

DECISION MAKING

FOR SINGLE-PILOT HELICOPTER OPERATIONS

TRAINING LEAFLET



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**FINAL REPORT
EHESST ANALYSIS OF 2000 – 2005**

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INTRODUCTION

This leaflet was developed by the European Helicopter Safety Implementation Team (EHSIT), a component of the European Helicopter Safety Team (EHEST). The EHSIT is tasked to process the Implementation Recommendations (IRs) identified from the analysis of accidents performed by the European Helicopter Safety Analysis Team (EHSAT).

SEE THE EHEST ANALYSIS OF 2000-2005 EUROPEAN HELICOPTER ACCIDENTS, FINAL REPORT 2010.

Research into the human factors related to aircraft accidents and incidents has highlighted Decision Making as a crucial element. Pilots usually intend to fly safely, but they sometimes make errors. It has been observed that the majority of fatal crashes are attributable to decision errors rather than to perceptual or execution errors. Many incidents are also associated with decision making errors. They could potentially have resulted in accidents had the situation not been recovered on time. While we cannot eliminate human error, a thorough understanding of human factors principles can lead to appropriate strategies, means and practical tools to prevent most errors, better detect and manage them, and mitigate their adverse impact on aviation safety.

This leaflet is part of a series of safety leaflets and publications aimed at sharing good practices. These leaflets are accompanied by web-based training materials, including videos, which are freely available on the Training and Safety Promotion section of the EHEST website.

Data from the European Safety Analysis Team (EHSAT) accident review confirms that a continuing significant number of helicopter accidents occur due to poor Decision Making. The aim of this leaflet is to improve helicopter training by explaining some of the factors that affect pilot's Decision Making and to provide tips for making better decisions.

1. HUMAN FACTORS

AFFECTING DECISION MAKING

Decision errors in aviation are typically not slips or lapses but mistakes. In other words, the problem doesn't lie with a failure to execute a correct decision but to making a wrong or poor decision in the first instance. The plan proceeds as intended, however the plan proves inadequate or inappropriate to the situation at hand. Decision errors are hence often referred to as true and honest mistakes.

HUMAN ERROR (HOOEY & FOYLE, 2006)

