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Guidance Material and Best Practices for the Implementation of Upset Prevention and Recovery Training

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1st Edition

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Guidance Material and Best Practices for the Implementation of Upset Prevention and Recovery Training
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Publications

The table below shows a list of publications, issued by Regulators and the industry, used in this manual.

Publication / Task	Date	Abbreviated essentials
Airplane Upset Recovery Training Aid (AURTA) Revision 2	November 2008	a) Establishment of an industrywide consensus on a variety of effective training methods for pilots to recover from airplane upsets. b) Development of appropriate educational materials. c) Development of an example training program, providing a basis from which individual operators may develop tailored programs.
FAA InFO 10010	7/6/10	Highlights availability and merits of AURTA
FAA SAFO 10012	7/6/10	Recovery from stall does not mandate a predetermined value for altitude loss
FAA AC No: 120-109 Stall and Stick Pusher Training	8/6/2012	a) Reduction of AOA is the most important response to a stall event b) Evaluation criteria for a recovery from stall event that does not include a predetermined value for altitude loss c) Realistic scenarios d) Training emphasizes treating "approach-to-stall" the same as a "full stall" and execute recovery at first indication of a stall e) Incorporation of stick pusher training
FAA SAFO 13002	1/4/13	To encourage operators to promote manual flight operations when appropriate.
EASA SIB No.: 2013-02 Stall and Stick Pusher training	22 January 2013	Corresponds to AC No: 120-109
EASA SIB No.: 2013-05 Manual Flight Training and Operations	23 April 2013	Reminder for NAAs and operators of the importance of manual flying during recurrent simulator training and also, when appropriate, during flight operations.
TCAA AC 700-031	2013-11-08	a) Guidance for the prevention and recovery from stall events b) Best practices and guidance for training, testing, and checking c) Emphasizes reducing the AOA as the most

Publication / Task	Date	Abbreviated essentials
		important response to a stall event
FAA NOTICE N 8900.241	11/4/2013	Compliance required no later than March 2019 a) Ground training on stall prevention and recovery and upset prevention and recovery b) Flight training in a Level C or higher FFS on specified maneuvers and procedures during initial, transition, upgrade, and recurrent training c) Flight training and checking on runway safety maneuvers and procedures and crosswind takeoffs and landings with gusts d) PM and workload management e) Scenario-based or maneuver-based stall prevention training during LOFT f) For PICs a proficiency check, within 12 calendar-months, in each aircraft type g) Initial or transition and recurrent training on the operation of FSTD and FSTD limitations for flight instructors, check pilots, and check Flight Engineers who conduct training or checking in FSTD h) Remedial training and tracking of pilots with performance deficiencies i) Approval of training equipment
ICATEE Research and Technology Report	12/2013	Analysis of training tasks and proposals to enhance FTSD capabilities.
ICAO Annex 1 – Amdt.172 Annex 6 – Amdt.38 PANS-TRG – Amdt. 3 **Doc 10011**	02/2014	ICAO amendments to Annex 1, Annex 6 and PANS-TRG (Doc 9868) to a) Meet the UPRT requirements for an MPL, contained in Annex 1 b) Provide UPRT recommendations for a CPL(A), contained in Annex 1 c) Meet the requirements for type-rating, contained in Annex 1 d) Meet the requirements for the recurrent training of pilots, contained in Annex 6, Part I, paragraph 9.3 – *Flight crew member training programmes* ICAO Doc 10011 - 1st Edition – Manual on Aeroplane Upset Prevention and Recovery Training (MAUPRT)
FAA, proposed AC No: 120-109A	2014 pending	Amendment of AC No: 120-109

Publication / Task	Date	Abbreviated essentials
FAA AC No: 120-111	4/14/15	Upset Prevention and Recovery Training a) Enhanced instructor training on the limitations of simulation b) Comprehensive pilot academic training on aerodynamics c) Early recognition of divergence from intended flight path d) Upset prevention through improvements in manual handling skills e) Training that integrates crew resource management including progressive intervention strategies for the pilot monitoring
EASA SIB No.: 2015-07	15 April 2015	Prevention of Hazardous Low Speed at High Altitude Cruise
EASA ED Decision 2015/012/R	4 May 2015	Amendment to Acceptable Means of Compliance and Guidance Material to Part-Definitions and Part-ORO of Regulation (EU) No 965/2012

Abbreviations and Acronyms

AC	FAA Advisory Circular
A/C	Aircraft
AOA	Angle of Attack
ANU	Aeroplane Nose Up
AND	Aeroplane Nose-Down
AURTA	Airplane Upset Recovery Training Aid
ATO	Approved Training Organization
CBT	Competency-Based Training
CAA	Civil Aviation Authority
CFE	Certified Flight Envelope
FBW	Fly by wire
FOQA	Flight Operational Quality Assurance
IMC	Instrument Meteorological Conditions
IOS	Instructor Operating Station
LOSA	Line Operations Safety Audit
LOC-I	Loss of Control In-Flight
NAA	National Aviation Authority
NFE	Normal Flight Envelope, synonymous to Normal Operating Flight Envelope
OEM	Original Equipment Manufacturer
PANS-TRG	ICAO Doc 9868, Procedures for Air Navigation Services (PANS) - TRAINING
PF	Pilot Flying
PM	Pilot Monitoring
QRH	Quick Reference Handbook
RAeS	Royal Aeronautical Society
SAFO	FAA Safety Alert for Operators
SIB	EASA Safety Information Bulletin
SOP	Standard Operating Procedure
TCCA	Transport Canada Civil Aviation
Vls	Lowest Selectable Speed, synonymous to Maneuvering Speed
VMC	Visual Meteorological Conditions
Vs	Stall Speed
VTE	Validated Training Envelope

Definitions Related to UPRT

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.

Aeroplane upset. An airplane 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.

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

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

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.

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

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

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

Behavioral 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.

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

Core competencies. A group of related behaviors, 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 behavioral indicators.

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.

Notes: 1. The philosophy of Competency-Based Training utilized in conjunction with properly-developed pilot core competencies can be applied to manage all areas of UPRT.[1]

2. 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 in Table App-1.[2]

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

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.

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

Error. See **Threat and Error Management.**

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

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 maneuvers.

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 an FSTD.

Extended Envelope Training (FAA). The flight training contained in §121.423 consisting of:

- Manually controlled slow flight
- Manually controlled loss of reliable airspeed
- Manually controlled instrument departure and arrival
- Upset recovery maneuvers
- Recovery from bounced landing; and,
- Instructor-guided hands-on experience of recovery from full stall and stick pusher activation

[1] ICAO Doc 10011, Appendix, 3.2

[2] ICAO Doc 10011, Appendix, 1.3

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

Flight crew resilience. The ability of a flight crew member to recognize, absorb and adapt to disruptions.

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.

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.

Maneuvers. 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.

Maneuver-based training. Training that focuses on a single event or maneuver 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.

Negative transfer of training. The application (and "transfer") of what was learned in a training environment (e.g., a classroom, an FSTD) to the job environment, i.e., it describes the degree to which what was learned in training is applied on-the-job. In this context, "negative transfer of training" refers to the inappropriate generalization of a knowledge or skill to a situation or setting on the job that does not equal the training situation or setting.

On-aeroplane training. A component of a UPRT program 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.

Example: Take-off, climb, cruise, descent, approach and landing.

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.

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 a complete organizational construct 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.

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.

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

Scenario-based training. Training that incorporates maneuvers 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:

1. Buffeting, which could be heavy at times
2. Lack of pitch authority and/or roll control; and
3. Inability to arrest the descent rate

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 airplanes 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)

Notes: 1. A stall warning indicates an immediate need to reduce the angle of attack.

2. Stall and stall warning definitions and descriptions are presently under review as they may not be fully consistent with Airworthiness Standards / Certification Specifications.

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

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

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

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

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

Stall recovery procedure. 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 and in the EASA SIB 2013-02.

Surprise and Startle.

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

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.

Threat and Error Management.

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.

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.

Undesired aircraft state. Flight crew-induced aircraft position or speed deviations, misapplication of flight controls, or incorrect systems configuration, associated with a reduction in margins of safety.

Notes: 1. Undesired states can be managed effectively, restoring margins of safety; or flight crew response(s) can induce an additional error, incident, or accident.

2. All countermeasures are necessarily flight crew actions. However, some countermeasures to threats, errors and undesired aircraft states that flight crews employ build upon "hard" / systemic-based resources provided by the aviation system.

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) Turbojets with 10 or more seats, or having a maximum take-off mass (MTOM) of greater than 5 700 kg (12 566 lb.); or

b) Propeller-driven aeroplanes with greater than 19 seats, or a MTOM greater than 8618 kg (19 000 lb.)

Upset. See **Aeroplane Upset.**

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

Foreword

Rob Eagles

Dear Colleagues,

It is my pleasure to introduce the first edition of the IATA Guidance Material and Best Practices for the Implementation of Upset Prevention and Recovery Training (UPRT).

Loss of Control In-Flight is one of the leading causes of fatalities in commercial aviation. This has led the Industry to revise current training practices and adopt new regulations to address the situation. As the trade association for the global airline industry for the past 70 years, we are well positioned to share industry expertise and best practices to support airlines with the implementation of new regulations in a harmonized manner.

The objective of this guide is not to repeat what has already been written or published on UPRT, but to provide practical guidance to airlines wishing to develop their own UPRT program. This guide is the result of the collaborative effort of the IATA Pilot Training Task Force (PTTF), which is made up of representatives from ten IATA member airlines and observers from aircraft manufacturers. The Task Force was created in June 2014 to guide and support IATA in identifying pilot training and qualification needs, and to provide solutions to all our member airlines. The creation of this guide was identified as a priority by the PTTF, and the hard work of this team of flight training experts has resulted in the publication of this manual in a very short timeframe.

I would also like to highlight the invaluable contribution of the International Civil Aviation Organization (ICAO), the International Federation of Air Line Pilot's Associations (IFALPA), the Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA).

It is our belief that the shared efforts put into the development of this guide will contribute to achieving our common goal of improving aviation safety worldwide.

Best regards,

Rob Eagles
Senior Vice-President (a.i.)
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Section 1—Scope of the Manual

This document serves as guidance material for operators to develop an Upset Prevention and Recovery Training (UPRT) program as part of their recurrent training. It can also be considered when including UPRT into other programs, such as conversion, upgrading and type rating training. The document specifically focuses on practical guidance for UPRT instructor training. It also includes recommendations for operators cooperating with ATOs providing licensing training for their ab-initio cadets.

Guidance is based on expert information within the industry, international working groups, such as Loss of Control Avoidance and Recovery Training (LOCART) and International Committee for Aviation Training in Extended Envelopes (ICATEE), ICAO Doc 10011, *Manual on Aeroplane Upset Prevention and Recovery Training (MAUPRT)*, and documents listed under the Publications section at the beginning of this manual.

Syllabi and air exercises are based on the *Airplane Upset Recovery Training Aid (AURTA) Revision 2*, 2008, published by Airbus, Boeing and the Flight Safety Foundation, related FAA ACs and EASA ED Decision/SIBs.

This manual may be used for both, traditional and competency-based training schemes. When addressing pilot competency, this manual uses the core competencies as set out in the ICAO Doc 9995[3] and its associated terminology.

As sufficient study material is available, existing information will not be replicated and academic training is not further detailed in this manual; however essential topics and sources are discussed.

This manual is provided for information and guidance purposes. It only describes examples of means, but not the only examples and means, of designing a UPRT program, in order to achieve compliance with regulations and standards. Operators are responsible to ensure compliance with regulations and standards and to obtain approval by their Authorities for their UPRT programs.

Note: The pronoun “he” is used synonymously for “she” or “he” throughout this manual.

[3] ICAO Doc 9995 Manual of Evidence-based Training

Section 2—Latest Essentials from ICAO

ICAO has amended Annex 1, Annex 6 and PANS-TRG (Doc 9868) to provide procedures to Civil Aviation Authorities, operators and approved training organizations to:

- Meet the UPRT requirements for an MPL, contained in Annex 1
- Provide UPRT recommendations for a CPL(A), contained in Annex 1
- Meet the requirements for type-rating, contained in Annex 1
- Meet the requirements for the recurrent training of pilots, contained in Annex 6, Part I, paragraph 9.3 – *Flight crew member training programmes*.

A new Chapter 7 was added in PANS-TRG (Doc 9868) to provide procedures in the delivery of upset prevention and recovery training for aeroplane pilots. This Chapter is supported by the *Manual on Aeroplane Upset Prevention and Recovery Training* (ICAO Doc 10011).

"Although not obligatory, training organizations engaged in the recurrent assessment and training of flight crew engaged in the operations of large or turbojet aeroplanes in accordance with Annex 6, Part II — *International General Aviation — Aeroplanes* (Section 3 refers) should also use this information to enhance the scope of their training services being offered"[4].

2.1 Manual on Aeroplane Upset Prevention and Recovery Training (Doc 10011)

Doc 10011 addresses in detail the following distinct areas for UPRT:

- Single-pilot training on-aeroplane
- Multi-crew training in an FSTD
  - non-type-specific and type-specific
- OEM recommendations in prevention and recovery techniques
- FSTD requirements for UPRT

To standardize terminology for UPRT, it provides an enhanced set of definitions, including "aeroplane upset", various "stall" terms, "startle" and "surprise".

[4] Amendment 3 to PANS-TRG

Areas/objectives of UPRT are divided into:

- **"PREVENTION"** including
  - heightened ***awareness*** and
  - effective ***avoidance***
- **"RECOVERY"**

Note: The training philosophy of FAA AC No: 120-111 uses the areas of **Prevention** (timely action to avoid progression toward a potential upset), **Recognition** (timely action to recognize divergence from the intended flight path and interruption of progression toward a potential upset), and **Recovery** (timely action to recover from an upset in accordance with the air carrier's procedures, or in the absence thereof, in accordance with recommendations provided in Chapter 4 of the AC).

