic training, trainees should be trained in the following: i) acceleration between two speeds of which the aeroplane is capable at low, medium and high altitude (e.g. 200–250 KIAS at low altitude, medium and high altitude with corresponding Mach numbers at high altitude); ii) acceleration performance from second regime (back side of power curve) at low altitude and high altitude; iii) the relationship between maximum cruise/climb/continuous thrust and take-off/go-around thrust at low and high altitude; iv) acceleration capabilities through descent versus power/thrust application; v) understanding and managing the type-specific differences between kinetic, potential and chemical energy and the relationship between pitch, power and performance; vi) roll rate performance of the aeroplane at different speeds, altitudes and configurations and with

Type-specific FSTD UPRT elements	
Training element	*Description*
	flight spoilers retracted/extended (as applicable) if a difference exists; and vii) pitch rate performance of the aeroplane at different speeds, altitudes and configurations and with flaps retracted/extended; also, demonstration of an aft centre of gravity (CG) versus a forward CG flying qualities, if these are significantly different and the effect of thrust on pitch control in aeroplanes with underslung engines.
F. *Flight path management*	Flight path management training should be developed with regard to which automated systems are on the type of aeroplane, including type-specific automation challenges.
1) Manual or automation inputs for guidance and control	The training objective related to the manual or automation inputs for guidance and control addresses correct pilot control inputs to avoid or recover from undesired flight path deviations. This training objective should include the control strategies pilots should use in both developing and developed upset events. Pilots need to know the type-specific conditions under which it is best to allow automated systems to control the aeroplane and those under which manual intervention by the pilot is best. This should include primary/alternate control strategies.
2) Type-specific characteristic	Training provided on type-specific characteristics will help avoid inadvertent upset events because of automation surprise. Integrated CRM training should include communication between pilots of their understanding of the current aeroplane state. Pilots should create a mutual mental picture of aeroplane state and keep it updated. In addition, pilots must be able to work as a crew to be aware of, recognize and prevent upsets. This will include instrument interpretation as it applies to recognizing upset events.
3) Automation management	The automation management training objective addresses correct pilot inputs to avoid undesired flight path deviations. Pilots need to know how to use the automation systems during prevention and recovery from an upset event. This training should include the following: i) common errors to avoid and why they occur; ii) specific automation modes to use for specific contexts; iii) the cross-check and verification of mode use and understanding of how the mode used has been directed to command the aeroplane; iv) control strategies pilots should use in both developing and developed upset events. v) advantages and disadvantages of using automated systems for upset prevention and recovery; and vi) the importance of ensuring correct pilot inputs to the automation systems and the consequences of failing to do so. It is imperative that the PF keep the aeroplane in trim while flying with an engine inoperative on a multi-engine aeroplane. At slow speed and high thrust on the remaining engine(s), the A/P on some aeroplanes is generally incapable of holding the correct attitude against an adverse yaw condition, which may result in an upset.

Type-specific FSTD UPRT elements	
Training element	*Description*
4) Manual handling skills	The manual handling skills objectives are to address correct pilot control inputs to avoid undesired flight path deviations. Refer to the discussion in section G 2) Pitch/power/roll/yaw on how to develop pilot skills for making the correct control inputs to arrest the divergence or to recover from the upset. These manual handling skills should be developed during the specialized training elements in section J below. UPRT should include the practice of manual handling at the edges of the flight envelope. Pilots should know the common errors to avoid, why they occur, the importance of cross-checking and verification of inputs, as well as have a shared understanding among the pilots of why the pilot is flying the aeroplane manually. Pilots should develop an understanding of how the aeroplane responds to inputs across all flight regimes. Manual handling training should include training on the use of full control inputs, if necessary to counter adverse external forces. For instance, flight controls become less effective when the aeroplane is at or near its critical AOA or stalled. The tendency is for pilots not to use full control authority because they rarely are required to do so in normal operations. Pilots need to overcome this habit when recovering from severe upsets. *Note 1.— Rudder control is still quite effective at a high AOA, and special care must be taken in the use of rudder during upset prevention and recovery.* *Note 2.— Excessive use of pitch trim or rudder during the recovery may aggravate the upset condition and/or may result in exceeding aeroplane structural limitations.* It is also important to guard against control reversals. To maintain structural integrity rapid full-scale reversal of control deflections should be avoided. In addition, manual handling training should include training on non-intuitive factors. For example, it may be counter-intuitive to use greater unloading control forces when recovering from a high AOA, especially at low altitude. If the aeroplane is stalled while already in a nose-down attitude, the pilot still needs to push the nose down (unload) in order to reduce the AOA. Additionally, for underwing mounted engines it may be necessary to reduce thrust in order to reduce the AOA due to the strong pitch-up forces from added thrust. Altitude cannot be maintained in a stall and should be of secondary importance. The training should highlight when it is appropriate to fly manually versus through automation. Specific aspects of the transition from automated to manual flight, and vice-versa, should also be covered.
G. *Recognition*	**Trainees should understand that anytime the aeroplane begins to diverge from the intended flight path or speed they need to identify and determine what, if any, action must be taken, and then act accordingly.**

Type-specific FSTD UPRT elements	
Training element	*Description*
1) Type-specific examples of instrumentation during developing and developed upset	A key aspect to UPRT is for trainees to recognize developing and developed upset conditions. The emphasis is on using examples of type-specific instrumentation and visual cues to improve awareness, prevention and recognition of a developing upset and recovery from a developed upset in order to train effective aeronautical decision-making to prevent upset events. This training should include visual representations of the outside view and type-specific instrument indications of a variety of developing and developed upset conditions, with a focus on pitch, power and roll, and on what is happening to the airspeed.
2) Pitch/power/roll/yaw	A key aspect of UPRT is for trainees to recognize developing and developed upset conditions so they can make control inputs based on desired aeroplane reaction. Control deflections at one point in the flight envelope might not be appropriate in another part of the flight envelope. Pilots should have a fundamental understanding of instrumentation and flight dynamics in pitch/power/roll/yaw in order to recognize the current state of the aeroplane and make the correct control inputs to arrest the divergence or recover from the upset. The ADI is the primary control instrument for recovery from an upset as, due to varying visibility conditions in operations, one cannot depend on having adequate outside visual references. (Ref. AURTA — 2.5.5.5 to 2.5.5.9)
3) Effective scanning (effective monitoring)	Effective instrument scanning techniques should be trained as appropriate to recognize normal states and divergence from normal flight parameters. Pilots should be trained on what to monitor and when, including cross-checking and verification, during all phases of flight, to identify the precursors and the initial development of an upset and then use that recognition to make timely and appropriate responses to bring the aeroplane back to the desired path. Specifically, to reduce delays in detecting a deviation and mitigate surprise events, pilots should be trained on a type-specific description of what instrumentation to monitor during developing and developed upsets, and during the recovery phase. Pilots should also be aware of the effects of fatigue on their ability to monitor effectively. Training should also be provided on communicating the current aeroplane state between pilots, including callouts to improve situation awareness. Pilots should be able to create a mental picture of the aeroplane state and keep it updated and cross-checked with the other pilot throughout the flight. The PM should know how to effectively assist the PF to return the aeroplane to a stable state. To improve the detection and interpretation of deviations, pilots should know the aeroplane normal states (particularly in pitch and power levels), detect deviations, interpret the meaning of the deviation, communicate effectively as a crew, decide on a response, and take action.
4) Stall protection systems	Accurate and early recognition of all available aural, visual and tactile alerts to both an approaching stall and an aerodynamic stall. Particular attention must be given to aeroplane stall characteristics in the absence of a stall warning indication. (Ref. AURTA — 2.5.5.1)
H. *Upset prevention and recovery techniques*	Upset prevention and recovery techniques should be accomplished in the highest fidelity FSTD qualified for the training, using the operator's upset prevention and recovery procedures published in the operations manual. These procedures should follow the OEM recommendations for upset prevention and recovery (see 3.5).

Type-specific FSTD UPRT elements	
Training element	*Description*
1) Timely and appropriate intervention	Training should emphasize the need for the PF or PM to recognize a divergence as early as possible and immediately ensure corrective action is taken to return the aeroplane to a stabilized flight path, including appropriate crew interaction. The corrective action should include managing the energy, arresting the flight path divergence and recovering to a stabilized flight path. If the aeroplane is stalled during the divergence from the intended flight path, then the training should also stress the importance of first applying and maintaining nose-down elevator until recovery from the stall is complete. The amount and rate of control input to counter a developing upset should be proportional to the amount and rate of pitch, roll and/or yaw experienced. If pilots' inputs do not arrest the divergence, then pilots should follow the aeroplane's flight manual recommended guidance. The ADI is the primary control instrument for recovery from an upset, as adequate outside visual references may not be available or may be misleading.
2) Nose-high/ wings-level recovery	See 3.5 for OEM recommended recovery techniques. (Ref. AURTA — 2.6.3.2)
3) Nose-low/ wings-level recovery	See 3.5 for OEM recommended recovery techniques. (Ref. AURTA — 2.6.3.3)
4) High bank angle recovery techniques	Ref. AURTA — 2.6.3.4.
5) Consolidated summary of aeroplane recovery techniques	Ref. AURTA — 2.6.3.5.
6) Stall event	Awareness of the distinction between aircraft attitude and AOA. Energy management trading altitude for speed. Awareness of the correlation between stall speed and g-load and the capability to reduce stall speed by unloading. Stall recovery technique (see 3.5). Suggested training exercises are detailed in 3.4.2.
I. *System malfunction*	Trainees should understand the systems of their aeroplane and how these systems can cause or contribute to an upset. FSTDs allow instructors to induce malfunctions that cannot be safely trained for in the aeroplane. Operators should refer to OEM checklists and procedures, which cover system and component failures. Upset-inducing failures/malfunctions related to systems, instruments, power, and automation should be incorporated into training, whenever applicable. Trainees should be made particularly aware of the insidious nature of inaccurate information (e.g. unreliable airspeed, failures of stall and icing alerting devices, degradation of envelope protection systems), so that trainees are trained to recognize the error, prevent an upset and maintain control of the aeroplane.