DECISION ERROR

42%

ACTION ERROR

35%

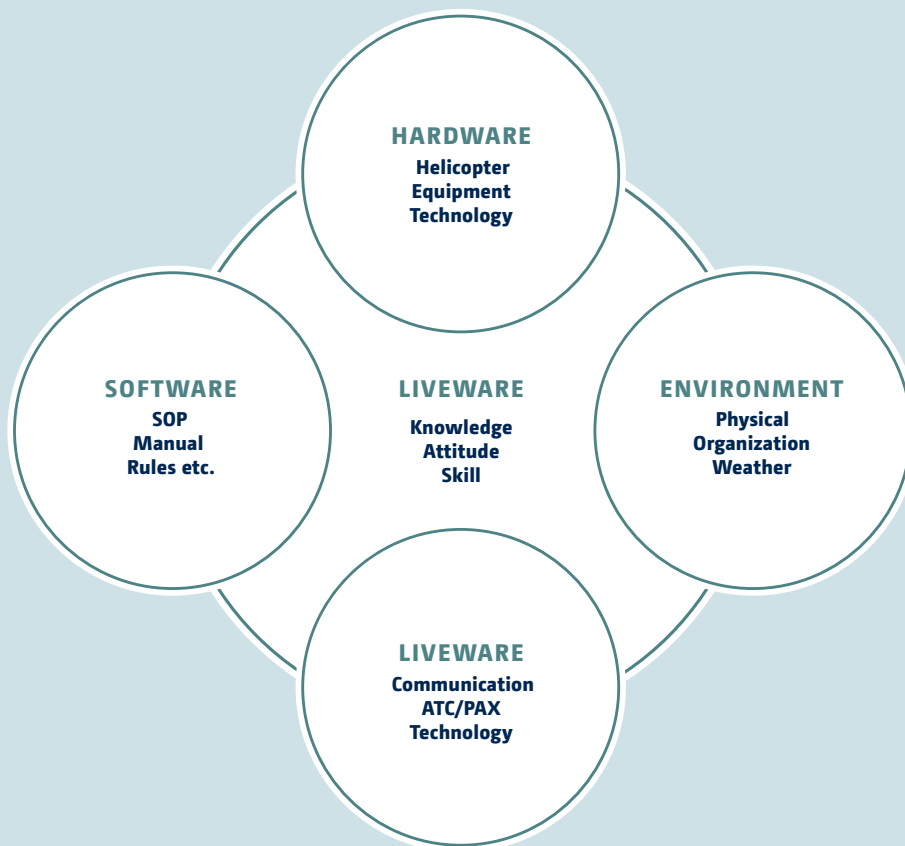
INFORMATION ERROR

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1.1 Introduction

Human Factors research and theories have described, using several models, the characteristics of human decision making, which rather differs from the way aircraft systems for instance 'make decisions'.

The **SHELL** model for instance provides a framework that illustrates the various components and interfaces or interactions between the different subsystems involved in aircraft operations.

SHELL MODEL

SOFTWARE >> Rules, Standard Operating Procedures, Rotorcraft Flight Manual, computer codes, etc.

HARDWARE >> Helicopter structure, engine, components, controls and surfaces, displays and systems, etc.

ENVIRONMENT >> Situation in which the Liveware - Hardware - Software system must function, i.e. the natural environment.

LIVEWARE >> The human component, for instance the pilot, the maintenance personnel, the air traffic controller, etc. Includes knowledge, attitudes and skills.

LIVEWARE >> A second Liveware component is introduced in the model to account for the interactions between the human elements: the pilot with the other pilots, ATC, operations, ground and maintenance personnel, the customers, the passengers, etc.

The **LIVEWARE** constitutes the hub of the model, the most critical as well as the most flexible component in the system. Adverse mental states may contribute to poor decision making.

Pilots behaviours and motivations affect decision making and training aims at improving the decision making process.

1.2 Hazardous attitudes

Five hazardous attitudes increase the risk of poor decisions. They are shown in the table below. These attitudes must be carefully addressed in training. Safer attitudes, often referred to as “antidotes”, are also identified in the table. Compliance with the SOP’s is a common, powerful antidote.

HAZARDOUS ATTITUDES	ANTIDOTES
1. Anti-Authority >> <i>“Don’t tell me what to do!”</i> This attitude is found in people who do not like anyone telling them what to do. In a sense, they tend to regard rules, regulations, and procedures as unnecessary.	Follow the rules: they are usually right.
2. Impulsivity >> <i>“Must do something now!”</i> This is the attitude of people who frequently feel the need to do something, anything, immediately. They do not take the time to think about what they are about to do; therefore they often do not select the best alternative.	Not so fast. Think first, and think twice.
3. Invulnerability >> <i>“It won’t happen to me.”</i> Many people feel that accidents happen only to others, but can’t happen to them. They never really feel or believe that they will be personally involved. Pilots who think this way are more likely to take chances and increase risk.	It could happen to me too.
4. Macho/Egocentric >> <i>“I can do it – I’ll show them.”</i> Pilots with this type of attitude often take risks to prove that they are good and to impress others.	Taking risks is foolish.
5. Resignation >> <i>“What’s the use? There is nothing I can do.”</i> The pilot will leave the action to others, for better or worse. Sometimes, such pilots will even go along with unreasonable requests just to be a “nice guy”.	I’m not helpless. I can make a difference.

1.3 Behavioural traps & biases

There are a number of behavioural traps and biases that can distort decision making. Pilots should be aware of these traps and take steps to avoid getting caught.

