Description of operations

Executive summary

The conduct of all-weather operations (AWOs) involves many different components. Some of these components are hardware (such as aircraft and the equipment installed on aircraft or at aerodromes), some components are software (such as computer codes or operating procedures used by personnel), and some components are liveware (i.e. the people who operate the system, e.g. air traffic controllers, pilots, maintenance personnel). For AWOs to be conducted safely, each component of the system must perform as intended and must interact correctly with the other components of the overall system. The safety of the AWO system, therefore, depends not only on the reliability of the individual components but also on the interaction between those components.

In order to ensure that the interactions of the components between the different domains are duly considered, the AWO Project has applied the Systems-Theoretic Process Analysis (STPA) methodology. This means that the total system for AWOs, including the interactions between the different components, is described in terms of systems theory as a network of controllers and controlled processes. Some of these controllers influence the nature of the system development structure for AWOs, which establishes the context within which AWOs are conducted, while other controllers constitute the system operations' structure that directly controls AWOs in real time.

In order to have a common framework for the development of consistent rules across the different domains, the AWO Project has adopted a classification of standard operations. Such standard operations are classified in terms of lowest aerodrome operating minima.

The main aim of the AWO Project is to introduce the appropriate regulatory framework for operations with operational credits. Considering a performance- and risk-based development concept, all requirements should be technology-independent. The performance required for certain types of operations with operational credits could be achieved with the use of the appropriate technologies (airborne or ground-based). Finally, appropriate procedures complementing the technology capabilities will enable operations with operational credits.

The concept of operations with operational credits is introduced to enable the best use of new technologies and provide further operational flexibility beyond the limits of standard operations. This concept will exploit in particular the performance of new vision systems to either allow operations to lower than standard minima for a particular class of operation or to standard minima despite the absence of some performance items normally required.

The different system components together must comply with the AWO safety constraints regardless of the classification of a particular operation. Each class of operation or each operation with an operational credit may require a different set of system components to comply with these safety constraints. This is further described in this document and will be further elaborated as the Project progresses.

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1. Context

The AWO Project involves many experts from different aviation domains, who are collaborating to reassess and modernise the requirements for approach (which includes landing), taxiing and take-off operations in conditions of reduced visibility. This document has been developed to ensure that all those involved in the Project have a common understanding of the methodology and operational concepts to be used.

The main aim of the AWO Project is to introduce the appropriate regulatory framework for operations with operational credits and the conditions for the issue of special approvals. Considering a performance- and risk-based development concept, all the requirements should be technology-independent. For certain types of operations with operational credits, the relevant performance of the systems and components shall be defined and the elements of the appropriate procedures shall be identified.

The performance required for certain types of operations with operational credits could be achieved with the use of the appropriate technologies. The technologies achieving the required performance can be either airborne equipment (on-board aircraft equipment) or ground-based equipment (typically aerodrome equipment). Finally, appropriate procedures, complementing the technology capabilities, will enable operations with operational credits; procedures affect mainly air operations and air navigation service providers' (ANSPs) activities.

Having regard to the objective to develop performance-based requirements and criteria, they are being developed and established on the basis of currently available prescriptive, mainly technology-dependent regulatory material. Taking into account the fact that the final maturity level of all descriptions of operations with operational credits has not been achieved yet due to ongoing development process, when describing the required performance, prescriptive and technology-dependent elements are used stemming from the current way of stipulating requirements and criteria. The objective is to convert all these elements into performance-based requirements and to make reference to technology-dependent issues only, avoiding prescribing certain technologies either directly or indirectly.

The cross-domain 'systems' approach is important for the AWO Project because safety depends not only on the individual components of the AWO system, but also on the way the different components of the system interact with each other. This is described mainly in Chapter 2 'AWO system description'. In order to be able to analyse these interactions, the AWO Project has adopted the STPA methodology to deduce safety constraints. Future requirements will be validated using the outcome of this methodology. This validation will examine the connection between proposed requirements and necessary safety constraints. In order to facilitate the use of this methodology, the 'total system' for AWOs is described in terms of systems theory, and a cross-domain, technology-independent description of the required AWO system performance is provided.

Much of the work of the Project is done in domain-specific 'clusters', so it is important for everyone involved in the Project to have a common understanding of the terminology used. This document, therefore, describes in Chapter 3 'Classification of standard operations' the classification of AWOs, which is relevant to all different domains. This classification includes a technology-independent description of 'standard operations', based on standard aerodrome operating minima.

Furthermore, a description of operations with 'operational credits' is described in Chapter 4 'Concept of operations with operational credits'. Such operations may allow for aerodrome operating minima that differ from the standard aerodrome operating minima for that class of operation.

The different system components together must comply with the safety constraints for AWOs regardless of the classification of a particular operation. Each class of operation or each operation with an operational credit may require a different set of system components to comply with the safety constraints. This is further described in Chapter 5 'Description of system components' for both standard operations and operations with operational credits. Operations with operational credits, such as special approval Category I (SA CAT I) operations, and a practical example of operations with the new technology using an enhanced flight vision system (EFVS)/combined vision system (CVS) are further described in Appendix 1 and Appendix 2 showing the relationship between the EASA proposals and the standards adopted by other regulators. In particular, these parts of the document will be further developed as the Project progresses.

To ensure that the terminology used is consistent across all the domains, a set of common definitions has been adopted. They are provided in Chapter 6 'Common definitions of terms to be used'.

2. AWO system description

The AWO system has evolved over the years and is now highly complex. It comprises many different components: some of its components are hardware (e.g. airborne, ground-based or satellite-based equipment), some are liveware (e.g. the people who operate the aircraft, and air traffic control), and some components are software (i.e. the protocols and procedures used by the people in the system as well as computer codes). In order to validate the regulatory requirements that will be developed during the AWO Project, the STPA methodology has been adopted. This is a new hazard analysis technique based on systems thinking and a model of accident causation based on systems theory rather than reliability theory[1]. To facilitate the use of this model, a description of the 'total AWO system' has been developed in terms of systems theory.

The system may be described in terms of a system development structure and a system operations' structure. The system development structure determines the nature of the different elements of the system, such as approved organisations, personnel, regulations, operating manuals, work instructions and operational practices. The system operations' structure determines how the system operates in 'real time', i.e. while aircraft is conducting AWOs.

Process models

The STPA methodology uses the concept of control loops. A controller is assigned requirements to enforce on a controlled process behaviour, which it does by issuing control actions to change the state of the controlled process (see **Figure 1)**. The controller receives feedback from the controlled process. A control algorithm uses information about the process state, contained in the process model, to generate control actions that will cause the process to achieve the requirements.

An example of a process model within the AWO system is shown in **Figure 2**. This shows the control loop between the flight crew and an aircraft conducting AWOs.

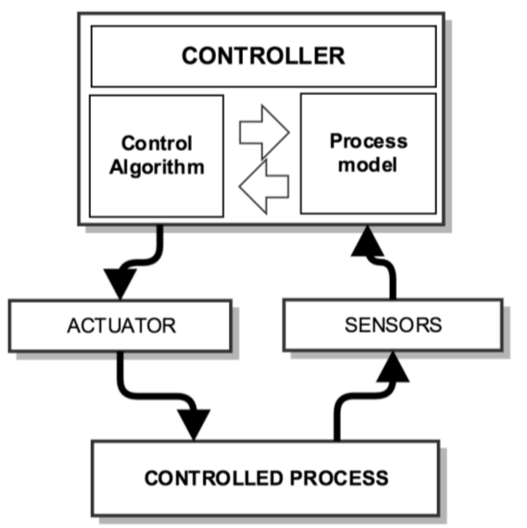

Figure 1: Generic control loop

[1] For a full description of the systems theory and the STPA methodology, please refer to 'Engineering a Safer World — Systems Thinking Applied to Safety' by Nancy G. Leveson, published by the MIT Press in 2011, and to 'An STPA Primer' (Version 1) by Nancy Leveson, published in 2013.

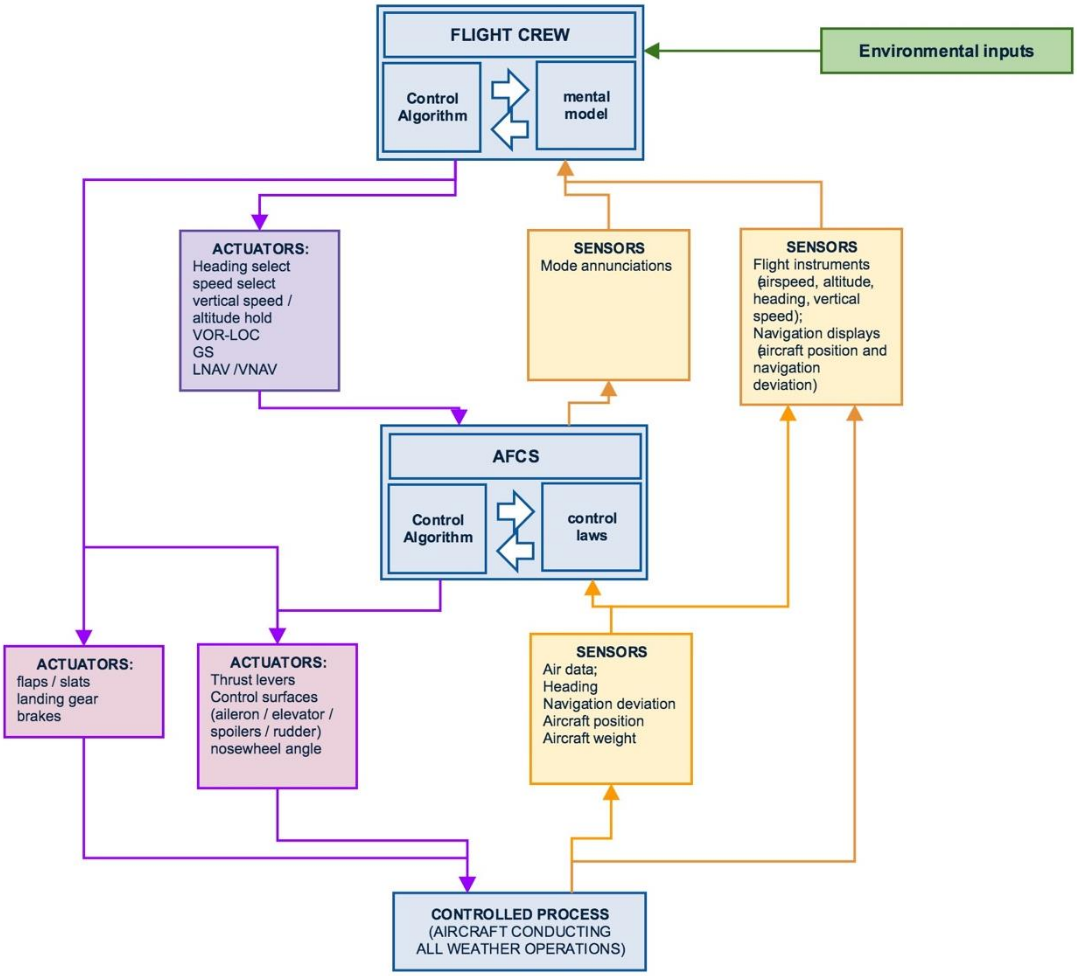

Figure 2: A control loop for AWOs where flight crew are the controller

Cascade of controllers

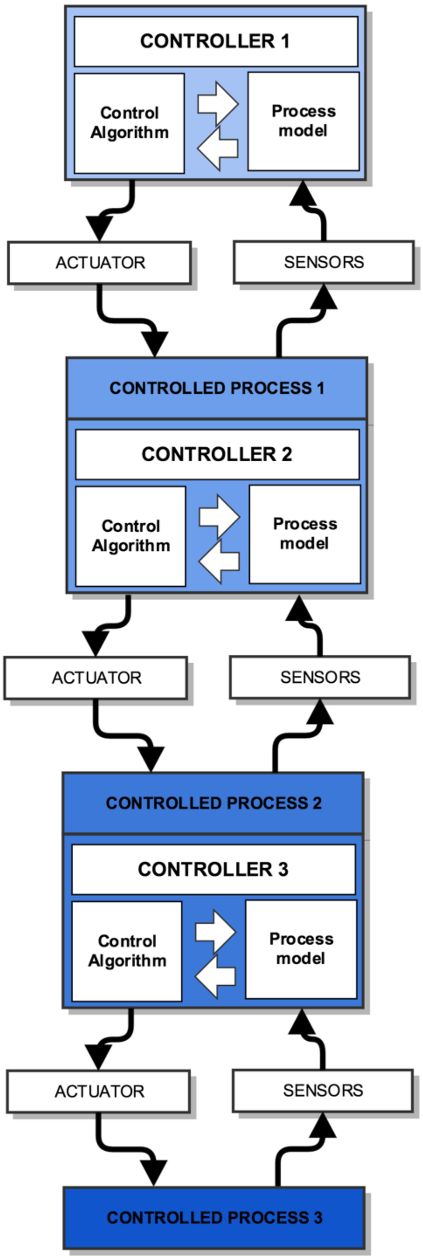

Figure 3: Cascade of controllers

The AWO system may be considered as comprising multiple, interlinked 'control loops'. Within each loop, a controller executes control actions on, and receives feedback from, a controlled process (see **Figure 1**). Within the system there is a 'cascade of controllers' where the controlled processes from one control loop constitute one of the set point (responsibilities, authorities and assumptions) for other controllers within the system (see **Figure 3**). This cascade of controllers may be considered to include some controllers that are involved in the development of the system and some that are involved in the operation of the system in real time. Both system development and system operation are relevant to the AWO Project.

System development

The following controllers have been identified within the AWO system development structure:

— regulatory authorities (for example, EASA and the European Commission) that develop regulatory material;

— competent authorities (for example, the national aviation authorities of the Member States) that certify and approve organisations;

— approved (and certified) organisations; these include design organisations, maintenance organisations, air operators, training organisations, ANSPs, aerodrome operators;

— operational management within approved organisations;

— and operational staff.

All these controllers take actions (such as developing regulations, operating manuals or work instructions), which influence the nature of the control structure. These controllers receive feedback based on operational experience, audits, inspections, etc., and thus the system is constantly changing. They do not have a role in the system operations' structure as they do not have control over aircraft conducting AWOs in real time.

