# GUIDELINES ON THE USE OF EFVS IN SBAS OPERATIONS

## Executive summary


The European Union Aviation Safety Agency (EASA) endeavours to carry out a continuous modernisation of the aviation regulatory framework applicable to all-weather operations (AWOs), in order to promote and achieve the highest possible level of safety while enabling efficiency gains based on the latest technological advancements.

Among the innovations incorporated by EASA, are provisions allowing for the use of Enhanced Flight Vision Systems (EFVS) to obtain operational credits during straight-in 3D approach operations (including non-precision approach procedures flown as CDFA with vertical path guidance calculated by on-board equipment).

Particularly, the combination of EFVS and SBAS technologies will greatly contribute to the increased availability of suitable destination and alternate aerodromes during periods of reduced visibility.

The relevant EFVS provisions have been assessed in order to develop the generic guidelines included in this document, which are developed with the aim of providing high level material to facilitate the implementation of EFVS operations based on SBAS. They are intended mainly for aircraft operators but also include relevant information for other affected stakeholders, such as aerodrome operators, Air Navigation Service Providers (ANSPs) and aircraft manufacturers / design organisations.


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# 1 Introduction

The European Union Aviation Safety Agency (EASA) endeavours to carry out a continuous modernisation of the aviation regulatory framework applicable to all-weather operations (AWOs), in order to promote and achieve the highest possible level of safety while enabling efficiency gains based on the latest technological advancements.

Among the innovations incorporated by EASA, are provisions allowing for the use of Enhanced Flight Vision Systems (EFVS) to obtain operational credits during straight-in 3D approach operations (including non-precision approach procedures flown as CDFA with vertical path guidance calculated by on-board equipment). These EFVS provisions have been assessed in order to develop the guidelines included in this document.

It is important to highlight that no references are made in these provisions to a specific navigation sensor being required; therefore, straight-in 3D approach procedures based on SBAS will be able to benefit from these operational credits when using EFVS.

In this regard, it should be noted that the operational concept for SBAS based approaches perfectly aligns with the objectives of the EFVS operational concept, in terms of offering advanced capabilities without requiring costly investments in ground infrastructure. The combination of these two technologies will greatly contribute to the increased availability of suitable destination and alternate aerodromes during periods of reduced visibility.

## 1.1 Purpose and scope of the document

The aim of the guidelines included in this document is to promote and provide high level material to facilitate the implementation of EFVS operations based on SBAS, with the objective of ensuring harmonised solutions and a common approach in accordance with Single European Sky (SES) Regulation[1]. It is mainly intended for aircraft operators but also includes relevant information for other affected stakeholders, such as aerodrome operators, Air Navigation Service Providers (ANSPs) and aircraft manufacturers / design organisations.

Nevertheless, these guidelines do not in any way exempt any of the addressed stakeholders from the process of independently assessing and following the applicable (EU) regulations for EFVS operations; they are intended exclusively as support and to resolve any questions that may arise during this process.

[1] The European regulatory framework for all-weather operations (AWOs) has also been developed with the aim of harmonisation with rule developments by the FAA and other major regulators, as far as possible. The following link details the materials the FAA has made available regarding EFVS operations; it includes regulations, advisory circulars, guidance, and other informational material:

https://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afx/afs/afs400/afs410/efvs

## 1.2 Applicability

At the time of preparation of the current version of this document, the EASA rulemaking process for all-weather operations[2] has adequately incorporated into regulation all AWO-relevant provisions across the domains of air operations (Commission Regulation 965/2012), aerodromes (Commission Regulation 139/2014), aircrew (Commission Regulation 1178/2011), airworthiness (CS-AWO) and ATM/ANS (Commission Regulation 2017/373).

Therefore, this version of the guidelines has been updated accordingly, taking all these provisions into consideration, and should be considered applicable henceforth.

[2] Carried out under EASA Rulemaking Task (RMT).0379.

# 2 Enhanced Flight Vision System (EFVS)

## 2.1 What is an EFVS?

**An EFVS is an installed airborne system which uses an electronic means to provide the flight crew with a real-time sensor-derived or enhanced display of the external scene topography** (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**, such as forward looking infrared, millimetre wave radiometry, millimetre wave radar, and/or low light level image intensifying[3].