Type-specific FSTD UPRT elements	
Training element	*Description*
	System malfunctions may also be used in scenarios with the aim of introducing a surprise or startle factor, either by distracting the flight crew when the simulated aeroplane encounters upset-inducing conditions or by triggering an unforeseen upset condition. (Ref. AURTA — 2.4.2)
J. *Specialized training elements*	These are several specific elements to be incorporated into the training that teach a specific skill set to help trainees prevent, and if needed, recover from an upset. *Note.— Communicating the current aeroplane state between pilots, including callouts to improve situation awareness, is essential. The PM should know how to effectively assist the PF to return the aeroplane to a stable state.*
1) Spiral dive	In this manoeuvre, sometimes called a graveyard spiral, the aeroplane is at a high bank angle and descending. Trainees will learn in this situation that applying up-elevator in an attempt to arrest both the increasing speed and sink rate causes the spiral to tighten. The skill learned is that it is imperative to get the wings close to level before beginning any pitching-up manoeuvre. Trainees must decrease the bank angle and then apply up-elevator to recover. If g-loading is large, the pilot will need to offload some g to regain adequate roll control. (Ref. AURTA — 2.4.2)
2) Slow flight	Slow flight exposes the trainee to flight right above the stall speed of the aeroplane and to manoeuvring the aeroplane at this speed without stalling. The purpose is to reinforce the basic stall characteristics learned in academics and allow the pilot to obtain handling experience and motion sensations when operating the aeroplane at slow speeds during the entire approach-to-stall regime in various aeroplane attitudes, configurations and bank angles.
3) Steep turns	Steep turns provide the trainee with practical experience of manoeuvring the aeroplane at higher than normal bank angles (see section D of this table for FSTD limitations).
4) Recovery from approach-to-stall	Particular emphasis should be placed on the early recognition of those symptoms associated with approaching a stall as well as on the recognition of stall warning system activation. Trainees should be made to understand that recovery action involving a deliberate and smooth application of nose-down pressure should be performed immediately upon recognition of the presence of stall-related symptoms or the activation of a stall alerting device.
5) Recovery from stall	With due regard to fidelity limitations of the FSTD in use, this portion of the training would normally be performed as a **demonstration exercise only,** highlighting the following: i) recovery training from an aerodynamic stall should focus on developing the awareness of stall-related cues such as buffet, degradation of control responsiveness in the pitch and roll axis, as well as the inability to arrest descent; and ii) the recovery portion of the training should constantly stress the primary importance of a smooth and deliberate reduction in the angle of attack sufficient to break the stalled condition and completing the recovery in compliance with aeroplane-specific recommended techniques. The effect of thrust/power application on pitch control capability should be covered for aeroplanes with underslung engines. The maintenance of a wings level condition during the recovery is secondary to the reduction in the angle of attack.

Type-specific FSTD UPRT elements	
Training element	*Description*
6) Recovery following stick pusher activation (if equipped)	Stick pusher activation is a sudden event that often startles the crew and is usually followed by an almost overpowering urge to pull back on the controls in an attempt to overcome the sharp nose-down movement of the elevator. Training in the FSTD should focus on developing a proper pilot response to such an occurrence recognizing that the stick pusher is a valued aid in the recovery from an aerodynamic stall.
7) Nose high/ high speed 8) Nose high/ low speed 9) Nose low/ high speed 10) Nose low/ low speed 11) High bank angle recovery	The FSTD training should include a variety of developing and developed upset conditions with focus on pitch, power, roll and yaw. It should include demonstrations and practice recovery techniques for various upset scenarios, to include nose-high and nose-low scenarios with various bank angles and speeds, including bank angles greater than 90° . Trainees should practice high bank angle recovery exercises in both nose-high and nose-low situations. FSTD manoeuvres training should be done in both visual and instrument conditions to allow trainees to practice recognition and recovery under both conditions and to train them to recognize some of the physiological factors. Upset training in an FSTD, which exceeds the VTE of the aeroplane flight envelope data provided by the OEM and used for the FSTD qualification, could increase the risk of negative training. See 3.5 for OEM-recommended recovery techniques. (Ref. AURTA — 2.6.3.2 to 2.6.3.5 and 3)
12) Line-oriented flight training (LOFT) or line-operational simulation (LOS)	Training should expose trainees, through LOFT or LOS scenarios, to situations or malfunctions, which could cause an upset if not properly managed. The focus of each scenario should be awareness and prevention of the upset. The operator should integrate the various LOFT/LOS scenarios into the LOFT/LOS training and rotate them to ensure a wide exposure to a wide variety of possible upset scenarios.
K. *Human Factors*	Human Factors are an overarching, integral part of UPRT. The Human Factors in UPRT address the physiological and crew responses in the event of a flight path divergence or a sudden upset. Integrating Human Factors into UPRT is also important to help develop airmanship, which requires perceptual, cognitive, and psychomotor knowledge and skills. Human Factors include, but are not limited to, CRM, the cognitive process, the learning process and the ability of the trainees to recall and apply appropriate knowledge and skills in operations.
1) Threat and error management (TEM)	TEM as it relates to upset prevention and recovery should be integrated in the UPRT. The flight crew should identify and manage any threat that may contribute to an upset. TEM training should include: communication/interaction techniques between pilots and between pilots and the aeroplane, the aeroplane normal states, identification and management of environmental threats that might induce an upset, detection of deviations, interpretation of the meaning of the deviation, decision on how to respond, and response. TEM is a crucial means of addressing Human Factors training elements. The flight crew's capacity to think effectively in flight conditions to which they have not previously been exposed may be challenged during an upset event and should be developed through UPRT. Training should define which control inputs are appropriate and how to prioritize the tasks to avoid overloading. TEM requires effective monitoring and for that, methods and training should be provided and include appropriate assessment techniques (i.e. what to monitor and when, what to cross-check, ensuring proper verification) during all phases of flight to prevent an upset event and during recovery efforts.

Type-specific FSTD UPRT elements	
Training element	*Description*
2) Human information processing	For pilots to understand how to respond appropriately and why they sometimes fail to do the correct action, they must understand how they process information. These are the “building blocks” of knowledge that allow a better understanding of how to maintain or improve such areas as communication, decision-making, situation awareness, and team dynamics. Those areas involved in all human information processing include: i) attention — the sensing and retrieval of relevant information from the environment; ii) perception — understanding that information which has been retrieved; iii) interpretation — associating the information which is relevant and the knowledge required for the task at hand; iv) judgement — aligning the requirement for action with the correct response; v) decision-making — assessing the correct response needed for the outcome required or an alternative; vi) action — implementing the response chosen; and vii) feedback — checking that the response action meets the correct requirements of the task.
3) Crew resource management (CRM)	Pilots should focus on stabilizing the aeroplane as a team, with clearly defined PF and PM roles, especially if one pilot becomes fixated. Training should include: i) development and application of appropriate communication patterns between pilots for a shared understanding of the current aeroplane state; ii) how to identify and communicate deviations and guide recovery in both PF and PM roles; and iii) type-specific description of assessment techniques for the aeroplane state during developing and developed upset. Training should define how to distribute the tasks between the PF and the PM to avoid overloading either pilot. Pilots should be able to create a mental picture of the aeroplane and its energy state and keep it updated and cross-checked with the other pilot throughout the flight. The training should also include appropriate communication techniques between the PF and PM for deviation avoidance and recovery. Crew callouts according to SOPs will assist in communication, leading the flight crew to implement a recovery strategy as necessary.

Type-specific FSTD UPRT elements	
Training element	*Description*
4) Situation awareness	Pilots need to maintain situation awareness at all times through effective monitoring (see the training element "Recognition" in this table). Pilots do this by maintaining a mental model while creating mental pictures of developing situations. A breakdown of a pilot's mental model or picture, which can be caused by several factors, such as spatial disorientation from in-flight perceptual illusions, being startled, inattention and complacency, can lead to a loss of situation awareness. Training should include how to maintain situation awareness and what to monitor to prevent, and recover from, upsets. Trainees should learn how the PM should assist/coach the PF in the recovery using appropriate callouts and other verbal feedback. After a deviation, it is important that the first actions be correct to prevent the recovery effort from developing into an even more serious situation. In order to accomplish that objective, the accurate and timely determination of the actual flight condition and energy state during the upset is of paramount importance. Troubleshooting the cause of the upset is secondary and can wait. Pilots should use the primary flight instruments because darkness, weather conditions, and the limited view from the cockpit may make it difficult/impossible to effectively use the outside horizon. The ADI is the primary reference. The situation analysis process includes: i) communicating with other flight crew members; ii) locating the bank indicator on the ADI and determining the bank angle; iii) determining the pitch attitude (from the ADI primarily); iv) confirming the attitude by reference to other indicators; and v) assessing the energy state.
5) Decision-making	Training should stress the importance of the pilots effectively communicating verbally and nonverbally. Another important subject is the criteria for a PM to decide whether to take control of the aeroplane if the PF is overwhelmed and is unresponsive. This should include the case of a co-pilot (pilot monitoring) taking over from an overwhelmed pilot-in-command (pilot flying). These criteria should be outlined and documented in the SOPs used by the ATO or the operator. The pilots should use a shared decision-making process where both are engaged in the outcome. Pilots should focus on stabilizing the aeroplane. They should understand the role of the PM in coaching the PF to a stable state. They should know the appropriate pitch and power targets for stabilization and take the appropriate action. To do so, trainees should be aware of what information they need to make the optimum decision for action, as well as of those factors, such as cognitive biases, that affect decision-making.

Type-specific FSTD UPRT elements	
Training element	*Description*
6) Problem-solving	Training should improve the problem-solving competency, and recognize those factors that can impede a trainee's ability to solve a problem, such as fatigue, fear and work overload. In particular, UPRT should emphasize the importance of evaluating whether a solution is working and of not rushing into an action that may be detrimental. Pilots should be able to communicate verbally or nonverbally to the other pilot if stress overwhelms them. Training should include how to self-assess impending incapacitation because of stress. This includes detecting and avoiding fixation on a particular item.
7) Startle and stress response	Training should include strategies to deal with the range of physiological, psychological and cognitive effects associated with the human stress response to unexpected threatening events with the pilots applying their competencies to maintain safe flight and crew coordination. Pilots may be startled when an unexpected event during flight contradicts their expectations. If an unexpected event is sufficiently serious and/or arises during a critical phase of flight, the correct response to that uncertainty becomes vital for survival. Upset training should strive to include the element of "unexpectedness" that pilots will experience in a real world application.
8) Physiological factors	Recognizing the effects of visual and vestibular (angular and linear) illusions and responding appropriately is a key aspect of UPRT. Areas to be addressed during on-aeroplane training include: i) conditions which can lead to spatial disorientation and the use of instrument interpretation to manage spatial disorientation; ii) avoiding errors in adjusting attitude/power; iii) avoiding and recovering from PIOs; and iv) recognizing and managing sensory illusions in flight. All of these items should be covered in academic training, but training in an FSTD can target some of them. Spatial disorientation has been a significant factor in many aeroplane upset accidents. The definition of spatial disorientation is the inability to correctly orient oneself with respect to the earth's surface. Pilots who are unable to resolve a perceived conflict between bodily senses and flight instruments are spatially disoriented. Allowed to continue, spatial disorientation may lead to aeroplane upset. Attention to flight instruments and a good cross-check are the keys to remaining spatially oriented. A review of aeroplane upsets reveals that inattention or neglecting to monitor the aeroplane's performance can lead to upsets. Neglecting to monitor the appropriate instruments or fixating on a certain instrument can lead to performance deviations. Distractions can be very subtle, such as warning or caution lights illuminating during critical phases of flight. Many aeroplane upsets occur while the pilot is engaged in some task that takes attention away from monitoring the aeroplane state.

3.3.2.2.2 Where noted, AURTA, Revision 2, which has specific details on each associated topic that could be very helpful during the development of a UPRT programme, is referenced. However, it is important to realize that the AURTA generally was developed to deal with topics pertaining to swept-wing aeroplanes with more than 100 passenger seats, although it still contains valuable guidance which often applies to smaller propeller-driven and turbojet aeroplanes (see 2.2.3).

3.3.2.2.3 It is recognized that type-specific FSTDs may not be available for the type rating and recurrent training, with such training being conducted in the aeroplane. This may be the result of unavailability of those FSTD in the region or non-existence of such FSTDs (e.g. Convair CV 440, Lockheed L-188 Electra, Cessna C-208 Caravan). Operators who have difficulty gaining access to a type-specific FSTD to conduct type rating or recurrent training may elect to use this table to conduct their UPRT utilizing a non-type-specific device.