BEHAVIORAL TRAPS & BIASES

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|--|--|
| 1. Peer Pressure >> | Poor decision making may be based upon an emotional response to peers, rather than evaluating a situation objectively. The solution offered by the peers is accepted without further assessment, even when this solution is wrong. |
| 2. Confirmation bias >> (fixation) | The tendency to search for or interpret information in a way that confirms one's pre-conceptions or backs up the decision that has already been made. Counter evidence is not considered or discarded. Fixation is the term used when such behaviour persists. |
| 3. Overconfidence >> | The human tendency to be more confident in one's skills, competences and capacities than one should be. |
| 4. Loss-aversion bias >> | The strong tendency for people to prefer avoiding losses. Changing the plan means losing all the effort you have already expended on. Explains why decisions are sometimes hard to change. |
| 5. Anchoring bias >> (attentional tunnel) | The tendency to rely too heavily, "anchor," or focus attention on one or a few elements or pieces of information only. |
| 6. Complacency >> | A state of self-satisfaction with one's own performance coupled with a lack of awareness of potential risks. Feeling to be at ease with the situation, which often result in lack of monitoring. |
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Other biases are listed for instance in the Operator's Guide to Human Factors in Aviation Briefing Notes (OGHFA BN) "**Decision Making**", published on SKYbrary.

Certain biases are very well known in an operational context, such as the willingness to please a customer or to complete the mission, even if the weather or other essential mission factors are deteriorating – a powerful bias especially in SAR and HEMS operations, because of the very nature of these missions. Other famous biases are disregard for one's own or other flight crew member's fatigue and self-induced pressure to return to base ("Press-On-Itis"). Another bias is the tendency to take risks for which consequences are considered remote in time and space and/or unlikely to realise in exchange of immediate and direct benefits such as saving time. A good everyday life example is crossing the street when the traffic light is red. The likelihood to take the risk increases when in a hurry or when the risk itself (to be hit by a car or to get caught by the police) are considered low.



EHEST TRAINING LEAFLET HE2: HELICOPTER AIRMANSHIP

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Decision making biases lead to poor decisions and put the safety of the flight at risk. Knowing the biases is important but is not enough: biases should be **actively combated!** The Briefing Note (OGHFA-BN) “Press-On-Itis” reviews different types of factors leading to Press-on-Itis. Biases and pressures are to be addressed in the Decision Making module of Crew Resource Management (CRM) training. For instance the decision to divert a flight due to weather or other adverse flying conditions may upset passengers and cost money. But failing to divert, however, can have catastrophic consequences. To guarantee the safety of the flight, the flight crew **must exercise proper decision making – never take chances!** REFER ALSO THE EHEST LEAFLET HE 2 “HELICOPTER AIRMANSHIP”.

1.4 Stress and stress management

Disturbing physiological or psychological influences may affect human performance and impact adversely the safety of the flight. A certain amount of stress increases performance as it keeps the person alert and prevents boredom and drowsiness. An accumulation of stressors, if not adequately addressed, will eventually add up to an intolerable burden however. Factors, referred to as stressors, can increase the risk of error in the cockpit. Various types of stressors are mentioned below.

STRESSORS	SYMPTOMS
Physiological »	Sleep disturbance, migraines, muscular tension, low-grade infections, sweating, dryness of the mouth, nausea, headaches, shaking, etc.
Psychological »	Anxiety, uneven temper, loss of interest, poor self-esteem, feelings of loss of control, irritability, depression, moodiness, aggression, etc.
Cognitive »	Difficulties in concentrating, omissions, errors, slowness, poor judgment, poor memory, reduced vigilance and attention, etc.
Behavioural »	Loss of motivation, tendency to skip items and look for short cuts, easily distracted, slowness or hyperactivity, nervous laughter, etc.

Managing stress in the cockpit not only involves the ability to perceive and accommodate stress in others, but above all, to anticipate, recognise and cope with ones’ own stress. Once we become aware of stress, we generally respond to it by using one of two strategies: Defence or Coping.