System operation

The system operations' structure involves 'operations control' within an approved organisation as one controller providing control actions to the flight crew, who in turn provide control actions to the aircraft either directly through the flight controls or indirectly through the auto-flight control systems. Other controllers in the system operations' structure include air traffic controllers, aerodrome operators and ANSPs. Feedback processes within the system operations' structure are the aircraft instruments and navigation displays, reports sent by the aircraft or pilots to the operations control, or ATC and air traffic surveillance systems.

Figure 4 is a simplified representation of these systems. At each level of this system there are, in reality, many different controllers and multiple, interlinked control loops.

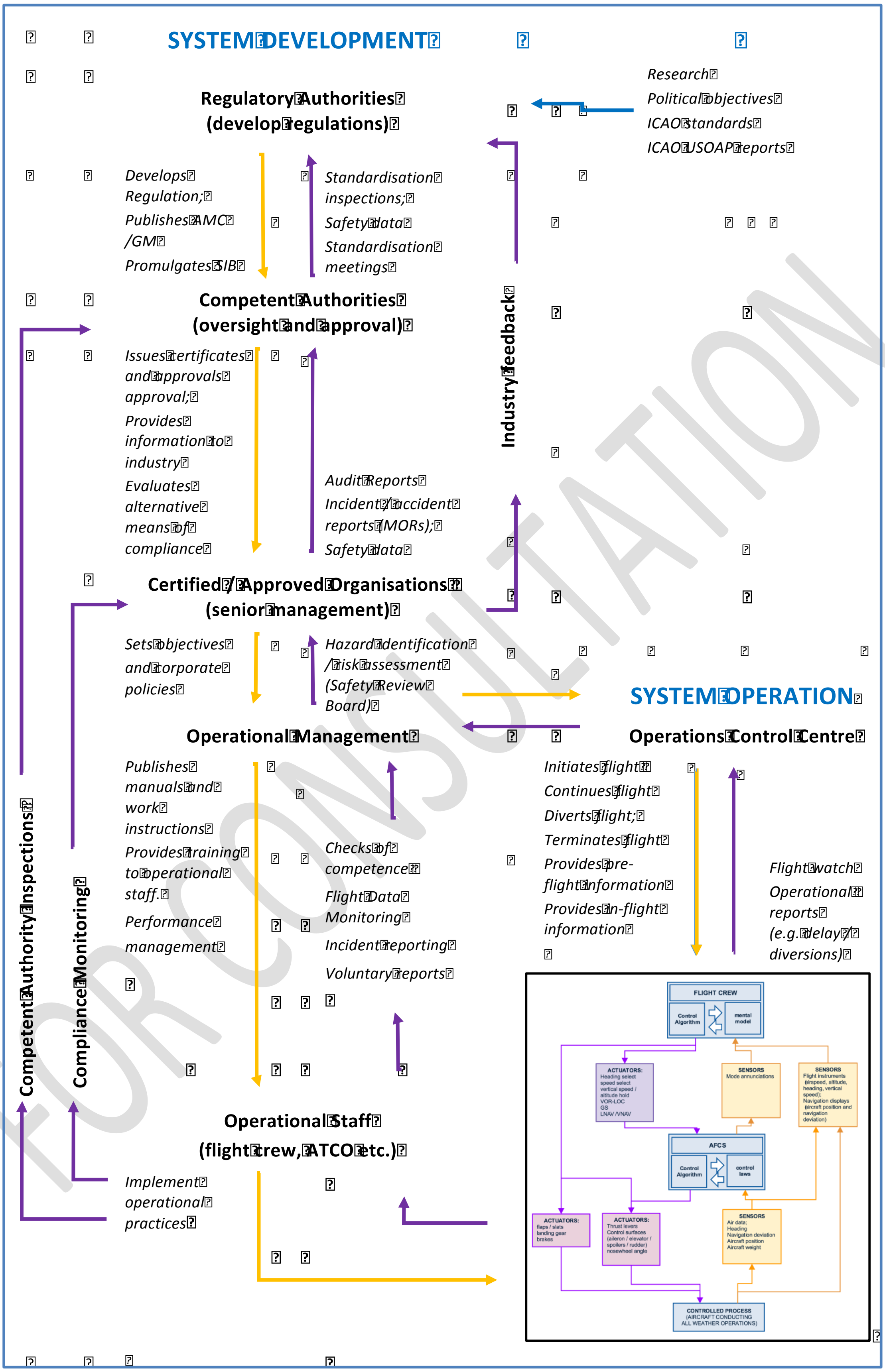

Figure 4: System development and system operations' structures for AWOs

System development structure

It is not possible to represent the complete 'cascade of control' for the system development structure because of its complexity. For the sake of simplicity, examples are given for the cascade of control relevant to the certification and continued airworthiness of an aircraft used for AWO aircraft cluster (**Figure 6**), and for the operation of an aircraft for AWO air operations cluster (**Figure 5)**.

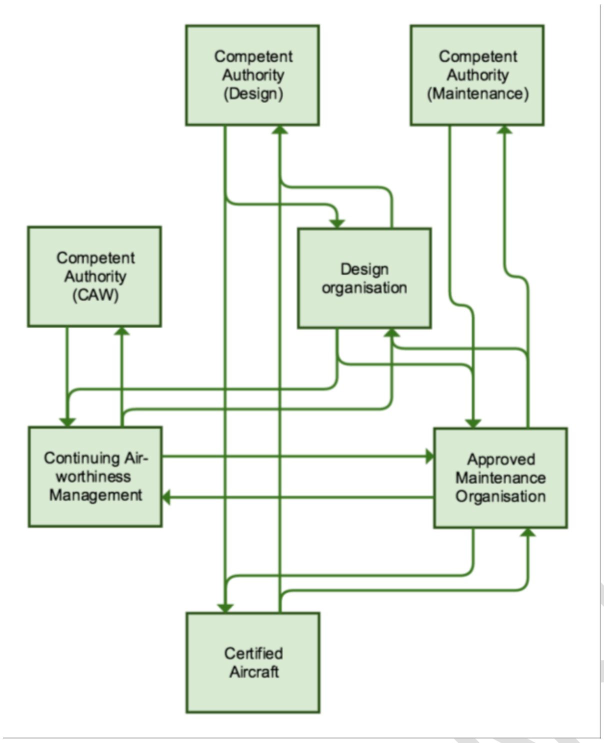

Figure 6: Cascade of control for the aircraft cluster

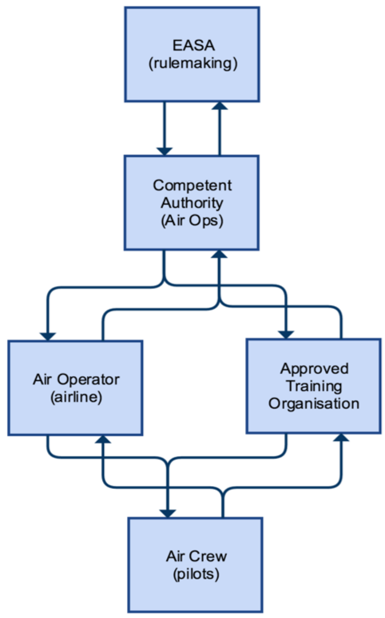

Figure 5: Cascade of control for the air operations cluster

System operations' structure

Figure 7 represents the interaction of some of the controllers within the system operations' structure of the AWO system. It represents the real-time environment of AWOs; therefore, it does not consider the policy and regulatory controllers in the system (system development structure). **Figure 8** shows one 'control loop' within this system, in which the flight crew issue control actions. **Figure 7** and **Figure 8** will be useful for the Project in considering the control loops involved in the real-time AWO scenario and conducting the hazard analysis for these processes.

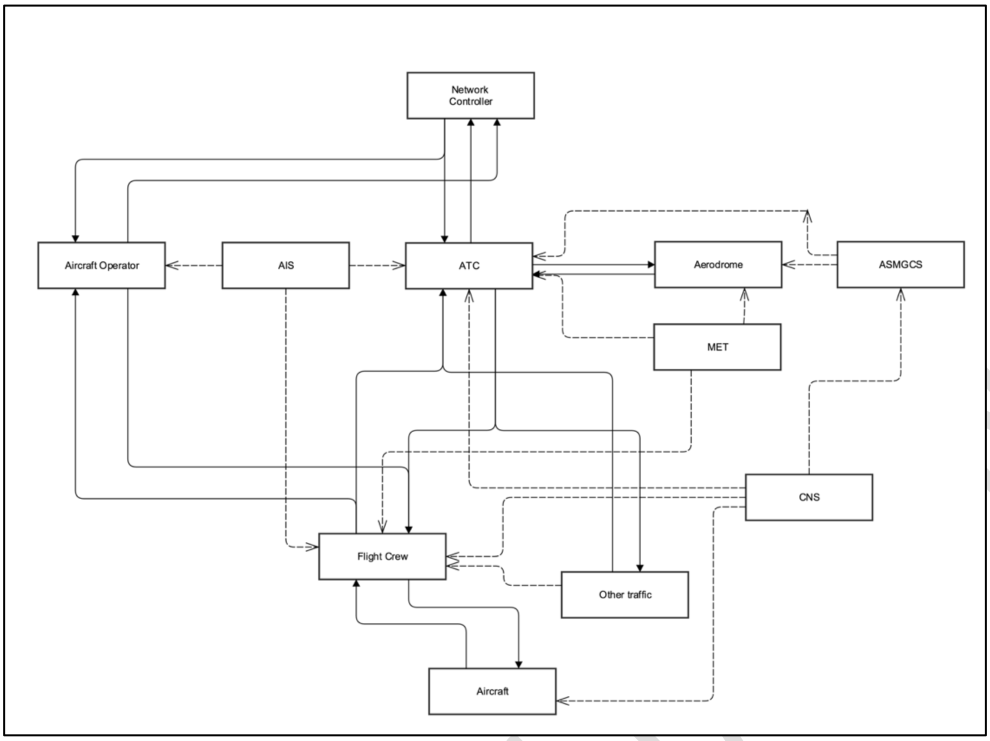

Figure 7: Simplified system operations' structure for the AWO system

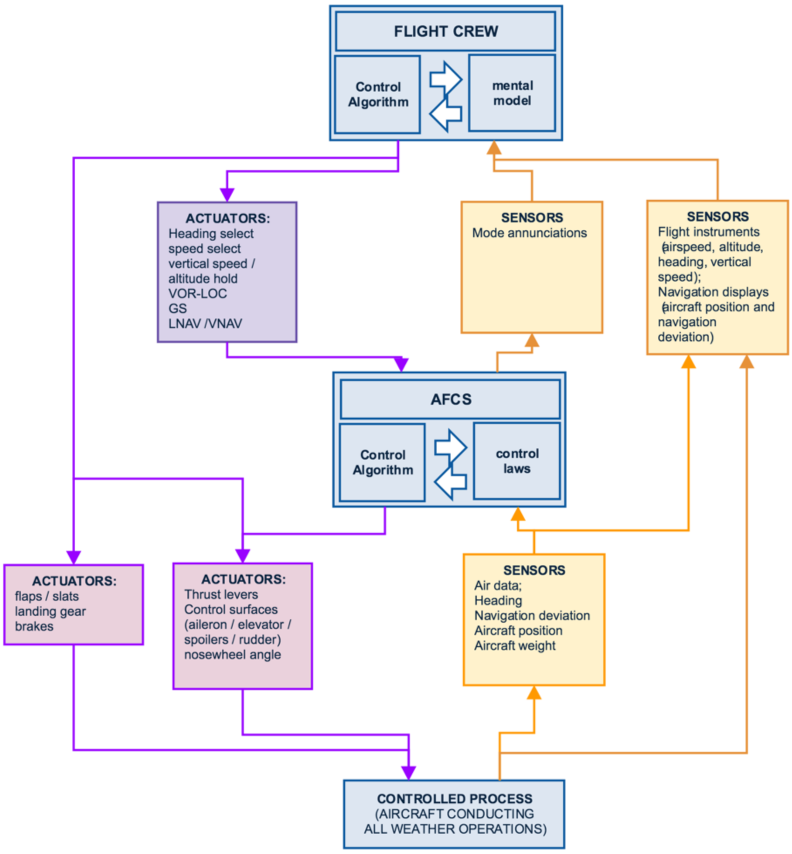

Figure 8: A control loop for AWOs where flight crew are the controller

Accidents and hazards

The objective of analysing the 'total system' and developing regulations is to eliminate hazards and reduce the risk of accidents. The following definitions have been established for the AWO Project based on the Systems-Theoretic Accident Model and Processes (STAMP)/STPA methodology[2]:

— **Accident:** Any event resulting to injuries and/or damages to property and/or equipment[3].

— **Hazard:** A system state or set of conditions that, together with a particular set of worst-case environmental conditions, will lead to an accident.

The following hazards have been identified in relation to the AWO system:

— H1: Uncontrolled aircraft when airborne;

— H2: Inadequate separation of the aircraft from terrain or obstacles before landing;

— H3: Inadequate separation of the aircraft from flying objects when airborne;

— H4: Inadequate separation of the aircraft from objects on the ground;

— H5: Uncontrolled landing and roll-out;

— H6: Uncontrolled taxiing;

— H7: Movement outside the movement areas (manoeuvring areas and apron);

— H8: Uncontrolled take-off.

Safety constraints

The STAMP/STPA methodology generates safety constraints that must be complied with in order to prevent a system hazard. These safety constraints form the starting point from which the rules will ultimately be derived. The generation of a complete set of safety constraints relies on the depth and quality of the system analysis, which in turn are influenced by the available resources (e.g. time, expertise). Also, compliance with all safety constraints might not be always feasible due to external factors (e.g. available technology and financial cost). Therefore, following the hazard identification and the generation of safety constraints, the 'imperfections' of the system in operation become part of its design assumptions. These 'imperfections' shall be monitored for their validity and shall be eliminated over time, when feasible.

The high-level safety constraints generated so far are as follows:

— S1: The aircraft shall be under control when airborne (instrument and visual segment) (Note: This includes runway contact during go-around manoeuvres);

— S2: The aircraft shall maintain adequate separation from terrain and obstacles excluding the intended landing surface;

— S3: The aircraft shall maintain adequate separation from flying objects;

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[2] The definitions of 'hazard' and 'accident' used here are specific to the STPA methodology and are not consistent with the ICAO standards or EU regulations relating to safety management.