Doc 10011 is supplemented by two important OEM recommended recovery techniques (or strategies) for Nose-high and Nose-low. They were jointly developed by representatives from Airbus, ATR, Boeing, Bombardier and Embraer.

Doc 10011 refers to the *Airplane Upset Recovery Training Aid* (AURTA) Revision 2. It is important to keep in mind that the AURTA was mainly developed to deal with topics pertaining to swept-wing airplanes with more than 100 passenger seats. Nonetheless, it still contains valuable guidance that often applies to smaller propeller-driven and turbojet powered airplanes; Revision 3, which is presently under development, may include these airplanes.

Amendment 3 to PANS-TRG states that UPRT programs should be competency-based in their design and delivery[5] and Doc 10011, Appendix, provides guidance to ATOs, organizations conducting EBT and other organizations that decide to conduct UPRT under an approved competency-based training curriculum.

UPRT can also be safely implemented within traditional training schemes. It is recognized that not all CAAs, operators, nor ATOs at this time have the capability to develop, maintain and oversee a competency-based UPRT program. Hence, the core of Doc 10011 is developed upon the premise that "it is well understood that several CAAs, ATOs, and air operators are currently unable to implement CBT[6] methodologies as defined in ICAO documentation, and that more traditionally used training paradigms relying on predetermined performance tolerances may have to suffice."[7]

[5] Amendment No. 3 to PANS-TRG, 7.6.1

[6] CBT - Competency-based training

[7] ICAO Doc 10011, 6.2.1

Section 3—Regulatory Compliance

Both the Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA) have implemented measures that will require operators to comply with recently issued UPRT regulations.

FAA NOTICE N 8900.241 of 11/4/13 "…outlines the regulatory and guidance changes related to the Qualification, Service, and Use of Crewmembers and Aircraft Dispatchers final rule. This rule revises the training and qualification requirements for pilots conducting operations under Title 14 Code of Federal Regulations (14 CFR) part 121". "All pilots operating under part 121 must complete ground training on stall prevention and recovery and upset prevention and recovery during initial, transition, upgrade, and recurrent training". Compliance is required no later than 12 March 2019. All associated recurrent training must be completed by 31 March 2020.

EASA has established rulemaking tasks RMT0581&0582 to develop the European rules for UPRT. ED Decision 2015/012/R, published on 4 May 2015, amends the Acceptable Means of Compliance and Guidance Material to Part-Definitions and Part-ORO of Regulation (EU) No 965/2012. Amendments to Part-FCL are envisaged to be published with a Notice of Proposed Amendment (NPA) in the summer of 2015.

Section 4—The Ideal UPRT Program

The ideal UPRT program involves both, operator training and ATO training. Many operators are connected to ATOs delivering First Officer candidates. IATA recognizes the benefits of operator-ATO partnerships and encourages operators to engage themselves at an early stage of pilot education (ideally in MPL courses) in order to ensure a top-down approach to training and to improve the quality of ab-initio pilot training.

The ideal UPRT program structure should therefore be designed as a coordinated effort between the operator and the ATO. It should include consistent on-aeroplane and non-type-specific UPRT of the ATO, and type-specific UPRT of the operator.

The overarching aim of UPRT is to develop flight crew resilience (competence and confidence) in prevention and recovery from undesired aircraft states, including upsets.

The following table shows an example for an ideal setup of a UPRT program of an operator/ATO partnership.

The ideal complete UPRT program	
Academic Preparation	Exposure to flight within the full range of the FAA25/CS25 certification g-envelope, all attitude exposure, essential human factor training.
On-aeroplane UPRT MPL, CPL	• Adapting to all attitudes • Adapting to g-exposure (-1g to 2,5g) • Overcoming surprise and startle • Developing counter-intuitive recovery skills • Developing AOA awareness • Recovery from aerodynamic stall • Recovery from all attitude aeroplane upsets
Academic Preparation	Non type-specific upset prevention and recovery training, consolidation of OEM recommendations
Non-type-specific UPRT in FSTDs MPL, CPL	

Academic Preparation	Type-specific upset prevention and recovery training including SOPs, OEM recommendations and operator training methodologies
Type-specific UPRT in FSTDs Operator training (type rating, conversion, recurrent, command upgrade) and MPL	

Section 5—Academic Training

Thorough understanding of environmental factors, aerodynamics, flight dynamics, aircraft performance, aircraft design principles and human factors is an indispensable prerequisite for successful upset *prevention*. Academic training is therefore of critical importance for the success of a UPRT program.

Operators are encouraged to first identify possible theoretical knowledge gaps in their pilots; then use AURTA and the variety of existing publications or Apps to develop the academic part of their UPRT program. Guidance for the content of academic training can be taken from ICAO Doc 10011, from APENDIX 1 of FAA AC No: 120-111 and from EASA ED Decision 2015/012/R. It is recommended to present academic training in a practical way, related to the cockpit and working environment of pilots.

Theoretical training should precede and be integrated into practical training. It should include classroom instruction and self-study in preparation for on-aeroplane and FSTD lessons. Briefings and debriefings may then refer to essentials from the preparation course. The time between academic training and practical training should be kept as short as possible.

Effective Energy Management (especially for high altitude flight) has been identified as one of the critical training elements, as energy trading in certain conditions may be of vital importance. The purpose of energy management is to keep the aircraft in the Normal Flight Envelope (NFE)[8]. The key question for pilots should be "do I have enough energy to stay within the NFE" or "is my energy state sufficient to maintain normal flight"?

Course developers should include a suitable learning model for energy management in their UPRT course, an example is provided in Section 11 in this manual.

[8] See Section "Training envelopes" in this manual.

Section 6—Practical Training

6.1 Conceptual Aspects

Upset prevention and recovery is not an isolated "art", it should be embedded in today's safety concepts. Threat and Error Management (TEM)[9] is designed to serve this purpose. This is the reason why TEM is described under "Practical training" in this manual.

6.2 TEM and the Core Competencies

Today, TEM is a mandatory component of all licensing training under ICAO. As the number and conditions of possible causes of upsets (threats, errors and undesired aircraft states) are infinite, there will always be unforeseeable events which have not been trained before. Therefore, shifting the focus away from replicating known events to developing the underlying core competencies aims at preparing flight crews to cope with the *unforeseen* (sometimes described under the metaphor "black swan").

Note: ICAO Doc 9995, *Manual of Evidence-based Training* (Section 7.6.1) says, "The purpose of the scenario-based training phase is to develop, retain and practice the competencies for effective management of threats and errors to enhance the crew's ability to cope with both predictable and unforeseen situations."

In the TEM framework the core competencies can be seen as the countermeasures of flight crews. They are the tools against the "ever present rain" of threats, errors and undesired aircraft states. Their continuous application leads to *prevention* of upsets and also serves *recovery*.

Instructors should point out how TEM can effectively be used in UPRT. Operators are encouraged to develop their competency framework or use the example set of core competencies provided in Doc 9995, Manual of Evidence-based Training.

Notes:
1. During the last decades the huge potential of TEM has been discovered by the industry. TEM has evolved from originally being only a LOSA observation tool to a practical tool in training. Its biggest advantage is that it can be applied consistently and practically at all levels of training, from licensing training with the ATO until operator training.
2. IATA supports the commonly named "total systems approach", which suggests using one defined set of core competencies throughout the entire career of a pilot. This enables operators to design true competency-based training systems. Starting with pilot aptitude testing and continuing through licensing training (MPL, CPL, ATPL) to operator training programs (EBT), the

[9] Threat and Error Management: ICAO Doc 9683 Human Factors Manual, Doc 9803 LOSA, Doc 9868 PANS-TRG

same core competencies would be trained and assessed. Training program evaluation would then be based on consistent performance data from all phases of pilot training.

6.2.1 How are Causes of Upsets Connected to TEM and the Core Competencies

Causes and contributory factors to upsets have been grouped into *environmental-, mechanical/aeroplane-systems* and *pilot/human induced*.

The table below shows the scope of TEM in context with UPRT. It also includes organizational threats and suggests how the core competencies can serve as countermeasures in TEM.

<table>
<tr><th colspan="3">TEM</th></tr>
<tr><td>Causes/contributory factors (may be any combination of):</td><td rowspan="3">
</td><td rowspan="3">Crews use the core competencies as countermeasures to recognize and manage all threats and errors to prevent and recover from undesired aircraft states.</td></tr>
<tr><td>THREATS
• environmental
• aeroplane systems
• organizational</td></tr>
<tr><td>ERRORS
• pilot/human</td></tr>
</table>

Figure 1. Connection between TEM, the core competencies and UPRT

6.2.2 Competency-Based Training Versus Traditional Training

Operators are not obliged to provide UPRT under a competency-based training scheme. UPRT may be provided under traditional training paradigms as well. Only for competency-based training schemes a defined set of pilot competencies is actually required.

Many operators have well developed sets of pilot competencies in place. These existing sets of competencies may be used for both traditional and competency-based training schemes, and also for the purpose of UPRT.

For operators that are in the process of developing their new set of pilot competencies, IATA recommends considering the core competencies of the ICAO Manual of Evidence-based Training (Doc 9995) as they have been collaboratively elaborated by a large group of stakeholders.

6.3 Flight Crew Discipline

A professional attitude is the key foundation of every competency. “Failures of flight-crew discipline can - in a single instant - overcome years of skill development, in-depth systems knowledge and thousands of hours of experience”, this verdict of an experienced aviation expert should encourage instructors to reinforce the importance of discipline in the cockpit. Flight crews should understand that it is vitally important to avoid inattention and to fight complacency. Their goal should be to continuously perceive and comprehend all relevant information and to anticipate what could happen that may affect their operation.

“What would you do if…?” reflections, especially during phases of low workload, have a beneficial effect on the response to stress in situations of surprise. “The hypothesis was that simply talking about novel events and creating solutions in a relaxed, stress free environment, would allow pilots to develop a cognitive “pre-plan” that could be stored away as a long-term memory, to be revisited in the event that such a situation, or even some unrelated novel event, ever occurred for real. Having a “model” solution to a complex problem already stored away, lets individuals use that knowledge to resolve future situations very quickly, simply by using or modifying a solution which has already been determined to work. The alternative, where a complex novel situation is encountered without having been previously considered, requires an enormous amount of cognitive effort, at a time when information processing is severely impaired by stress, and possibly at the expense of other processes such as situation awareness”[10].

To avoid erosions of discipline over time, pilots should also be mindful of and maintain obvious basics such as correct seating position, fastened seatbelts as well as permanent situation awareness of the airplane’s energy state and flight path.

6.4 Flight Path Monitoring

Flight path monitoring is a crew effort (PF and PM) and *not only allocated to the PM*. Flight path monitoring commences already during ground operations. Effective fight path monitoring shall result in increased awareness and avoidance of threats and errors related to upset conditions; therefore it plays a key role in the *prevention* part of UPRT.

Recent guidance is available from following studies:

- CAA Paper 2013/02, *Monitoring Matters*
- Flight Safety Foundation, November 2014, *A Practical Guide for Improving Flight Path Monitoring*

[10] Wayne L. Martin, Patrick S. Murray, Paul R. Bates, What would you do if....? Improving pilot performance during unexpected events through in-flight scenario discussions, Aeronautical, Issue 1, 2011

In some instances, the PM may be more aware of the airplane state than the PF. Training should emphasize crew interaction to vocalize a divergence from the intended flight path. A progressive intervention strategy is initiated by communicating a flight path deviation (alert), then suggesting a course of action (advocacy and assertion), and then directly intervening, if necessary, by taking the controls to prevent an incident or accident[11].

Correlations exist between monitoring and TEM performance of flight crews. LOSA data show that effective monitoring and crosschecking occur on flights that have fewer mismanaged errors and undesired aircraft states[12]. UPRT-specific monitoring techniques or crew cooperation procedures specifically addressing the important role of the PM in undesired aircraft states and upsets are still to be developed.

6.5 Flight Path Management – Manual Flight Operations/Flying Skills

Flight crews manage the airplane's flight path by a combination of automation and manual handling. Continuous use of autoflight systems could lead to degradation of the pilot's manual handling skills and ability to recover the aircraft from an upset[13]. As manual handling errors have been increasing[14] operators and authorities have recognized that operators need to enhance the manual flying skills of flight crews. This includes new guidance by regulators[15], OEMs, and the review of operator policies to promote manual flying and manual throttle/thrust operation where appropriate in line operations, and the respective adaptation of recurrent training programs in FSTDs.

When implementing UPRT, operators should consider combining UPRT with manual flying skills training to allow flight crews to gain proficiency. This includes unplanned transition from automated to manual flight and transition from using a flight director to "raw data", as applicable. Setups 1 to 3 of the sample syllabus contained in this manual are dedicated to manual flying.

6.6 Scenario-Based Training, Maneuver-Based Training

As a basic rule maneuver-based training should precede scenario-based training. From a training perspective it is also of interest to examine how the methodologies of scenario- and maneuver-based training are linked to the training objectives of *prevention* and *recovery* during UPRT.

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[11] AC No:120-111

[12] FSF, Nov. 2014, A Practical Guide for Improving Flight Path Monitoring

[13] AC No:120-111 3-b

[14] FAA SAFO 13002

[15] EASA SIB 2013-05

6.6.1 Scenario-Based Training and Upset *Prevention*

Training scenarios should be designed in a way that crews can develop the core competencies to recognize and manage threats, errors and undesired aircraft states successfully and to achieve a safe outcome. The ultimate training objective of scenario-based training is to avoid or arrest a divergence from the intended flight path as early as possible and secure the intended flight path. Scenario-based training therefore is ideal for upset prevention training. Scenarios leading to upsets, despite correct intervention by the crew, are not recommended. Therefore, the methodology of scenario-based training mainly serves *prevention* training.

Note: Operators should work with their OEMs when designing scenarios to ensure that all assumptions related to aircraft behavior are valid. When creating a scenario database for UPRT it is advisable to group the scenarios by upset-inducing causes (1. Environmental, 2. Aeroplane-Systems, 3. Pilot-induced). ICAO Doc 10011 provides FSTD training scenarios suggested by 5 OEMs.

