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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.

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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:

The Secretary General
International Civil Aviation Organization
999 University Street
Montréal, Quebec H3C 5H7
Canada

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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

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

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

<i>Subjects and training elements</i>	<i>Academic training</i>	<i>On-aeroplane training — CPL(A)/MPL</i>	<i>Non-type-specific FSTD training — (CPL(A)/MPL)</i>	<i>Type-specific FSTD training</i>	<i>AURTA, Revision 2, references</i>
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	•	•	•	•	

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

<i>Subjects and training elements</i>	<i>Academic training</i>	<i>On-aeroplane training — CPL(A)/MPL</i>	<i>Non-type-specific FSTD training — (CPL(A)/MPL)</i>	<i>Type-specific FSTD training</i>	<i>AURTA, Revision 2, references</i>
I. <i>System malfunction</i>					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. <i>Specialized training elements</i>					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. <i>Human Factors</i>					section 2.5.5.11.10
1) situation awareness					
i) human information processing	•	•	•	•	

<i>Subjects and training elements</i>	<i>Academic training</i>	<i>On-aeroplane training — CPL(A)/MPL</i>	<i>Non-type-specific FSTD training — (CPL(A)/MPL)</i>	<i>Type-specific FSTD training</i>	<i>AURTA, Revision 2, references</i>
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).

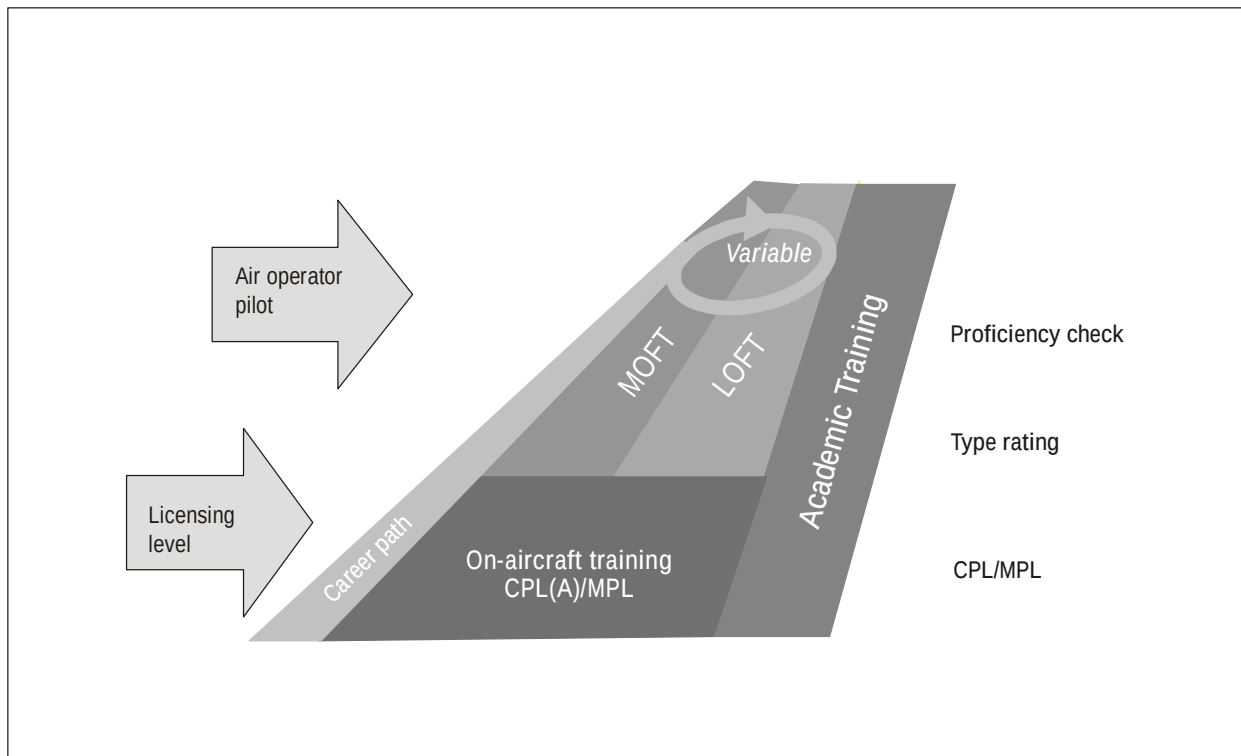


Figure 3-1. Integrated training concept

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