DEFENCE STRATEGIES involve the alleviation of the symptoms (taking medication, alcohol, etc.) or reduction of the anxiety (i.e. denying to yourself that there is a problem, or blaming someone else).

COPING STRATEGIES involve dealing with the source of the stress rather than merely the symptoms (i.e. delegating workload, prioritising tasks, sorting out the problem). When 'coping', the individual either adjusts to the perceived demands of the situation, or changes the situation itself.

Defence and coping strategies

- **Have a healthy life style**
- **Improve pre-flight planning**
- **Comply with SOPs.**
- **Avoid situations that distract you from flying the aircraft.**
- **Reduce and manage your workload, keep margins.**
- **If an emergency does occur, stay calm. Take time, consider the alternatives, then act.**

1.5 Health and performance

Healthy pilots should perform at their optimum level and make decisions to the best of their ability. Factors known to influence fitness include diet, exercise, stress levels and the use of tobacco, alcohol or drugs. Incapacitation of a pilot due to the effects of a medical condition or a physiological impairment is a serious potential threat to flight safety. The brain and the body require food and oxygen to perform, therefore pilots should ensure that they eat properly and exercise regularly to perform at their best during flight.

1.6 Fatigue, tiredness

Fatigue and tiredness are a threat to aviation safety because it can lead to impaired performance. One of the most insidious aspects of fatigue is an individual's inability to recognise when their own performance is deteriorating and to take action accordingly. Fatigue may lead to potentially unsafe conditions and deterioration in decision making and situational awareness.

2. DECISION MAKING

A good decision outcome does not necessarily mean that a good decision process was used. Decisions are often based on heuristics. Heuristics are simple mental rules used to solve problems and make decisions, especially when facing complex problems, incomplete information and time constraints. Heuristics can however sometimes flaw judgement and lead to poor decisions.

Studies indicate that pilots often take decisions using a heuristic approach based on past experience instead of thoroughly analysing the situation. With acquiring experience, most of what we do gets 'routinised' and is performed in an automated manner. As we learn to do something (such as manually flying the helicopter) the brain is on the lookout for tasks that can be mentally automated, and hence done with low workload. This is a very efficient strategy as it frees mental resources. This is what makes humans so capable. But 'routinisation' can lead to routine errors and other shortcomings.

Two models of human behaviour help understand shortcomings further.

2.1 The Rasmussen's SRK model

This model defines three levels of decision making used depending on the characteristics of the situation at hand (e.g., task load, time, stress, etc.) and past experience:

-
- A) Skill-based** *Stick and rudder* type of behaviour. Behaviour that has been learned and 'compiled' over time and has thus become relatively fast, unconscious, and automated. Skill-based behaviour doesn't consume much mental resources.
-
- B) Rule-based** *"IF this happens THEN I do that"* type of behaviour. At that level, decisions are based on pattern recognition: IF condition X is met, THEN implement action Y. This type of decision process is quasi-rational (i.e.: some cues can be processed analytically and others in a more automatic manner).
-
- C) Knowledge-based** *Simply called reasoning or problem solving* behaviour is applied in those situations where rule-based or skill-based answers are simply not available and the decision maker must resort to knowledge or mental models of more theoretical nature. Such situations for which no pre-existing solutions are available are often novel or unexpected. Decisions are based on conscious, analytical thinking and requires a considerable amount of mental resources and time. Under acute stress, knowledge-based decisions and solutions are error prone.
-

2.2 The Recognition Primed Decision-Making (RPDM) model

This model shows that very often decisions are made very quickly and without full consideration of all the factors that may affect the outcome. It appears that a decision is made by rapidly recognising a course of action based on previous experience and then evaluating consequences through simple 'scenario testing'. But the exploration of scenarios often stops at the first satisfactory option, which may not be the most suitable one. Consequently, from a training point of view, it is important not to prime a specific action to a specific set of circumstances unless they are the only proper actions to take in those circumstances. Consider whether very similar circumstances could mean something quite different and require a different decision and course of actions.