6.6.2 Maneuver-Based Training and Upset *Recovery*

Recovery exercises assume that prevention has failed and an upset condition exists. The instructor, not the crew, takes responsibility for the creation of the upset condition. Training starts after the upset condition has been established. Reasons/causes for upset conditions may be taken from case studies but should not be the responsibility of the crew under training. The ultimate training objective is to effectively apply recovery actions and to return the aircraft to a stabilized flight path. Therefore, recovery training should mainly be delivered as maneuver-based training.

6.7 Training Envelopes

All UPRT should remain within an “area”, or envelope, where “realistic” data describing the aircraft behavior are available. Various definitions of flight envelopes exist that serve flight testing, certification and air operations. The number of envelope definitions may be confusing to UPRT course developers.

Note: As an example, some of the “envelopes” are Aeroplane Operating Envelope, Operational Envelope, Flight Envelope, Service Envelope, Safe Envelope, Protected Envelope, Flight Maneuvering Envelope, Limit Flight Envelope, Operational Flight Envelope, Normal Flight Envelope, Validated Training Envelope, etc.

6.7.1 The Valid Training Envelope (VTE)

It is important to clearly identify the parameters within which upset prevention and recovery training should be conducted in FSTDs. Data representing the actual aircraft behavior are typically available from the OEMs, as they were recorded during the aircraft certification process to prove compliance with the certification specifications. Additional data to define the aerodynamic model of the FSTD may also be available from wind tunnel testing and/or analytical methods and extrapolated data beyond flight test and wind tunnel/analytical regions. In instances when flight data is not readily available, engineering data may be used as a supplement, as long as the model is checked by a subject matter expert pilot. These data form a foundation for creating a simulator model, which ultimately may have its own limitations. They are represented by both a validated aerodynamic envelope and the aircraft's design limits. This envelope is referred to as *Valid Training Envelope* (*VTE*). UPRT in FSTDs should stay within the VTE to avoid negative training and negative transfer of training.

6.7.2 The Normal Flight Envelope (NFE)

The established boundary of parameters associated with the practical and routine operation of a specific aeroplane that is likely to be encountered on a typical flight is referred to as *Normal Operating Flight Envelope* (term used in FAA documents), or *Normal Flight Envelope* (NFE), term used in EASA documents.

The defined parameters of "aeroplane upset" (unintentionally >25deg aircraft-nose-up, >10deg aircraft-nose-down, >45deg of bank, or airspeed inappropriate for the condition) are beyond the NFE.

Prevention training focuses on awareness and avoidance of upsets. This may include developing upsets leaving the NFE, but staying below the boundaries constituting an upset condition.

Recovery exercises assume that the NFE has unintentionally been exceeded and upset conditions exist. The training objective is to effectively apply recovery techniques and procedures to return to a stabilized flight path within the NFE.

6.7.3 Staying within the Valid Training Envelope (VTE) of the FSTD

The VTE of modern FSTDs usually provides a level of fidelity (the level of cueing, simulator modeling, visual, motion and environmental features) sufficient to support *prevention* training.

For *recovery* training some training tasks may exceed the VTE and the FSTD may not be able to accurately replicate the event.

For example: Most models of today's FSTDs are deficient in adequately representing the aerodynamic stall regime[16], they are not validated beyond the critical angle of attack and aerodynamic stall characteristics are not fully reflecting reality.

Exercises outside the VTE can create misperceptions, as the FSTD's simulation model may not satisfactorily represent the airplane behavior. Therefore, exposing crews to un-validated flight regimes should be avoided. Stall recovery training should presently be limited to approach-to-stall training, if possible

[16] ICAO Doc 10011, Chapter 4

with enhanced modeling of airplane-specific cues including stick pusher activation (if installed), and recovery should be initiated at the first indication of stall.

Note: FSTD enhancements to allow demonstrations of and recovery training from aerodynamic stall (sometimes referred to as “stall boxes”)[17] can be expected from FSTD manufacturers in the future. These enhancements would be required when the national regulations mandate, or the FSTD operator determines the need for, training in recovery from aerodynamic stall (beyond the critical angle of attack).

In this case, Doc 9625 introduces the concept of “exemplar” stall models that provide a level of fidelity that is type-specific of the simulated airplane to the extent that the training objectives can be satisfactorily accomplished. In order to provide the full scope of UPRT to their pilots ATOs and operators should consider implementing the necessary FSTD improvements without undue delay.

Course designers cannot assume that FSTDs qualified for other training are automatically qualified for UPRT. Before submitting UPRT programs to the Authorities, operators should cooperate with the FSTD manufacturer to ensure that each exercise contained in the UPRT program can be performed within the VTE of each specific FSTD[18] to be used for UPRT. Even the exercises listed in the AURTA (and depicted in this document) may exceed the VTE of certain FSTDs, although they have been designed to keep most modern simulators within the VTE.

Instructor Operating Stations (IOS) should be equipped with enhanced instructor tools to include training features (scenarios, etc.), allow accurate feedback of pilot performance and convey:

- When the VTE is exceeded
- When the NFE is exceeded; and
- When inappropriate control inputs are used

6.7.4 FSTDs, Required Levels of Qualification

FAA has mandated extended envelope training to be conducted in Full Flight Simulators (FFS), Level C or D, during initial, transition, upgrade, and recurrent training. Other flight training that is part of UPRT, but not required by regulation to be conducted in an FFS, may be conducted in another type of FSTD. However, the FSTD should have the level of fidelity required to meet the learning objective. Training providers are encouraged to use the highest level FFS available when developing their UPRT curriculums[19].

EASA requires FFS, Level C or D for *recovery* training under Part ORO.

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[17] *The American Institute of Aeronautics and Astronautics, AIAA 2014-1003 and 2014-1002*

[18] *Guidance is available in ICAO Doc 9625, the ICATEE Research & Technology Report of 17th December 2013 and in the NSP Guidance Bulletin 11-05, FSTD Evaluations Recommendations for Upset Recovery Training Maneuvers*

[19] U.S. Department of Transportation, FAA, NOTICE N8900.241

Both regulators will provide provisions for cases were such FSTDs for a specific aircraft type should not exist or are not available.

6.8 Training Policies from the OEMs

To provide operators with an overview of UPRT-related OEM training policies, SOPs and recommendations, IATA has distributed a survey to major OEMs. The results of the survey will be published in the Second Edition of this manual.

6.9 Liability Aspects

When designing their UPRT programs operators should follow existing guidance from Regulators, their OEMs and AURTA. FAA advises operators to also consult the Flight Standardization Board (FBS) reports. In Europe, the equivalent body would be the Operational Evaluation Board (OEB). Type-specific SOPs and recommendations of the OEMs take precedence over the general guidance of ICAO and national ACs or SIBs. In the absence of type-specific OEM-approved SOPs or recommendations, the AURTA applies. As AURTA REV02 has been jointly developed by Airbus and Boeing it can be assumed that all exercises contained in the AURTA are compliant with these two OEMs and that there are no technical objections against these exercises.

Note: Operators should also check current training policies of their OEMs as they may be more restrictive than AURTA.

The same applies to the OEM recommendations for upset recovery techniques in nose-high and nose-low situations (contained in ICAO Doc 10011). They were jointly developed by five OEMs, Airbus, ATR, Boeing, Bombardier and Embraer.

Operators should work closely with Authorities and OEMs when wishing to design their own UPRT exercises. This would present a significant challenge to operators because normally operators are not in a position to fully evaluate the type-specific technical implications of “self-made” exercises. Therefore, operators should carefully evaluate all aspects when developing training with exercises and scenarios other than those recommended by ICAO, AURTA, ACs or SIBs.

Section 7—The “OEM Recommendations”

Airbus, ATR, Boeing, Bombardier, and Embraer have provided input for the creation of the two predominant schemes of UPRT, which are known as:

- STALL RECOVERY TEMPLATE[20] (with associated rationale) and
- OEM Recommendations[21] (Nose-high and Nose-low recommendation) or UPSET RECOVERY TEMPLATE[22]

Both serve as straightforward guidance to recovery from upsets and stall events and are not aircraft-specific. Before following these generic templates operators should check with their OEMs whether manufacturer approved aircraft-specific procedures are available. Manufacturer’s procedures take precedence over the recommendations.

Although the recent changes in stall recovery philosophies might require some unlearning, the STALL RECOVERY TEMPLATE will appear quite familiar to flight crews. However, the OEM recommendations for recovery from nose-high and nose-low situations might be new to most pilots and instructors and require detailed explanation. Instructors should take the time to “walk” with their students through every step of the OEM recommendations, explaining the underpinning rationale and refreshing them on aerodynamic and flight control principles. It is important for pilots to fully comprehend the complete rationale behind each step of the strategies, including all options. This might initially appear as a complicated process. Instructors should therefore also take great care that trainees memorize and translate the recommended strategies as a simple sequence of actions that can be applied under stress.

As the OEM recommendations and the associated rationales are distributed through different source documents, the following tables are provided to support instructors when teaching them. They combine the OEM recommendations of Doc 10011 with the original explanations contained in AURTA. FAA AC No: 120-111, Chapter 4, shows pilot actions and explanations in a similar way.

[20] FAA AC 120-109, Proposed AC120-109A

[21] ICAO Doc 10011

[22] FAA AC No: 120-111

<table>
<tr><th colspan="3">Nose-high Recommendations from ICAO Doc 10011 and rationale quoted from AURTA
[1] Recognize and confirm the developing situation. Announce “Nose-high”</th></tr>
<tr><th>PF</th><th>PM</th><th>Rationale quoted from AURTA 2.6.3</th></tr>
<tr><td>[2] A/P - DISCONNECT</td><td rowspan="6">Monitor airspeed and attitude throughout the recovery and announce any continued divergence.</td><td rowspan="2">[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.</td></tr>
<tr><td>A/T - OFF</td></tr>
<tr><td>APPLY
as much nose-down control input as required to obtain a nose-down pitch rate</td><td>This may require as much as full nose-down input. If a sustained column force is required to obtain the desired response, consider trimming off some of the control force. However, it may be difficult to know how much trim should be used; therefore, care must be taken to avoid using too much trim. Do not fly the airplane using pitch trim, and stop trimming nose-down as the required elevator force lessens. If at this point the pitch rate is not immediately under control, there are several additional techniques that may be tried. The use of these techniques depends on the circumstances of the situation and the airplane control characteristics.</td></tr>
<tr><td>Thrust – Adjust
(if required)</td><td>If altitude permits, flight tests have shown that an effective method for getting a nose-down pitch rate is to reduce the power on underwing-mounted engines. (Refer to Sec 2.5.5.11) This reduces the upward pitch moment. In fact, in some situations for some airplane models, it may be necessary to reduce thrust to prevent the angle of attack from continuing to increase. This usually results in the nose lowering at higher speeds and a milder pitchdown. This makes it easier to recover to level flight.</td></tr>
<tr><td rowspan="2">Roll - Adjust
(if required)
not to exceed 60 degrees</td><td>Pitch may be controlled by rolling the airplane to a bank angle that starts the nose-down. The angle of bank should not normally exceed approximately 60 deg. Continuous nose-down elevator pressure will keep the wing angle of attack as low as possible, which will make the normal roll controls effective. With airspeed as low as the onset of the stick shaker, or lower, up to full deflection of the ailerons and spoilers can be used. The rolling maneuver changes the pitch rate into a turning maneuver, allowing the pitch to decrease. (Refer to Fig. 33) In most situations, these techniques should be enough to recover the airplane from the nose-high, wings-level upset.</td></tr>
<tr><td>However, other techniques may also be used to achieve a nose-down pitch rate. If control provided by the ailerons and spoilers is ineffective, rudder input may be required to induce a rolling maneuver for recovery. Only a small amount of rudder input is needed. Too much rudder applied too quickly or held too long may result in loss of lateral and directional control. Caution must be used when applying rudder because of the low-energy situation. (Refer to Sec. 2.5.5.10, “Directional Maneuvering.”)</td></tr>
</table>

		High-Bank-Angle Recovery Techniques: Bank angles can exceed 90 deg. In high-bank situations, the primary objective is to roll the airplane in the shortest direction to near wings level. However, if the airplane is stalled, it is first necessary to recover from the stall. A nose-high, high-angle-of-bank attitude requires deliberate flight control inputs. A large bank angle is helpful in reducing excessively high pitch attitudes. (Refer to Sec. 2.5.5.8, “Mechanics of Turning Flight.”) Recognize and confirm the situation. Disengage the autopilot and autothrottle. Unload (reduce the angle of attack) and adjust the bank angle, not to exceed 60 deg, to achieve a nose-down pitch rate. Maintain awareness of energy management and airplane roll rate. To complete the recovery, roll to wings level as the nose approaches the horizon. Recover to a slightly nose-low attitude. Check airspeed and adjust thrust and pitch as necessary.
When airspeed is sufficiently increasing: [3] RECOVER to level flight		[3] Avoid stall because of premature recovery or excessive g-loading. To complete the recovery, roll to wings level, if necessary, as the nose approaches the horizon. Recover to slightly nose-low attitude to reduce the potential for entering another upset. Check airspeed, and adjust thrust and pitch as necessary.
Recovery to level flight may require use of pitch trim.		