3.3.2.3 ***Type-specific FSTD training***

3.3.2.3.1 The type-specific FSTD UPRT is applicable to the type-rating training and the recurrent training of commercial air transport pilots (see 3.3.2.2.3 if a type-specific FSTD is not available). It addresses all multi-crew training objectives including high-altitude operations and provides guidance that may be adapted for single crew type rating and recurrent training. Care should be exercised to ensure that an assumption regarding preconceived knowledge levels based upon previous flying experience does not negatively affect the comprehensiveness of UPRT when implementing such a programme for experienced pilots operating transport category aeroplanes (see bridge training in 3.2.5). The regulatory oversight guidance material in Chapter 6 contains some complementary courses of action during UPRT implementation.

3.3.2.3.2 Where noted, the AURTA, Revision 2, which has specific details on each associated topic that could be very helpful during the development of a UPRT programme, is referenced. However, it is important to realize that the AURTA generally was developed to deal with topics pertaining to swept-wing aeroplanes with more than 100 passenger seats. Nonetheless, it still contains valuable guidance which often applies to smaller propeller-driven and turbojet aeroplanes (see 2.2.3).

3.4 OEM RECOMMENDATIONS — FSTD TRAINING SCENARIOS

> The training scenarios in this section were jointly developed by representatives from Airbus, Avions de transport régional (ATR), Boeing, Bombardier and Embraer and are drawn from the LOCART outcomes and, where indicated, from the FAA's AC 120-109, *Stall and Stick Pusher Training*.

3.4.1 Overview

3.4.1.1 With focus upon awareness and avoidance, it is the OEMs' motivation to ensure pilots are properly taught to operate their aeroplanes. Passing a type rating check is not a measure of how well the pilots understand aeroplane performance throughout the entire operating envelope, because the check is completed within a very narrow band of operating performance. Training programmes leading up to type rating checks usually focus on the environment to be tested, rather than the larger operating environment to which the pilots will be exposed during line operations. Moreover, pilots systematically use A/Ps to manage the portion of the operating envelope where the aeroplanes will usually fly. Therefore, it is not realistic for any pilot to become aware of and avoid an upset without practical knowledge of the performance available (or unavailable) throughout a wider portion of the aeroplane's capabilities.

3.4.1.2 It is unreasonable to develop training sequences at the edges, or even beyond the normal envelope, without first exposing pilots to the aeroplane's capabilities within the normal operating envelope. Combined with adequate training for recognition and recovery from upsets, simple exercises to expose the pilot to aeroplane capabilities add significant benefits toward upset avoidance.

3.4.1.3 Upon completion of academic training, the recommended FSTD exercises in 3.4.2 are a prerequisite for the performance envelope demonstration training of a given aeroplane and clearly demonstrate the aeroplane capabilities.

3.4.2 Recommended training sequences

> All of the recommended scenarios should be demonstrated to effectively teach the trainee when (or if it is even necessary) to disconnect the autoflight system. For example, if transitioning a wake encounter, it may be best to leave the autoflight system engaged rather than disconnecting it as long as the autoflight system is performing adequately.

3.4.2.1 The OEM's recommended training sequences are grouped by upset-inducing topics, with each topic consisting of the exercise conditions, training description and rationale.

3.4.2.2 ***Environmental factors***

Conditions: for example, mountain wave, rotor cloud, horizontal and vertical windshear.

Training: demonstrate how a rapid windshear can alter the flight path of an aeroplane operating at high altitude.

Rationale: high-altitude upset with environmental factors as a causal factor.

3.4.2.3 ***Wake vortex***

Conditions: take-off and approach configuration — behind a heavy aeroplane.

Training: demonstrate how a prompt roll can alter the flight path of an aeroplane.

Rationale: awareness of how a vortex can affect the aeroplane, i.e. understanding that different roll capabilities and mass of the aeroplane would affect how a pilot would respond to a wake encounter with particular emphasis on time to transition through the vortex and effective mitigation strategies.

3.4.2.4 ***Mechanical/system-induced***

Conditions: upset as a function of roll, yaw and pitch path failures.

Training: demonstrate how a failure or degradation of flight controls affecting each axis can create an upset. Training has to be aeroplane-specific to correctly reflect failure mode of that aeroplane (e.g. hydraulics/fly-by-wire/A/P failure).

Rationale: aeroplane-specific training to demonstrate how a flight control failure can create an upset and how to mitigate the effect (for example, limited or uncontrollable flight control surface(s) or thrust asymmetry).

3.4.2.5 ***Stall recovery training***[1]

a) Condition 1: clean configuration approach-to-stall (high altitude).

Training: in level flight with the A/P on, introduce an event or reduce thrust to less than adequate for manoeuvring flight. Simulator capabilities to induce approach-to-stalls may include use of airspeed slewing, attitude changes, aeroplane weight and CG changes, environmental changes and systems malfunctions (e.g. full or partial pitot/static blockage, artificial thrust reduction, surreptitious disabling of automation).

Rationale: the trainee should be able to recognize the stall warning and immediately perform the stall recovery procedure. Demonstrate willingness to trade altitude for airspeed to accomplish an expeditious recovery from a stall event.

b) Condition 2: take-off or departure approach-to-stall with partial flaps.

Training: the scenario will be conducted during take-off and/or departure at an altitude that will allow for a recovery. For unexpected approach-to-stall on departure prior to flaps being fully retracted crew distractions may be used as mentioned above.

Rationale: often pilots attempt recovery with no loss of altitude and without recognizing the importance of pitch control and AOA.

c) Condition 3: landing configuration approach-to-stall.

Training: implement scenarios that result in an unexpected approach-to-stall during an approach.

Rationale: the trainee should be able to recognize the stall warning and immediately perform the stall recovery procedure, demonstrate a deliberate and smooth reduction of AOA and then commence a missed approach. Positive recovery from the aerodynamic stall or approach-to-stall takes precedence over minimizing altitude loss.

d) Condition 4: stick pusher demonstration only (if equipped).

Training: in level flight at idle thrust with the autoflight system set up to maintain altitude, introduce an event or reduce airspeed to less than adequate for manoeuvring flight allowing the stick pusher to activate.

Rationale: often pilots attempt recovery by suddenly applying immediate back pressure to overcome the life-saving nose-down elevator force being applied by the stick pusher.

[1] These stall training scenarios are based upon the FAA AC 120-109, *Stall and Stick-Pusher Training* and the *Stick Pusher and Adverse Weather Event Training* Aviation Rulemaking Committee (ARC) recommendations and are additional to the OEMs' recommended training sequences of this section.

3.4.2.6 ***Pilot factors***

Conditions: loss of pilot situation awareness leading to LOC-I.

Training: highlight how a loss of situation awareness can allow a flight path degradation leading to LOC-I (e.g. disengagement of autothrottles; misusing pitch, roll or yaw trim; engine loss; airspeed loss from international standard atmosphere deviation when operating at too high an altitude; forgetting to re-engage autothrottle after making an entry in an engine monitoring log).

Rationale: recent accidents have shown a failure of the flight crews to effectively monitor their aeroplane energy state and/or understand system logic.

3.4.2.7 ***Energy management***

3.4.2.7.1 *Engine performance/power*

Conditions: demonstrate acceleration between two speeds of which the aeroplane is capable at low, medium and high altitude; for example, 200 to 250 knots at low, medium and high altitude (where those speeds correspond to Mach numbers at high altitude).

Training: observe time to reach target speed in level flight and in descending flight.

Rationale: demonstrate and highlight the performance decrement at higher altitudes.

3.4.2.7.2 *Aeroplane acceleration*

Condition: demonstrate acceleration performance from the second regime (back side of the power curve) at low altitude and high altitude.

Training: observe capability and determine the only option (if available thrust will not permit acceleration, the only option will be to accelerate by descending).

Rationale: demonstrate the potentially different recovery technique from flight in the second regime at low altitude versus high altitude.

3.4.2.7.3 *High-altitude engine power management*

Condition: demonstrate the relationship between maximum cruise/climb/continuous thrust and take-off/go-around (TOGA) thrust at high altitude.

Training: highlight to the trainee the practical relationship between available engine power modes at high altitude.

Rationale: teach the trainee that TOGA is not likely to produce significantly more thrust at maximum altitude than maximum cruise thrust, for example.

3.4.2.7.4 *High-altitude energy management*

Condition: demonstrate acceleration capabilities through descent versus power application.

Training: the objective is to understand the advantage of using elevator instead of thrust levers to regain the desired energy state (observe a rapid acceleration during descent versus the slow acceleration previously demonstrated with only the use of power).

Rationale: demonstrate the inability of the aeroplane to power out of a high‑altitude slowdown.

3.4.2.8 ***Flight control effectiveness***

Condition: demonstrate a defined flight control deflection at a fixed speed V_c at both low altitude and high altitude.

Training: demonstrate how a fixed flight control deflection outcome is different at low and high altitude (for example, exercises a 2‑cm deflection of pitch control at a common V_c and at both low altitude and maximum altitude and observe the difference in aeroplane reaction).

Rationale: trainee appreciation of high‑altitude response differences to same flight control input.

3.4.2.9 ***Buffet***

Condition: demonstrate high‑speed buffet and low‑speed buffet.

Training: demonstrate the aeroplane behaviour at the low‑ and high‑speed buffet entry. Highlight how loading the aeroplane in a high‑speed buffet will aggravate the condition.

Rationale: teach the trainee to correctly identify the low‑ and high‑speed buffet with corresponding recovery techniques.

3.4.2.10 ***Roll capabilities***

Condition: demonstrate roll rate performance of the aeroplane at different speeds and different configurations and with flight spoilers retracted/extended if a difference exists (e.g. on the B727).

Training: demonstrate roll response at V_{ref} versus clean configuration speed, and at 250 knots indicated airspeed (IAS), V_{mo} and M_{mo}.

Rationale: demonstrate what the full roll capabilities of the aeroplane are.

3.4.2.11 ***Pitch capabilities***

Condition: demonstrate pitch-rate performance of the aeroplane at different speeds and different configurations and with flaps retracted/extended. Also, show pitch-rate performance at an aft CG versus a foreword CG if flight qualities are significantly different.

Training: demonstrate pitch response at V_{ref} versus clean configuration speed, and at 250 knots IAS, V_{mo} and M_{mo}.

Rationale: demonstrate the full pitch capabilities of the aeroplane.

3.5 OEM RECOMMENDATIONS — UPSET RECOVERY TECHNIQUES

> The recommended recovery strategies in this section were jointly developed by representatives from Airbus, ATR, Boeing, Bombardier and Embraer and are drawn from the LOCART outcomes.

3.5.1 This section contains the upset recovery recommendations that should be used as a template for the development of, and revisions to, UPRT flight crew guidance. In instances where an ATO or operator desires to use a different technique from what is published in this section, a determination of "no technical objection" must be obtained from the applicable OEM unless that specific technique is published in the appropriate aeroplane flight manual (see Tables 3-4 and 3-5).