VARIATIONS OF THE RPDM MODEL

Variation 1	The individual recognises the situation and applies a known solution. Very similar to the Rule-based behaviour described by Rasmussen.
Variation 2	The individual faces an unusual situation but applies a known solution that seems suitable.
Variation 3	The individual faces an unusual situation and applies a new solution. Very similar to the Knowledge-based behaviour described by Rasmussen.
Variation 4	The individual recognises the situation and applies a new solution . The model predicts that this is unlikely to happen (unless specifically trained).

When more time is available, we can make more thorough assessments and judgements. However it is well understood that humans do not possess the mental resources necessary to make complex decisions in the way we would like, even when plenty of time is available.

Pilots often find short-cuts to procedures, which seem to work well. However these 'local-heuristics' can sometimes be hazardous if combined with the wrong set of circumstances.

A more experienced pilot is more likely to develop a viable course of action quickly because he will rapidly eliminate the poor options, based on past experience. An inexperienced pilot instead will have to reject several options or create one from scratch before finding a suitable course of actions.

3. DECISION ERROR FACTORS

When exploring factors that contribute to decision errors, a common pattern is the pilot's decision to continue with their original plan whereas conditions suggest that other courses of action might be more prudent or appropriate.

In other words, they decided to “go” in a “no go” situation, usually in the face of ambiguous or dynamically changing conditions, e.g. DVE or continuing with a landing when it might have been more appropriate to make a go-around. Four factors contribute to decision errors:

Situational Factors (Ambiguity) >>	The situations are not recognised as requiring a change of course of action, due to the ambiguity of the cues resulting in a poor representation or understanding of the situation (poor situation awareness).
Erroneous Risk Perception & Risk Management >>	Pilots typically under-assess the level of threat or risk associated with the situation, due to risk misperception or tolerance to risk. Pilots risk pressing on into a rushed landing or deteriorating weather (DVE) simply because they do not realise the risks associated with doing so or accept to take the risk.
Goal Conflicts >>	Pilots may be willing to take a safety risk (an unlikely loss) to arrive on time (a sure benefit). Social factors (for instance to please passengers) can also play a role. Among pilots, peer pressure can encourage risky behaviour. Also people seem to disregard risk to avoid losses. An en-route diversion can be seen as a loss.
Workload & Stress >>	Workload and stress may overload pilots, deteriorate mental processes (i.e.: tunnelling of attention or vision, memory limitation, etc.) and lead to errors. As situations degrade, risk and time pressure may increase up to a point where making correct decisions becomes very difficult.

4. DECISION MAKING MODELS

Many models have been developed to describe decision making. Two of these are presented below.

4.1 NASA model

NASA research describes a decision process model for aviation that involves two components: Situation Assessment (SA) and choosing a Course of Action (CoA).

1. Situation Assessment (SA) Situation assessment and awareness is crucial. It involves defining the situation or problem as well as assessing the levels of risk associated with it and the amount of time available for solving it. It is also an awareness of what the situation will be in the future.

2. Course of Action (CoA) Once the problem is defined, the course of action is selected from the options available (known about) in the situation. Once the pilot understands a situation, an acceptable course of action is often easily identified.

4.2 The OODA Loop model

This simple model based on the **Observe, Orientate, Decide and Act** stages originates from the military fighter pilot community. Developed for single-pilot operations, it describes control of behaviour in a rapidly changing environment. **Observation, orientation,** and action occur continuously and simultaneously in flight (Skill based behaviour). The **Decide stage** is dependent on remaining resources. During periods of rapid change, these can be very limited (hence the importance of flight preparation). **Orientation** (*safety oriented approach*) is the most important part of the **OODA LOOP MODEL** because it shapes the way **we observe**, the way **we decide**, and the way **we act**.