Nose-low Recommendations from ICAO Doc 10011 and rationale quoted from AURTA **Warning:** Excessive use of pitch trim or rudder may aggravate the upset situation or may result in high structural loads [1] Recognize and confirm the developing situation. Announce “Nose-low”		
PF	**PM**	**Rationale quoted from AURTA 2.6.3**
[2] **A/P** - DISCONNECT	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.
A/T - OFF		
RECOVER from stall if required		**Airspeed low:** Even in a nose-low, low-speed situation, the airplane may be stalled at a relatively low pitch. It is necessary to recover from the stall first. This may require nose-down elevator, which may not be intuitive. Once recovered from the stall, apply thrust. The nose must be returned to the desired pitch by applying noseup elevator. Avoid a secondary stall, as indicated by stall warning or airplane buffet. Airplane limitations of g forces and airspeed must be respected. (Refer to Sec. 2.5.2, “Energy States.”). **Airspeed high:** Apply noseup elevator. Then it may be necessary to cautiously apply stabilizer trim to assist in

		obtaining the desired noseup pitch rate. Stabilizer trim may be necessary for extreme out-of-trim conditions. Reduce thrust, and, if required, extend speedbrakes. The recovery is completed by establishing a pitch, thrust, and airplane configuration that corresponds to the desired airspeed. (Refer to Sec. 2.5.2, "Energy States."). Remember that a very clean airplane can quickly exceed its limits. When applying noseup elevator, there are several factors that the pilot should consider. Obviously, it is necessary to avoid impact with the terrain. Do not enter into an accelerated stall by exceeding the stall angle of attack. Airplane limitations of g forces and airspeed should also be respected.
[3] ROLL in the shortest direction to wings level		[3] It may be necessary to reduce the g-loading by applying forward control pressure to improve roll effectiveness. **High-Bank-Angle Recovery Techniques:** A nose-low, high-angle-of-bank attitude requires prompt action, because altitude is rapidly being exchanged for airspeed. Even if the airplane is at an altitude where ground impact is not an immediate concern, airspeed can rapidly increase beyond airplane design limits. Recognize and confirm the situation. Disengage the autopilot and autothrottle. Simultaneous application of roll and adjustment of thrust may be necessary. ***It may be necessary to unload the airplane by decreasing backpressure to improve roll effectiveness. If the airplane has exceeded 90 deg of bank, it may feel like "pushing" in order to unload. It is necessary to unload to improve roll control and to prevent pointing the lift vector towards the ground.*** Full aileron and spoiler input may be necessary to smoothly establish a recovery roll rate toward the nearest horizon. It is important that positive g force not be increased or that nose-up elevator or stabilizer trim be used until the airplane approaches wings level. If the application of full lateral control (ailerons and spoilers) is not satisfactory, it may be necessary to apply rudder in the direction of the desired roll. ***Only a small amount of rudder input is needed. Too much rudder applied too quickly or held too long may result in loss of lateral and directional control and cause structural damage.*** As the wings approach level, extend speedbrakes, if required. Complete the recovery by establishing a pitch, thrust, and airplane drag device configuration that corresponds to the desired airspeed. In large transport-category airplanes, do not attempt to roll through (add pro-roll controls) during an upset in order to achieve wings level more quickly. Roll in the shortest direction to wings level.
Thrust and drag – Adjust (if required)		
[4] **Recover** to level flight		[4] Avoid stall because of premature recovery or excessive g-loading.
Recovery to level flight may require use of pitch trim.		

Section 8—Sample Syllabus for Operator UPRT in FSTDs

This sample syllabus contains 4 FSTD Setups for UPRT.

Setups 1-3 focus on prevention training by reinforcing manual flying skills; they contain exercises at different altitudes.

Note: FAA AC No: 120-111 recommends training at high altitudes (within 5,000 ft. of the service ceiling of the airplane), and low altitude (below 10,000 ft. above ground level); use of normal operational cruise altitudes for high-altitude training should be encouraged.

Setup 4 addresses recoveries from upsets.

All 4 setups may be integrated into existing operator recurrent lessons or provided in a dedicated UPRT FSTD lesson. The exercises are based on AURTA Revision 2, ACs and SIBs. They are non-type-specific; operators need to adapt them to their aircraft types and observe latest UPRT guidance issued by their OEMs.

Sample outline of UPRT in FSTDs		
Setup	**Content**	**Terminal training objectives**
Setup 1	Advanced Manual Flying Skills Low / Medium / High ALT	• Enhance the core competency “Aircraft Flight Path Management, manual control” • Explore handling characteristics and airplane response to *specific* primary and secondary flight control inputs • Gain confidence for appropriate application of manual flight control inputs required during upset prevention and recovery conditions • Establish energy awareness, prepare for AOA awareness
Setup 2	AOA awareness Medium / High ALT	• Transfer the Vn diagram into practical application • Explore the function of loading and unloading (manipulation of Vs), understand that g-load controls Vs • Understand that stall depends on AOA only and stall is not directly related to speed and/or attitude • Understand that recovery from stall will be based on AOA reduction only and must be separated from the application of thrust • Explore maneuvering with reduced buffet margins at cruising altitude • Perform Energy Trading at high altitude • Consolidate smooth control inputs at high altitude

Sample outline of UPRT in FSTDs		
Setup	**Content**	**Terminal training objectives**
Setup 3	FAA Specialized Flight Training Elements for Upset Prevention	• FAA required extended envelope training including steep turns
Setup 4	Recovering from upsets • Nose-low • Nose-high • High bank angle • Stall event	• Apply the OEM recommendations, apply correct control inputs, deliberately separate "push/unload" from "roll", control thrust at the correct time during recovery • Increase resilience by managing surprise and startle, and develop ability to apply counter-intuitive control inputs • Apply the airplane specific STALL RECOVERY SOP correctly and deliberately

8.1 Setup 1 – Advanced Manual Flying Skills

Advanced manual flying skills – Low ALT Intermediate Approach altitude, configuration and speed. GW = MLW	
Use of Primary Flight Controls (Primary Flight Controls are: Elevator, Aileron, Rudder)	Training Objectives • (FBW aircraft use the appropriate control laws and point out differences) • (Demonstrate effects of aft center of gravity (CG) versus forward CG)
Exercise A (AURTA SEC3, 1.) – Ailerons • Roll with full aileron to 60 deg bank, neutralize Controls, • Roll to other side 60 deg bank, • Neutralize controls and return to level flight • Maintain approximate level flight and constant airspeed	Experience roll-rate performance with full aileron inputs
Exercise B (AURTA SEC3, 2.) – Rudder • Using rudder only roll to 15 deg of bank, neutralize rudder • Then roll to opposite side to 15 deg of bank, neutralize rudder • Roll back to level flight • Maintain approximate level flight and constant airspeed	Experience magnitude of yaw and roll-resulting from small rudder inputs; compare to aileron inputs

Use of Secondary Flight Controls (Secondary Flight Controls are: Trim, Thrust, Speedbrakes)	Training Objectives (FBW aircraft use the appropriate control law and point out differences)
Exercise C (AURTA SEC3, 3.) – Pitch using trim only • Adjust stabilizer trim nose-high and nose-low	Experience the rate of pitch change **Note:** Pitch rate change occurs with delay and slowly because of slow stabilizer movement.
Exercise D (AURTA SEC3, 4.) – Pitch using thrust only • From a stabilized power setting rapidly add full power and at a stabilized power setting reduce thrust rapidly to idle	Experience the pitch change. **Note:** Resulting pitch movements depend on engine mounting.
Exercise E (AURTA SEC3, 5.) – Pitch change with the use of speedbrakes • From a stabilized condition rapidly deploy the flight spoilers	Experience resulting aircraft response.
Exercise F (AURTA SEC3, 6.) – Yaw motion and resultant roll due to asymmetric thrust with autopilot • From a stabilized condition with A/P on reduce thrust rapidly on engine(s) on one side to idle	• Experience the yaw and resultant roll • Experience the autopilots attempt to control roll and observe the decaying condition with decreasing airspeed • Experience the forces and necessary inputs to recover at A/P disengagement
Exercise G (AURTA SEC3, 7.) – Yaw motion and resultant roll due to asymmetric thrust without autopilot • From a stabilized condition reduce thrust rapidly on engine(s) on one side to idle • Recover when reaching 30deg of bank	• Experience the yaw and resultant roll • Experience the rapid onset of roll without A/P input

Advanced manual flying skills – Medium ALT FL 100, Va (Design Maneuvering Speed), GW = MLW	
Use of Primary Flight Controls (Primary Flight Controls are: Elevator, Aileron, Rudder)	Training Objectives • (FBW aircraft use the appropriate control laws and point out differences) • (Demonstrate effects of aft center of gravity (CG) versus forward CG)
Exercise A – Ailerons • Roll with full aileron to 60 deg bank, neutralize Controls, • Roll to other side 60 deg bank	Experience resulting roll-rate as a result of increased speed.

• Neutralize controls and return to level flight • Maintain approximate level flight and constant airspeed	
Exercise B – Rudder (this exercise also covers use of rudder at high altitude) • Using rudder only roll to 15 deg of bank, neutralize rudder • Then roll to opposite side to 15 deg of bank, neutralize rudder • Roll back to level flight, • Maintain approximate level flight and constant airspeed	Experience resulting yaw and roll-rates at increased speed with the same small rudder inputs; compare to aileron inputs. **Note:** Do not allow the student to reverse the rudder inputs in a cyclic manner.
Use of Secondary Flight Controls (Secondary Flight Controls are: Trim, Thrust, Speedbrakes)	Training Objectives (FBW aircraft use the appropriate control law and point out differences)
Exercise C – Pitch using trim only • Adjust stabilizer trim nose-high and nose-low	Experience the rate of pitch change **Note:** Pitch rate change occurs slowly and with delay because of slow stabilizer movement.
Exercise D – Pitch using thrust only • From a stabilized power setting rapidly add full power • At a stabilized power setting reduce thrust rapidly to idle	Experience the resulting pitch change **Note:** Resulting pitch movements depend on engine mounting
Exercise E – Pitch change with the use of speedbrakes • From a stabilized condition rapidly deploy the flight spoilers	Experience resulting aircraft response
Exercise F – Yaw motion and resultant roll due to asymmetric thrust with autopilot • From a stabilized condition with A/P on reduce thrust rapidly on engine(s) on one side to idle	Experience the yaw and resultant roll; • Observe the autopilots attempt to control roll and the decaying condition with decreasing airspeed; • Experience the forces and necessary inputs to recover at A/P disengagement.
Exercise G – Yaw motion and resultant roll due to asymmetric thrust without autopilot • From a stabilized condition reduce thrust rapidly on engine(s) on one side to idle • Recover when reaching 30deg of bank	Experience the yaw and resultant roll. Experience the rapid onset of roll without A/P input.

<table>
<tr><th colspan="2">Advanced manual flying skills – High ALT
Optimum Cruise Altitude - Turbulence Penetration Speed
(High- and Low Speed buffet limits should be visible on the PFD)</th></tr>
<tr><td>Use of Flight Controls (primary and secondary)</td><td>Training Objectives
• (FBW aircraft use the appropriate control laws and point out differences)
• (Demonstrate effects of aft center of gravity (CG) versus forward CG)</td></tr>
<tr><td>Exercise A – Ailerons
• Roll with ailerons to 30deg bank, neutralize Controls,
• Roll to other side 30deg bank
• Neutralize controls and return to level flight
• Maintain approximate level flight and constant airspeed</td><td>• Experience resulting roll-rate at high TAS
• Observe change of maneuver margin on PFD</td></tr>
<tr><td>Exercise B – Elevator
• Increase pitch attitude slightly
• Set max. thrust
• Manage AOA to stay above min. airspeed</td><td>• Experience resulting Vs
• Experience resulting change of airspeed
• Experience increasing AOA and decreasing buffet margin as the situation develops
• Experience that thrust available may be insufficient to maintain airspeed
• Experience that energy trading (trade altitude for airspeed) may be necessary to maintain buffet margin</td></tr>
<tr><td>Exercise C – Thrust and Acceleration</td><td>• Acceleration between two speeds of which the airplane is capable, compare to low and medium altitude (e.g., accelerating between 200 and 250 knots at low altitude and high altitude, which corresponds to Mach changes at high altitude) to demonstrate changes in available thrust.
• The relationship between Maximum Cruise/Climb/Continuous Thrust and takeoff/go-around (TOGA) power settings at high altitude.</td></tr>
<tr><td>Exercise D – Pitch change with the use of speedbrakes
• From a stabilized condition rapidly deploy the flight spoilers</td><td>• Experience resulting aircraft response</td></tr>
</table>

Exercise E – Thrust loss on all engines • Set pitch acc. SOP and establish idle descent	• Observe resulting airspeed • Observe AOA and resulting Vs • Observe increase of maneuver margin with decreasing altitude • Experience stable idle thrust descent
Exercise F – Unreliable Airspeed • Set pitch/power from SOP Unreliable Airspeed	• Observe resulting airspeed and maneuver margin • Observe AOA and resulting Vs • Compare flying techniques, speed controlled by elevator versus speed controlled by thrust • Unplanned transition from automated to manual flight, including transition from using a flight director to "raw data"

8.2 Setup 2 – AOA and G-Awareness

The Vn diagram (which is often taught in a purely academic manner) is essential to help a pilot understand that stall speed is variable as it depends on g-load (at 0g the Vs is 0kts!). Therefore exercises to practically explore the Vn diagram are essential. They show that the aircraft may not stall at the published 1g stall speed, but may stall at different airspeeds in other than 1g conditions, to see the negative effect of "loading" and the benefit of "unloading" and to understand maneuvering limitations and, if installed, g-load protections of the aircraft. This Setup forms the basis for upset recovery exercises including the STALL RECOVERY SOP in Setup 3.

AOA and G-Awareness – Medium ALT FL 100 - Clean Maneuvering Speed	
Exercise	Training Objectives • (FBW aircraft use the appropriate control laws and point out differences) • (Highlight type-specific systems that use AoA inputs with emphasis on warning systems and limitations of those systems)
Exercise A (level flight) • Level turn with 45° bank • Load and unload a/c by elevator input • "play" with Vs	Experience increase / decrease of Vs with varying g-load Understand that g-load and not bank angle increases Vs. Separate g-load from bank. **Notes:** 1. Loading increases Vs, unloading reduces Vs. At 0-g the stall speed is 0! Stall at g-loads higher than 1g is called "accelerated stall" 2. AOA reduction during stall recovery is accompanied by

	unloading; unloading reduces the stall speed and provides time to regain airspeed necessary for normal flight. 3. Thrust application will not reduce AOA; with underwing-mounted engines the resulting pitch-up moment may even increase AOA. Avoid to under/over control of pitch inputs.
Exercise B (nose below horizon) • Establish 45° bank turn • Power idle • Pitch -7,5° • Load and unload a/c by elevator input	Experience increase/decrease of Vs with varying g-load Experience that AOA (risk of stall) is independent from **attitude**. **Notes:** 1. Loading/unloading increases/decreases Vs also in nose-below-horizon attitudes. 2. Recognize risk of secondary stall, which happens when loading too much during recovery.