Table 3-4. Nose-high recommendation

Recognize and confirm the developing situation. Announce: "Nose High"[1]	
Pilot flying (PF)	***Pilot monitoring (PM)***
A/P — DISCONNECT[2] A/T — OFF APPLY as much nose-down control input as required to obtain a nose-down pitch rate. Thrust — adjust (if required) Roll — adjust (if required) not to exceed 60° When airspeed is sufficiently increasing: RECOVER to level flight[3] *Note.— Recovery to level flight may require use of pitch trim.*	Monitor airspeed and attitude throughout the recovery and announce any continued divergence.
1. If the A/P and/or A/T are responding correctly, it may not be appropriate to decrease the level of automation while assessing whether the divergence is being stopped. 2. A large out-of-trim condition could be encountered when the A/P is disconnected. 3. Avoid stall because of premature recovery or excessive g-loading.	

Table 3-5. Nose-low recommendation

Warning: Excessive use of pitch trim or rudder may aggravate the upset situation or may result in high structural loads

Recognize and confirm the developing situation. Announce: "Nose Low"[1]	
Pilot flying (PF)	***Pilot monitoring (PM)***
A/P — DISCONNECT[2] A/T — OFF RECOVER from stall if required ROLL in the shortest direction to wings level[3] Thrust and drag — adjust (if required) Recover to level flight[4] *Note.— Recovery to level flight may require use of pitch trim.*	Monitor airspeed and attitude throughout the recovery and announce any continued divergence.

1. If the A/P and/or A/T are responding correctly, it may not be appropriate to decrease the level of automation while assessing if the divergence is being stopped.
2. A large out-of-trim condition could be encountered when the A/P is disconnected.
3. It may be necessary to reduce the g-loading by applying forward control pressure to improve roll effectiveness.
4. Avoid stall because of premature recovery or excessive g-loading.

3.5.2 These recovery techniques will also be updated in due course in the respective OEMs' manuals, which contributed to their development, and remain consistent with the information contained in the AURTA, Revision 2. It is important to note that correct interpretation and application of techniques and recommendations can only be determined when the supporting information is well understood.

3.5.3 The following techniques represent a logical progression for recovering the aeroplane. They are not necessarily procedural. The sequence of actions is for guidance only and represents a series of options for the pilot to consider and to use depending on the situation. Not all actions may, or should, be necessary once recovery is underway. If needed, use pitch trim sparingly. Careful use of rudder to aid roll control should be considered **only** if roll control is ineffective and the aeroplane is not stalled.

3.5.4 These techniques assume the aeroplane is not stalled. A stalled condition can exist at any attitude and may be recognized by continuous stall warning activation accompanied by one of the following:

a) buffeting, which could be heavy at times;

b) lack of pitch authority and/or roll control; and

c) inability to arrest the descent rate.

3.5.5 If the aeroplane is stalled, recovery from the stall must be accomplished first by applying and maintaining nose-down elevator until stall recovery is complete and stall warning (e.g. stick shaker activation) ceases.

Note 1.— Operators should work with their aeroplane manufacturer(s) to ensure they have the manufacturer-approved, aeroplane-specific upset prevention and recovery guidance and techniques in their operations manual.

Note 2.— The manufacturer's published procedures take precedence over the following recommendations.

Note 3.— In the following recommendations, the term autothrottle (A/T) may be substituted by A/THR as applicable to the aeroplane type.

Chapter 4

FSTD FIDELITY REQUIREMENTS FOR UPRT

4.1 OVERVIEW

4.1.1 This section describes areas that require consideration to enable effective upset prevention and recovery training in FSTDs. Additional and detailed guidance on the technical requirements and on the IOS functions and tools for UPRT can be found in Doc 9625, Volume I, (to be incorporated in the fourth edition of Doc 9625 to be published end of 2014).

4.1.2 The most significant concern with UPRT conducted in FSTDs pertains to the potential of negative training, which can result from many factors including the improper simulation of the upset condition, the improper behaviour of the FSTD in the upset condition, the improper response of the key feedback cueing (motion, visual, sound) during the upset condition and/or improper instruction. Improvements in the following areas should help ensure that the FSTD is suitably equipped to provide this training:

a) fidelity requirements for UPRT, including stall training if conducted;

b) scenario-based feature requirements for UPRT; and

c) instructor operating station requirements for UPRT.

> Unless the UPRT FSTD's simulation model satisfactorily represents the aeroplane's behaviour and performance during an aerodynamic stall, training demonstrating conditions beyond the critical angle of attack can create harmful misperceptions about such an event and the recovery experience. Therefore, CAAs should consider requiring ATOs and, if applicable, operators to implement the recommendations for FSTD improvements contained in 4.2 and 4.4 without undue delay. This is covered in more detail in Doc 9625, Volume I, and in the RAeS ICATEE *Research and Technology Report*.

4.2 FIDELITY REQUIREMENTS FOR UPRT AND STALL TRAINING

4.2.1 Introduction

4.2.1.1 Most FSTDs can be used satisfactorily for AOA-related training and for a significant portion of upset training not involving full stalls. As long as the simulated aeroplane remains within its VTE (of the aeroplane flight envelope data provided by the OEM and used for the FSTD qualification) for angle-of-attack and sideslip, upsets that subsequently have large (angle-of-attack or sideslip) attitudes can be represented faithfully. However, most current FSTD models are deficient in adequately representing the aeroplane in the post-stall regime. The development and utilization of a "type-representative post-stall aerodynamic model" to support demonstration of a stall past the critical angle of attack (full aerodynamic stall or post-stall regime) is recommended, if such demonstration is to be conducted.

4.2.1.2 An effective and comprehensive aerodynamic stall training programme necessitates improvements in the flight model dynamics, aeroplane performance model and the FSTD cueing systems. The following related considerations apply to the requirements for FSTDs.

4.2.2 Flight model dynamics improvements

4.2.2.1 The control and response characteristics during stall recovery in simulation should be examined to ensure that they are similar to those expected in flight.

4.2.2.2 *Rationale.* Most aeroplane types exhibit flight dynamics and control characteristics that are different at, and beyond, stall angles of attack as compared to angles of attack related to stall warning activation. These characteristics are almost always degraded and are exemplified by reduced, and sometimes negative, stability and diminished control effectiveness. Until now, only approach-to-stall training was necessary in FSTDs, and as such, FSTD data packages did not necessarily concentrate on flight characteristics at angles of attack beyond the first indication of a stall. In most of these cases, the result will be that the FSTD will present dynamic characteristics in the stall and post-stall regimes that are easier to recover from than in the actual aeroplane. In particular, the wing drop that may accompany a stall is seldom modelled. Evidence from accidents and recent studies has shown that pilots may inappropriately try to control axes that are becoming, or have become, unstable instead of first reducing the angle of attack. This application of the incorrect order of the steps in the stall recovery technique would only reveal itself if the appropriate FSTD dynamics are shown.

4.2.3 Aeroplane model performance improvements

4.2.3.1 The performance characteristics for high-altitude stall recovery in simulation should be examined to ensure that these accurately represent the simulated aeroplane and are similar to those expected in flight.

4.2.3.2 *Rationale.* Some FSTDs may allow a pilot to apply full thrust and reasonably recover from high-altitude stalls when it is not possible to do so in the actual aeroplane. Current FSTD specifications do not check the high-altitude stall characteristics, and this should be included in the specifications when the FSTD is used for UPRT.

4.2.4 Aeroplane model cueing improvements

4.2.4.1 The fidelity of buffet models should be examined and, if necessary, improved to portray key variations that may exist in a particular aeroplane type.

4.2.4.2 *Rationale.* Presently, the buffet onset speed in most FSTD qualification standards is validated against two flight conditions and its frequency and magnitude characteristics evaluated for one flight condition. In addition, the g-threshold for the start of a buffet is less than that required for motion turnaround bumps. Some simulators presenting cases where the buffet occurs in the wrong order relative to the other stall warnings, as well as cases where the buffet cues misrepresent those of flight. In addition, at least one event has occurred for which pilots misidentified the conditions associated with a stall, as those conditions were not portrayed in the FSTD.

4.3 FSTD SCENARIO-BASED TRAINING REQUIREMENTS FOR UPRT

An effective way to teach the prevention and recovery from upsets is to use realistic scenarios that could occur in actual operations. UPRT scenarios should not be intended necessarily to progress to a developed upset condition. The purpose of introducing these events is to allow consolidation of theoretical knowledge gained from academic training on situations known to contribute to loss of control. Including UPRT scenarios in all aspects of training reinforces the awareness of precursors and promotes the prevention phase of UPRT. Most FSTDs provide a variety of features that may be used in supporting this training, and it is anticipated that little-to-no FSTD improvements are needed to enable useful training with such scenarios. The AURTA manual provides a good source for such features, which can include aeroplane wake, gusts, icing and system malfunctions. It is not the intent here to prescribe specific features or malfunctions, and the training organization may use appropriate available features and/or malfunctions to support the training of the UPRT elements described in this manual.

4.4 INSTRUCTOR TOOL REQUIREMENTS FOR UPRT

4.4.1 The development and utilization of enhanced instructor tools is recommended to allow accurate feedback of pilot performance. These enhancements are technically feasible today and can be installed on existing FSTDs with limited costs. Such tools should include suitable audio and video recording capability as well as a data recording function to monitor certain parameters in real time during training and for use in the debriefing after training.

4.4.2 Instructors should have available, and be trained to effectively utilize, IOS tools that convey:

a) when the simulator model is no longer valid;

b) when the aeroplane operational envelope is exceeded; and

c) when inappropriate control inputs are used.

4.4.3 *Rationale.* Incorrect recoveries from upsets in simulation can result in:

a) excursions outside of the valid training envelope;

b) excursions outside the aeroplane's operational envelope; or

c) inappropriate flight control inputs such as excessive rudder pedal inputs.

While data exist today to determine any of these events, it is currently not made available to the instructor, and if it is, instructors have not necessarily received adequate training on their proper use.

Chapter 5

UPRT INSTRUCTORS

The UPRT instructor requirements in this chapter are based on the LOCART outcomes.

5.1 OVERVIEW

5.1.1 A comprehensive UPRT programme encompasses the entire operating envelope of commercial aeroplanes. Because of its large scope, there are specific risks associated with UPRT, which demand that the training be effectively managed by the applicable QA and safety management related practices of the training provider. In UPRT the safety implications and the consequences of applying poor instructional technique or providing misleading information are arguably more significant than in some other areas of pilot training. Hence, an essential component in the effective delivery of UPRT is a properly trained and qualified instructor who possesses sound theoretical and operational knowledge relevant to UPRT course content.

5.1.2 Although Annex 1 — *Personnel Licensing* only requires ATOs to have a QA programme designed, in part, to ensure that their personnel are competent to safely and effectively carry out their assigned duties, operators who intend to provide in-house UPRT to their flight crews should employ similar governance practices in the delivery of their programmes.

5.2 INSTRUCTOR QUALIFICATION

Regardless of an individual's background, all instructors assigned to provide training in a UPRT programme should successfully complete a UPRT instructor qualification training course approved by the Licensing Authority. Table 5-1 provides a non-exhaustive list of training elements appropriate to the level of an instructor's participation in delivering a UPRT programme. Both the initial qualification and recurrent training curriculum for instructors should address all these elements, as a minimum, to ensure that the instructor assigned to UPRT acquires and maintains the required UPRT knowledge levels and skill sets.