The **OODA LOOP** decision strategy model is adaptable to various problem types (familiarity, ambiguity, complexity, stability), various environments (time, risk, resources, problem relevant and weather), and various decision maker characteristics (expert, novice, different levels of motivation, knowledge or abilities, etc.).

Because decision making is not always perfect and may suffer short cuts, pilots should be trained to better prepare and review their decisions, as time allows. When reviewing a decision it is a good practice to ask a question such as *“Could this be a wrong choice? What if I as a pilot, or we as a crew, are wrong?”* Such questions help defeat the confirmation bias. However it is important to assess the situation and capacity available to avoid getting stuck in a decision loop.

4.3 How to improve Decision Making

The following **strategies** can improve decision making. Training pilots on these solutions will allow them to make better decisions.

» **Standard Operations Procedure (SOPs):** SOPs are widely used throughout the commercial aviation community as a means to manage risk. Establishing safety oriented SOPs (including personal and weather minimums) will provide pilots with pre-planned responses that manage the risks and break the “chain of events” leading to accidents. To be effective, SOPs must be clear, concise and free of conflict. Use of SOP’s is a form of Rule-based behaviour and is less error prone than Knowledge-based behaviour.

» **Pre-Flight Planning:** Planning conducted prior to a flight in a low stress environment can enable a pilot to produce a safe strategy for the flight (i.e.: the pilot can be proactive and plan ahead to select a safe route and establish “decision points” during each flight phase). Collaborative decision-making with ATC, weather services, and other pilots will help to size up a general situation. Good pre-flight planning also reduces the workload once airborne.

» **Illusion of Safety - The Plan B:** Research has suggested that having a plan B (safety net) encourages continuation and possibly more risky behaviour. Naturally it is indeed easier to take a risk when you know that you can count on a plan B. Pilots however rarely assess their plan B properly; so the protection can be weaker than expected.

» **Single Pilot CRM (SRM) Training:** This is a practical way to teach pilots better decision making and judgement strategies. SRM is the capacity to manage all resources (both on-board the aircraft and from outside sources) available to the single-pilot prior to and during the flight to ensure a safe flight. SRM is a form of CRM for single pilot operations. SRM includes several modules such as Aeronautical Decision Making (ADM), Risk Management (RM), Task Management (TM), Automation Management (AM), Controlled Flight Into Terrain (CFIT) Awareness, and Situational Awareness (SA). SRM training helps the pilot to maintain situational awareness by managing the flight and navigation tasks and to enhance the social skills needed to communicate and interact for instance with

ATC and the passengers. SRM training enables the pilot to accurately assess and manage risk and to make better decisions.

» **Threat and Error management (TEM) Training:** TEM training can be referred to as a form of 'defensive flying' for pilots. The objective of TEM is to manage in an effective manner the risks stemming from threats and errors to ensure a safe flight. Undetected, unmanaged or mismanaged, threats and errors have the potential to impact the safety of the flight by creating Undesired Aircraft States (UAS). UAS can usually be recovered but if not properly managed, UAS can lead to accidents or incidents.

» **Simulator Training:** Simulators can allow training decision making in high stress, high workload situations with poor or conflicting information. Training scenarios can be tailored to the trainees needs. In addition, simulators allow exploration of the consequences of poor decisions without endangering the safety of the aircraft and its occupants.

» **Decision Making Training:** As early as possible in their training, pilots should be made aware of the characteristics and limitations of human decision making. Trainers should emphasise the importance of maintaining Situation Awareness, of prioritising responses to UAS's (1. Aviate → 2. Navigate → 3. Communicate), and of contingency planning (*What if something goes wrong during the flight?*).

» **Decision Making Aids:** Decision aids are easy to remember lists intended to support the decision maker and to avoid errors. They are particularly beneficial in the case of critical and stressful situations.

Preparing to Manage the Crisis: by prioritising the tasks.

The 'FADEC' decision aid helps prioritising tasks. It is also easy to remember.