AOA and G-Awareness – REC MAX ALT Note: From an AOA awareness aspect it is important to deliver training at low and high altitudes because with typical modern swept wing jet aircraft the critical AOA varies largely with Mach-No. ECON Cruise Speed	
Exercise C (buffet margin) • Determine buffet margin from QRH • Perform level turns at 15° / 30° / 45° bank	Experience that level turns increase g-load and therefore decrease the margin to buffet. **Notes:** 1. Understand advantage of lower bank angles when maneuvering at high altitude. 2. Critical AOA is lower at high Mach numbers.
Exercise C Prevention of Hazardous Low Speed at High Altitude Cruise	Determine L/D max. Experience effects of speed reduction from trimmed flight condition at cruise Mach. Explore front-side and back-side of the drag/power curve, compare to low/medium altitude. Experience that descent is necessary to avoid stall and recover the initial targeted Mach, if continuous Mach decrease cannot be stopped after the maximum thrust has been applied and Mach/airspeed indication can be considered reliable.
Exercise D (energy management/energy trading) • Reduce speed in level flight to Vls with slightly reduced power setting • Stabilize at Vls • Set maximum thrust and	Experience time needed to regain maneuvering speed. Experience time and altitude loss needed to regain maneuvering speed. Experience temporary increase of Vs during loading and temporary decrease of Vs during unloading. **Notes:** 1. React to the first indication of high AOA always by reducing AOA (unloading).

observe resulting acceleration and time required to regain speed • Reduce again to Vls with slightly reduced power setting • Maintain reduced power setting • Apply nose-down input to establish descent • Continue descent to regain maneuvering speed • Set cruise thrust • Level off	2. Energy trading is key at high altitude. Trade altitude for speed. Due to thrust limitation at high altitude, altitude loss must be accepted when recovering from high AOA. At high altitudes altitude loss is significant and time needed to regain speed is high.

Note: Vls is used synonymous to Minimum Maneuvering Speed.

8.3 Setup 3 – FAA – Specialized Flight Training Elements for Upset Prevention

The table below shows the FAA required extended envelope training including steep turns.

FAA required Specialized Flight Training Elements for Upset Prevention	
Manually-controlled slow flight	Refer to AC No: 120-111, Appendix 1 and Appendix 2 for detailed descriptions of the required maneuvers, scenarios or procedures
Steep turns	
Manually-controlled loss of reliable airspeed	
Manually-controlled instrument departure and arrival	

Setups 1-3 should include instruction on the causes and contributory factors that may lead to upsets. Mechanical/aeroplane systems failures and malfunctions, related to systems, instruments (including inaccurate indications, e.g., unreliable airspeed), power, and automation should all be incorporated into training, whenever applicable. Flight envelope protection in normal and degraded modes should be demonstrated and differences in symbology, instrumentation, and flight characteristics should be highlighted as appropriate.

8.4 Setup 4 – Recovering from Upsets Including Stall Recovery

<table>
<tr><th colspan="3">Recovering from Upsets including Stall Recovery</th></tr>
<tr><th colspan="3">NOSE-HIGH / NOSE-LOW / HIGH BANK[23]</th></tr>
<tr><th colspan="2">Exercise</th><th>Training Objective</th></tr>
<tr><td rowspan="3">AURTA
Exercise 1
NOSE-HIGH</td><td>Use of Nose-down Elevator</td><td rowspan="7">Apply SOPs
or
OEM Recommendations</td></tr>
<tr><td>Use of Bank Angle</td></tr>
<tr><td>Thrust Reduction (Underwing- Mounted Engines)</td></tr>
<tr><td rowspan="4">AURTA
Exercise 2
NOSE-LOW</td><td>Nose Low Recovery</td></tr>
<tr><td>Accelerated Stall Demonstration</td></tr>
<tr><td>High Bank Angle/Inverted Flight
Notes: 1. Observe current OEM guidance
2. Consider using wake vortex encounter or “sub-threshold roll” as causes for high bank angle</td></tr>
<tr><td>Optional Practice Exercise</td></tr>
<tr><th colspan="3">STALL EVENT[24]</th></tr>
<tr><td rowspan="5">Exercise 1
STALL PREVENTION TRAINING
(from approach-to-stall)</td><td>Impending stall recovery with only Idle Thrust Available</td><td rowspan="6">Apply SOPs</td></tr>
<tr><td>Stick Pusher Demonstration
(if installed)</td></tr>
<tr><td>Clean configuration Stall Prevention (Low and High Altitude)</td></tr>
<tr><td>Takeoff and Initial climb, or Maneuvering configuration Stall Prevention</td></tr>
<tr><td>Landing configuration Stall Prevention during Approach Phase</td></tr>
<tr><td>Exercise 2
STALL RECOVERY TRAINING **
(from aerodynamic stall)</td><td>Full Stall Experience Training
** Requires considerable evaluation of the FSTD before being conducted. Full Stall Experience Training has been mandated by FAA only.</td></tr>
</table>

[23] AURTA SECTION 3 Simulator Training Exercises

[24] FAA AC No:120-109 / Proposed AC No:120-109A (pending), AC No:120-111, EASA SIB No: 2013-02

Section 9—Instructors

9.1 Regulatory Aspects

ICAO has mandated UPRT for MPL, type-rating and recurrent training, and recommended it for CPL courses. Instructor qualification requirements are currently being developed by the national authorities. AC No: 120-111 Chapter 2 describes instructor requirements, training and standardization/validation under FAA.

ICAO Doc 10011 Chapter 5, Paragraph 5.2, states that “Regardless of an individual’s background, all instructors assigned to provide training in a UPRT program should successfully complete a UPRT instructor qualification training course approved by the Licensing Authority.”

It is expected that in the future:

- Risk assessment of on-aeroplane UPRT may lead to special qualification requirements for UPRT flight instructors
- Instructor training courses for FTSD instructors will include UPRT elements
- Operators and ATOs will be required to provide appropriate UPRT instructor training courses (train-the-trainer courses) to their existing instructors before they can deliver UPRT

There is consensus that special emphasis on instructor training is needed as “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”. [25]

9.2 Training and Standardization

9.2.1 The Core-Group

When starting a UPRT project, operators should first select an individual or a team to be charged with the design and implementation of the program. This team should form the core-group of instructors to setup the UPRT program. As an example, operators with several fleets might select two instructors per fleet as core instructors.

The core-group will first acquire expertise, then design the program, thereafter start UPRT and in parallel train the remaining regular instructors of the operator for that task.

[25] ICAO Doc 10011 Chapter 5, Paragraph 5.1.1.

Thorough training and standardization of the core-group is one key to success as the core-group will be tasked with training and standardization of all regular instructors later on. When selecting instructors for the core-group the following aspects should be considered:

- Motivation to deliver UPRT
- All-attitude flying experience (civil or military aerobatics)
- Experience as a Flight Instructor
- Experience as Test Pilot
- Experience as FTSD instructor

Instructors selected for the core-group should then be qualified through a UPRT train-the-trainer course.

9.2.2 Train-the-Trainer Course for Core-Group FSTD Instructors

The aim of the train-the-trainer course for core-group FSTD instructors is to qualify them to deliver UPRT and to enable them to train the remaining regular instructors of the operator.

As an example, the initial course for core-group FSTD instructors may include:

Pre-studies and Academic instructor training
On-aeroplane UPRT (human factors – counter intuitive behaviors)
FTSD training

The operator may build an "in-house" train-the-trainer course (if possible supported by experts, i.e., Training Captains with previous experience as test pilots, etc.) or send the core-group to an experienced UPRT provider. Typically train-the-trainer courses take 4-5 days and contain academic, on-aeroplane and FSTD training. Academic training elements for instructors include knowledge of the FSTD VTE, UPRT related functions of the IOS and instructional aspects specific to the delivery of UPRT[26].

Notes:
1. ICAO Doc 10011 Chapter 5 and AC No: 120-111 Chapter 2.5 describe training elements and subject areas of instructor training to ensure accurate UPRT and to minimize the risk of negative transfer of training.
2. On-aeroplane training for the core-group instructors is not a requirement. It is recommended however to allow the core-group to acquire first-hand experience of the success-critical human factors during recoveries of upsets. The core-group will later-on train the operator's regular

[26] ICAO Doc 10011, Section 5

FSTD instructor staff, who normally do not possess this experience and will have to rely on the expertise of the core-group to compensate for this gap.

FSTD instructor training for the core-group should include a part where the instructor flies the recovery maneuvers as a trainee and a second part where he practices teaching under supervision. Such instructor training does not necessarily need to be type-specific, as in some cases the core-group will be composed of instructors of several fleets, and fleet-/type-specific UPRT program variants will have to be developed by them in the next step.

Once qualified, the core-group will develop the operator's type-specific UPRT programs for each fleet (ideally in cooperation with the OEMs) and finally submit them for approval to the authority.

Before qualifying the remaining regular FSTD instructors of the organization, it would be beneficial for the core-group instructors to gain experience in the delivery of UPRT by teaching trainees for a certain time. Ideally, this phase would be supervised/accompanied by an experienced mentor, preferably from the initial UPRT train-the-trainer course.

9.2.3 Regular Instructor Training

The authority should be involved again when designing the instructor training course for the remaining regular instructors of the organization. This course should be type-specific and will normally be conducted in FSTDs of the operator.

As a minimum the course should include:

Pre-studies and Academic instructor training
FTSD training – Plus*

Academic and FSTD training can be structured in the same way as for the core-group.

* As regular instructors might not receive on-aeroplane UPRT, additional emphasis should be placed on their ability to teach the human-factor effects during recovery exercises in the absence of realistic motion cues in FSTDs.

When selecting and qualifying new instructors, the operator should consider requiring recent on-aeroplane UPRT experience or including such training in the initial instructor training course.

9.2.4 Standardization

New UPRT instructors should teach under the supervision of a core-group instructor until they are competent in delivering the course. Thereafter UPRT should become a regular topic of the existing instructor standardization program; it can be included in instructor meetings, instructor assessments, etc. AC No: 120-111 Chapter 2-6 divides Instructor Standardization into Initial Standardization Validation and Continuing Standardization.

Standardization topics in general should include:

- Correct demonstration of the operator's/OEM recommended upset recovery techniques and SOPs
- Ability to distinguish between SOPs and recommended techniques
- Understanding of the importance of adhering to the scenarios that have been validated by the training program developer, and correct facilitation of the scenarios to trainees
- Capabilities and limitations of FSTDs:
    - Understanding of the capabilities and limitations of the FSTD used for each UPRT exercise
    - Appropriate use of the Instructor Operating Station (IOS) of the FSTD in the context of effective UPRT delivery
    - Appropriate use of the FSTD instructor tools available for providing accurate feedback on flight crew performance
    - Awareness for the potential of negative training that may exist when training outside the capabilities of the FSTD
- Understanding the missing critical human factor aspects due to the limitations of the FSTD's motion system, and conveying this to the trainees to support their resilience.

9.3 Instructors, Practical Guidance

The topics contained in this section are selected highlights, but not a complete list, from various source documents and are intended to support instructors and operators when developing the instructor training course.

9.3.1 Understanding AOA

Instructors should ensure that trainees know:

A) Where the AOA can be identified on the flight instruments

B) That critical AOA at a given aircraft configuration depends mainly on Mach-No.

C) That critical AOA at high Mach-No. is lower than at low Mach-No.

D) That critical AOA increases when slats are extended

E) That critical AOA decreases when trailing edge devices are extended (flaps/ ailerons)

F) Stall is always related to high AOA

G) Stall can occur at any attitude

H) Stall can occur at any airspeed

9.3.2 Teaching the Stall Recovery SOP

Instructors should ensure that:

A) They do not distinguish between approach-to-stall and aerodynamic stall conditions and instruct trainees to always immediately react to any stall warning[27] by decreasing the AOA (pushing/unloading).

B) Trainees understand the benefits of "unloading" when applying the Stall Recovery SOP. Unloading directly reduces the stall speed, which might eliminate the stall condition already before / until sufficient airspeed for flight at 1g or higher than 1g is regained.

C) Besides increasing thrust to regain airspeed, thrust may also be used as a secondary flight control to assist pitch movements. In certain stall conditions and with underwing mounted engines thrust reduction to induce a nose-down moment may be necessary; the ability to reduce thrust if necessary during a stall recovery is a counter-intuitive action which requires training; in some cases unlearning of existing habits may be necessary.

9.3.3 Teaching the OEM Recommendations

Flight crews are faced with several SOPs containing memory items. To recover from undesired aircraft states related to LOC-I the predominant SOPs appear to be STALL RECOVERY and UNRELIABLE AIRSPEED. The OEM recommendations for recovery from nose-high and nose-low attitudes are not necessarily procedural as the number of possible upset conditions and energy states is infinite; they are for guidance only and present a series of options for the crew.[28]

To recognize and memorize the small differences in the sequence of steps between the NOSE-HIGH and NOSE-LOW recommendation (they are also referred to as "techniques" or "strategies") might be challenging for regular crews and distinction from other SOPs might be difficult.

Instructors should in particular:

- Analyze and fully comprehend the strategies and underlying rationale of the OEM recommendations
- Understand the effectiveness of control surfaces and the order in which the control surfaces lose and regain their effectiveness (e.g., spoilers, ailerons, etc.)

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[27] See Section Definitions related to UPRT for clarification of terms

[28] ICAO Doc 10011, 3.5.3

- Know UPRT related essentials of transport category airplane certification requirements
- Point out
  - The necessity for smooth, deliberate, and positive control inputs to avoid unacceptable load factors and secondary stalls
  - Avoiding cyclical or oscillatory control inputs to prevent exceeding the structural limits of the airplane
  - Structural considerations, including explanation of limit load, ultimate load, and the dangers of combining accelerative and rolling forces (the ***rolling pull***) during recovery

As a teaching methodology, some operators (see also TCCA for the stall recovery template[29]) support learning of the ICAO/OEM recovery recommendations by offering alternative ways to present the required steps.