[3] According to the STPA methodology, the definition of accident can include 'mission loss'. For the purposes of the AWO Project, this has been excluded from the definition of accident. The hazard analysis, therefore, considers only safety-related outcomes rather than operational disruption or commercial loss.

— S4: The aircraft shall maintain adequate separation from objects on the ground;

— S5: The aircraft shall be under control during landing and roll-out[4] on the intended landing surface;

— S6: The aircraft shall be under control during taxiing;

— S7: The aircraft shall remain within the movement area (on the ground);

— S8: The aircraft shall be under control during take-off.

Different safety constraints apply to the different phases (approach, taxiing, and take-off) of operations, as shown in **Table 1**.

Approach			Taxiing	Take-off
Instrument and visual segment (if applicable)	Flare, touchdown and roll-out	Go-around		
S1: The aircraft shall be under control when airborne.	S4: The aircraft shall maintain adequate separation from objects on the ground.	S1: The aircraft shall be under control when airborne.	S3: The aircraft shall maintain adequate separation from flying objects.	S3: The aircraft shall maintain adequate separation from flying objects.
S2: The aircraft shall maintain adequate separation from terrain excluding the intended landing surface.	S5: The aircraft shall be under control during landing and roll-out on the intended landing surface.	S2: The aircraft shall maintain adequate separation from terrain and obstacles excluding the intended landing surface.	S4: The aircraft shall maintain adequate separation from objects on the ground.	S4: The aircraft shall maintain adequate separation from objects on the ground.
S3: The aircraft shall maintain adequate separation from flying objects.	S6: The aircraft shall remain within the movement areas (on the ground).	S3: The aircraft shall maintain adequate separation from flying objects.	S6: The aircraft shall be under control during taxiing.	S7: The aircraft shall remain within the movement areas.
			S7: The aircraft shall remain within the movement areas.	S7: The aircraft shall be under control during take-off.

Table 1: Safety constraints by phase of operation

[4] For helicopter operations, this relates to transition/manoeuvre to hover and landing. A roll-out or rolling landing is only performed as part of an emergency procedure in case of engine failure (in case of multi-engine helicopters) or other controllability failures, but these failures are not considered in these safety constraints.

Application of the STPA methodology

A hazard analysis will be conducted according to the STPA methodology for the different ‘control loops’ within the AWO system. The hazard analysis considers the control actions that may be taken by different controllers, the actuators available and the sensors providing feedback. From these control actions, ‘unsafe control actions’ are derived. These are the actions that could result in a system hazard. The types of unsafe actions are as follows:

— An unsafe control action is provided that creates a system hazard;

— A required control action is not provided to avoid a hazard;

— A potentially safe control action is provided too late, too early or in the wrong order;

— A continuous safe control action is provided for too long or is stopped too soon.

An unsafe condition can also exist when a control action is provided but not followed.

These ‘unsafe control actions’ are used to derive ‘safety requirements’. For each safety requirement interfaces to other controlled process are considered and causal factors evaluated. These lead to further safety requirements. It is these safety requirements that will be used to validate the proposed regulatory requirements and identify any hazards that are not adequately addressed by the proposed rules.

Operational capabilities

The operational capabilities of the AWO system are described in terms of the following attributes:

— **Resilience:** The ability of the system to timely monitor deviations from the required flight path and maintain/restore it within the predefined limits;

— **Functionality:** The ability of the system to support its resilience with technology;

— **Continuity:** The ability of the system to maintain its functionality.

Table 2 below shows the required operational capabilities that are applicable to the different classifications of operations according to the phase of operation. The description of operational capabilities is intended to be technologically neutral in that operational capabilities might be achieved using different technologies.

	Approach					Taxiing	Take-off
	Instrument segment	Visual segment (if applicable)	Flare and touchdown	Roll-out	Go-around		
Resilience	The aircraft is flown on a defined trajectory from the final approach fix to arrive at DA/H (if applicable) at a position from which visual references can be acquired.	The aircraft trajectory from DA/H to the touchdown zone remains within the required tolerance for a successful landing.	The aircraft lands within the touchdown zone with an appropriate rate of descent, side-slip angle and bank angle.	The aircraft maintains the runway centre line and slows to taxiing speed within the landing distance available.	The aircraft remains within the obstacle-free zone and/or within the missed approach segment of the procedure.	The aircraft follows the intended route.	The aircraft maintains the runway centre line and becomes airborne within the take-off run available.
Functionality			The pilot has sufficient visual reference (natural or augmented) to detect any deviation from the required parameters or the probability of deviation is sufficiently remote.	The pilot is able to detect steering faults and take control under prevailing visibility conditions.	The pilot is able to follow the required vertical and horizontal path in the event of system failure or the probability of such failure is sufficiently remote.	The pilot has sufficient visual reference (actual or synthetic) to maintain taxiway centre line. Guidance and timely warning of failures is provided to enable the pilot to follow the required route.	The pilot has sufficient guidance to control the aircraft in the event of either a rejected take-off or a continued take-off after failure of the critical engine.
Continuity	The missed approach rate	A lack of visual reference is	The pilot is able to complete the	The pilot is able to complete the	The pilot is able to safely execute		The pilot is able to complete the

	Approach					Taxiing	Take-off
	Instrument segment	**Visual segment (if applicable)**	**Flare and touchdown**	**Roll-out**	**Go-around**		
	attributable to system performance or reliability is very low.	immediately obvious to the pilot and any failure of augmented visual systems is clearly evident.	landing manually in the event of system failure or the probability of system failure is sufficiently remote.	roll-out manually in the event of system failure or the probability of system failure is sufficiently remote.	a go-around from any point on the flight path from the final approach point to touchdown in all configurations.		take-off in the event of system failure or the probability of system failure is sufficiently remote.

Table 2: Operational capabilities (General)

3. Classification of standard operations

Overview

The scope of the AWO Project includes approach, taxiing and take-off operations in reduced visibility. In order to ensure a common understanding among the members of the AWO Project team, these operations are classified as shown in **Table 3**.

Type of operation	Classification		Lowest MDA/H, DA/H (ft)	Lowest RVR (m)
Approach	Type A		250	600
	Type B	CAT I	200	550
		CAT II	100	300
		CAT III	0 or no DA/H	0
Taxiing *(see Note)*	Normal taxiing		N/A	550
	Low-visibility taxiing		N/A	0
Take-off	Take-off		N/A	550
	LVTO I		N/A	400
	LVTO II		N/A	0

Note: RVR is measured only on a runway and is, therefore, not directly relevant to taxiing. The minimum value stated will be required on the runway to be used for take-off/approach to ensure that aircraft can safely taxi on and off the runway.

Table 3: Classification of standard operations

The classification of standard operations presented here is not the same as in existing rules and also differs from ICAO terminology.

Approach

The different types of approach and landing operations have been classified according to the lowest DA/H (or MDA/H) and RVR required for the approach type. The classification of approach types does not depend on the technology used for the approach. The lowest minima specified do not take account of 'operational credits' that may allow for lower operating minima.

In accordance with the ICAO terminology, approach operations have been classified as either 'Type A' or 'Type B'. Type A approach operations are those with a minimum DA/H (or MDA/H) at or above 250 ft;

Type B approach operations are those with DA/H below 250 ft. Type A approach operations may be 2D operations (lateral guidance) or 3D operations (lateral and vertical guidance), whereas all Type B approaches are 3D operations. Type B approach operations are then further subcategorised into CAT I, II or III according to the usual DA/H and RVR.

This classification does not subdivide CAT III operations into CAT IIIA, IIIB, and IIIC. The actual minima applicable to any operation would depend on the aircraft equipment and the specific LVO approval held by the air operator.

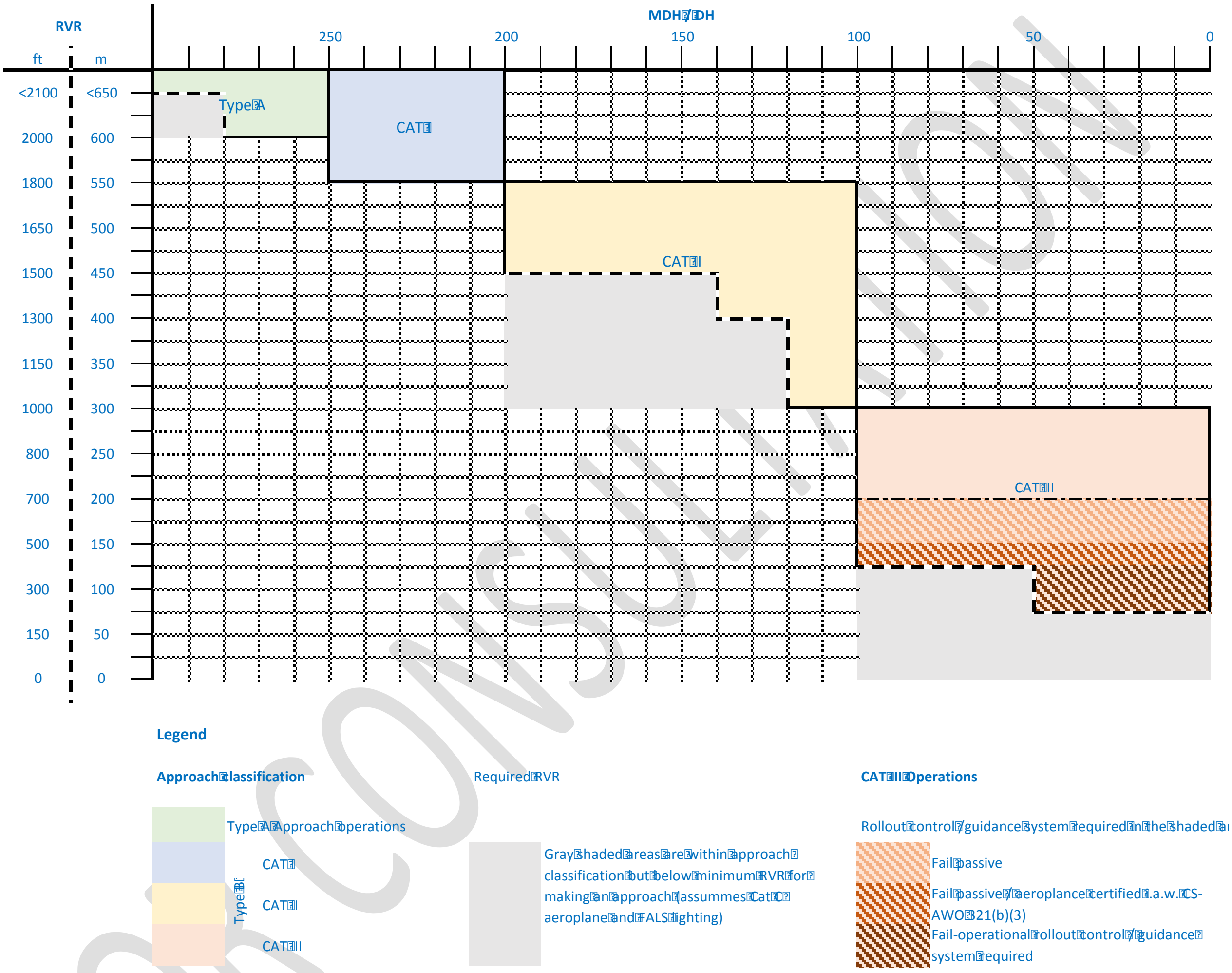

Figure 9: Graphical representation of standard approach classifications

Taxiing

In order to be consistent with the definitions of other low-visibility operations, ‘normal taxiing’ corresponds to a visual range equivalent to an RVR at or above 550 m and ‘low-visibility taxiing’ applies when the visual range is equivalent to an RVR below 550 m. Current Air Operations regulations do not contain restrictions on taxiing operations — these are determined by aerodrome operators based on the ability of aircraft to taxi using visual references and to avoid collisions, and on the capability of control units to exercise control over traffic, using visual or other means.

Take-off

Take-off operations are to be classified as 'normal take-off operations' with an RVR at or above 550 m and 'low-visibility take-off operations' with an RVR below 550 m, which are further subdivided into:

— LVTO I: RVR between 400 and 550 m; and

— LVTO II: RVR less than 400 m.

For the purposes of the AWO Project, take-off is considered to be completed once the aircraft is airborne.

It is proposed to remove the current minimum RVR value of 75 m for take-off from this classification. Stakeholders are requested to provide their opinions as to whether regulations should enable taxiing and take-off in RVRs of less than 75 m and, if appropriate, to provide supporting evidence.

4. Concept of operations with operational credits

General

For specific classes of standard operations, a standard combination of airborne equipment, aerodrome infrastructure and equipment, and procedures (system components) needs to be available to ensure the required system performance. In real-life operations, however, often one or more system components exceed the required standard performance. The aim of the concept of operations with operational credits is to enable the best use of new technologies and provide further operational flexibility beyond the limits of standard operations.

The enhanced performance of certain items of equipment or procedures may allow the conduct of operations to lower than standard minima, which are presented in **Table 3**. In order to apply an operational credit, the assessment of the enhanced performance must be combined with the cross-domain systemic hazard identification and assessment. It would be necessary to demonstrate that the equipment and/or procedures employed at least maintain the operational performance of the total system while complying with the safety constraints. Operational credits may require advanced performance in more than one domain.

Airborne systems that could enable the implementation of operational credits include enhanced flight vision systems (EFVSs), synthetic vision guidance systems (SVGSs), combined vision systems (CVSs), head-up display (HUD) (or equivalent), and autoland. The scope of operational credits should not be limited to airborne equipment as operational credits may also be granted on the basis of enhanced ground-based equipment. Lower-than- standard CAT I (LTS CAT I), other-than-standard (OTS) CAT II and airborne radar approach operations are current examples of operational credits. The possibility to introduce other types of operational credits, such as preferably special approval Category I (SA CAT I), should be introduced by the AWO Project. The AWO Project should already take into account possible enablers for operations with operational credits, such as the use of EFVSs or CVSs.