FLY THE HELICOPTER >>	Be aware of aircraft limitations and if the conditions permit, use all available aircraft automation systems: auto-pilot, etc.
ASSESS SITUATION (RISK & TIME) >>	More time spent assessing the situation can lead to a better outcome. Try to avoid snap/quick decisions unless time available is very short.
DECIDE ON A WORKABLE OPTION AND REFER TO ABNORMAL OR EMERGENCY CHECKLIST >>	Situation in which the Liveware - Hardware - Software system must function, i.e. the natural environment.
EVALUATE >>	Continue assessing the situation and action as the situation evolves (feedback loops).
COMMUNICATE >>	with ATC for collaborative decisions review and with other personnel as appropriate.

Another decision aid is presented in the Operator's Guide to Human Factors in Aviation Briefing Notes (OGHFA BN) "Decision-Making Training" published on SKYbrary: **Remember the 5 P's:**

PRIOR	PLANNING	PREVENTS	POOR	PERFORMANCE
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**ON THE IMPORTANCE OF PROPER PRE-FLIGHT PLANNING
SEE ALSO THE EHEST LEAFLET HE 2 "HELICOPTER AIRMANSHIP".**

6. DEFINITIONS & ACRONYMS

ADM	AERONAUTICAL DECISION MAKING is a systematic approach to the mental processes used by pilots to determine the best course of action in response to a given set of circumstances.
AROUSAL	Arousal is the state of responsiveness to sensory or mental stimulation.
BEHAVIOURAL MARKERS	Short, precise markers describing in behavioural terms non-technical skills or competencies
BIASES	Biases are particular tendencies or inclinations that prevent unprejudiced consideration of a situation and may lead to incorrect, “biased” decisions.
CRM	CREW RESOURCE MANAGEMENT - The effective use of all resources available to the crew , including human (flight crew, ATC, cabin crew when applicable, etc.), technical resources such as automated systems, and other resources such as time, procedures, information, communication, etc. Good CRM allows making good decisions as a crew.
DVE	DEGRADED VISUAL ENVIRONMENT.
ERROR	Erroneous intention (mistake) or unintended deviation from a correct intention (slip, lapse) that may result in an unsafe condition and contribute to an incident or an accident. Deviations that are intentional (for instance deliberate non-compliance with an SOP) are called violations. The fundamental difference between errors and violations is that violations are deliberate, whereas errors are not.
HEURISTICS	Simple mental rules that the human mind uses to solve problems and make decisions, especially when facing complex problems or incomplete information. Heuristics are helpful but may lead to systematic misjudgements.
NOTECHS	NON-TECHNICAL SKILLS: Specific human factors competencies, sometimes referred to as ‘soft skills’, such as lookout, situation awareness, decision making, task management, communications, etc.

RPDM	RECOGNITION PRIMED DECISION MAKING. A theory that describes how decisions can be made very quickly based on situation recognition (already encountered and solved this way before).
SITUATION AWARENESS	Knowing what is going on around us and being able to predict what could happen next.
SLIPS/LAPSES	Failures in the execution of the intended action. A particular form of error.
SOP	Standard Operations Procedure
SRM	SINGLE-PILOT RESOURCE MANAGEMENT: the capability for a single pilot to manage all the resources (on-board the aircraft and from outside sources) available to him or her (prior to & during flight) to ensure a safe flight. SRM is a form of CRM for single pilot.
TEM	THREAT AND ERROR MANAGEMENT: The process of detecting and responding to threats and errors to ensure that the outcome is safe.
THREATS	Events or errors that occur beyond (or within) the influence of the flight crew, increase operational complexity, and which must be managed to maintain safety margins.
UAS	UNDESIRED AIRCRAFT STATE: Undesired aircraft position, speed or attitude deviation associated with reduced safety margins due to environmental, technical or pilot-induced factors such as misapplication of flight controls, incorrect systems configuration or mismanagement of automation.
VIOLATION	Intentional deviation from rules, regulations, operating procedures or standards.

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