The following tables show examples and variants of such teaching methodologies. The terms used are examples and are not explained in detail.

Note: The sequential steps shown will not always necessarily trigger actions.

Recognize and confirm
DISCONNECT

UNLOAD	Thrust and Drag as required
ROLL	
STABILIZE	

Or

Centralize - Analyze
DISCONNECT

PUSH
ROLL
POWER
STABILIZE

[29] TCCA AC 700-031, 8.3

Or

Recognize and Confirm - Disconnect

PUSH to UNLOAD	
ROLL	Thrust and Drag as required
STABILIZE	

It is important however for operators to be aware that such methodologies serve as learning aids only and that in all cases where operators might suggest using a technique that differs from the published OEM recommendation, a determination of “no-technical-objection” should be obtained from the respective OEM.

9.3.4 Teaching Human Factors in the FSTD

9.3.4.1 Achieving Resilience

Flight crew resilience has been defined by EASA as “the ability of a flight crew member to recognize, absorb and adapt to disruptions”. (A system is resilient if it can adjust its functioning prior to, during, or following events -changes and disturbances, but also opportunities-, and thereby sustain required operations under both expected and unexpected conditions).

Flight crew resilience can be increased by raising the level of competence and by achieving the appropriate level of confidence (trust). Besides teaching technical knowledge and skills, instructors should be aware of their obligation to deliver UPRT in a spirit of collaborative learning so that success is possible. Success will allow crews to build positive thinking and confidence that they are able to prevent upsets and to recover successfully. Such experience may positively contribute to resilience and consequentially reduce the level of stress in difficult situations. Lower stress-levels will then allow problem-focused coping with the situation and avoid or reduce emotional effects, such as attention channeling and degraded information processing.

9.3.4.2 Deviating from 1g

In simple words, it is common understanding that motion systems of modern full flight simulators are only capable of delivering less than 10% of the real g-loads. Hence, when teaching upset-recovery exercises instructors are faced with the problem that the simulation environment cannot deliver the real sensations associated with the exercises (sometimes referred to as “teaching how to swim without water”). As the human factors in recovery situations are essential, it is up to the instructor to compensate for the shortcomings of FSTD motion by persistently including hints regarding the actual “feel” during the exercises.

Note: First-hand all-attitude on-aeroplane experience is beneficial to UPRT students and instructors. For many of today’s instructors it might have been long ago since they received such training or some may not have received it at all in their career. Therefore, it might be considered to undergo or refresh all-attitude training during UPRT instructor training courses.

G-loads: During an aircraft upset and subsequent recovery, g-loads that vary greatly from the +1g feeling of level flight may be experienced by the crew. Pilots not familiar with such g-load deviations might suffer from degraded perception and psycho-motor performance.

G-loadings below +1g: G-loads below 1g may be experienced at any time when unloading the wing to reduce AOA during a STALL RECOVERY or nose-high recovery and therefore are vitally important in UPRT.

G-loadings between +1 and zero create a physiological effect that might feel like “floating". Normal movements of the arms and legs are not affected, but as the loading approaches zero movement can become uncoordinated because of the lack of normal gravitational cues. Flight close to zero-G removes all 'normal' load from the airframe and is thus structurally benign; but prolonged low-g sensations may lead to regurgitation or vomiting in those unfamiliar with the weightless sensation.

At g-loadings less than zero, unsecured items or personnel will move towards the aircraft "ceiling". Crew will be incapacitated unless secured by belts and will have to maintain a physical effort to keep their feet on the floor or rudder controls. At -1g pilots may experience sensory inputs equivalent to being inverted, even though the aeroplane may be physically upright. Pilots without previous exposure to this situation are likely to be disorientated and incapacitated, thus unable to ensure returning of the aeroplane to a normal flight path.

G-loadings exceeding +1g: G-loads greater than 1g may be experienced during the later stages of recoveries from Nose-low attitudes, STALLs or when initiating a PULL-UP maneuver following a GPWS alert. Transport aircraft are certificated to withstand g-loadings in the range of -1g to +2.5g, or +3g in some business aircraft. Sustained high positive g-loadings can induce loss of vision and subsequently loss of consciousness, but not when the duration of the exposure is short, 2-3 seconds, or within the range of -1 to 2,5g.

The increase in limb weight as the g-loading increases hinders control operation in those unfamiliar with the condition. At +2g, most people without prior experience are unable to lift a foot from the floor or to maintain a visual scan of their surroundings. Between +2g and +3g this temporary incapacitation can be easily overcome by trained pilots, but might result in stasis and lack of situational awareness in pilots unfamiliar with the sensations.

G-load tolerance. Exposure during on-aeroplane training or on specialized UPRT platforms[30] to these "unusual" g-loadings increases crew resilience by improving g-load tolerance, reduction of disabling symptoms such as startle, and the ability to retain psychomotor functions. Retention of this tolerance relies on the recency and regularity of the exposure.

[30] Chris Long, CAT Magazine - Issue 6/2014

9.3.4.3 Motion ON or OFF

The use of motion in FSTDs becomes relevant for UPRT when pilots are taught to include this particular stimulus in their prevention and recovery skills. Literature comparing the use of motion versus no-motion in upset maneuvering is available as given below[31] [32].

This literature does not elicit concerns for using typical hexapod motion in UPRT.

Field: "No negative effect was observed when upset or stall maneuvers were flown on motion compared to fixed base, this suggests that motion can be applied for UPRT on conventional simulators."[33]

Groen: "Moreover, the study showed no negative effects of conventional hexapod motion versus no-motion simulation on UPRT."[34]

AC 700-031 of TCAA states:

> "(1) As an aeroplane approaches a stall, it typically becomes less stable and, in some cases, may even become unstable. This may be characterized by degraded, ineffective or reversed control inputs, or uncontrolled departures from stable flight conditions in roll or pitch. Motion feedback is particularly important as a system becomes less stable, where visual information may not provide timely feedback. The human eyes are relatively slow compared to the vestibular system and visual information may not even be available, depending on the situation or scenario. In the approach-to-stall regime, FFS motion cueing can provide significant benefits to recognizing changes to the airplane stability, and applying proper recovery techniques.
>
> (2)….
>
> (3) Buffet is an important indication of stall and the approach to stall. For some aeroplane types, buffet may be the first indication of stall at high altitude or in icing conditions. For training, it is important that the onset and amplitudes of the buffet components are consistent with the occurrence of stall warning and the stall break or critical stall angle of attack. Considerable variation may exist in buffet onset and randomness in the buffet magnitude depending on entry rate and load factor."

When tuned correctly, motion feedback can help pilots recognize upset conditions and trigger timely intervention. Initial accelerations during upsets, such as from a wing-drop during stall events can be simulated by current hexapods devices.

Therefore, it can be assumed that most modern FSTDs are able to fully support prevention training.

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[31] AIAA 2012-4949, Some Aspects of Upset Recovering Simulation On Hexapod Simulators

[32] 2012-4947, Development and Testing of an Adaptive Motion Drive Algorithm for Upset Recovery Training

[33] AIAA 2012-4948, Developing Upset Cueing for Conventional Flight Simulators

[34] AIAA 2012-4630, SUPRA – Enhanced Upset Recovery Simulation

For recovery training the limitations of motion systems must be carefully observed. The disparity between the real aircraft motion cues and the simulator motion cues increases in upset recovery training compared to prevention training.

Hexapod motion systems are unable to create sustained positive or negative g-loading in the vertical direction, or along the pilot's spine. During recovery from upsets, the airplane may undergo unloading or positive loading, which FFS motion systems cannot replicate. It is impossible to correctly reproduce these motions 1:1 in any device except in the real airplane. Instructors are therefore obliged to point out to trainees that the sensations in the FSTD will vary from the ones experienced on the aircraft.

As there will indeed be confusing sensations during any real upset condition, it is difficult to conclude that training in a "no-motion-cues" environment would be more adequate. Therefore, in general, the use of FSTD motion is recommended. "Motion in an FFS should be used when those cues influence recognition or recovery."[35]

9.3.4.4 Visual Meteorological Conditions (VMC) or Instrument Meteorological Conditions (IMC)

The Commercial Aviation Safety Team (CAST) study of 18 accidents and incidents determined that 17 occurred in IMC or night. Recovery training should therefore be done in both visual and instrument conditions, as well as in day and night.

9.3.4.5 Surprise, Stress and Startle

Stress is an individual's reaction to the perception of threat and it manifests itself physiologically, emotionally, and cognitively. Startle is one of the responses of the human brain to an emotional stimulus. The startle reflex is common to all mammals, birds, reptiles and amphibians. It happens within milliseconds following a startling stimulus, possibly caused by the potential threat. If the threat persists, the startle may transition from a simple aversive reflex to a full-blown startle or surprise reaction (sometimes also referred to as startle response).[36]

Note: "The perception of threat comes about through a conditioning process, a gradual learning of what is fearful and what isn't which we develop throughout our lives. The amygdala, which is part of the emotional centre of the brain, is largely responsible for this appraisal of threatening stimuli, and is continuously involved in evaluating the environment for meaningful components... Where the amygdala does detect something which has been previously associated with harm, threat, loss, or even challenge, then it will induce autonomic bodily reactions to help manage those stressors... These are commonly referred to as "fight or flight" reactions, and involve the activation of the

[35] FAA AC No: 120-111

[36] Martin, W.L., Murray, P.S., & Bates, P.R. (2010). The effects of stress on pilot reactions to unexpected, novel, and emergency events

sympathetic nervous system which enables the individual to deal physically with a threatening situation, and to orient the attentional system.

The other role of the amygdala and its related brain structures is the ongoing evaluation of coping mechanisms which would relieve the stress. This “secondary appraisal” is a process designed to alleviate an organism’s stress by employing compensatory or coping strategies in order to return it to a state of homeostasis, or neutrality. These coping mechanisms may be long term strategies (generally called defence mechanisms) or may be short term, dynamic solutions employed to ease the perception of the situation.

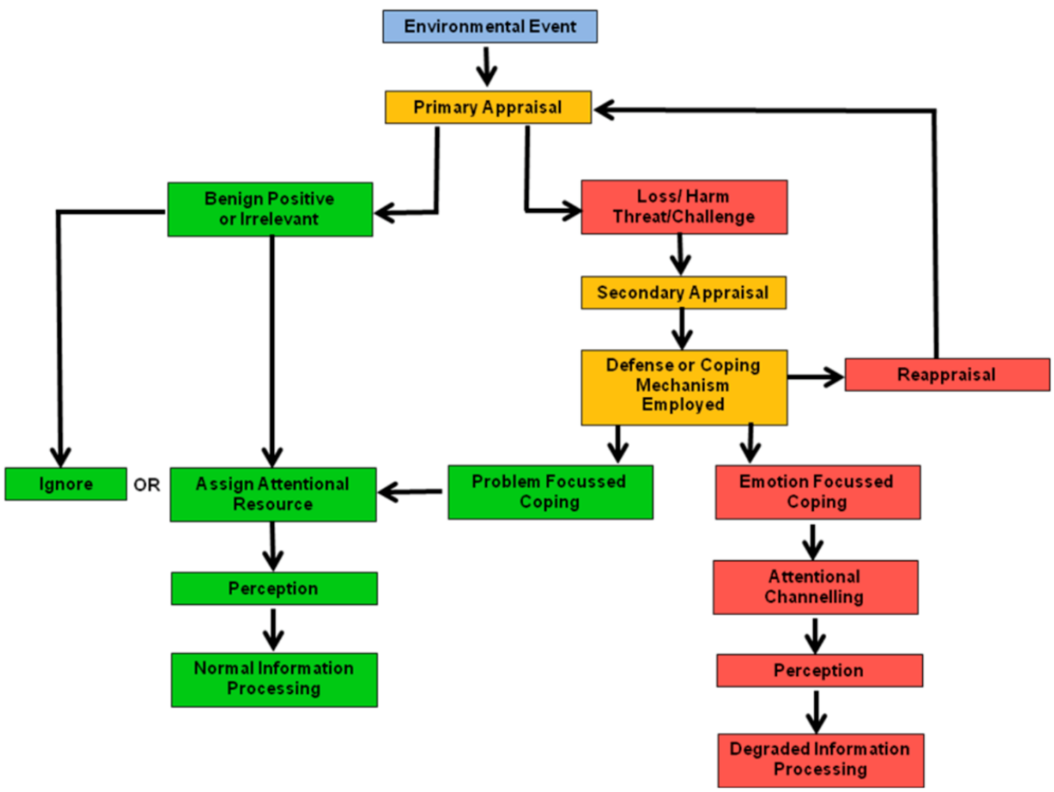
Coping mechanisms fall under two distinct categories: problem focussed coping, and emotion focussed coping... Problem focussed coping strategies are generally employed where the individual has some control over the situation and can take some positive action to change or remove the problem... This is largely a rational, orchestrated mechanism which facilitates normal information processing, with nominal working memory and long term memory function.

The second form of coping is the principal area for concern. Emotion focussed coping is generally employed where an individual feels no control over the situation, and is forced to take some withdrawal type action to avoid the harsh reality of the situation... Techniques such as denial are common in these types of situations, however other dissociative mechanisms such as freezing may also occur... Any of these emotion focussed coping mechanisms are very likely to be detrimental to situation outcome, and generally involve a partial or total breakdown in normal information processing.”[37]

[37] Martin, W.L., Murray, P.S., & Bates, P.R. (2010). The effects of stress on pilot reactions to unexpected, novel, and emergency events.

Martin, Murray and Bates[38] propose a certain relationship between appraisal, coping and information processing as provided in the table below.