For approach operations, an operational credit could be applied to the instrument and/or visual segment.

In certain circumstances it may be possible to achieve the required system performance without some standard items being available by using other enhanced equipment or procedures. In such circumstances an operational credit may also be granted to apply to the standard minima for that class of operation.

Note: The description of operations with operational credits should become as less as possible technology-dependent — ideally being independent from technology but only referring to the required performance and operational criteria; the required performance and operational criteria are developed by using to quite a large extent derived characteristics from the assumed operational (current or future) technologies.

Overview of LTS CAT I operations

An LTS CAT I operation is an operational credit that allows approach operations in lower RVR than that required for standard CAT I operations, using determined 3D approach path with both lateral and vertical guidance, corresponding to the accuracy criteria relevant to today's instrument landing system (ILS) and microwave landing system (MLS). The credit exploits the adequate performance of the runway referring to the current standard of enhanced runway lighting and a localiser signal that is useable down to the runway threshold together with the appropriate airborne equipment represented by the use of coupled approach, flight director or HUD. This may be considered a more demanding CAT I operation. The DH for LTS CAT I operations is the same as for standard CAT I operations but the required RVR may be less (e.g. in the case of ILS as enabler 450 or 400 m depending on the performance of the ILS installation — Class I/T/1 or II/D/2 respectively). LTS CAT I is already permitted by current European Union (EU) regulations. The requirements are summarised in **Table 5**.

Overview of SA CAT I operations

SA CAT I is an operational credit that exploits a navigation solution by extending the instrument segment of CAT I approach operations from 200 ft down to 150 ft above the runway. SA CAT I will allow approach operations with a lowest DH of 150 ft and an RVR of 400 m to aerodromes suitably equipped for CAT I operations. Similar operations are already successfully conducted in several non-EU States. One of the objectives of the AWO Project is to make the operational benefits of these operations available within the EU Member States.

The proposal is to make this operational credit available to aircraft whose performance is equivalent to that of aircraft equipped with appropriately certified flight guidance systems. Examples of currently known eligible technologies include autoland, HUD systems with an integrated flight guidance system, or SVGS/CVS with an integrated flight guidance system.

For details on the proposed requirements for SA CAT I operations, see **Table 5** and **Appendix 1**. **Figure 12** shows a graphical representation of SA CAT I and LTS CAT I operations.

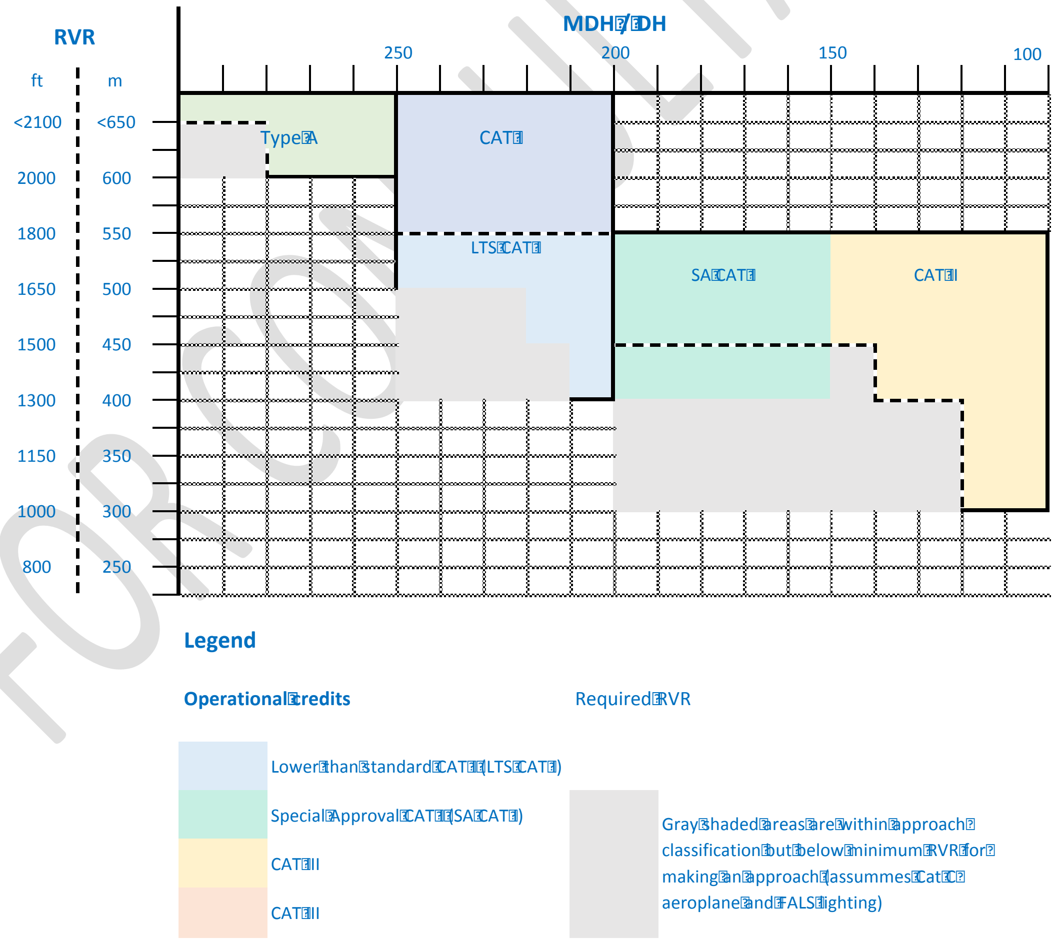

Figure 10: Graphical representation of LTS CAT I and SA CAT I operations

Overview of OTS CAT II operations

OTS CAT II is an operational credit that allows operations using autoland or an approved HUD to touchdown and can, therefore, allow operations in the visual segment without a complete precision approach Category II lighting system. The DH may be as low as 100 ft (as for standard CAT II) and the required RVR will depend on the class of light facility installed, down to a lowest minimum of 350 m. OTS CAT II is already permitted by current EU regulations. The requirements are summarised in **Table 5**.

Overview of SA CAT II operations

SA CAT II is not available in current EU regulations. The US FAA authorises 'Special Authorisation CAT II' approaches where an aerodrome runway and approach lighting system does not meet the usual requirements for a CAT II precision lighting system. Use of autoland or HUD to touchdown is required. Like OTS CAT II, this operational credit allows operations in the visual segment using a flight guidance system to mitigate reduced lighting. The lowest RVR permitted for SA CAT II is 1 200 ft, equivalent to 375 m.

Note: The feasibility to develop and introduce this type of operations into the EU regulations depends on the outcome of further developments on this Project.

Example of technological enablers for operations with operational credits — EFVS/CVS

Operational credit for the use of EFVS/CVS will exploit the ability of a pilot to fly the visual segment of a 3D instrument approach by using an image displayed on an HUD or equivalent system to augment the natural view of the external environment. It is anticipated that approaches to a CAT I runway could be permitted to a lowest RVR of 300 m using the standard CAT I DA/H. EFVS/CVS may be used in conjunction with any classification of approach operation and so allow operations in reduced RVR compared with standard operations.

Use of EFVS/CVS does not affect the instrument segment of the approach and thus MDH/DH remains unchanged. At MDH/DH the pilot must have the required visual reference, through either enhanced or natural vision, in order to continue the approach. For any particular aircraft installation there will be a height below which the pilot needs 'natural' visual reference and can see the runway environment without use of EFVS/CVS in order to continue the approach and landing.

For details on the proposed requirements for use of the EFVS/CVS, please refer to the explanation in **Table 5** and **Appendix 2**.

5. Description of system components

Standard operations

The different system components together must comply with the safety constraints for AWOs regardless of the classification of a particular operation. Each class of operation may need a different set of system components to comply with these safety constraints. This is further described in **Table 4** and will be further developed as the AWO Project progresses. **Table 4** is not exhaustive; for detailed requirements, please refer to the ICAO documents and EU regulations.

	ATM/ANS	Aerodromes	Aircraft certification	Air operations
Type A	OCA/H published in accordance with PANS-OPS. Approach charts available. RVR reporting available below 800 m visibility.	Runway, infrastructure, approach and runway lights and marking in accordance with CS-ADR-DSN/ ICAO Annex 14 for non-precision approach runways. (Non-precision runway is suitable for type A operations with visibility in excess of 1 000 m.) Navaids protection areas should be safeguarded. Maximum switchover time for approach lights 15 seconds (as addressed in current relevant CS-ADR-DSN).		Specific visual references at MDA/H or DA/H specified. Operating procedures are available, including normal, abnormal and emergency conditions.
CAT I	OCA/H published in accordance with PANS-OPS. Approach charts available.	Runway, infrastructure, approach and runway lights and marking in accordance with CS-ADR-DSN/	Basic autopilot (AP) safety objectives. Basic airworthiness requirements	

	ATM/ANS	Aerodromes	Aircraft certification	Air operations
	RVR reporting available below 800 m visibility.	ICAO Annex 14 for CAT I precision approach runways.	(see Chapter 6 of Appendix 2 AC 120-29A, edition 2002). If installed, the basic airworthiness (AW) requirements are a prerequisite for any equipment. Equipment mentioned below shall comply with the applicable standards as mentioned in the associated ETSOs. CS-25 (in particular CS 25.1309, 1301, 1322, 1329), including the relevant AMC. Be able to safely bring the aeroplane at DA/H 200 ft or above from which it can be landed safely within the touchdown zone of the runway and/or to safely perform a go-around (position is defined in such a way that the pilot may be able to make a correction; performance criteria are therefore aircraft-dependent (e.g. large transport aircraft vs business jet).	

	ATM/ANS	Aerodromes	Aircraft certification	Air operations
CAT II	ATC required. ATC has suitable RVR display equipment. Two RVR reporting positions. For ILS-supported approaches, sensitive areas to be protected from aircraft and vehicles. ILS certified to Class II/D/2. OCA/H published in accordance with PANS-OPS. Approach charts available.	Runway, infrastructure, approach and runway lights and marking in accordance with CS-ADR-DSN/ ICAO Annex 14 for CAT II precision approach runways. Additional surface markings and holding signs required. Information on status of relevant systems to be provided to pilots. Low-visibility procedures (LVP) in place.	CS-AWO. Performance criteria are in CS-AWO 231 and associated AMC. Safety objective CS-AWO 201. Additional safety objectives criteria are in the 'failure conditions' section of CAT 2 of CS-AWO. Equipment (navigation display, FD, AFCS, HUD): CS-AWO 221 and AC 120-xls Chapter 3.3 and Appendix 3. CS-AWO 221(i) and 236 require excessive deviation alerts; however, according to the FAA AC 120-xls para 3.16, an excessive deviation alert is not required. See also CS-AWO 206. Navigation sensors: AC 120-XLS (ILS, GLS, MLS).	Competent authority approval required. Flight crew need additional training at an ATO to qualify for operations below DH or 200 ft. Specific crew training (ground and FSTD) required. Minimum crew of two pilots is required. The air operator must conduct operational demonstration prior to approval. The air operator must have a certain level of experience in operating the given aircraft type (e.g. 6 months). The air operator must have a process for continuous monitoring of the success rate of AWO approaches. The air operator's SMS evaluates hazards from all components of the system, not just hazards internal to the air operator. Any resulting risks are assessed and

	ATM/ANS	Aerodromes	Aircraft certification	Air operations
				managed effectively. The air operator has established an acceptable level of safety for LVO operations and maintains suitable performance indicators. The air operator is able to demonstrate that the acceptable level of safety is achieved. The air operator shall document crew qualifications (CAT). Competent authority shall issue qualifications record to crew (NCC).
CAT III	Approach charts available. RVR reporting available. Three RVR reporting positions.	Runway, infrastructure, approach and runway lights and marking in accordance with CS-ADR-DSN/ ICAO Annex 14 for CAT II precision approach runways. Information on status of relevant systems to be provided to pilots. LVP in place.	Equipment: CS-AWO 321 and AC 120-xls Chapter 3.4 and Appendix 4. CS-AWO 321(a)(5) requires excessive deviation alerts; however, according to the FAA AC 120-xls para 3.16, an excessive deviation alert is not required. Autoland: CS-AWO 321 and AC-120 xls and Appendix 4. Aircraft shall be capable of	Reporting system shall utilise FDR. Approach shall be automatically flown to touchdown (except approved HUD). Specified RVRs required for TDZ and MID. With fail-passive flight control, the pilot shall be able to manually land or perform a go-around.

	ATM/ANS	Aerodromes	Aircraft certification	Air operations
			clearing obstacles following a missed approach at any height. Roll-out control/guidance system required (below 200 m RVR) Fail-operational roll-out flight control system required for RVR below 125 m.	Visual reference of three centre line lights required at DH (RVR 200 m). Eligible aerodromes and runways verified. If DH is specified, then visual reference of one centre line light is required (CAT III with fail-operational flight control).
LVTO I	Additional separation is required between arriving/departing and successive arriving aircraft (to protect LOC signal, also from vehicles).	LVP in place. Maximum switchover time for runway end, centre line lights and stop bars 1 second. Maximum switchover time for other runway lights, essential taxiway lights and obstacle lights 15 seconds.	CS-AWO Subpart 4. AC 120-XLS Appendix 2, in particular Chapter 6.	
LVTO II		Power supply switchover time for runway lights 1 second or less. Below RVR 150 m, 15 m spacing runway centre line lights required.		Specific operational approval required. Specific crew training required.
Low-visibility		Aerodrome shall establish		

	ATM/ANS	Aerodromes	Aircraft certification	Air operations
taxiing		procedures (LVP).		

Note: The requirements for approach and take-off operations are cumulative, i.e. all the requirements of a lower class of operations must be satisfied in addition to the requirements listed for the specific category, unless the item is underlined. Items that are underlined do not apply to higher classification of operations.

Table 4: System components for different classification of operations

Operations with operational credits

Table 5 shows the proposed system components for the different types of operational credits, which are derived from standards adopted in other States and from the STPA hazard analysis. For further details, please refer to the relevant concept papers in **Appendix 1 and 2**.