5.2.1 Academic instructors

After completing their course of study, instructors who will be providing academic UPRT courses should be assessed in their ability to accurately deliver theoretical UPRT courses and assess a trainee's level of understanding while employing sound instructional techniques before they receive the final authorization to teach without supervision.

Table 5-1. Instructor training elements

UPRT instructor training elements	*UPRT academic instructor*	*UPRT aeroplane instructor*	*UPRT FSTD instructor*
Comprehensive knowledge of all applicable training elements (refer to Table 2-1)*	•	•	•
Training platforms (aeroplanes and devices)			
1) limitations of training platform		•	•
2) operation of IOS and debriefing tools			•
Review of LOC-I accidents/incidents	•	•	•
Energy management factors*	•	•	•
Disorientation	•	•	•
Workload management	•	•	•
Distraction	•	•	•
OEM recommendations*	•		•*
UPRT recognition and recovery strategies*	•	•	•
How to do a flight risk assessment (aeroplane)	• (as applicable)	•	
Recognition of trainee errors	•	•	•
Intervention strategies		•	
Aeroplane type-specific characteristics*	•	•	•
Operating environment	•	•	•
How to induce the startle factor		•	•
Value and benefits of demonstration	•	•	•
How to assess pilot performance using core competencies if conducting CBT (refer to the appendix)	•	•	•

* OEMs may at some point develop differing guidance regarding procedures to address these areas of training which may deviate from the material provided herein. In all cases, whenever type-specific UPRT is being conducted, training organizations should provide procedural training which conforms to the appropriate aeroplane flight manual.

5.2.2 On-aeroplane instructors

5.2.2.1 The UPRT on-aeroplane environment may be beyond that which is experienced during normal training operations. The unpredictable nature of trainee inputs, reactions, and behaviour requires fluency in response to a wide variety of potential situations requiring a time-constrained and accurate response. This specialized expertise cannot be acquired through routine flight operations alone, but demands that instructor training provide the appropriate degree of exposure necessary to develop a comprehensive understanding of the entire UPRT operating environment, as well as the aeroplane's limitations and capabilities.

5.2.2.2 On-aeroplane instructors shall meet the requirements as specified in Annex 1, sections 2.1.8 and 2.8, respectively, entitled "circumstances in which authorization to conduct instruction is required" or "flight instructor rating appropriate to aeroplanes, airships, helicopters and powered-lifts". Prior to qualifying, on-aeroplane instructors assigned to conduct UPRT should be assessed by the CAA and ATO as successfully demonstrating competency in:

a) accurately deliver the training curriculum employing sound instructional techniques;

b) understanding the importance of adhering to the UPRT scenarios, during the lesson, that were validated by the training programme developer;

c) accurately assessing a trainee's performance levels and providing effective remediation;

d) recovering the aeroplane in those instances when corrections are required which could exceed the capabilities of the trainee;

e) foreseeing the development of flight conditions which might exceed aeroplane limitations and acting swiftly and appropriately to preserve necessary margins of safety;

f) projecting the aeroplane's flight path and energy state based on present conditions with consideration to both current and anticipated flight control inputs; and

g) determining when it becomes necessary to discontinue training to maintain safety and the well-being of the trainee.

5.2.3 FSTD instructors

5.2.3.1 In addition to preparing the instructor to effectively deliver the course material, UPRT FSTD instructor training should focus on:

a) understanding the capabilities and limitations of the specific FSTDs used for UPRT;

b) understanding the VTE of the device in use and the appreciation for the potential of negative training that may exist when training beyond the boundaries of this VTE;

c) specific UPRT-related functionality of the IOS and other tools as described in 4.4;

d) distinguishing between generic UPRT strategies and OEM specific recommendations with respect to their relevance to the device capabilities and limitations; and

e) understanding the importance of adhering to the UPRT scenarios that have been validated by the training programme developer during the lesson.

5.2.3.2 Prior to qualifying, UPRT FSTD instructors should have previous multi-crew experience as described in section 6.1.2, instructor qualifications, of PANS-TRG (Doc 9868) (to become section 3.2 of Part I in the second edition), and be assessed as successfully demonstrating their competency in:

a) accurately delivering the training while employing sound instructional techniques and ensuring that the device fidelity is appropriate to the course content being taught;

b) accurately assessing a trainee's performance levels and providing effective remediation; and

c) effectively operating the device and all its available debriefing tools.

5.3 UPRT COMPETENCY-BASED PROGRAMMES — INSTRUCTORS

5.3.1 UPRT programmes that are intended to be given to either MPL candidates or to those flight crews undergoing evidenced-based recurrent training are **required** to be developed and delivered as an integrated CBT syllabus in accordance with the applicable instructions in the *Procedures for Air Navigation Services — Training* (Doc 9868) and the *Manual on the Approval of Training Organizations* (Doc 9841).

5.3.2 Instructors participating in such a programme or in other CBT UPRT programmes should be screened and selected in order to determine whether they possess the right attributes to effectively deliver CBT programmes. Accordingly, these instructor pilots should meet the qualification requirements listed in Chapter 5 for UPRT instructors as well as the prerequisites detailed in those competencies for flight instructors described in PANS-TRG (Doc 9868). They must also possess a thorough understanding of delivering UPRT within a CBT environment, which is explained in the appendix to this document.

Chapter 6

REGULATORY OVERSIGHT

6.1 OVERVIEW

6.1.1 Until recently, international licensing standards did not require training programmes to teach upset prevention and recovery, even at the theoretical level. The study of aerodynamics and its effects, and the practical lessons focusing on stall and, in some cases, spin recovery seemed to be the training benchmarks that defined the industry's efforts to mitigate the likelihood of a LOC-I occurrence. Advanced training programmes conducted by several institutions or required by some States even incorporated some aerobatic training into their programmes to further develop the handling skills of their graduates, thereby gaining a wider appreciation of flight path dynamics. With the applicability of the MPL in 2006 came the first attempt to include upset training into a licensing framework. Yet, at the time, MPL standards only required upset recovery training to exist.

6.1.2 The study of LOC-I occurrences revealed overarching training deficiencies that failed to adequately prepare the affected flight crews to recognize, avoid, and, in the worst instances, recover from an aeroplane upset condition. Consequently, the LOCART initiative clearly recognized that improvements to existing international standards and training methodologies were a necessity. Their subsequent recommendations are listed in 1.2.6 and State Authorities are expected to review their regulatory frameworks and make every effort to incorporate the recommended UPRT programmes while appreciating the need to strike a balance between affordability/accessibility of training platforms and the imperative to improve upon those current training practices that are deemed to be inadequate.

6.1.3 In several instances UPRT is not optional. It is a requirement for the MPL as well as for those pilots receiving type rating training or commercial air transport operator-specific initial and recurrent training. It is also recommended for pilots undergoing training towards the issuance of a CPL(A). As detailed in PANS-TRG (Doc 9868), States shall ensure that operators and training organizations apply the principles of the *Manual on Aeroplane Upset Prevention and Recovery Training* (Doc 10011) when developing and implementing such a programme.

6.2 UPRT TRAINING PHILOSOPHY

> Important: CAAs should view UPRT as purely a train
> -to-proficiency programme designed to achieve end-state objectives. Accordingly, CAAs should **not** invoke direct testing requirements on the trainee as part of their oversight process (see 6.2.2).

6.2.1 The UPRT approach is a means of assessing and training critical areas of flight crew performance in conditions of flight during which pilots are likely to be exposed to an increased risk of an in-flight upset. For the MPL and EBT programmes and for those training organizations which so wish UPRT should be developed and conducted as a CBT programme (see appendix) that is singularly focused on the trainee acquiring specifically-targeted competencies rather than just completing the prescribed events/scenarios within an allotted training time. However, it is well understood that several CAAs, ATOs, and air operators are currently unable to implement CBT methodologies as defined in ICAO documentation and that more traditionally-used training paradigms relying on predetermined performance tolerances may have to suffice.

6.2.2 To realize the full value of UPRT programmes and permit ATOs to focus their attention on ensuring that the trainee achieves the targeted performance/competency requirements, CAAs should view UPRT as purely a train-to-proficiency programme designed to achieve end-state objectives. Accordingly, CAAs should **not** invoke direct testing requirements on the trainee as part of their oversight process. Other regulatory due-diligence processes can be used to validate that operational safety levels are not compromised and determine whether the approved training programme is meeting its stated objectives. Therefore, any criteria used to determine the programme's success should be based upon the trainees being able to consistently apply effective countermeasures to upset-related threats in a safe and expeditious manner upon completion of the approved training.

6.3 TRAINING RISK MITIGATION

6.3.1 UPRT-related risks

As part of its oversight responsibilities, the CAA should ensure that the training organization has a risk mitigation policy and procedures incorporated into its QA programme as well as an effective SMS programme whenever conducting on-aeroplane UPRT. Annex 19, 3.1.3 a), states that as part of its State safety programme (SSP), each State shall require that ATOs exposed to safety risks related to aircraft operations implement an SMS. The training recommendations set out in this manual have identified UPRT-specific training risks
in that:

a) On-aeroplane UPRT will require departures from normal flight parameters with recovery affected by the pilots undergoing training while under supervision. This should be mitigated by thorough flight planning processes and briefings, and by only utilizing qualified UPRT instructors who are able to demonstrate the necessary competencies to deliver the in-flight training. There are several other avenues available to reduce risks associated with the manoeuvring requirements inherent in on-aeroplane UPRT. Aeroplane certification and capabilities appropriate for the training tasks, strict operational control involving appropriate minimum dispatch and weather conditions, adhering to minimum safe altitudes and airspace restrictions are just some examples. However, the most important factor affecting safety in the conduct of UPRT is an instructor qualified for the delivery of on-aeroplane UPRT who operates within a well-structured QA/SMS environment;

b) Instructors should be trained to proficiency and remain current to ensure competence in on-aeroplane manoeuvring as well as consistently employing effective interventions that may become necessary to maintain adequate margins of safety. Such interventions may be required with regard to aeroplane limitations, altitude, airspace, avoidance of collision, human performance and limitations of the instructor or the trainee or any other threat or error that might reduce margins of safety; and

c) FSTD-based training may require putting the flight crews into upset situations which they would have avoided in the normal course of events. It is essential that the potential negative training aspects of such situations be considered and either avoided or remedied. In addition, FSTDs are not capable of simulating accurately the full range of physical sensations, structural limitations and aeroplane responses that may be experienced in an in-flight upset, and this may lead to negative training in a training scenario that does not take these aspects into account for mitigation. To address these concerns, CAAs should be mindful that the UPRT programme design recommendations herein be based upon the understanding that:

    1) simulation training will be conducted using the highest level of FSTD fidelity available utilizing flight test data for the design of the simulation model whenever possible;

2) when flight test data simulation modelling is not available, other appropriate engineering data may be used provided the simulation is then validated using appropriately qualified personnel which may include test pilots; and

3) validation of simulation modelling must be completed in the context of the training curriculum for which the device is being used.

> Unless the UPRT FSTD's simulation model satisfactorily represents the aeroplane's behaviour and performance during an aerodynamic stall, training demonstrating conditions beyond the critical angle of attack can create harmful misperceptions about such an event and the recovery experience. Therefore, CAAs should consider requiring ATOs and, if applicable, operators to implement the recommendations for FSTD improvements contained in 4.2 and 4.4 without undue delay. See Doc 9625, Volume I, and the RAeS ICATEE *Research and Technology Report* for more details.