Conceptual Relationship between Appraisal, Coping, and Information Processing



Reactions to surprise and startle are difficult to predict. The behavioral consequences can vary from being passive to uncontrolled instinctive reflexes, instant inadequate motor responses or an emotional shock. "Failure of a relatively simple system (e.g., radio altimeter) may have a cascade effect that may result in catastrophic outcome"[39]. Such effects may also appear at unexpected autopilot disengagements, an overspeed indication, an unexpected behavior of a system, etc. They may be amplified by a lack of proficiency in manual flying skills or inadequate training.

Potentially, surprise and startle can distract and occupy a crew for some time and control inputs may further destabilize the aircraft's flight path. To train crews to manage surprise and startle it is recommended to

[38] Martin, W.L., Murray, P.S., & Bates, P.R. (2010). The effects of stress on pilot reactions to unexpected, novel, and emergency events.

[39] IATA Safety Report 2013

include elements of "unexpectedness" in UPRT. Scenarios should include the effects of surprise in order to train pilots to face these phenomena and to work in situations with a highly charged emotional factor.[40]

The goal of using startle in training is to provide the crew with a startle experience, which allows for the effective recovery of the aeroplane. Considerable care should be used in startle training to avoid negative learning.[41]

Further guidance on "how to induce startle or surprise" can be taken from the AURTA and the ICATEE Research and Technology Report.

> "The surprise factor can be recreated in a simulation environment through the management of pilot's expectations in a training scenario to generate realistic unexpected distractions. Research is required to identify the best methods to introduce cognitive surprise within a training scenario in a realistic manner. In this way, the skills that are required in an unexpected event, such as an upset, can be trained to a level where the surprise factor can be anticipated, and potentially managed. The level to which surprise can be achieved in ground-based simulation that is transferable to the mentally and physically demanding environment of an upset needs to be identified.
>
> The physiological effects of startle that apply to managing an aeroplane upset cannot be fully achieved in ground-based simulation. The inclusion of on-aeroplane training in a UPRT program therefore immerses the pilot within an environment where the startle and surprise factor are present and are an important contribution to the training. The ability to reproduce the key physiological factors of startle in a ground-based simulator is a research topic for future UPRT support. The full effect of startle on the response of a trained pilot has not been analyzed, particularly with respect to upset recovery. This would be an important element of this research. This research would contribute to the definition of the optimum combination of training environments for initial and recurrent UPRT"[42].

9.3.4.6 Counter-Intuitive Behavior

Several vitally important flight control inputs required by pilots during upset recovery maneuvers are considered to be counter-intuitive. Training is needed to enable crews to perform counter-intuitive actions reliably. Some of the conditions requiring counter-intuitive actions are:

- Reducing thrust (with underwing mounted engines) in a stall recovery to achieve a nose-down pitch movement
- Unloading (pushing) during stall recovery in a nose-down attitude
- Unloading (pushing) at high bank angles before rolling wings level

[40] Recommendation FRAN-2012-046

[41] TCCA, AC 700-031, 7.3.5

[42] RAeS ICATEE Research and Technology Report, Part A, 5.2

- Not rolling wings level in nose-high situations before pitch attitude is acceptable and airspeed is sufficient
- Maintaining high g-load (up to 2,5g) during Ground Proximity Pull-Up

FSTD instructors should consider that counter-intuitive actions would be even more challenging under the influence of real accelerations.

9.3.4.7 Avoiding over-confidence

UPRT should be delivered in a very focused and professional manner. When trainees perform well they may be tempted to ask their instructors to try out additional maneuvers, or instructors may wish to add some challenges to syllabi and exercises. Both ideas can easily lead to over-confidence or more likely to failures and affect all previous learning outcomes. Instructors should set an example of flight crew discipline and professional attitude for the trainees.

9.4 Renewing Mental Models of Aerodynamics

The following topics are examples of areas where UPRT may provide an opportunity to realign or refresh previously acquired mental models for the benefit of better understanding prevention and recovery strategies.

9.4.1 Stall Speed is Variable, Unloading May Reduce it to ZERO

The Vn diagram can be used to explain in a practical way that the certified 1g stall speed may be less relevant during actual flight operations, as the aircraft may not be in a 1g condition when it stalls.

Instructors should ensure that trainees know that:

- Stall speed is variable, it depends on g-load
- The aircraft may stall at any speed
- Unloading is achieved by a nose-down elevator input, “PUSH”
- “PUSH” also applies at bank angles beyond 90 degrees
- Unloading decreases stall speed
- At 0g the stall speed is Zero
- Bank angle per se does not increase stall speed, loading increases stall speed
- By loading or unloading you can increase or decrease stall speed

Discussion:

Wing loading, unloading and stalling speeds: When an aeroplane is flying in other than 1g conditions (induced by any initial elevator input, during level turning, etc.) any change of g-load changes the stall speed. Critical AOA is then reached at higher or lower airspeeds than in 1g- conditions.

The increase or decrease in stalling speed is related to g-loading only. The related numbers are shown in the following table: angle of bank is only relevant when maintaining altitude and increasing g-load to maintain level flight, otherwise the angle of bank has no influence on the stall speed.

Loading increases Vs						
Increased G-loading (“loading”)	1.03g	1.15g	1.41g	2.00g	2,5g	3.86g
Increase of Vs	1.4%	8%	19%	41%	58%	96%
Angle of bank **in level turn**	15°	30°	45°	60°	67°	75°
Unloading decreases Vs						
Decreased G-loading “unloading”	0g	0.25g	0.5g	0.75g	1g	
Reduction of Vs	100%	**50%**	**30%**	13%	Vs_{1g}	

The relationship between angle of bank and g-loading or stalling speed is non-linear. Of particular interest is the rapid increase of g-loading and stalling speeds at bank-angles in excess of 45° when maintaining altitude in turning. As the critical AOA changes with Mach number (at high Mach no. it is lower than at low Mach), g-loading (for example by level-turning) at high altitude is more critical.

If g-loading is reduced to less than 1g, for example in transitioning from a climbing to a descending flight path or by unloading during STALL RECOVERY, the wing may remain un-stalled at speeds well below published 1g stall speed.

Adequate unloading to 0.5g or 0.25g still *maintains positive g-load* of the aircraft (no objects floating around in the cabin or cockpit) but decreases stall speed by 30-50%.

9.4.2 It is Always “Push” to Unload – Even Beyond 90deg of Bank

If the airplane is close to the critical AOA, the unloading action is always to apply a nose-down elevator input (PUSH) regardless of bank angle or pitch attitude.

9.4.3 Stall Warning

Instructors should remind their trainees that besides synthetic indications, natural indications might also precede stall events[43]. Natural Stall warnings may be:

- Reduced roll stability and aileron effectiveness
- Reduced elevator (pitch) authority
- Inability to maintain altitude or arrest rate of descent
- Aerodynamic buffeting (some airplanes will buffet more than others)

The mental model of "how the airplane talks to you" might help trainees be receptive to indications associated with high AOA.

9.4.4 Flight Controls

Instructors should:

- Refresh trainees on the concept and control responses of Primary and Secondary Flight Controls
- Explain the use of rudder for normal flight, abnormal and emergency conditions
- Explain the risk of inappropriate rudder inputs
- Explain the conditions under which the use of rudder may be considered during application of the OEM Recommendations for NOSE-HIGH/LOW situations as described in AURTA and ICAO Doc 10011; if available, instructors should refer to the type-specific procedures and recommendations of the aircraft manufacturer.[44]

9.4.5 Energy Management

Instructors should:

- Refresh the trainees on the 3 types of energy available
- Explain how to determine the "energy state" of the aircraft (there is no direct indication for it)
- Explain how to put the energy state of the aircraft into operational context (e.g., speed *margin* over stall speed and the altitude *margin* above obstacles)
- Explain the difference between thrust and energy state
- Explain energy trading (for example at high altitude)

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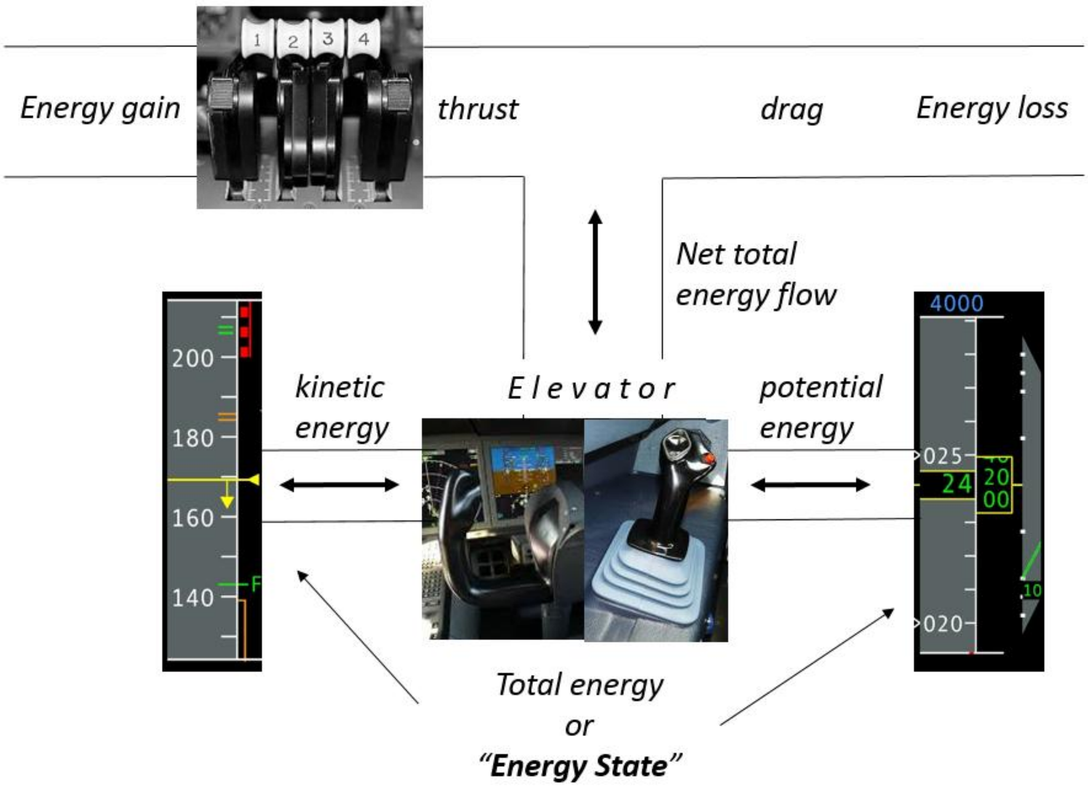
[43] See Section Definitions, Stall Warning

[44] ICAO Doc 10011, FAA AC No: 120-111, Proposed AC120-109A

The following picture shows one of the various models available to illustrate energy management.[45]

Energy Management Model



In this model the role of thrust and elevator in controlling the aircraft's energy balance is shown. Thrust levers control the energy gain while the elevator, like a "valve", regulates the distribution of net-energy between altitude and airspeed.

9.5 Avoiding Negative Training – Negative Transfer of Training

Course developers should ensure compliance and consistency of their training programs with the regulations, procedures and recommendations provided by Authorities, OEMs and the AURTA. Training described in these publications should be sufficient to cover state-of-the-art UPRT. A high risk of negative training is associated with the well-intended design of self-made exercises and is inherent to scenario-design; especially when deriving scenarios from case studies where the affected aircraft type may be

[45] Juan R. Merkt, Flight Energy Management Training: Promoting Safety and Efficiency. Journal of Aviation Technology and Engineering 3:1 (2013) 24-36.

different from the type used for the training. In such cases, operators should cooperate with their OEMs to avoid negative training.

Negative transfer of training can occur for example when using FSTDs outside the VTE and from inappropriate on-aeroplane UPRT. When following the exercises of ICAO Doc 10011and AURTA most FSTDs may be able to provide the required level of fidelity, but course developers need to confirm this before commencing training.

Operators should work closely with ATOs delivering on-aeroplane training to their ab-Initio cadets or to pilots wishing to refresh their on-aeroplane experience. As the flight characteristics and control responses of the aeroplanes used for UPRT (normally small propeller driven single engine piston aircraft) may differ from the type of transport aircraft used by the operators, there is a risk of negative transfer of training associated with such training. On-aeroplane training should therefore focus mainly on the human factor associated with upsets and recovery, and use care when addressing the flying skills. Addressing human factors like adapting to the impressions of deviations from 1g flight, high bank angles, the ability to perform counter-intuitive actions for recovery and to develop strategies to minimize the effects of surprise/startle, are most valuable aspects of on-aeroplane UPRT. Compared to flying skills, human factors are not specific to the training platform used and there is a low risk of negative transfer when on-aeroplane human factors training is delivered properly.

9.5.1 Instructor-Led Demonstrations

When conducting *recovery* training, the instructor takes the responsibility for setting up the upset condition. This can be accomplished in various ways. Instructors may take a pilot’s seat, may use simulator pre-sets or may allow trainees to fly into the upset attitude.

Some operators have reported that additional value can be gained in the area of manual flying skills, situation awareness, recognition and decision making by allowing the trainees to fly the entry profile. (This may not be possible for every operator as it may be in conflict with general simulator instruction policies). Trainees have acknowledged this “extra-time” and have provided positive feedback. Their course developers and instructors used special care to prevent that this methodology resulted in negative training. For example, negative training could arise from allowing trainees to ignore stall warnings, omitting callouts, deviating from procedures or from intentionally leaving the boundaries of the NFE without proper briefing by the instructor. When choosing this methodology, the training program should take into account that trainees normally will not be able to precisely fly the desired entry attitudes and energy states of the intended recovery exercise. Several attempts and some additional time may be needed; on the other hand varying entry conditions may create more realistic conditions compared to precisely defined and well anticipated setups. When taking a pilot’s seat, instructors should not only setup the upset condition but also demonstrate correct recovery.

Section 10—Assessing Pilots Performance

There is consensus in the training community that UPRT should be non-jeopardy. It is seen as training and not as checking. However, in terms of the instructional system design process, UPRT programs would not be effective without guidance for instructors on how to measure acceptable performance of crews.

Evaluation standards have shifted from precisely defined entry and recovery profiles to more realistic scenarios, with emphasis on recognition and avoidance of the event. The evaluator should also consider the actual conditions/variables.