	ATM/ANS and aerodromes	Aircraft certification	Air operations
LTS CAT I	Requirements for 'standard CAT I' and additional requirements for 3D approach path with lateral and vertical guidance with performance equivalent to: — an ILS or MLS supporting LTS CAT I operations shall be an unrestricted facility with a straight-in course, <= 3degree offset and the ILS shall be certified to: (i) Class I/T/1 for operations to a minimum of 450 m RVR, or (ii) Class II/D/2 for operations to less than 450 m RVR. *Note:* Single ILS facilities are only acceptable if level 2 performance is provided. The available visual aids shall be equivalent to: — standard CAT I runway markings, runway-edge lights, threshold lights and runway-end lights;		Operations with operational credits require a specific approval. The flight crew shall be current and qualified for the intended operation.

	ATM/ANS and aerodromes	Aircraft certification	Air operations
	— additional touchdown zone and/or runway centre line lights for operations with RVR below 450 m.		
SA CAT I	An SA CAT I instrument approach procedure (IAP) shall meet PANS-OPS CAT I procedure design criteria using adequate and accurate altitude values to establish the DA/H, equivalent to the one provided by a radio altimeter (RA), or the air operator shall conduct an operational assessment. A precision approach terrain chart shall be required for LVO except where the requisite information is provided electronically in an Aerodrome Terrain and Obstacle Chart in accordance with ICAO Annex 4 Chapter 5. Where used, a ground-based navigation system shall meet the ICAO Annex 10 requirements for unrestricted CAT I ILS operations. Aerodrome siting, operations and continuity needs shall be considered for eventual additional requirements. The runway and the pre-threshold area of the runway shall meet the requirements for a runway supporting CAT I operations and determining the DA/H with an RA if no other equivalent system can be used.	Aircraft shall be certified for SA CAT I, CAT II or CAT III operations, and this shall be reflected in the AFM. A high-performance manual or automatic flight guidance system certified for SA CAT I, CAT II or CAT III operations must be available. RA or equivalent system required.	Operations with operational credits require a specific approval. The flight crew shall use an IAP designed and an aerodrome qualified for the intended operation. For IAP with procedure design criteria significantly deviating from the PANS-OPS criteria, the air operator shall conduct an operational assessment. A flight guidance system approved for SA CAT I, CAT II or CAT III operations must be used. Where autoland is used, the pre-threshold terrain must be suitable. If the approved flight guidance system fails after passing a height of 200 ft above the threshold, a missed approach shall be initiated unless the pilot has already acquired the necessary visual cues for a safe landing. For SA CAT I operations, actual TDZ RVR reports shall be available based on RVR sensors.

	ATM/ANS and aerodromes	Aircraft certification	Air operations
	For SA CAT I autoland operations with an RA, the pre-threshold terrain must be suitable. For operations using autoland, the pre-threshold terrain must be suitable. Low-visibility procedures will be required, including protection of ILS-sensitive and ILS-critical areas (where applicable). Visual aids shall be available as prescribed for a runway supporting CAT I operations. The obstacle limitation surfaces shall meet the requirements for a runway supporting CAT II operations. LVP shall be established and in force. Power supply switchover time for approach and runway lights shall be 1 second or less. RVR sensors required.		Single-pilot operations could be permitted unless a safety assessment demonstrates that SA CAT I operations cannot be conducted as safely as CAT I operations. The flight crew shall be current and qualified for the intended operation. The air operator shall be responsible for initial and recurrent training and checking. The air operator shall be responsible to record the current privileges of a pilot.

Note: For completeness of the description of possible operations, also these with operational credits with regard to CAT II are described as well (OTS CAT II, SA CAT II); their introduction into the EU regulatory system depends on the further development of the AWO Project.

OTS CAT II	As for CAT II except that full precision approach Category II lighting system not required. Standard runway day markings and approach, and the following runway lights: runway-edge lights, threshold lights and runway-end lights. For operations in RVR below 450 m, additionally touchdown zone lighting and/or runway centre line lights. For operations with an RVR of 400 m or less, additionally runway centre line lights. The terrain ahead of the runway threshold shall have been surveyed.	As for CAT II with autoland or HUD approved for use to touchdown.	As for CAT II, specific approval for OTS CAT II required (OPSPECS or approvals document). Autoland or approved HUD to be used to touchdown.
SA CAT II	As for CAT II except that full precision approach Category II lighting system not required. Precision approach lighting required with additionally: — simplified short approach lighting system with runway alignment indicator lights (SSALR), medium-intensity approach lighting system with runway alignment indicator lights (MALSR) (with threshold bar separate from runway-end lights), ALSF-1/ ALSF-2;	As for CAT II with autoland or HUD approved for use to touchdown.	As for CAT II, specific approval for OTS CAT II required (OPSPECS or approvals document). Autoland or approved HUD to be used to touchdown.

	— high-intensity runway lights (HIRL). Runway lighting systems must have standby power with 1 second transfer and must be remotely monitored. Single RVR reporting with TDZ sensor is acceptable for minimum 550 m RVR (1 600 ft). RVR down to 350 m (1 200 ft) requires minimum two RVR sensors including one for the TDZ. Declared landing distance of 600 ft or more required.		

Table 5: Functional criteria for operational credits

Example of possible enablers for operations with operational credits: EFVS/CVS

From ATM/ANS and aerodrome side, the following should be available: the State shall specify in the AIP whether an aerodrome is eligible for operations with operational credits, specifying RVR minima, where necessary; any aerodrome with specific requirements for the conduct of operations with operational credits, where necessary; those parts of the lighting facilities which use LED lights; the runway threshold accuracy in compliance with Annex 14 Appendix 5 Table A5-1; such IAPs which are not permitted for operations with operational credits, if any; RVR information shall be reported below visibility of 800 m; RVR information shall not be older than 5 minutes in accordance with ICAO Annex 3 ATT-C; the aerodrome shall be secured through fences and barriers in accordance with ICAO Annex 14, 9.10; at least 85 % of the lighting of the available lighting facilities shall be operative in accordance with ICAO Annex 14, 10.5.; the secondary power supply switchover time shall be no more than 1 second for runway lights in accordance with ICAO Annex 14, 8.17; LVP shall be established and in force for air operations with an RVR below 550 m.

From aircraft certification side: the EFVS/CVS shall be certified for the intended operation, and the performance of the sensors for different meteorological conditions shall be demonstrated and specified in the AFM; the AFM shall specify a height above the threshold below which natural vision shall be available; the AFM shall specify any limitations concerning eligible instrument approach procedures; the manufacturer shall provide the air operator with supplementary information relevant to assess the operational performance and operational constraints of the vision system; aircraft shall be certified for the intended operation; the AFM shall specify the flight guidance system to be used for obtaining an operational credit.

From the air operations side: the air operator shall establish aerodrome operating minima based on the approved method for operations with operational credits; the competent authority shall approve the method for establishing aerodrome operating minima for operations with operational credits, and shall specify the lowest minima for such operations; the air operator shall only select aerodromes for operations with operational credits, which meet the provisions for the intended operation; the air operator shall use published IAPs based on PANS-OPS criteria, which provide a vertical guidance and meet any IAP limitations specified in the AFM; for IAPs with procedure design criteria deviating from PANS-OPS criteria or not providing vertical guidance, or runway ends.

6. Common definitions of terms to be used

The following definitions are common to the different domains which are covered by the AWO Project.

For IRs:

'aerodrome operating minima' means the limits of usability of an aerodrome for:

(a) take-off operations, expressed in terms of visibility and/or runway visual range (RVR) and, if necessary, cloud conditions;

(b) two-dimensional (2D) instrument approach operations, expressed in terms of visibility and/or RVR, minimum descent altitude/height (MDA/H) and, if necessary, cloud conditions; and

(c) three-dimensional (3D) instrument approach operations, expressed in terms of visibility and/or RVR and decision altitude/height (DA/H);

'aeroplane' means an engine-driven, fixed-wing aircraft heavier than air that is supported in flight by the dynamic reaction of the air against its wings;

'aircraft' means a machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface;

'all-weather operations' means any surface movement, take-off, departure, approach or landing operations in conditions where visual reference is limited due to meteorological conditions;

'approach and landing phase — helicopters' means that part of the flight from 300 m (1 000 ft) above the elevation of the final approach and take-off area (FATO), if the flight is planned to exceed this height, or from the commencement of the descent in the other cases, to landing or to the balked landing point;

'continuous descent final approach (CDFA)' means a technique, consistent with stabilised approach procedures, for flying the final approach segment of a non-precision approach procedure as a continuous descent, without level-off, from an altitude/height at or above the final approach fix altitude/height to a point approximately 15 m (50 ft) above the landing runway threshold or the point where the flare manoeuvre shall begin for the type of aircraft flown;

'combined vision system (CVS)' means the combination in real-time of an imaging sensor and display with a synthetic image generated using a terrain and obstacle database utilising a precision navigation position; a CVS can include either an EFVS or EVS and an SVGS or SVS;

'decision altitude (DA) or decision height (DH)' means a specified altitude or height in a 3D instrument approach operation at which a missed approach must be initiated if the required visual reference to continue the approach has not been established;

'enhanced vision system (EVS)' is an electronic means to provide flight crew with a real-time sensor-derived or enhanced image of the external topography scene (the natural or man-made features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging sensors; an EVS does not have an integrated flight guidance system;

'enhanced flight vision system (EFVS)' is an electronic means to provide flight crew with a real-time sensor-derived or enhanced image of the external topography scene (the natural or man-made features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging sensors; an EFVS is integrated with a flight guidance system and is implemented on a head-up (or equivalent) display on which the imagery and symbology are visible to the pilot flying in their normal position with the line of vision looking forward along the flight path;

'final approach' means that part of an instrument approach procedure which commences at the specified final approach fix or point, or where such a fix or point is not specified:

(a) at the end of the last procedure turn, base turn or inbound turn of a racetrack procedure, if specified; or

(b) at the point of interception of the last track specified in the approach procedure, and ends at a point in the vicinity of an aerodrome from which:

— a landing can be made; or

— a missed approach procedure is initiated;

'final approach and take-off area (FATO)' means a defined area for helicopter operations over which the final phase of the approach manoeuvre to hover or land is completed, and from which the take-off manoeuvre is commenced; in the case of helicopters operating in Performance Class 1, the defined area includes the rejected take-off area available;

'final approach segment (FAS)' means that segment of an instrument approach procedure in which alignment and descent for landing are accomplished;

'go-around' means a transition from an approach to a stabilised climb; this includes manoeuvres conducted at or above DA/H and those conducted below DA/H ('balked landings');

'head-up display (HUD) or equivalent systems' means a display system which presents flight information to the pilot's forward external field of view and which does not significantly restrict the external view;

'helicopter' means a heavier-than-air aircraft supported in flight chiefly by the reactions of the air on one or more power-driven rotors on substantially vertical axes;

'instrument approach operations' means an approach and landing using instruments for navigation guidance based on an instrument approach procedure; there are two methods for executing instrument approach operations:

(a) 2D instrument approach operation, using lateral navigation guidance only; and

(b) 3D instrument approach operation, using both lateral and vertical navigation guidance;

'instrument approach procedure' means a series of predetermined manoeuvres by reference to flight instruments with specified protection from obstacles from the initial approach fix or, where applicable, from the beginning of a defined arrival route to a point from which a landing can be completed and thereafter, if a landing is not completed, to a position at which holding or en-route obstacle clearance criteria apply; instrument approach procedures are classified as follows:

(a) non-precision approach (NPA) procedure, which means an instrument approach procedure designed for 2D instrument approach operations Type A;

(b) approach procedure with vertical guidance (APV), which means a performance-based navigation (PBN) instrument approach procedure designed for 3D instrument approach operations Type A;

(c) precision approach (PA) procedure, which means an instrument approach procedure based on navigation systems designed for 3D instrument approach operations Type A or B;

'instrument runway' means one of the following types of runways intended for the operation of aircraft using instrument approach procedures:

(a) 'non-precision approach runway': a runway served by visual and non-visual aid(s) intended for landing operations following an instrument approach operation Type A and a visibility not less than 1 000 m;

(b) 'precision approach runway, Category I': a runway served by visual and non-visual aid(s) intended for landing operations following an instrument approach operation Type B with a decision height (DH) not lower than 60 m (200 ft) and either a visibility not less than 800 m or a runway visual range (RVR) not less than 550 m;

(c) 'precision approach runway, Category II': a runway served by visual and non-visual aid(s) intended for landing operations following an instrument approach operation Type B with a DH lower than 60 m (200 ft) but not lower than 30 m (100 ft), and an RVR not less than 300 m;

(d) 'precision approach runway, Category III': a runway served by visual and non-visual aid(s) intended for landing operations following an instrument approach operation Type B to and along the surface of the runway and:

(1) intended for operations with a DH lower than 30 m (100 ft), or no DH and an RVR not less than 175 m; or

(2) intended for operations with a DH lower than 15 m (50 ft), or no DH and an RVR less than 175 m but not less than 50 m; or

(3) intended for operations with no DH and no RVR limitations;

'low-visibility operations (LVO)' means an approach or take-off operation with an RVR less than 550 m;

'low-visibility procedures (LVP)' means the procedures applied at an aerodrome for the purpose of ensuring safe operations during low-visibility operations;

'low-visibility take-off (LVTO)' means a take-off with an RVR less than 550 m;

'operation with an operational credit' means an operation using specific airborne or ground equipment, or a combination of airborne and ground equipment, such that lower-than-standard operating minima can be applied for a particular classification of operation;

'runway visual range (RVR)' means the range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line;

'stabilised approach (SAp)' means an approach operation that is flown in a controlled and appropriate manner in terms of configuration, energy and control of the flight path from a predetermined point or altitude/height down to a point of 50 ft above the threshold or the point where the flare manoeuvre is initiated, if higher;

‘synthetic vision system (SVS)’ is an electronic means to display a computer-generated image of the applicable external topography from the perspective of the flight deck that is derived from aircraft attitude, altitude, position, and a coordinate-referenced database;

‘synthetic vision guidance system (SVGS)’ is an electronic means to display a computer-generated image of the applicable external topography from the perspective of the flight deck that is derived from aircraft attitude, altitude, position, and a coordinate-referenced database in combination with a flight guidance display and high-precision position assurance monitors; the SVGS flight instrument display provides a continuous, geo-spatially correct depiction of the external topography scene, including obstacles, augmented by the display of the runway of intended landing;

‘Type A instrument approach operation’ means an operation with a minimum DA/H or MDA/H at or above 250 ft;

‘Type B instrument approach operation’ means an operation with a minimum DA/H below 250 ft. Type B instrument approach operations are categorised as:

(a) Category I (CAT I): a DA/H not lower than 200 ft and with either a visibility not less than 800 m or an RVR not less than 550 m;

(b) Category II (CAT II): a DH lower than 200 ft but not lower than 100 ft, and an RVR not less than 300 m;

(c) Category III (CAT III): a DH lower than 100 ft or no DH, and an RVR less than 300 m or no RVR limitation;

‘visual approach’ means an approach operation when either part or all parts of an instrument approach procedure are not completed and the approach operation is executed with visual reference to the terrain.