6.3.2 The ATO's SMS

6.3.2.1 Safety is defined as the state in which risks associated with aviation activities, related to, or in direct support of the operation of aircraft, are reduced and controlled to an acceptable level. The purpose of an SMS is to provide the ATO conducting on-aeroplane UPRT with effective policies, processes and procedures that permit it to achieve and maintain safe operations through a continuing process of hazard identification and safety risk management. Annex 19, 4.1.1, further indicates that the ATO's SMS be established in accordance with the framework elements contained in Appendix 2 to Annex 19. Guidance on the implementation of the framework for an SMS is contained in Doc 9859.

6.3.2.2 The way an ATO operates is affected primarily by the decisions and actions of its management. The style of management and the approach that is taken in dealing with operational issues will profoundly influence the employees' beliefs, behaviours and even their values. Therefore, it is essential that the ATO's senior management takes an active and genuine interest in the development and maintenance of the organization's SMS. That enthusiasm and commitment must be repeatedly conveyed to all employees through the words and actions of every member of the management team.

6.3.2.3 The ATO's safety policy needs to be developed, documented and signed off by the accountable executive. It should be communicated and made clear to all employees. The policy is required to state the management's commitment to safety, all employee responsibilities and safety accountabilities with respect to the SMS, and to identify the key safety personnel. The policy should also reflect management's resolve to foster a robust safety-reporting culture and should identify those conditions under which employees will not be subjected to punishment or retribution.

6.3.2.4 Combined with well-structured QA policies and procedures, an ATO's SMS programme should easily mitigate any increased risk levels associated with conducting on-aeroplane UPRT.

6.4 QA AND SMS EVALUATIONS

6.4.1 The shift towards adopting systems-based approaches (i.e. ISD, SMS, and QA) within the industry has presented a significant challenge for CAAs in coming to grips with the need to tweak and, in some cases refocus, their existing safety oversight programme and perhaps even their regulatory framework. UPRT programmes are going to demand the implementation and maintenance of good governance practices by industry and State Authorities alike.

6.4.2 The approval process for UPRT should include a re-evaluation of the ATO's documented policies, processes and procedures to confirm that the ATO has a well-articulated and developed QA and, when applicable, SMS processes to deliver a high-quality programme. This re-evaluation should not be viewed simply as a 'paper' exercise, where the ATO submits a copy of their quality and safety manuals to the Authority for review. Determining each manual's regulatory compliance needs to take place; however, the Authority needs to ensure that the documents are actually being used and consistently being adhered to by all ATO personnel and, to the extent applicable, their clients. Similarly, the same evaluative process needs to be applied when the air operator conducts its own UPRT.

6.4.3 Effective evaluative approaches of system-based governance models by CAAs involve the determination that desired outcomes are being achieved and that the ATO's or operator's processes are robust and designed to ensure that the outcomes are sustainable. The commensurate audit of those established processes can be best summed up as the act of confirming that an organization actually says what it does and does what it says, measured by the observable behaviour of the employees and the organization as a whole against their documented practices. Such an approach is known as an "outcomes process" audit. If done thoroughly, the State has not just ensured that the prescribed regulatory safety minimums are being observed, but rather that the highest standards of safe conduct are being achieved while attempting to achieve performance excellence.

6.4.4 The results of an evaluation of an effective QA and, if applicable, SMS programme can indeed be impressive. Notwithstanding, CAAs should guard against allowing an impressive approval process to cloud good risk mitigation efforts. On-going surveillance activity proportionate to the levels of identified risk must continue to take place. Scheduled surveillance activities should also be reviewed when new risk indicators, such as a change in management, arrival of new equipment or a sudden increase in employee turnover rates, become apparent.

> To ensure the maintenance of high delivery standards in UPRT, CAAs should consider making it obligatory for training programmes approved under the training criteria outlined in Annex 6 — *Operation of Aircraft*, Part I — *International Commercial Air Transport — Aeroplanes*, Chapter 9, 9.3, to be similarly conducted within a QA governance structure.

6.5 IMPLEMENTING UPRT

6.5.1 At the outset of UPRT implementation efforts, CAAs may find that a significant number of those air operators under their oversight programme will have many pilots who have **never** undergone a formal UPRT course. Additionally, there may be ATOs that lack the infrastructure and expertise to immediately incorporate UPRT into their CPL(A) licensing qualification courses. These types of likely situations give reason for CAAs to adopt a graduated, phased-in approach to implementing UPRT regulatory requirements.

6.5.2 During implementation of the MPL, several States chose to introduce these new training programmes by issuing only certain ATOs with interim approval to conduct the training as a proof-of-concept trial. During this period, training was subjected to a CAA surveillance programme that required frequent on-site inspection activities by the Authorities until the desired outcomes were deemed achieved and sustainable for future courses. Concerning UPRT, States may wish to employ a similar methodology, by limiting authority to conduct UPRT to only those few ATOs and operators that have consistently demonstrated effective QA and SMS (whenever the ATO conducts on-aeroplane UPRT) processes, which could help guide a proof-of-concept trial to a successful conclusion. Once sufficient data is collected from the proof-of-concept trials and through implementation of this manual, the CAA will have a much clearer understanding of the entire regulatory framework required to fully support UPRT efforts in that State.

6.6 APPROVAL AND ON-GOING SURVEILLANCE

It is recommended that the following areas be evaluated and determined to meet the expected standards of the applicable CAA for the approval and maintenance of UPRT programmes:

a) assess an ATO's application to conduct a UPRT programme:

1) validate the ATO background data and certification history;

2) review the application for completeness;

3) review the ATO's management structure and supervision levels;

4) assess the effectiveness of the SMS, where required;

5) ensure UPRT is captured by the ATO's QA programme; and

6) document the assessment findings;

b) evaluate the proposed UPRT programme:

1) assess the supporting job/task analysis (if competency-based) and training objectives;

2) assess the curriculum design for relevance;

3) assess the courseware suitability (academic, FSTD and on-aeroplane, as applicable);

4) assess the functionality of the learning management system;

5) assess the suitability of performance criteria and the evaluation processes of trainees and their instructors;

6) confirm the qualifications and competencies of UPRT instructors and those personnel that assess the performance of those instructors (see Appendix A of Doc 9841 regarding the training and procedures manual);

7) review any ATO-developed risk assessments and risk mitigation strategies; and

8) document the evaluation findings;

c) conduct surveillance:

1) carry out a risk assessment;

2) establish an initial surveillance plan;

3) conduct a proof-of-concept trial or operational review of the training programme;

4) instigate follow-up rectification/enforcement action;

5) conduct a review of the functionality and effectiveness of the ATO's QA practices while training is underway;

6) document the surveillance findings; and

7) establish an ongoing surveillance plan;

d) conduct a trend analysis of approval/surveillance activity:

1) identify and document training programme outcomes;

2) ensure continuous improvement processes are implemented and adhered to; and

3) review identified programme-related risks and update mitigation/surveillance strategies.

Note 1.— If applicable, in order to be able to exercise comprehensive oversight of a CBT programme, CAA inspectors should receive specific training as described in Appendix G to Doc 9841.

Note 2.— Doc 9841 provides additional details on the approval process as well as QA and SMS programmes.

APPENDIX

COMPETENCY-BASED UPRT PROGRAMMES

PANS-TRG (Doc 9868); the *Manual of Procedures for Establishment and Management of a State's Personnel Licensing System, Part II,* (Doc 9379); and the *Manual on the Approval of Training Organizations* (Doc 9841) contain additional guidance for the implementation of competency-based training (CBT) programmes and for the oversight of such programmes by the CAA. CAAs are strongly encouraged to refer to those aforementioned documents prior to granting approval of such programmes.

1. APPLICABILITY

1.1 This appendix is relevant to approved training organizations conducting MPL programmes, organizations conducting evidence-based training (as described in Doc 9995), and other organizations which decide to conduct UPRT under an approved CBT curriculum.

1.2 It is important to note that the training organization developing a competency-based UPRT module will need to integrate upset prevention and recovery knowledge, skills and attitudes (KSA) in its competency framework. In the case of MPL programmes, the existing competency framework of PANS-TRG does not yet cover the necessary upset prevention and recovery KSA.

1.3 Approved training organizations and/or air operators that are implementing UPRT may develop their own competency framework or may use the example of core competencies provided in Doc 9995 — *Manual of Evidence-Based Training* reproduced in Table App-1.

1.4 This appendix is not relevant to those training organizations conducting UPRT using traditional, non-CBT methodologies.

2. UNDERSTANDING COMPETENCY-BASED TRAINING (CBT)

2.1 The application of CBT methodologies was introduced recently by ICAO in training towards the MPL and for evidence-based recurrent training requirements in an FSTD, among others. This approach represents a shift away from "traditional" training practices and can be misunderstood by those unfamiliar with the concepts involved because of its complex course development methodology and the requirement for continuous assessment. The goal of CBT is different from other traditional training programmes that are designed so that the trainee meets the minimum skill, knowledge and experience requirements of the licence, permit, certificate, rating or operational authorization being sought. In CBT, the training programme focuses on trainees acquiring all the KSA necessary to achieve the required competencies to perform their duties in a safe, efficient and effective manner.

2.2 A well-designed training programme should take a systematic approach to developing the trainee's ability to achieve end-state objectives. Applying an ISD methodology to its design will result in a fully integrated training solution that clearly maps out the training syllabus, terminal objectives and expected timelines of each training event, module and phase of training, which is often referred to as the “training footprint”.

2.3 The requirement for continuous assessment and managing the learning experience when conducting CBT programmes raises the need to establish an effective and robust learning management system (LMS). Although it is possible to manage the delivery of such a programme with tools as simple as chalkboards, tracking sheets and training booklets, the necessities of this type of specialized training make it highly desirable to have more effective LMSs in place to fulfil the following competency-based training processes:

a) courseware control;

b) documentation and record-keeping;

c) trainee and instructor performance monitoring;

d) course progression tracking;

e) standardization of delivery; and

f) data analysis.

2.4 In order to effectively introduce competency-based training, ATOs, operators conducting EBT and CAAs need to understand and be able to effectively implement or oversee the following underpinning attributes of such a highly-structured training programme:

a) ISD processes;

b) LMSs;

c) programme and learning dynamics; and

d) continuous assessment principles.

3. PILOT CORE COMPETENCIES — EXAMPLE

3.1 Although in use for decades by many air forces worldwide, the introduction of competency-based flight training methodologies within the civil aviation community has been a relatively new and evolutionary process, which first took hold in 2006 with the adoption of new ab initio training standards for the MPL. Training programmes such as MPL programmes are characterized by a thorough job and task analysis that underpins all the training objectives and benchmarked performance standards against which trainees are assessed and their competency levels determined. In 2013, evidenced-based training (EBT), another competency-based programme, was introduced at the airline level as an acceptable methodology for satisfying the recurrent training requirements of Annex 6. The recommendation to now conduct UPRT as a CBT programme is the latest step in the industry’s recognition of the powerful training benefits derived from programmes designed not only to meet the qualification requirements for a licence, rating or privilege but also to meet the competency requirements for the tasks that pilots are expected to always perform safely, effectively and efficiently.