Additionally, for such a system to be considered an EFVS, it must be:

- **Integrated with a flight guidance system** incorporating aircraft flight information and flight symbology (e.g. aircraft attitude, command guidance, flight path vector - FPV)[4].
- **Implemented on a head-up display (HUD) or an equivalent display system**. This display shall also be conformal; that is, the sensor imagery, aircraft flight information/symbology and other cues that are referenced to the imagery and external scene shall be aligned with and scaled to the external view.

Figure 1: EFVS implementations: HUD (left), HUD equivalent wearable display (right)
(Sources: Dassault Aviation and Elbit systems)

An EFVS includes the display element, sensors, computers, power supplies, indications, and controls. This can be seen in the following notional diagram of an EFVS.

[3] Different types of sensing technology are used on different aircraft installations and additional technologies may be developed in the future.

[4] Exhaustive requirements regarding flight symbology can be found in RD 5 (see also Section 4.4).

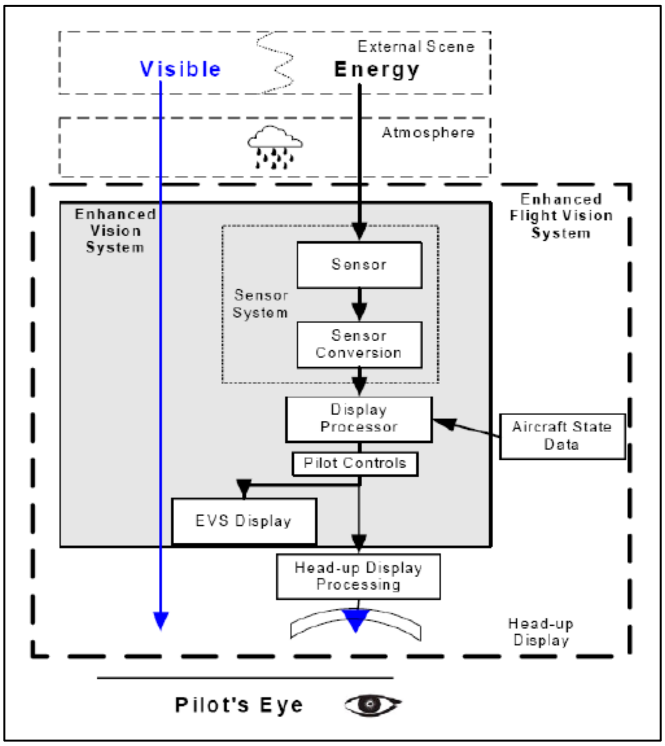


Figure 2: EFVS notional diagram
(Source: EUROCAE ED-179B)

If EFVS equipment is certified according to the applicable airworthiness requirements[5] and an operator holds the necessary specific approvals (if required), then the EFVS may be used to carry out an EFVS operation (i.e. an operation with an operational credit which allows operating in visibility conditions lower than those in which operations without the use of EFVS are permitted).

It is also important to mention the following particular cases regarding systems which can also be used for EFVS operations:

- Legacy enhanced vision systems (EVS) which meet the minimum requirements may be certified as 'EVS with an operational credit'[6]. Such systems may be considered as an EFVS used for approach (EFVS-A).
- A Combined Vision System (CVS) consisting of an EFVS and an SVS can be approved for EFVS operations if it meets all the certification requirements for an EFVS. It is the EFVS part of the system which enables operational credits.

[5] EFVS equipment can be certified as either an approach system (EFVS-A) or a landing system (EFVS-L). Definitions for each of these systems are included in Annex C: Definitions.

[6] As indicated in RD 1 (AMC1 CAT.OP.MPA.312(c), AMC1 NCC.OP.235(c) and AMC1 SPO.OP.235(c)): The EVS should be certified before 1 January 2022 as 'EVS with an operational credit'.