For AMC/GM/CSs:

‘fail-operational flight control system’ means a flight control system with which, in the event of a failure below alert height, the approach, flare and landing operation can be completed automatically; in the event of a failure, the automatic landing system will operate as a fail-passive system;

‘fail-operational hybrid landing system’ means a system that consists of a primary fail-passive automatic landing system and a secondary independent guidance system enabling the pilot to complete a landing manually after failure of the primary system;

‘fail-passive flight control system’ means a flight control system that, in the event of a failure, there is no significant out-of-trim condition or deviation of flight path or attitude but the landing is not completed automatically; for a fail-passive automatic flight control system the pilot assumes control of the aeroplane after a failure;

‘flight control system’ in the context of low-visibility operations means a system that includes an automatic landing system and/or a hybrid landing system.

Appendix 1. Operations with operational credits: SA CAT I

Context

One of the objectives of the AWO Project is to introduce into the EU regulatory framework SA CAT I approach operations with a minimum DA/H of 150 ft and a minimum RVR of 400 m. SA CAT I operations are already successfully conducted in a number of States, e.g. the US, Australia, and China.

This Appendix provides a proposal outlining the operational performance for SA CAT I operations. For each domain, key subject areas are described with explanatory remarks, an initial EASA proposal, and corresponding rules from the Federal Aviation Administration (FAA) and the Australian Civil Aviation Safety Authority (CASA).

This Appendix builds upon the common elements described above, and in particular the description of the concept of operational credits, identified high-level hazards for approach operations, and high-level safety constraints.

General considerations

Focus on CAT I vs CAT II operations

The primary, general question is whether SA CAT I operations should be designed as more demanding CAT I operations or as less demanding CAT II operations.

As the term of this operation already implies, the initial proposal is based on the aim to develop a more demanding CAT I operation. This proposal needs to be supported by a safety assessment.

This initial proposal, therefore, takes into account all current navigation systems eligible for CAT I operations: instrument landing system (ILS), ground-based augmentation system (GBAS) landing system (GLS), microwave landing system (MLS), satellite-based augmentation system (SBAS).

Operational credit vs new approach category

SA CAT I operations could be designed as a new approach category or as CAT I operations for which operational credits apply.

Based on the comments received so far on the proposed amendments to the definition of approach categories, it is understood that the majority of stakeholders prefer the concept of operational credits. This proposal is, therefore, built upon this concept.

The operational credit in terms of lower aerodrome operating minima (DA/H and RVR) is generated primarily through enhanced airborne flight guidance systems.

Note: The description of type of operations with operational credits should become as much as possible technology-independent — ideally, it should not be technology-dependent at all. The type of operations should primarily depend only on the performance and criteria for operational procedure. Both the type of operations and operational procedures are derived from/developed on the basis of the operational technology (either current or future one).

Description of system components

Airworthiness

Aircraft

Remarks	The aircraft performance for SA CAT I operations must be demonstrated. It is assumed that SA CAT I airworthiness certification criteria will be available.
Initial EASA proposal	Aircraft shall be certified for the intended operation.
FAA	The aircraft must be operationally approved for CAT II or III operations.
CASA	The aircraft must be certified for CAT II or III operations.

Flight guidance system

Remarks	Advanced performance of the flight guidance system (compared to that required for conventional CAT I operations), or of vision systems combined with a flight guidance system, produces an improved overall performance and the possibility to obtain an operational credit. The following systems are considered eligible: — autoland systems (at least autocoupled to 80 % of DH followed by manual landing); — HUD or equivalent systems with an integrated flight guidance system; — SVGS or CVS in combination with a flight guidance system (on an HUD or an equivalent system or a head-down display). It is assumed that airworthiness certification criteria for these systems will be available.
Initial EASA proposal	The flight guidance system and vision system shall be certified for the intended operation.
FAA	The HUD must be operationally approved for CAT II or III operations and must meet at least the requirements of Advisory Circular (AC) 120-29A.
CASA	Where used, the HUD must be certified for CAT II or III operations. Where used, the autoland system must be approved for CAT IIIA operations.

Radio altimeter (RA) or equivalent system

Remarks	An RA or equivalent system seems to be necessary from an airworthiness and instrument procedure design perspective. It is currently further assessed whether there are systems available which would achieve a performance similar to that of an RA. If existing height loss values (Table II-1-1-2) for barometric altimeters of PANS-OPS are used, most of the current CAT I IAP may not allow an obstacle clearance altitude/height (OCA/H) of 150 ft. Only when applying the height loss values for RA, the full potential of a DA/H of 150 ft can be exploited. (These tables assume that there no other alternatives to the RA performance.) In addition, it should be noted that terrain awareness warning system (TAWS) Class A provides an additional safety net. TAWS provides advisory call-outs from 2 500 to 10 ft and the minimum call-out at the DH (mode 6). TAWS also provides advisory call-out for excessive glide slope deviations (mode 5).
Initial EASA proposal	DA/H shall be established with an RA or equivalent system.
FAA	DH must be established with an RA.
CASA	DH must be established with an RA.

Air Operations and Flight Crew

Use of SA CAT I instrument approach procedure (IAP) for approved aerodromes

Remarks	A published IAP intended for SA CAT I operations should be available. For EU aerodromes, it is assumed (but still pending further clarification) that the IAP design will be based on PANS-OPS CAT I IAP criteria and that CAT I runways meet the provisions of Annex 14 with some minor additional provisions. However, in other regions the applied procedure design criteria may not fully meet PANS-OPS criteria. Additionally, for certain aerodromes the application of standard PANS-OPS criteria may not be practical. Furthermore, aerodrome provisions in some States may not fully comply with Annex 14 provisions for runways supporting CAT I operations; this should not be a major case for the EU Member States following common EU requirements, which are aligned with Annex 14. The air operator, therefore, should conduct an operational assessment similar to the method required for non-standard required navigation performance authorisation required approach (RNP AR APCH) IAPs if: — the IAP does not meet standard PANS-OPS procedure design criteria for CAT I operations using the RA for determining DA/H; and/or — the aerodrome does not meet Annex 14 provisions for CAT I operations including the specific provisions for SA CAT I operations. It needs to be further assessed whether available CAT II/III IAPs automatically qualify for SA CAT I operations without the need for a published procedure. The assessment needs to focus on the minimum dimension and location of the area before the DA/H for the use of the RA. Last but not least, it is assumed that a published SA CAT I procedure also ensures that the aerodrome meets the applicable provisions for such operations.
Initial EASA proposal	The flight crew shall use an IAP designed for an aerodrome suitable for the intended operation. For IAP with procedure design criteria significantly deviating from PANS-OPS criteria, the air operator shall conduct an operational assessment.
FAA	The air operator is utilising a Part 97 SIAP authorising CAT I minima with RVR less than 1 800 ft.
CASA	N/A

Use of the flight guidance system

Remarks	The use of advanced flight guidance systems is a condition to benefit from an operational credit. Specific rules for the use of these systems are, therefore, necessary.
Initial EASA proposal	SA CAT I operations require the use of an approved flight guidance system for the intended operation or lower approach operations. If this flight guidance system fails after passing a height of 200 ft above the threshold, a missed approach shall be initiated unless necessary visual cues are obtained for a safe landing.
FAA	The flight crew must use the HUD in the mode normally used for CAT II or III operations to the DH, or to the initiation of a missed approach. If the HUD fails, the flight crew must execute a missed approach unless visual reference to the runway environment has been established and the aircraft is in a position to allow safe continuation to a landing.
CASA	For HUD operations, the flight crew must use the HUD in the mode normally used for CAT II or III operations to the DH, or to the initiation of a missed approach. If the HUD fails, the flight crew must execute a missed approach unless visual reference to the runway environment has been established and the aircraft is in a position to allow safe continuation to a landing. For autoland operations, the aircraft must be flown coupled to an automatic landing.

RVR data

Remarks	Currently, in Europe, approach operations with a visibility below 800 m require the availability of RVR reports at least for the TDZ. For SA CAT I operations, RVR reports should be based on RVR sensors.
Initial EASA proposal	For SA CAT I operations, actual TDZ RVR reports shall be available based on RVR sensors.
FAA	TDZ RVR reports are controlling. The mid RVR report may NOT be substituted for the TDZ RVR report in SA CAT I operations.
CASA	TDZ RVR reports are controlling. The mid RVR report may NOT be substituted for the TDZ RVR report in SA CAT I operations.

Crosswind considerations

Remarks	Crosswind considerations are relevant from an aircraft performance/handling perspective. Crosswind limitations may also be derived from the use of the vision system and flight guidance system. The AFM usually reports the average demonstrated crosswind value (reported in the normal operations section), and in some cases the crosswind limitation values (reported in the limitation section of the AFM). If a manufacturer can demonstrate a higher value, there does not seem to be sufficient justification for a limitation in the operational rules.
Initial EASA proposal	The maximum crosswind value should be no more than that reported in the AFM.
FAA	The crosswind can be no more than 15 kt or the maximum demonstrated crosswind, whichever is less.
CASA	The crosswind can be no more than the limit specified in the AFM, or if no limit is specified in the AFM, not more than 15 kt.

Single-pilot operations

Remarks	CAT I operations can be conducted as single-pilot operations under certain conditions. Single-pilot operations, therefore, should also be permitted for SA CAT I operations unless safety assessment indicates that there are certain conditions which would rely on multi-pilot operations and render single-pilot SA CAT I operations hazardous. The focus of such an assessment should be on the use of the flight guidance system, the use of the vision system, and on the lower aerodrome operating minima.
Initial EASA proposal	For the time being, no specific requirement is proposed.
FAA	Single-pilot operators are not authorised to conduct SA CAT I approaches.
CASA	Single-pilot operators are not authorised to conduct SA CAT I approaches.

Flight crew qualifications and training

Remarks	It is assumed that the current flight crew licensing (FCL) rules for the instrument rating (IR), which grants the privilege to fly approach operations down to a DA/H of 200 ft, will not be changed. The air operator is, therefore, responsible for the initial and recurrent training and checking of the flight crew as for any other low-visibility operation (LVO). The pilot's SA CAT I privilege is, therefore, linked to a specific air operator. The documentation of this privilege in the licence or through records of the air operator needs to be decided. Initially, it is assumed that no endorsement on the licences is necessary. Furthermore, it is assumed that the general rules for recurrent training and checking intervals will apply as follows: — 6 months for CAT operators; — 1 year for all other types of operators. Credits for training and checking for or from other LVOs need to be assessed.
Initial EASA proposal	The flight crew shall be current and qualified for the intended operation. The air operator shall be responsible for initial and recurrent training and checking. The air operator shall be responsible to record the privileges of a pilot.
FAA	The flight crew must be current and qualified for CAT II or III operations. In both initial and recurrent training, the flight crew must demonstrate proficiency in ILS approaches to RVR of 1 400 ft or less.
CASA	The flight crew must be current and qualified for CAT II or III operations.

Specific approval

Remarks	The initial proposal requires a specific approval for the following reasons: — SA CAT I minima are not covered during initial pilot training and checking for the instrument rating. — Moreover, this type of operation is a new operation for Europe and a specific approval is regarded as an additional safety assurance until more experience is gained. — Last but not least, SA CAT I qualifies as an operational credit of an LVO for which ICAO Annex 6 requires a specific approval and an entry into OPSPECS/list of specific approval. The need for a specific approval, however, may be reviewed after some years of implementation when more experience will have been gained. For the specific approval, the general approval criteria for LVO should apply. To achieve the highest degree of flexibility for future advancements, the lowest possible minima for SA CAT I should be specified in an acceptable means of compliance (AMC).
Initial EASA proposal	LVOs applying operational credits require a specific approval.
FAA	The air operator must be operationally approved for CAT II or III operations.
CASA	The air operator must be approved for CAT II or III operations.

Air traffic management (ATM)/air navigation services (ANS) and aerodromes

Instrument approach procedure (IAP)

Remarks	It is understood that existing PANS-OPS CAT I IAP criteria can be used to design SA CAT I procedures using an RA for establishing the DA/H. It is assumed that EU SA CAT I procedures will be based on these PANS-OPS criteria. It needs to be further assessed whether additional limitations are required, in particular for the use of certain flight guidance systems, e.g. for autoland operations, or for glide path angles. It is further assumed that the visual segment surface area is considered in the procedure design.
Initial EASA proposal	An SA CAT I IAP should meet PANS-OPS CAT I procedure design criteria using an RA for establishing the DA/H.
FAA	A standard CAT I DH of no more than 200 ft and visibility minimum of no more than 2 400 ft RVR. CAT II/III missed approach criteria per AFS-400 policy. Any obstacles which require an adjustment of greater than 50 ft will also increase the DH, and may or may not increase the visibility as well. 3.0° commissioned glide slope angle, with satisfactory clearance below path. Threshold crossing height or reference datum height (RDH) or achieved reference datum height (ARDH) not greater than 60 ft.
CASA	The glide path angle must be no greater than 3°. The threshold crossing height (TCH) or RDH must not exceed 60 ft.

Aerodrome charts

Remarks	Provisions for aerodrome charts are specified in ICAO Annex 4. For CAT I operations, an aerodrome terrain and obstacle chart should be available. For CAT II operations, a precision approach terrain chart is required. It needs to be further assessed whether a precision approach terrain chart is necessary for the air operator. There is at least one State with several years of experience of CAT I RA operations without providing a full precision approach terrain chart.
Initial EASA proposal	A precision approach terrain chart shall be required for LVOs, except where the requisite information is provided in the Aerodrome Terrain and Obstacle Chart — ICAO (electronic) in accordance with Annex 4 Chapter 5.
FAA	N/A

CASA	Precision approach terrain chart required in accordance with ICAO Annex 4.