In the absence of specific regulatory guidance for assessing nose-high, nose-low and high-bank recoveries, existing evaluation criteria for stall recovery may be used to measure crew performance for all *recoveries* of undesired aircraft states. These include:

- Prompt recognition
- Correct application of SOPs or recommendations/strategies
- Appropriate control inputs
- Recovery to the NFE without exceeding the aeroplane's limitations

As the predominant challenge of UPRT lies in the area of prevention, *prevention* training consequentially needs similar guidance regarding acceptable crew performance. For prevention, the recognition and management of threats and errors that may lead to undesired aircraft states is critical for success. In multi-crew operations this is a crew effort and performance should be measured as a crew. It is closely connected to their TEM task. Instructors may benefit from their experience in teaching LOFT scenarios containing conditions such as cold weather operations, all weather operations, windshear and high altitude operations, etc.

Therefore, performance criteria for *prevention* training would be:

- Timely recognition of threats and errors
- Effective application of countermeasures to manage upset-related threats and errors in an expeditious manner
- Recognition of developing upsets, arresting of divergence from the intended flight path and
- Maintaining the aircraft within the NFE

Operators should have procedures in place to ensure that pilots have reached the required level of performance and to provide training or re-training up to proficiency if necessary.

In a similar way FAA AC No: 120-111 Chapter 2 includes Completion Criteria for Prevention, Recognition and Recovery. These completion criteria also highlight PF and PM duties.

Section 11—Operator UPRT Implementation

This Section provides suggestions for the implementation of UPRT programs.

Note: UPRT for "seasoned" pilots should still encompass all relevant topics; previous experience (number of flying hours) alone cannot be assumed to be a measure of competency.

11.1 UPRT in One Additional FSTD Lesson

Several operators have decided to enhance the manual flying skills of their crews by adding an additional FSTD lesson dedicated to the core competency of Flight Path Management, manual control.

The training objectives of UPRT and operational aspects of manual flight could be combined in one recurrent training (RT) lesson. Scenario-based training would thereafter be included in the subsequent lessons of the three-year recurrent training cycle.

The table below provides an example for a "one additional SIM" solution.

Academic UPRT course (i.e., classroom or computer-based self-study)	
One additional RT	– Setup 1 – Advanced handling skills – Setup 2 – AOA and g-awareness – Setup 3 – FAA specialized flight training elements for upset prevention – Setup 4 – Recovery from upsets including stall recovery – Manual flight during normal operations (raw data approach, Go-Around, TCAS, Ground Proximity, OEI at high altitude, etc.)
Existing RT lessons	– Scenario-based upset prevention training and recovery exercises

11.2 UPRT Integrated in Recurrent Training

If operators cannot provide an additional FTSD lesson for UPRT the following table provides an example on how academic and practical training can be distributed over an existing three-year recurrent cycle containing six refresher training lessons (RT1 to RT6).

Note: Operators with an Advanced Qualification Program (AQP) or Alternative Training and Qualification Program (ATQP) should integrate UPRT in conjunction with the current edition of FAA AC No: 120-54 or applicable EU regulations.

The scheme below shows academic training, practical training and also integrates scenario-based prevention training using type-specific SOPs.

Academic UPRT course (i.e., classroom or computer-based self-study)	
RT 1 & 4	• Causes and contributing factors • Case studies • UPRT Academics • Setup 1 - Advanced handling skills
RT 2 & 5	• TEM • Energy Management • Flight path monitoring • Setup 2 – AOA and g-awareness
RT 3 & 6	• Aeroplane system induce causes • Setup 3 – Recovery from upsets including stall recovery • Human factors related to upset recovery
SOPs	
RT 1&3	• Unreliable Speed, Volcanic Ash, Stall Recovery
RT 5	• Abnormals leading to flight with degraded control laws • Abnormals affecting protection systems

Attachment 1 in this document shows an example of a UPRT implementation plan. It contains the development plan for instructors and a suggestion on how to integrate UPRT into an Evidence-Based Training program.

11.3 Checking and Testing

ICAO Doc 10011 recommends that "…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." [46]

(Stall Recovery procedures continue to be required for existing tests and checks.)

Operators should however install a process to validate their approved UPRT program and ensure that it meets its stated training objectives. "…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." [45]

[46] ICAO Doc 10011, Chapter 6, Paragraph 6.2.2

Section 12—ATOs Serving Operators

Operators engaged in ab-initio schemes should ensure that UPRT delivered by their contracted ATOs is consistent with their own training principles. Operators may also consider using contracted ATOs to offer on-aeroplane training to airline instructors and line pilots.

12.1 On-Aeroplane UPRT in MPL Courses and Future CPL Courses

UPRT in an MPL course must be delivered at three levels:

a) On-aeroplane UPRT in an airplane

b) Multi-crew non type-specific UPRT in an FSTD (basic and/or intermediate phase)

c) Type-specific UPRT in an FSTD of the specific type (latest in the advanced phase)

The general MPL scheme of PANS-TRG suggests that on-aeroplane UPRT be delivered in Phase 2. Some states allocate on-aeroplane UPRT to Phase 1. There are also good reasons to deliver on-aeroplane UPRT at later stages of the course.

When delivering UPRT, theoretical knowledge, especially in energy management, aerodynamics and aircraft performance (including at high altitude) and the effects of surprise and startle on human performance, needs to be consolidated.

12.2 On-Aeroplane Instructors

UPRT-qualified instructors are essential for this task. Specific instructor training is required prior to delivering UPRT. Whether training is in an FSTD or an airplane, UPRT involves the delivery of complex concepts and relationships, often in a dynamic setting. It is therefore essential to minimize risk through strict and disciplined operational safety management and highly competent instructors.

On-aeroplane and FSTD training should be "from the same page". Both modules should be interconnected so that they complement each other. Simply put, FSTD training is the "*look*"-module and on-aeroplane training is the "*feel*" module. Therefore, on-aeroplane instructors should also be familiar with FSTD training, especially the type-specific UPRT module; in order to ensure that negative transfer of training from small aeroplanes to heavy jets is avoided.

Special attention should be given to instructors teaching on-aeroplane training. Required instructor performance in the all-attitude/all-envelope environment is beyond that experienced in normal operations. By no means should an ATO assign this task to flight instructors without specific qualification. On-aeroplane UPRT instructors' training focuses on risk/safety-margin management, strong instructional skills with respect to human factors, students psychophysiological reactions (startle and surprise), confidence building, and in-flight recovery skills when the instructor needs to intervene to maintain flight safety.

On-aeroplane UPRT should be conducted under strict operational control procedures involving appropriate training airspace areas, minimum dispatch and weather conditions and within a well-structured safety management system (SMS) environment.

ATOs should consider outsourcing the on-aeroplane UPRT to a specialized organization where the availability of suitable aeroplanes and instructors is assured. In case of outsourcing, the MPL ATO remains responsible for the delivery of UPRT as part of the overall MPL program (see Section 3 for examples of other contractual arrangements).

12.3 Benefits of On-Aeroplane UPRT

Compared to, and in addition to teaching flying skills in FSTDs, on-aeroplane UPRT should first and foremost be a confidence-builder. It serves mainly human-factor training objectives and less flying skills training; therefore, the risk of negative transfer of training from small airplanes to large airplanes is mitigated.

On-aeroplane exposure to variations from 1g and training of counter-intuitive behaviors is required for the pilot to build resilience and the psycho-physiological skills required to apply appropriate control inputs in the event of an upset. For optimum delivery of UPRT objectives, the use of an aeroplane capable of all attitude maneuver training would be recommended.

On-aeroplane UPRT can be a valuable tool to build long-lasting confidence for the young pilot. This confidence is psychologically built on realistic proof of the student’s ability to control and recover the airplane to normal flight from any “3D” upset situation. The existence of such proof forms the underlying basis of true confidence and is a prerequisite for the ability to contain the effects and the duration of startle.

Not simply the flying skills, but the timely employment of effective strategies to prevent such an occurrence or, if unforeseen, during the actual recovery stage of an upset, should be the success-critical elements in the on-aeroplane UPRT module of an MPL course. The recovery strategies should include how to manage surprise and startle induced by unusual attitudes and stall, and how to perform even counter-intuitive actions under the presence of deviations from 1g flight.

12.3.1 Training Airplanes

ICAO did not mandate the use of aerobatic aircraft for on-aeroplane UPRT, but expressed that it does not intend to "dissuade" states and ATOs from using them.

ICAO Doc 10011 states:

> "3.3.1.3 It is important to make the distinction that UPRT is not synonymous with aerobatic flight training. ..... 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 the additional 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. "

and it's Appendix – Competency-Based UPRT Programmes, On-aeroplane training, states:

> "... Use of aerobatic aeroplanes would be the optimum solution to provide maximum training value and safety margins".

Therefore, though Annex 1, PANS-TRG and Doc 10011 do not require all-attitude UPRT and the use of aerobatic aeroplanes, conducting UPRT using such maneuvers and aeroplanes for the MPL provides the most effective training solution.

Normal or Utility category aeroplanes (certified to ≤60 or ≤90deg bank) are not suitable to achieve the complete human-factor training outcome and can only provide part of the desired outcome. Technically and operationally the use of Normal or Utility category aircraft for on-aeroplane UPRT may create a substantial safety risks, depending on the training maneuvers.

12.3.2 UPRT is Not Aerobatic Training

On-aeroplane UPRT should not be misinterpreted and approached in the same manner as aerobatic training. Although basic aerobatics do contribute to certain pilot competencies, such as Airplane Flight Path Management, manual control, and Situation Awareness, aerobatics are neither required during commercial pilot licensing nor do they contain the same training objectives as UPRT. Simply put, basic aerobatics focus on performing a sequence of precision maneuvers, passing through defined attitudes and using effective energy management.

UPRT focuses exactly on the contrary; the prevention of aircraft states outside of normal operating parameters and the most effective recovery from these abnormal attitudes/speeds, which often result from poor energy management. From that perspective, UPRT modules should be designed to develop the full spectrum of analytical reasoning skills required to rapidly and accurately determine the best course of recovery action during periods of high stress.

Section 13—The Safety Management System (SMS) and UPRT Implementation and Evaluation

The operator's Safety Management System should be utilized to support the implementation of UPRT and the evaluation of the training program.

13.1 Evaluation of the Training Program

Validation of training content and evaluation of the course are of special importance for UPRT programs. To follow a structured Instructional System Design (ISD)[47] process is advisable. Training and safety management staff should cooperate to validate the program content and perform the evaluation of the training program based on all available data. Ineffective training can be avoided with this methodology.

13.2 Implementation of the UPRT Program

The operator should use its SMS to ensure that the training program itself, or its implementation, will not introduce additional risks or that additional risks are properly mitigated. These risks may occur for example when developing pilot behavior in unrepresentative FSTD scenarios.

The implementation of UPRT should therefore be undertaken with an understanding of the risks associated with inappropriate training, potential mitigations and the validity of such mitigations.

Operators should focus their mitigations on quantified deviations from the normal operating envelope, in other words on developing upsets instead of developed upsets.

Airline specific data indicating upsets may be limited, but a correlation between the rates of particular upsets and the rates of developing upsets may assist the airline in understanding which type of divergences pilots find most difficult to manage. Additionally, data from FSTD training and other inputs of the SMS should be used. By focusing on these areas, there is likely to be more available and relevant data from FOQA and LOSA.

This may help identify the areas of the operation that are most vulnerable to unintentional divergence from the intended flight path or airspeed. Greater exposure to such areas and resilience building in training may then assist pilots to prevent upsets.

If all divergences are managed before the aircraft is in upset conditions, then the current crew strategies are likely to be successful, which will increase safety.

[47] ICAO Doc 9868 PANS-TRG, Attachment to Chapter 2

Section 14—Attachments

14.1 Attachment 1 – UPRT Implementation Plan

5 - step UPRT implementation plan of an operator using EBT and 2 training events of 2 days per year								
EBT Module / Recurrent Phase			**3**	**4**	**5**	**6**	**1**	**2**
Start Date			**FEB YY**	**AUG YY**	**FEB YY**	**AUG YY**	**FEB YY**	**AUG YY**
			LOE / LPC	LOE / LVO	LOE / LPC	LOE / LVO	LOE / LPC	LOE / LVO
	Aim	**Media**	**Time scale**					
1.	**UPRT Instructor Core-Group** Training (3 fleets, 6 Instructors)	External provider	JAN – FEB YY					
2.	**Distance Learning** development for: • All pilots (including exam) • Recurrent instructor standardization	In-house or purchase	MAR – OCT YY					
3.	**Instructors Training Course** development: • For all instructors • Incl. briefing guides for UPRT lessons	In-house or purchase	MAR – OCT YY					
4.	**Instructors Training** for • all regular instructors	• Classroom • SIM (combined with recurrent instructor standardization)			NOV – JUL YY			

5.	Maneuver-based **UPRT** • min x hours pilot	Setups 1,2,3 • Briefing • SIM		AUG – FEB YY		
6.	Scenario-based **UPRT** • Recurrent Day 2	EBT Module • RTGS • SIM			FEB – AUG YY	

14.2 Attachment 2 – ICAO Doc 9995, Manual of Evidence-based Training, Appendix 1 Core Competencies and Behavioural Indicators

Note: Demonstration of the competencies can be assessed using the behavioural indicators, which should meet the required level of performance, as established by the operator for its specific operation.

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

Competency	Competency Description	Behavioural Indicator
		procedures 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 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

Competency	Competency Description	Behavioural Indicator
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[48] Engages others in planning and allocates 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

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

<table>
<tr><th>Competency</th><th>Competency Description</th><th>Behavioural Indicator</th></tr>
<tr><td>Situation Awareness</td><td>Perceives and comprehends all of the relevant information available and anticipates what could happen that may affect the operation.</td><td>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
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</td></tr>
<tr><td>Workload Management</td><td>Managing available resources efficiently to prioritize and perform tasks in a timely manner under all circumstances.</td><td>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</td></tr>
</table>

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