3.2 The philosophy of CBT utilized in conjunction with properly developed pilot core competencies can be applied to manage all areas of UPRT. Table App-1 contains an example set of pilot core competencies. ATOs and/or air operators may choose to use these or develop their own set of core competencies.

Table App-1. Pilot core competencies and behavioural indicators
(extracted from Doc 9995, Appendix 1)

Example of use: demonstration of the competencies can be assessed using the behavioural indicators, which should meet the required level of performance, as established by the operator or ATO for its specific operation. To perform the tasks of upset prevention and recovery, a flight crew needs to deploy several competencies. During the prevention phase, the critical competencies might be *situation awareness*, *problem-solving and decision-making* as well as *leadership* and *teamwork*. During recovery from an aeroplane upset, the most critical competencies could initially be *application of procedures* and *aeroplane flight path management — manual control*. Whilst all pilot core competencies are required when recognizing threats, errors and undesired aircraft states, and managing them, the *application of procedures* and *aeroplane flight path management — manual control* are arguably critical for a successful recovery from an upset.

Competency	*Competency description*	*Behavioural indicator*
Application of Procedures	Identifies and applies procedures in accordance with published operating instructions and applicable regulations, using the appropriate knowledge.	Identifies the source of operating instructions Follows SOPs unless a higher degree of safety dictates an appropriate deviation Identifies and follows all operating instructions in a timely manner Correctly operates aircraft systems and associated equipment Complies with applicable regulations. Applies relevant procedural knowledge
Communication	Demonstrates effective oral, non-verbal and written communications, in normal and non-normal situations.	Ensures the recipient is ready and able to receive the information Selects appropriately what, when, how and with whom to communicate Conveys messages clearly, accurately and concisely Confirms that the recipient correctly understands important information Listens actively and demonstrates understanding when receiving information Asks relevant and effective questions Adheres to standard radiotelephone phraseology and procedures

Competency	*Competency description*	*Behavioural indicator*
		Accurately reads and interprets required company and flight documentation Accurately reads, interprets, constructs and responds to datalink messages in English Completes accurate reports as required by operating procedures Correctly interprets non-verbal communication Uses eye contact, body movement and gestures that are consistent with and support verbal messages
Aircraft Flight Path Management, automation	Controls the aircraft flight path through automation, including appropriate use of flight management system(s) and guidance.	Controls the aircraft using automation with accuracy and smoothness as appropriate to the situation Detects deviations from the desired aircraft trajectory and takes appropriate action Contains the aircraft within the normal flight envelope Manages the flight path to achieve optimum operational performance Maintains the desired flight path during flight using automation whilst managing other tasks and distractions Selects appropriate level and mode of automation in a timely manner considering phase of flight and workload Effectively monitors automation, including engagement and automatic mode transitions
Aircraft Flight Path Management, manual control	Controls the aircraft flight path through manual flight, including appropriate use of flight management system(s) and flight guidance systems.	Controls the aircraft manually with accuracy and smoothness as appropriate to the situation Detects deviations from the desired aircraft trajectory and takes appropriate action Contains the aircraft within the normal flight envelope Controls the aircraft safely using only the

Competency	*Competency description*	*Behavioural indicator*
		relationship between aircraft attitude, speed and thrust Manages the flight path to achieve optimum operational performance Maintains the desired flight path during manual flight whilst managing other tasks and distractions Selects appropriate level and mode of flight guidance systems in a timely manner considering phase of flight and workload Effectively monitors flight guidance systems including engagement and automatic mode transitions
Leadership and Teamwork	Demonstrates effective leadership and team working.	Understands and agrees with the crew's roles and objectives. Creates an atmosphere of open communication and encourages team participation Uses initiative and gives directions when required Admits mistakes and takes responsibility Anticipates and responds appropriately to other crew members' needs Carries out instructions when directed Communicates relevant concerns and intentions Gives and receives feedback constructively Confidently intervenes when important for safety Demonstrates empathy and shows respect and tolerance for other people[1] Engages others in planning and allocates

1. This behavioural indicator should only be used in the context of debriefing after an EBT session and not be recorded.

Competency	*Competency description*	*Behavioural indicator*
		activities fairly and appropriately according to abilities Addresses and resolves conflicts and disagreements in a constructive manner Projects self-control in all situations
Problem-Solving and Decision-Making	Accurately identifies risks and resolves problems. Uses the appropriate decision-making processes.	Seeks accurate and adequate information from appropriate sources Identifies and verifies what and why things have gone wrong Employ(s) proper problem-solving strategies Perseveres in working through problems without reducing safety Uses appropriate and timely decision-making processes Sets priorities appropriately Identifies and considers options effectively Monitors, reviews, and adapts decisions as required Identifies and manages risks effectively Improvises when faced with unforeseeable circumstances to achieve the safest outcome
Situation Awareness	Perceives and comprehends all of the relevant information available and anticipates what could happen that may affect the operation.	Identifies and assesses accurately the state of the aircraft and its systems Identifies and assesses accurately the aircraft's vertical and lateral position, and its anticipated flight path. Identifies and assesses accurately the general environment as it may affect the operation Keeps track of time and fuel Maintains awareness of the people involved in or affected by the operation and their capacity to perform as expected

Competency	*Competency description*	*Behavioural indicator*
		Anticipates accurately what could happen, plans and stays ahead of the situation Develops effective contingency plans based upon potential threats Identifies and manages threats to the safety of the aircraft and people Recognizes and effectively responds to indications of reduced situation awareness
Workload Management	Manages available resources efficiently to prioritize and perform tasks in a timely manner under all circumstances.	Maintains self-control in all situations Plans, prioritizes and schedules tasks effectively Manages time efficiently when carrying out tasks Offers and accepts assistance, delegates when necessary and asks for help early Reviews, monitors and cross-checks actions conscientiously Verifies that tasks are completed to the expected outcome Manages and recovers from interruptions, distractions, variations and failures effectively

4. UPRT PRACTICAL TRAINING — CBT ASSESSMENTS

Tables App-2 and App-3 represent examples of high-level practical training topics mapped out to the pilot core competencies and behavioural indicators listed in Table App-1, which are designed to assist the trainee performance assessment process.

Table App-2. On-aeroplane training

Training topic	*Description*	*Desired outcome* *Develop competency and gain confidence in prevention and recovery from upsets and stalls in the real aircraft and the real environment*	*Details* *The following list and core competency map are not exhaustive and are intended to guide in the construction of training programmes*. Note.— Manoeuvres identified by an an asterisk(*) are optional, depending on suitable aeroplane availability, CAA licensing requirements and ATO training objectives.	*Application of procedures*	*Communication*	*Flight path management, automation*	*Flight path management, manual control*	*Leadership and teamwork*	*Problem-solving and decision-making*	*Situation awareness*	*Workload management*
				Core competency map							
Human Factors	Understanding and awareness of, and exposure to, upset conditions relating directly to errors. *Note.— The direct factors affecting performance are categorized as:* – *awareness;* – *distraction;* – *decision; and* – *dexterity.*	Provide exposure to and develop awareness of specific Human Factors issues related to upset prevention and recovery	**Error management**								
			– **Distraction** through: complacency, stress, task saturation, fixation							x	x
			– Lack of **awareness** through: inattention, prioritization, scan							x	x
			– Lack of **dexterity**: mishandling controls, over controlling, pilot-induced oscillations (PIOs)				x				
			– Poor **decisions**: intentional non-compliance, aircraft performance	x					x		
			Consequential psychological and physiological effects of developed upsets *Note.— Human performance and limitations should be included if not already undertaken during initial licence training.*								
			– Surprise, startle							x	x
			– Effects of g-loads							x	
			– Spatial disorientation							x	
			– The need for counter-intuitive behaviour				x			x	
Approach-to-stall/stall	Approach-to-stall: flight conditions bordered by stall warning and aerodynamic stall. Stall: an aerodynamic loss of lift caused by exceeding the critical angle of attack. *Note 1.— Aerodynamic stall is equivalent to stall, and for some aeroplanes, stall can be identified by activation of a stick pusher.* *Note 2.— The aeroplane must be evaluated for each specific manoeuvre to ensure that its capabilities are not exceeded, with adequate safety margins. Use of aerobatic aeroplanes would be the optimum solution to providing maximum training*	Develop competency and gain confidence in prevention and recovery from approach-to-stall and stall. Respond to the first recognition of an approach-to-stall condition by immediately applying the stall recovery procedure.	– Awareness of the distinction between aircraft attitude and AOA.							x	
			– Energy management, trading altitude for speed.				x		x	x	
			– Awareness of the correlation between stall speed and g-load, and the capability to reduce stall speed by unloading.						x	x	
			– Demonstrations of stall warning characteristics:							x	
			• buffet, visual, aural cues							x	
			• lack of pitch authority							x	
			• lack of roll control							x	
			• inability to arrest descent rate							x	
			Demonstrations of and practice recoveries from approach-to-stall and stall.								
			– Approach-to-stall	x			x				
			– Stall	x			x				
			– Secondary stall	x			x				
			– "Nose below the horizon" stall	x			x				

Training topic	*Description*	*Desired outcome*	*Details*	*Application of procedures*	*Communication*	*Flight path management, automation*	*Flight path management, manual control*	*Leadership and teamwork*	*Problem-solving and decision-making*	*Situation awareness*	*Workload management*
		Develop competency and gain confidence in prevention and recovery from upsets and stalls in the real aircraft and the real environment	*The following list and core competency map are not exhaustive and are intended to guide in the construction of training programmes*. Note.— Manoeuvres identified by an an asterisk(*) are optional, depending on suitable aeroplane availability, CAA licensing requirements and ATO training objectives.	*Core competency map*							
	value and safety margins.		– Accelerated stall	x			x				
			– Sideslip/skidded stall *(Note.— Refer to aircraft limitations.)*	x			x				
			– Spin* *(Note.— Refer to aircraft limitations.)*	x			x				
Developing upsets	Anytime the aeroplane begins to unintentionally diverge from the intended flight path or airspeed.	Develop competency and gain confidence in prevention and recovery from developing upsets.	**Demonstrations and practice in the following areas:**								
			– means and uses of orientating the lift vector				x		x		
			– energy management				x		x		
			– need for and the application of full control inputs				x		x		
			– factors contributing to upsets based on threats (e.g. environ-mental, mechanical) and errors (see Human Factors above)	x				x		x	x
			Exposure, demonstrations and practice in manual aircraft control skills:								
			– operations throughout the certified flight envelope				x			x	
			– primary and secondary instrument scans and uses							x	x
			– slow flight				x				
			– steep turns				x				
			– effect of increased AOA on roll rate				x			x	
			– correlation between roll under g-load and stall				x			x	
			– general awareness of the effects of g -loading							x	
			– control effectiveness at different altitudes, speeds and configurations				x			x	
			– high-speed buffet (if applicable) and low-speed buffet						x	x	
Developed upsets	A condition meeting the definition of an aero-plane upset. *Note.— The aeroplane must be evaluated for each specific manoeuvre to ensure that its capabilities are not exceeded, with adequate safety margins. Use of aerobatic aeroplanes would be the optimum*	Develop competency and gain confidence in prevention and recovery from developed upsets.	**Demonstrations and practice in the following areas:**								
			– G-awareness							x	
			– means and uses of orientating the lift vector				x		x	x	
			– nose-high/nose-low attitudes, high/low speeds				x		x		
			– bank angles up to 90°				x		x		
			– inverted flight* (*Note.— Refer to aircraft limitations.*)				x		x		
			– application of full control inputs				x		x		