Navigation systems

Remarks	For the time being, ILS, GLS and localiser performance with vertical guidance (LPV) 200 can satisfy the CAT I performance level. It is, therefore, intended that these navigation systems be also available for SA CAT I operations.
Initial EASA proposal	The ground-based navigation system shall meet ICAO Annex 10 requirements for CAT I operations. Aerodrome siting, operations and continuity needs shall be considered for eventual additional requirements.
FAA	A CAT I ILS facility with no restrictions to localiser (LOC) course structure and alignment or glide path structure (no restrictions which affect the aircraft on final approach, from the final approach fix (FAF) to the runway threshold).
CASA	The ILS must be a dual-channel facility classified at least I/T/1, otherwise — provided the ILS facility is certified and maintained to meet ICAO Annex 10 Volume I requirements for Category I ILS at least to ILS Point ‘C’ — the procedure must be restricted to be used only by HUD-equipped aircraft. At locations where two separate ILS facilities serve opposite ends of a single runway, a system must be in operation to ensure that only the LOC serving the approach direction in use shall radiate.

Runway and pre-threshold terrain

Remarks	As stated above, SA CAT I is considered CAT I operation for which lower aerodrome operating minima are generated primarily through enhanced airborne equipment. Therefore, there should be no need for additional runway installations. However, assuming that the DA/H should be determined with an RA, the pre-threshold area of the runway should be eligible for using the RA to a DA/H of 150 ft. It is further assumed that for the RA and the CAT I runway the relevant provisions of Annex 14 and PANS-OPS shall apply. Any differences thereto should be specified in the AIP. For autoland operations, it needs to be established that the pre-threshold terrain is compatible with the aircraft autoland system.
Initial EASA proposal	The runway shall meet the requirements for a runway supporting CAT I operations, and the pre-threshold terrain shall be suitable for determining the DA/H with an RA.
FAA	A runway with a declared landing distance of 5 000 ft or greater and at least 150 ft wide.

CASA	The runway must have a declared landing distance available of 1 524 m or greater/longer. The runway must have or be qualified for a precision approach Category I ILS procedure.

Visual aids

Remarks	As stated above, SA CAT I is considered CAT I operation for which lower aerodrome operating minima are generated primarily through enhanced airborne equipment. Therefore, there should not be a need for additional requirements for visual aids. This includes visual aids for surface ground movements. It is understood that potentially hazardous conditions caused by lower visibility values of an SA CAT I operation compared to a conventional CAT I operation can be safeguarded through LVP.
Initial EASA proposal	Visual aids should be available as prescribed for a runway supporting CAT I operations.
FAA	An approach lighting system with sequenced flashing lights (ALSF-2), medium-intensity approach lighting system with runway alignment indicator lights (MALSR), or simplified short approach lighting system with runway alignment indicator SSALR. High-intensity runway lights (HIRL).
CASA	Visual aids appropriate for precision approach runway Category I, including high-intensity runway-edge lighting; wherever possible, a precision approach Category I lighting system or a precision approach Category II and III lighting system at least 720 m in length. There must be no obstructions obscuring any light of the approach lighting system.

Aerodrome surfaces

Remarks	As stated above, SA CAT I is considered CAT I operation for which lower aerodrome operating minima are generated primarily through enhanced airborne equipment. Therefore, there should be no need for additional requirements for aerodrome surfaces. Annex 14 does not require an obstacle-free zone (OFZ) for CAT I operations. The visual segment surface area, however, should be considered in the procedure design. It needs to be further assessed whether an OFZ is necessary for the air operator. Pending the outcome of this assessment, the OFZ should not be initially required.
Initial EASA proposal	The obstacle limitation surfaces shall meet the requirements for a runway supporting CAT II operations, so OFZ is required. Considering the intended DA/H, the protection surfaces shall comply with Annex 14.

FAA	CAT I OFZs required.
CASA	An OFZ must be established. A runway strip and obstacle limitation surfaces that meet the full requirements for a precision approach Category I runway.

Low-visibility procedure (LVP)

Remarks	Several ICAO documents, as well as EU rules, require LVPs for approach operations with an RVR below 550 m. This rule consequently should apply for SA CAT I operations. LVP takes into account the navigation aid available for the SA CAT I operation. Further assessments are required to determine whether the use of certain flight guidance systems has an impact on LVP.
Initial EASA proposal	LVP shall be established and enforced.
FAA	N/A
CASA	The relevant ILS-critical area — and if required, an ILS-sensitive area — must be determined, documented and associated protection requirements defined in the aerodrome's LVPs.

References

ICAO

PANS-OPS Volume II

US

OSA SA CAT I

8400.13

C078 template

Australia

CAAP 257-EX-01 'Approval to conduct low visibility operations'

Risk assessment for SA CAT I

Rule amendments for SA CAT I

Appendix 2. Operations with operational credits using EFVS/CVS

Context

One of the objectives of the AWO Project is to introduce into the EU regulatory framework operations using EFVS/CVS for obtaining an operational credit on the RVR minimum. For approach operations, this credit may go as low as 300 m RVR on a CAT I runway based on technologies currently available. The FAA is currently finalising a rule change to enable such approach operations for US air operators.

This Appendix provides a proposal outlining a certain system performance from all relevant aviation domains. It builds upon the common elements already described above, and in particular the description of the concept of operational credits, identified high-level hazards for approach operations, and high-level safety constraints.

For each domain, key subject areas are described with explanatory remarks and an initial EASA proposal. It is proposed that the FAA and CASA add their relevant current or proposed rules where possible.

General considerations

Definitions

Enhanced vision system (EVS)

An EVS is an electronic means to provide flight crew with a real-time sensor-derived or enhanced image of the external topography scene (the natural or man-made features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging sensors. An EVS does not have an integrated flight guidance system.

Head-up display (HUD) or equivalent systems

'Head-up display (HUD) or equivalent systems' means a display system which presents flight information to the pilot's forward external field of view and which does not significantly restrict the external view.

Enhanced flight visibility (EFV)

EFV is the average forward horizontal distance, from the cockpit of an aircraft in flight, at which prominent topographical objects can be clearly distinguished and identified by day or night by a pilot using an enhanced flight vision system (EFVS).

Enhanced flight vision system (EFVS)

An EFVS is an electronic means to provide flight crew with a real-time sensor-derived or enhanced display of the external topography scene (the natural or man-made features of a place or region especially in a way to show their relative positions and elevation) through the use of imaging sensors. An EFVS is integrated with a flight guidance system and is implemented on a head-up display (or an equivalent display) on which the imagery and symbology are visible to the pilot flying in their normal position with the line of vision looking forward along the flight path.

EFVS I

An EFVS can be designated as 'EFVS I' if it has been demonstrated that the installed EFVS meets the required certification provisions to enable it to be used for instrument approach operations to a height/altitude of 100 ft.

EFVS II

An EFVS can be designated as 'EFVS II' if it has been demonstrated that the installed EFVS meets the required certification provisions to enable it to be used for instrument approach and landing operations that rely on sufficient visibility conditions to enable unaided roll-out and to mitigate loss of EFVS function.

Synthetic vision system (SVS)

An SVS is an electronic means to display a computer-generated image of the applicable external topography from the perspective of the flight deck that is derived from aircraft attitude, altitude, position, and a coordinate-referenced database.

Synthetic vision guidance system (SVGS)

A SVGS is an electronic means to display a computer-generated image of the applicable external topography scene from the perspective of the flight deck that is derived from aircraft attitude, altitude, position, and a coordinate-referenced database in combination with a flight guidance display and high-precision position assurance monitors. The SVGS flight instrument display provides a continuous, geo-spatially correct depiction of the external topography scene, including obstacles, augmented by the display of the runway of intended landing.

Combined vision system (CVS)

A CVS combines a real-time imaging sensor and display with a synthetic image generated using a terrain and obstacle database utilising a precision navigation position. A CVS can include either an EFVS or EVS and an SVGS or SVS.

Intended use

EFVS/CVS can be used in any phase of the flight to enhance situational awareness.

For operations with operational credits, EFVS/CVS is primarily used for the visual segment of a flight, e.g. the visual segment of the final approach, taxiing, or take-off.

To obtain an operational credit, EFVS/CVS must be displayed on an HUD or an equivalent system and be combined with a flight guidance system.

For approach operations, it is assumed that EFVS/CVS is used only for 3D operations Type A and Type B. Although CAT I operations is the most likely category, EFVS/CVS should be open to any category.

Furthermore, it is assumed that eligible IAPs will provide a vertical guidance (3D operations). However, EFVS/CVS specifications may require certain limitations to offset the glide path angle.

There is no limitation on navigation aids foreseen as long as they support 3D operations. Therefore, such operations should be possible with ILS, GLS, MLS, SBAS and Baro vertical navigation (VNAV).

Operational credit

Since EFVS/CVS allows an operational credit for the visual segment of the flight, the operational credit can be granted in terms of a reduced RVR compared to the conventional RVR minima without the EFVS/CVS performance.

Description of system components

Airworthiness

EFVS/CVS

Remarks	The sensor performance of EFVS/CVS must be demonstrated during certification. An operational credit can only be granted by the State of the air operator if the aircraft has been certified for such operations and if the scope of the operational credit, in terms of reduction of RVR, has been demonstrated. The sensor performance of EFVS may vary for different meteorological conditions. Although it might not be possible to test the sensor performance under all conditions, it is essential that the manufacturer provides demonstrated values for as much different conditions as feasible. The AFM should also include any limitation concerning the type of lights which can and cannot be recognised by the sensor. Furthermore, the AFM shall specify for approach operations any height limit below which the vision should not be used without natural visual reference, e.g. to 100 ft, 50 ft, touchdown. Additionally, the EFVS/CVS may require limitations to offset the final approach axis and runway axis, as well as limitations on the eligible glide path angle. Such limitations need to be specified in the AFM. The AMF shall specify whether the operational credit of an EFVS requires that the EFVS information is presented on an HUD or an equivalent display. Supplementary documents should describe the environmental parameters for the demonstrated values, e.g. visual and non-visual aids, runway characteristics, services provided by air navigation services (ANS) and the aerodrome. This information shall be readily available to the air operator.
Initial EASA proposal	The EFVS/CVS shall be certified for the intended operation, and the performance of the sensors for different meteorological conditions shall be demonstrated and specified in the AFM. The AFM shall specify a height above the threshold below which the vision system should not be used without natural visual reference. The AFM shall specify any limitations concerning eligible IAPs. The manufacturer shall provide the air operator with supplementary information relevant to assess the performance and operational constraints of the vision system.

FAA	
CASA	

Flight guidance system

Remarks	The EFVS/CVS most likely needs to be combined with a flight guidance system. The AFM should specify whether the integration with a flight guidance system is essential to obtain an operational credit for a certain product.
Initial EASA proposal	The AFM shall specify the flight guidance system to be used for obtaining an operational credit.
FAA	
CASA	

Altimeter system

Remarks	It is assumed that the operation is using a CAT I IAP, which is based on the use of a barometric altimeter system to establish the DA/H. The EFVS/CVS operation should permit the use of a barometric altimeter. Therefore, no specific requirement is needed.
Initial EASA proposal	
FAA	RA or equivalent system required for EFVS to touchdown.
CASA	

Air Operations and Flight Crew

Establishment of aerodrome operating minima

Remarks	The air operator should specify a method for establishing aerodrome operating minima. This method should cover operations with operational credits, when used. EFVS/CVS operations are intended to provide operational credits only on the RVR minimum, not on the DA/H. Therefore, the method for the DA/H may be the normal method used for operations without the use of EFVS/CVS. A specific method is necessary to establish the RVR minimum, which should in particular consider the product-specific limitation of the EFVS/CVS and the limitations specified in the specific approval.

Initial EASA proposal	The air operator shall establish aerodrome operating minima based on the approved method for operations with operational credits. The competent authority shall approve the method for establishing aerodrome operating minima for operations with operational credits, and shall specify the lowest minima for such operations.
FAA	
CASA	

Selection of suitable aerodromes and IAPs

Remarks	The air operator should only select aerodromes that meet the provisions of CS-ADR-DSN within the EU, and those of Annex 14 for aerodromes outside the EU (with some minor additional provisions for SA CAT I) and additional EFVS/CVS-specific provisions (see below for further details). The air operator should use a published IAP providing a vertical guidance (PA and APV). For EU aerodromes, it is assumed that the IAP design will be based on PANS-OPS IAP criteria. In accordance with PANS-OPS, the IAP should ensure that the visual segment surface (VSS) is clear of obstacles. However, the EFVS/CVS may require limitations to offset the final approach axis and the runway axis, as well as limitations on the eligible glide path angle. Furthermore, to ensure safe go-arounds below DA/H, a published take-off procedure should be available for the intended runway end, or the air operator has to establish a procedure to be used in case of a balked landing. The air operator should conduct an operational assessment similar to the method required for non-standard RNP AR APCH IAPs or SA CAT I operations if: — the applied IAP does not meet the standard PANS-OPS procedure design criteria; or — there is no take-off procedure available for the intended runway end; or — the aerodrome does not meet Annex 14 provisions for the intended operations (including the specific provisions for SA CAT I operations).
Initial EASA proposal	The air operator shall only select aerodromes for operations with operational credits that meet the provisions for the intended operation. The air operator shall use published IAPs based on PANS-OPS criteria, which provide a vertical guidance and meet any IAP limitations specified in the AFM. For IAPs with procedure design criteria deviating from PANS-OPS criteria or not providing vertical guidance, or runway ends without a standard instrument departure (SID) procedure, the air operator shall conduct an operational assessment.