Finally, the following images show some examples of aircraft which are currently equipped with EFVS:


Figure 3: Examples of aircraft equipped with EFVS
(Sources: Dassault Falcon, Gulfstream, ATR aircraft, Airbus aircraft and Universal Avionics)

## 2.2 What isn't an EFVS?

There are currently other technological solutions in the aviation market, and described in the current European regulatory framework, with a similar objective to that of EFVSs in terms of enhancing the flight crew's view of the external scene during operations at night or in conditions of reduced visibility.

Though these tools may be used in all phases of flight and have a significant potential to enhance the flight crew's situational awareness, they cannot be used to conduct EFVS operations.

The following paragraphs describe some of these systems:

- **Enhanced Vision System (EVS)**

  Similarly to an EFVS, an enhanced vision system is an electronic means to provide the flight crew with a real-time image of the actual external scene topography through the use of imaging sensors. However, in the case of an EVS, there are no requirements regarding integration with a flight guidance system or implementation on a head up-display (or equivalent).

  This can be observed in the following figures, which show an example of an EVS implementation and a notional diagram of the system:

Figure 4: EVS implementation on a MFD
(Source: Astronics)

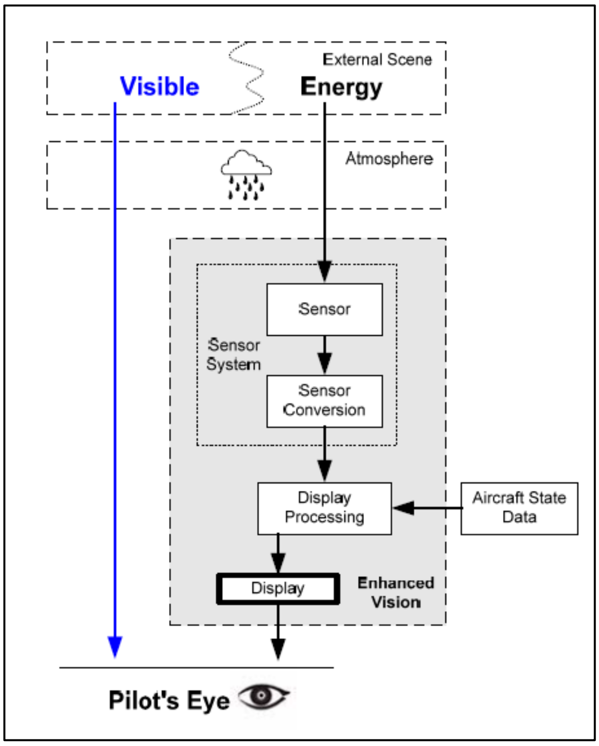


Figure 5: EVS notional diagram
(Source: EUROCAE ED-179B)

- **Synthetic Vision System (SVS)**

  It is an electronic means to display data derived synthetic (computer-generated) images of the applicable external topography from the perspective of the flight deck that is derived from aircraft attitude, altitude, position, and coordinate-referenced databases (e.g. terrain, obstacles, geopolitical, hydrological). As in the case of an EVS, there are no requirements regarding integration with a flight guidance system or implementation on a head up-display (or equivalent).

  The figures below show an example of an SVS implementation and a notional diagram of the system:

Figure 6: SVS implementation on a PFD
(Source: Honeywell)

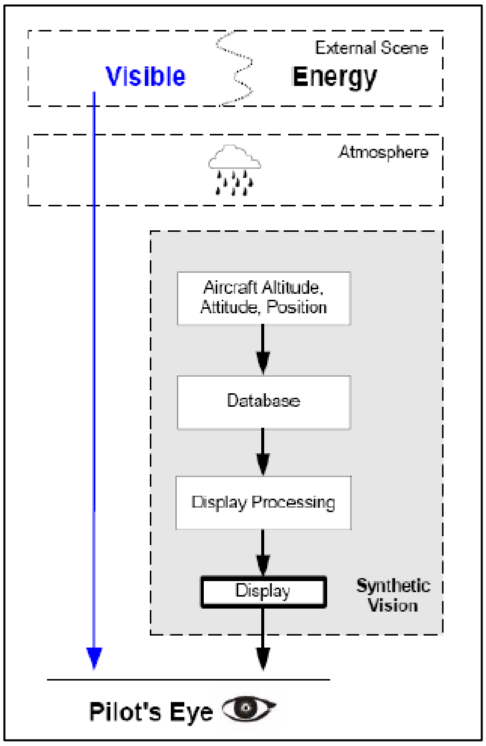


Figure 7: SVS notional diagram
(Source: EUROCAE ED-179B)