Training topic	*Description*	*Desired outcome* *Develop competency and gain confidence in prevention and recovery from upsets and stalls in the real aircraft and the real environment*	*Details* *The following list and core competency map are not exhaustive and are intended to guide in the construction of training programmes*. Note.— Manoeuvres identified by an an asterisk(*) are optional, depending on suitable aeroplane availability, CAA licensing requirements and ATO training objectives.	*Application of procedures*	*Communication*	*Flight path management, automation*	*Flight path management, manual control*	*Leadership and teamwork*	*Problem-solving and decision-making*	*Situation awareness*	*Workload management*
				Core competency map							
	solution to providing maximum training value and safety margins.		– upsets requiring no intuitive behaviour during recovery				x		x	x	x
Aircraft malfunctions	Aircraft system malfunctions influencing aircraft control or instrumentation, that place significant demand on a proficient crew. *Note.— These malfunctions should be determined in isolation from any environmental or operational context.*	Develop competency and gain confidence in handling the effects of aircraft system malfunctions influencing aircraft control or instrumentation.	System malfunctions resulting in significant degradation of flight controls in combination with abnormal handling characteristics and use of alternative flight control strategies.	x			x	x	x	x	

Table App-3. FSTD training

Training topic	*Description*	*Desired outcome* *Develop competency and gain confidence in prevention and recovery from upsets and stalls in a type-specific multi-crew FSTD environment*	Details *The following list and map are not exhaustive and are intended to guide in the construction of training programmes*	*Application of procedures*	*Communication*	*Flight path management, automation*	*Flight path management, manual control*	*Leadership and teamwork*	*Problem-solving and decision-making*	*Situation awareness*	*Workload management*
				Core competency map							
Human Factors	Understanding and awareness of, and exposure to upset conditions relating directly to errors. *Note 1.— The direct factors affecting performance are categorized as:* – *awareness,* – *distraction,* – *decision, and* – *dexterity.*	Provide exposure to and develop awareness of specific Human Factors issues related to upset prevention and recovery.	**Error management**								
			– Timely switching from error management to upset management (change-over points)					x	x		
			– Monitoring, communication and the use of keywords like pitch, bank, speed, unload, push		x			x		x	
			– **Distraction** through: complacency, stress, task saturation, fixation					x		x	x
			– Lack of **awareness** through: inattention, prioritization, scan					x		x	x
			– Lack of **dexterity**: mishandling controls, over-controlling, pilot-induced oscillations (PIOs)			x	x			x	

Training topic	*Description*	*Desired outcome* *Develop competency and gain confidence in prevention and recovery from upsets and stalls in a type-specific multi-crew FSTD environment*	Details *The following list and map are not exhaustive and are intended to guide in the construction of training programmes*	*Application of procedures*	*Communication*	*Flight path management, automation*	*Flight path management, manual control*	*Leadership and teamwork*	*Problem-solving and decision-making*	*Situation awareness*	*Workload management*
				Core competency map							
	Note 2.— All exercises should be understood in the context of the threat and error management (TEM) model.		– Poor **decisions**: intentional non-compliance, aircraft performance	x				x	x		
			Consequential psychological and physiological effects of developed upsets *Note.— Human performance and limitations should be included if not already undertaken during initial licence training.*								
			– surprise, startle							x	x
			– effects of g-loads							x	
			– spatial disorientation							x	
			– the need for counter-intuitive behaviour						x	x	
Approach-to-stall/stall	Approach-to-stall: flight conditions bordered by stall warning and aerodynamic stall. Stall: An aerodynamic loss of lift caused by exceeding the critical angle of attack. *Note 1.— Aerodynamic stall is equivalent to stall and, for some aeroplanes, stall can be identified by activation of a stick pusher.* *Note 2.— FSTDs must be evaluated for each specific stall manoeuvre to ensure that device capabilities are not exceeded. Future FSTD enhancements may allow extension of approach-to-stall exercises to aerodynamic stall.*	Develop competency and gain confidence in prevention and recovery from approach-to-stall. Respond to the first recognition of an approach-to-stall condition by immediately applying the stall recovery procedure.	– Awareness of the distinction between aircraft attitude and AOA							x	
			– Energy management, trading altitude for speed			x	x		x		
			– Awareness of the correlation between stall speed and g-load, and the capability to reduce stall speed by unloading				x		x	x	
			– Use of thrust to assist pitch changes				x		x	x	
			– Stall warning characteristics, e.g.:								
			• aerodynamic buffeting							x	
			• reduced roll stability and aileron effectiveness							x	
			• visual or aural cues and warnings							x	
			• reduced elevator (pitch) authority							x	
			• inability to maintain altitude or arrest rate of descent							x	
			• stick shaker/stick pusher activation (if installed)							x	
			Demonstrations of and practice recoveries from:								
			– approach-to-stall, entry at 1 g	x			x				
			– approach-to-stall, entry >1 g	x			x				
			– approach-to-stall at a "nose below horizon" attitude	x			x				

Training topic	*Description*	*Desired outcome* *Develop competency and gain confidence in prevention and recovery from upsets and stalls in a type-specific multi-crew FSTD environment*	Details *The following list and map are not exhaustive and are intended to guide in the construction of training programmes*	*Application of procedures*	*Communication*	*Flight path management, automation*	*Flight path management, manual control*	*Leadership and teamwork*	*Problem-solving and decision-making*	*Situation awareness*	*Workload management*
				Core competency map							
			– secondary stall warning during stall recovery	x			x				
Developing Upsets	Anytime the aeroplane begins to unintentionally diverge from the intended flight path or airspeed.	Develop competency and gain confidence in prevention and recovery from developing upsets.	**Demonstrations and practice in the following areas:**								
			– means and uses of orientating the lift vector				x			x	
			– energy management			x	x		x	x	
			– need for and the application of full control inputs				x		x	x	
			– factors contributing to upsets based on threats (e.g. environmental, mechanical) and errors (see Human Factors above)	x	x			x	x	x	x
			Exposure, demonstrations and practice in manual aircraft control skills:								
			– operations throughout the certified flight envelope			x	x				
			– primary and secondary instrument scans and uses							x	x
			– slow flight			x	x				
			– steep turns				x				
			– effect of increased AOA on roll rate				x			x	
			– correlation between roll under g-load and stall				x			x	
			– general awareness of the effects of g-loading							x	
			– control effectiveness at different altitudes (high vs. low), speeds and configurations				x		x		
			– buffet			x	x			x	
			– understand the need for using elevator as primary control strategy to reduce AOA and thrust as a secondary strategy						x		
			– roll rate increase by unloading				x		x		
			– CG effects, Mach effects on critical AOA				x			x	
Developed upsets	A condition meeting the definition of an aeroplane upset.	Develop competency and gain confidence in prevention and recovery from developed upsets.	**Demonstrations and practice in the following areas:**								
			– G-awareness				x		x	x	
			– means and uses of orientating the lift vector				x		x		

Training topic	*Description*	*Desired outcome* *Develop competency and gain confidence in prevention and recovery from upsets and stalls in a type-specific multi-crew FSTD environment*	Details *The following list and map are not exhaustive and are intended to guide in the construction of training programmes*	*Application of procedures*	*Communication*	*Flight path management, automation*	*Flight path management, manual control*	*Leadership and teamwork*	*Problem-solving and decision-making*	*Situation awareness*	*Workload management*
				Core competency map							
			– nose-high/low attitudes, high/low speeds		x	x	x				
			– excessive bank angles		x		x				
			– application of up to full control inputs				x		x		
			– upsets requiring counter-intuitive behaviour during recovery				x		x	x	
Aircraft malfunctions	Aircraft system malfunctions influencing aircraft control or instrumentation that place a significant demand on a proficient crew. These malfunctions should be determined in isolation from any environmental or operational context.	Develop competency and gain confidence in handling the effects of aircraft system malfunctions influencing aircraft control or instrumentation.	Type-specific FSTD: system malfunctions resulting in significant degradation of flight controls in combination with abnormal handling characteristics, use of alternative flight control strategies, e.g. jammed flight controls, certain degradation of FBW control, de/anti-icing failure.	x	x	x	x	x			x
			System failures that require monitoring and management of the flight path using degraded or alternative displays, e.g. unreliable primary flight path information, unreliable airspeed, automation failures.	x	x	x	x	x		x	x

5. PERFORMANCE-BASED REGULATORY FRAMEWORKS

The use of performance-based regulatory frameworks is particularly effective when accompanied by a requirement for affected stakeholders to operate within a systems-based governance structure. Approved training organisations are now required to have such structures as detailed in the QA and SMS obligations described in Annex 1 — *Personnel Licensing* and Annex 19 — *Safety Management*, and in the *Manual on the Approval of Training Organizations* (Doc 9841).

5.1 State aviation regulations obligate affected organizations and individuals to meet prescribed minimum standards that are deemed to provide acceptable levels of safety. These standards are frequently derived by determining quantitative measurements that, when present, are designed to provide Authorities with sufficient assurances that the resultant conditions are likely to mitigate safety risks. Regulations governing aviation training are predominantly focused on the imposition of course requirements which heavily impact training programme design and its subsequent delivery. In many instances, if these prescribed “input” requirements are all met, then the course is simply approved and the Authority can remain assured that the established criteria serve the needs of all stakeholders. However, as a result of the competitive nature of the training industry and the pressure on pricing in the market place, training programme content and delivery too often only just meet minimum Authority requirements with little regulatory incentive to address the training needs of each individual. It should come as no surprise then that many of the major commercial aviation accidents still point to systemic breakdowns that are often the result of the quality of training provided to the affected crews.

5.2 Aviation regulations are designed to mitigate identified risks. The regulatory structure is based upon legal interpretation or jurisprudence of the courts and the ability of the State to enforce law-abiding behaviour. As a result, States have tended to develop prescriptive provisions that attempt to address every conceivable action or situation that could impact upon stakeholder safety. However, this approach does not ensure effectiveness in the current aviation environment, which is rapidly evolving. The combination of overly-prescriptive provisions, the often lengthy regulatory provision approval process within a State and the speed of technological advancements often results in the regulatory system lagging behind and being in a state of perpetual change. Fortunately, some CAAs are beginning to introduce a more proactive approach to ensure a responsive and relevant set of regulations and associated standards. This involves taking a more systems-based approach to regulatory design, whereby regulations and standards are focused on employing processes to ensure that end-state obligations of the product or service are being met as opposed to defining the necessary components in the delivery of such a service or in the development of a product. It involves focusing on "what needs to be achieved" instead of "how it must be achieved". This type of provisioning is often referred to as an outcomes-based or a performance-based regulatory approach and is particularly apt when defining regulatory provisions to support CBT programmes designed to achieve overarching objectives such as UPRT (see Table App-4).

Table App-4. Example of a performance-based regulatory exemption (when provided for in the legislation)

Approved training programmes may be exempted from the normally prescribed experience and content requirements if it can be demonstrated by the ATO that: • the competencies of the trainees consistently meet or exceed those expected from graduates of approved traditional programmes; and • the programme is being conducted within a quality system as defined in Appendix B to Doc 9841, which has been assessed by the CAA as being effective.

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