FAA	
CASA	

ATS

Remarks	Not all aerodromes are controlled aerodromes and may only provide flight information services (FIS). It needs to be further assessed whether operations with operational credits can be allowed on non-controlled aerodromes and how LVPs could be provided in such a case. It should also be taken into account that an air traffic control (ATC) requirement may seriously curtail the use of operational credits for helicopter operations. Almost all instrument approach operations to offshore installations and many hospitals are instrument flying rules (IFR) operations in uncontrolled airspace.
Initial EASA proposal	
FAA	ATC not required.
CASA	

Failure of EFVS/CVS

Remarks	The use of EFVS/CVS is a condition to benefit from an operational credit. Specific rules for the use of these systems are, therefore, necessary. There may also be the need to assess whether flight planning restrictions should be considered, such that the alternate aerodrome minima may not be predicated upon EFVS.
Initial EASA proposal	If the EFVS/CVS fails, a missed approach shall be initiated unless the pilot has already acquired the unaided visual reference necessary for a safe landing.
FAA	
CASA	

RVR data

Remarks	Currently, in Europe, approach operations with a visibility below 800 m already require the availability of RVR reports at least for the TDZ. Therefore, no further requirement is necessary.

Initial EASA proposal	
FAA	
CASA	

Crosswind considerations

Remarks	Crosswind considerations are relevant from an aircraft performance/handling perspective. Crosswind limitations may also be derived from the use of the vision system and the flight guidance system. The AFM usually reports the average demonstrated crosswind value (reported in the normal operations section), and in some cases the crosswind limitation values (reported in the limitation section of the AFM). If a manufacturer can demonstrate a higher value, there does not seem to be sufficient justification for a limitation in the operational rules.
Initial EASA proposal	The maximum crosswind value should be no more than that reported in the AFM.
FAA	
CASA	

Single-pilot operations

Remarks	Currently, single-pilot operations are allowed for Type A and CAT I, and potentially for SA CAT I operations. These requirements should be the reference for operations with vision systems if there are no specific AFM limitations requiring a multi-pilot operation. Therefore, no EFVS/CVS-specific requirements are needed.
Initial EASA proposal	No specific requirement is proposed.
FAA	Not prohibited and may not be addressed in the new rule for EFVS to touchdown.
CASA	

Flight crew qualifications and training

Remarks	It is assumed that the current FCL rules for the instrument rating (IR), which grants the privilege to fly approach operations down to a DA/H of 200 ft but does not contain any limitation on RVR conditions, will not be changed. This means that EFVS/CVS operations to a DA/H of 200 ft with RVR below 550 m would be permitted within the privilege of the IR. However, it should also be noted that Part-FCL does not foresee any EFVS/CVS-specific theoretical knowledge or practical training. The air operator is, therefore, responsible for the initial and recurrent training and checking of the flight crew for operations with operational credits based on EFVS/CVS. In analogy to LVO, the pilot's EFVS/CVS privilege is, therefore, linked to a specific air operator. The documentation of this privilege in the licence or through records of the air operator needs to be decided. Initially, it is assumed that no endorsement on the licences is necessary. Furthermore, it is assumed that the general rules for recurrent training and checking intervals will apply as follows: — 6 months for CAT operators; — 1 year for all other types of operators. Credits for training and checking for or from other LVOs need to be assessed.
Initial EASA proposal	The flight crew shall be current and qualified for the intended operation. The air operator shall be responsible for initial and recurrent pilot training and checking. The air operator shall be responsible to record the privileges of a pilot.
FAA	
CASA	

Specific approval

Remarks	The initial proposal requires a specific approval for the following reasons: — operations with operational credit based on EFVS/CVS are not covered during initial pilot training and checking for the instrument rating; — ICAO Annex 6 requires a specific approval and an entry into OPSPECS/list of specific approval. For the specific approval, the general approval criteria for LVO should apply. It is, therefore, assumed that the operational credit would extend to an RVR below 550 m. To achieve the highest degree of flexibility for future advancements, the implementing rule should not contain any limitations on aerodrome operating minima.
Initial EASA proposal	Operations with operational credits to require a specific approval.
FAA	
CASA	

Air traffic management (ATM)/air navigation services (ANS) and aerodromes

Aeronautical information publication (AIP)

Remarks	The following proposal stems from the outcome of a SESAR project, which assessed the impact of operations with operational credit based on EFVS for aerodromes and ATM/ANS with minor amendments.
Initial EASA proposal	States shall specify in the AIP: — whether an aerodrome has been approved for operations with operational credits, specifying DA/H or RVR minima, where necessary; — any aerodrome-specific requirements to conduct operations with operational credits, where necessary; — those parts of the lighting facilities which use LED lights; — the runway threshold accuracy in compliance with Annex 14 Appendix 5 Table A5-1; — such IAPs which are not permitted for operations with operational credits, if any.
FAA	
CASA	

Aerodrome installations

Remarks	The following proposal stems from the outcome of a SESAR project, which assessed the impact of operations with operational credit based on EFVS for aerodromes and ATM/ANS with minor amendments.
Initial EASA proposal	RVR information shall be reported below visibility of 800 m. RVR information shall not be older than 5 minutes in accordance with ICAO Annex 3 ATT-C. The aerodrome shall be secured through fences and barriers in accordance with ICAO Annex 14, 9.10. At least 85 % of the lighting of the available lighting facilities shall be operative in accordance with ICAO Annex 14, 10.5. The secondary power supply switchover time shall not be more than 1 second for runway lights in accordance with ICAO Annex 14, 8.17.
FAA	
CASA	

Low-visibility procedure (LVP)

Remarks	Several ICAO documents, as well as EU rules, require LVP for approach operations with an RVR below 550 m. This rule consequently should apply whenever an operation with operational credits is conducted below an RVR of 550 m.
Initial EASA proposal	LVP shall be established and enforced for air operations with an RVR below 550 m.
FAA	
CASA	

References

SESAR

SESAR project — AAL EFVS operation with operational credit — Impact on ATM-Aerodrome

ICAO

Annex 6 'Air operations'

AWO Manual

Appendix 3. ICAO definitions (Annex 6 Part I)

Aerodrome operating minima

The limits of usability of an aerodrome for:

a) take-off, expressed in terms of runway visual range and/or visibility and, if necessary, cloud conditions;

b) landing in 2D instrument approach operations, expressed in terms of visibility and/or runway visual range, minimum descent altitude/height (MDA/H) and, if necessary, cloud conditions; and

c) landing in 3D instrument approach operations, expressed in terms of visibility and/or runway visual range and decision altitude/height (DA/H) as appropriate to the type and/or category of the operation.

Instrument approach operations

4.2.8.3 Instrument approach operations shall be classified based on the designed lowest operating minima below which an approach operation shall only be continued with the required visual reference as follows:

a) Type A: a minimum descent height or decision height at or above 75 m (250 ft); and

b) Type B: a decision height below 75 m (250 ft). Type B instrument approach operations are categorized as:

1) Category I (CAT I): a decision height not lower than 60 m (200 ft) and with either a visibility not less than 800 m or a runway visual range not less than 550 m;

2) Category II (CAT II): a decision height lower than 60 m (200 ft) but not lower than 30 m (100 ft) and a runway visual range not less than 300 m;

3) Category IIIA (CAT IIIA): a decision height lower than 30 m (100 ft) or no decision height and a runway visual range not less than 175 m;

4) Category IIIB (CAT IIIB): a decision height lower than 15 m (50 ft) or no decision height and a runway visual range less than 175 m but not less than 50 m; and

5) Category IIIC (CAT IIIC): no decision height and no runway visual range limitations.

Note 1.— Where decision height (DH) and runway visual range (RVR) fall into different categories of operation, the instrument approach operation would be conducted in accordance with the requirements of the most demanding category (e.g. an operation with a DH in the range of CAT IIIA but with an RVR in the range of CAT IIIB would be considered a CAT IIIB operation or an operation with a DH in the range of CAT II but with an RVR in the range of CAT I would be considered a CAT II operation).

Instrument approach procedures (IAP)

A series of predetermined manoeuvres by reference to flight instruments with specified protection from obstacles from the initial approach fix, or where applicable, from the beginning of a defined arrival route to a point from which a landing can be completed and thereafter, if a landing is not completed, to a position at which holding or en-route obstacle clearance criteria apply. Instrument approach procedures are classified as follows:

Non-precision approach (NPA) procedure. An instrument approach procedure designed for 2D instrument approach operations Type A.

Note.— Non-precision approach procedures may be flown using a continuous descent final approach (CDFA) technique. CDFAs with advisory VNAV guidance calculated by on-board equipment (see PANS-OPS (Doc 8168), Volume I, Part I, Section 4, Chapter 1, paragraph 1.8.1) are considered 3D instrument approach operations. CDFAs with manual calculation of the required rate of descent are considered 2D instrument approach operations. For more information on CDFAs, refer to PANS-OPS (Doc 8168), Volume I, Part I, Section 4, Chapter 1, paragraphs 1.7 and 1.8.

Approach procedure with vertical guidance (APV). A performance-based navigation (PBN) instrument approach procedure designed for 3D instrument approach operations Type A.

Precision approach (PA) procedure. An instrument approach procedure based on navigation systems (ILS, MLS, GLS and SBAS CAT I) designed for 3D instrument approach operations Type A or B.

Note.— Refer to 4.2.8.3 for instrument approach operation types.

Instrument runways

One of the following types of runways intended for the operation of aircraft using instrument approach procedures:

a) Non-precision approach runway. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type A and a visibility not less than 1 000 m.

b) Precision approach runway, category I. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type B with a decision height (DH) not lower than 60 m (200 ft) and either a visibility not less than 800 m or a runway visual range not less than 550 m.

c) Precision approach runway, category II. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type B with a decision height (DH) lower than 60 m (200 ft) but not lower than 30 m (100 ft) and a runway visual range not less than 300 m.

d) Precision approach runway, category III. A runway served by visual aids and non-visual aid(s) intended for landing operations following an instrument approach operation type B to and along the surface of the runway and:

A — intended for operations with a decision height (DH) lower than 30 m (100 ft), or no decision height and a runway visual range not less than 175 m.

B — intended for operations with a decision height (DH) lower than 15 m (50 ft), or no decision height and a runway visual range less than 175 m but not less than 50 m.

C — intended for operations with no decision height (DH) and no runway visual range limitations.

Note 1.— Visual aids need not necessarily be matched to the scale of non-visual aids provided. The criterion for the selection of visual aids is the conditions in which operations are intended to be conducted.

Note 2.— Refer to Annex 6 for instrument approach operation types.

System performance requirements for instrument approach operations

<table>
<tr><th colspan="3">Performance requirements in support of instrument approach operations</th></tr>
<tr><th colspan="2">Annex 10 system performance</th><th>Annex 6 method — Approach operation category</th></tr>
<tr><td>Non-precision approach (NPA)</td><td></td><td>2D-Type A (1)</td></tr>
<tr><td>Approach with vertical guidance (APV)</td><td></td><td>3D-Type A (2)</td></tr>
<tr><td rowspan="4">Precision approach (PA)</td><td>Category I, DH equal to or greater than 75 m (250 ft)</td><td>3D-Type A (3)</td></tr>
<tr><td>Category I, DH equal to or greater than 60 m (200 ft) and less than 75 m (250 ft)</td><td>3D-Type B — CAT I (3)</td></tr>
<tr><td>Category II</td><td>3D-Type B — CAT II</td></tr>
<tr><td>Category III</td><td>3D-Type B — CAT III</td></tr>
</table>

(1) Without vertical guidance.
(2) With barometric or SBAS vertical guidance.
(3) With ILS, MLS, GBAS or SBAS vertical guidance.

Appendix 4. Abbreviations

AC	advisory circular
ADOP	Aerodrome Design And Operations Panel (ICAO)
AFM	aircraft flight manual
AIP	aeronautical information publication
Air OPS	air operations
AIRP	Airworthiness Panel (ICAO)
AIS	aeronautical information services
ANS	air navigation services
ATM	air traffic management
ATC	air traffic control
ATCO	air traffic controller
ATO	approved training organisation
ATQP	alternative training and qualification programme
ATMOPSP	Air Traffic Management Operations Panel (ICAO)
ATS	air traffic services
AWOs	all-weather operations (for the purpose of this document, this refers to approach/landing, taxiing and take-off operations in reduced visibility)
AWOG	All Weather Operations Group (ICAO)
AWOHARC	All Weather Operations Harmonization Aviation Rulemaking Committee (FAA)
CAT	category (for approach operations, e.g. CAT I, CAT II, CAT III)
CNS	communication navigation surveillance
CVS	combined vision system (EVS or EFVS and SVS or SVGS)
DA/H	decision altitude/height
DH	decision height
EBT	evidence-based training
ECQB	European Central Question Bank
EFVS	enhanced flight vision system
EUROCAE	European Organisation for Civil Aviation Equipment
EVS	enhanced vision system

FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FLTOPSP	Flight Operations Panel (ICAO)
FP	focal point
FSTD	flight simulation training device
GBAS	ground-based augmentation system
GLS	GBAS landing system
GNSS	global navigation satellite system
HUD	head-up display
ICAO	International Civil Aviation Organization
IFPP	Instrument Flight Procedures Panel (ICAO)
ILS	instrument landing system
IMP	Information Management Panel (ICAO)
LED	light-emitting diode
LTS CAT I	lower-than-standard CAT I
LVOs	low-visibility operations
LVP	low-visibility procedure
LVTO	low-visibility take-off
MASPS	minimum aviation system performance standard
MET	meteorological services
METP	Meteorology Panel (ICAO)
MID	runway mid-point (for RVR readings)
MLS	microwave landing system
NDB	non-directional beacon
NSP	Navigation Systems Panel (ICAO)
OSD	operational suitability data
OTS CAT II	other-than-standard CAT II
PANS-ATM	procedures for air navigation services ATM
PANS-OPS	procedures for air navigation services OPS
RA	radio altimeter
RNAV	area navigation

RTCA	Radio Technical Commission for Aeronautics
RVR	runway visual range
SA	special approval
SA CAT I	special approval standard Category I (approach operation)
SAE	Society of Automotive Engineers
SARPs	Standards and Recommended Practices (ICAO)
SERA	Standardised European Rules of the Air
SBAS	satellite-based augmentation system
SOPs	standard operating procedures (for flight crew)
STC	supplemental type certificate
SVGS	synthetic vision guidance system
SVS	synthetic vision system
TC	type certificate
TDZ	touchdown zone (for RVR reading)
TERPS	terminal instrument procedures
ToR	terms of reference
VHF	very high frequency
VOR	VHF omnidirectional range