- **Synthetic Vision Guidance System (SVGS)**

Equivalent to SVS, in the sense that it is an electronic means to display data derived synthetic (computer-generated) images of the external topography. However, in the case of SVGS, integration with a flight guidance system is required. There are no requirements regarding implementation on a head up-display (or equivalent).

- **Combined Vision System (CVS)**

  A system which combines information from an EVS and a SVS in a single integrated display. The specific way in which the information from each of these systems is combined (e.g. superimposition, blending, as a function of altitude) will depend on the intended use of the system.

Figure 8: CVS implementation on a PFD
(Source: Elbit systems)

- **Night Vision Imaging System (NVIS)**

  A system which enhances the flight crew's ability to maintain visual reference to the surface at night. The main element of this system is the Night Vision Goggles (NVGs), a binocular appliance that amplifies ambient light and is worn by flight crew. However, the NVIS integrates all elements necessary to successfully and safely operate with them, such as the actual NVGs, NVIS compatible lighting and any other necessary components.

Figure 9: NVG example
(Source: Jigsaw Aviation)

## 2.3 Comparison between EFVS and EVS/SVS/SVGS/CVS/NVIS technologies

| Type of technology | Real-time sensor-derived / Enhanced image? | Integrated flight guidance system? | Head-up display (or equivalent)? | Enables EFVS operations? |
|---|---|---|---|---|
| EFVS | YES | Required | Required | YES |
| EVS* | YES | Not required | Not required | NO |
| SVS | NO | Not required | Not required | NO |
| SVGS | NO | Required | Not required | NO |
| CVS (EVS+SVS) | YES | Not required | Not required | NO |
| CVS (EFVS+SVS) | YES | Required | Required | YES |
| NVIS | YES | Not required | YES (NVG) | NO |

* Legacy enhanced vision systems (EVS) which meet the minimum requirements may be certified as 'EVS with an operational credit'. Such systems may be considered as an EFVS used for approach (EFVS-A).

Table 1: Comparison between EFVS and EVS/SVS/SVGS/CVS/NVIS technologies

# 3 EFVS implementation drivers

## 3.1 EASA promotion of EFVS to support All-Weather Operations (AWOs)

The ability to conduct all-weather operations (AWOs) at an aerodrome is an important factor in flight and/or network planning. Aerodromes that cannot support this type of operation have an additional cost and risk attached, due to factors such as:

- Increased likelihood of delays and cancellations. Under the provisions of EU-261[7], these events may lead to aircraft operators incurring significant charges in the form of compensation paid to passengers.
- It is more likely that aircraft will need to be diverted to an adequate alternate destination aerodrome. In order to ensure a safe diversion, aircraft may need to carry additional fuel, which will have a negative effect both on flight cost and on the environment[8].

  In addition, such diversions also negatively impact passengers and/or flight crew, who may land at an airport some distance from their intended destination.
- An approach in marginal conditions which must be aborted (go-around) is also costly in terms of fuel, having a negative impact both financially and on the environment[8].

For these reasons, flights are more likely to take place at aerodromes which can support all-weather operations, benefitting the local region by increasing the aerodrome's connectivity. While large aerodromes are, for the most part, already equipped for such operations (e.g. CAT II/III aerodromes), medium-size or regional airports have typically so far been unable to afford the investment required in ground infrastructure (e.g. lighting, ground-based navigation aids).

With this in mind, the European Union Aviation Safety Agency (EASA) has modernised the aviation regulatory framework in order to allow for certain types of all-weather operations to take place with minimal investment in ground infrastructure.

To achieve this, EASA has incorporated provisions allowing for the use of EFVS to obtain operational credits during straight-in 3D approach operations (including non-precision approach procedures flown as CDFA with vertical path guidance calculated by on-board equipment).

[7] Regulation (EC) 261/2004, of the European Parliament and of the Council, of 11 February 2004, laying down common rules on compensation and assistance to air passengers in the event of denied boarding and cancellation or long delay of flights.

[8] Environmental impact of $CO_2$ emissions may lead to aircraft operators incurring additional charges under the provisions of carbon market-based programmes such as the EU Emissions Trading System (EU ETS) or the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

Enabling these EFVS operations with operational credits provides a greater availability of suitable destination and alternate aerodromes during periods of reduced visibility, which in turn:

- Reduces the number of weather-related delays, cancellations, or diversions.
- Permits shorter routings.
- Enables a faster return to scheduled operations.
- Diminishes the likelihood of inconveniences to passengers and/or flight crew.

In addition to the operational credits for straight-in 3D approach operations, it is also important to note that the use of EFVS equipment will also significantly improve situational awareness of the flight crew in other phases of flight (e.g. taxi, take-off[9], approach and landing), increasing the overall safety of operations by reducing the likelihood of occurrences such as runway incursion incidents, potential accidents or wildlife strikes.

Also, certain specialised emergency services which are carried out in challenging environmental conditions may also benefit from the visual advantage provided by EFVS. A good example of this are aerial firefighting operations, as EFVS could be used to pinpoint fire hotspot and allow operators to expand their operational windows into the night and in adverse conditions (either weather related or due to smoke).

## 3.2 SBAS enabling EFVS operations

As mentioned previously, EU regulatory framework establishes provisions for the use of EFVS to obtain operational credits during straight-in 3D approach operations (including non-precision approach procedures flown as CDFA with vertical path guidance calculated by on-board equipment). No references are made within these provisions to the navigation sensor required, only the type of approach.

Therefore, straight-in 3D approach procedures based on SBAS will be able to benefit from the EFVS operational credits described in the following section.

Furthermore, the operational concept for SBAS approaches is particularly complementary to the objectives and benefits of the EFVS operational concept described in the previous section:

- SBAS allows for IAPs with minima as low as 200 ft (LPV-200) to be established at aerodromes which may not have or be able to afford the ground infrastructure required to carry out approaches based on other types of navigation sensor (e.g. ILS/GLS/VOR/NDB).

[9] As indicated in RD 1 (GM1 SPA.LVO.105(a)): It is expected that EFVSs will be certified for (low visibility) take-off guidance in the future.

- Inherent limitations to SBAS operations (in comparison to CAT II/III ILS or GLS) can be overcome by the advanced capabilities provided by EFVS. In certain scenarios, combining SBAS with EFVS will also expand the range of conditions in which operators can continue to use SBAS operations instead of reverting to CAT II/III (e.g. a hub airport may be able to keep more runways open in marginal conditions instead of using only runways with advanced ILS/GLS capabilities).

- SBAS operations have been shown to reduce the environmental impact of aviation by enabling closer alternate destination aerodromes and more direct routings, and reducing the rate of missed approaches and circling procedures. All these environmental benefits of SBAS will be further enhanced by the combined use with EFVS.

- SBAS approaches are more flexible in terms of the runways for which procedures can be designed (e.g. terrain characteristics preventing the installation of ground based navigation aids), allowing for approaches to be conducted to runway ends that could not be served by traditional ground-based navigation, e.g. ILS.

- Under the provisions of the EU PBN-IR[10], all non-precision and precision approach runways in the European Union must establish RNP APCH procedures down to 3 minima, including EGNOS LPV. This is also expected to lead to a drawdown of ILS CAT I at aerodromes where operational needs may be met by SBAS CAT I procedures at a fraction of the cost.

  Therefore, the ubiquitous presence of SBAS approach operations make them the ideal candidate for EFVS operations

**In conclusion, the combination of SBAS and EFVS technologies will greatly contribute to the increased availability of suitable destination and alternate aerodromes during periods of reduced visibility without requiring significant investments in advanced ground infrastructure.**

## 3.3 Operational credits associated with the use of EFVS

### 3.3.1 Descent below published DA/H

The use of certified EFVS equipment enables pilots to descend beyond the instrument approach procedure's decision altitude/height (DA/H) by maintaining visual references thanks to the EFVS. The typical EFVS operation to descend below the DA/H would be carried out as follows:

- The instrument approach procedure is flown down to the DA/H.

[10] Commission Implementing Regulation (EU) 2018/1048, laying down airspace usage requirements and operating procedures concerning performance-based navigation.

- If at this point pilots can maintain the required visual references through the EFVS[11], descent may continue down to a specified height above threshold elevation (determined by use of a barometric altimeter) or even to touchdown. This will be dependent on the type of EFVS operation[12]:
    - **EFVS 200 operations allow descents below the DA/H down to 200 ft above the runway threshold elevation.**

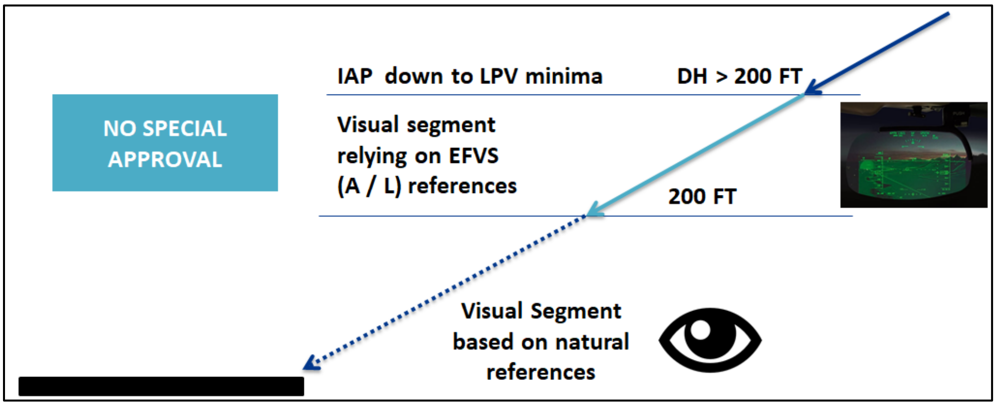


Figure 10: EFVS operation down to 200 ft above threshold elevation (EFVS 200)

- 
    - **EFVS Approach operations allow descents below the DA/H down to 100 ft above the runway threshold elevation (unless a different height is specified in the Aircraft Flight Manual).**

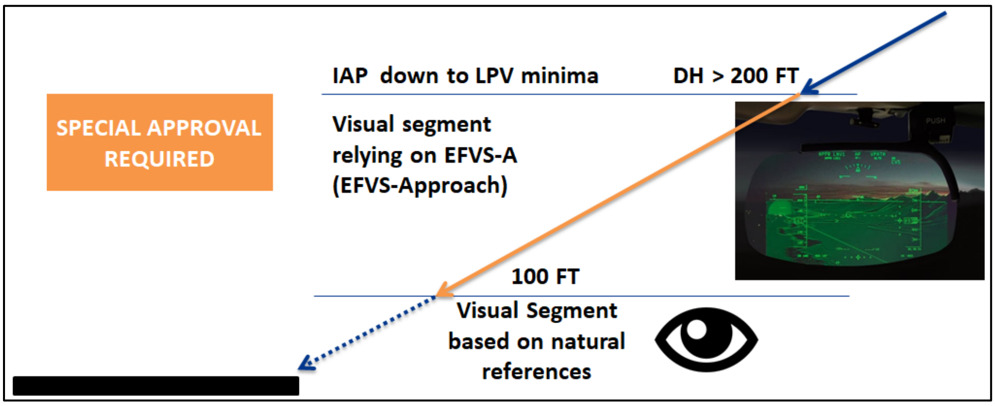


Figure 11: EFVS operation down to 100 ft above threshold elevation (EFVS Approach)

[11] EFVS image requirements for features to be identifiable at the DA/H are specified in AMC1 CAT.OP.MPA.312(a)(4), AMC1 NCC.OP.235(a)(4) and AMC1 SPO.OP.235(a)(4) for EFVS 200 operations; and in AMC7 SPA.LVO.105(c) for EFVS Approach and Landing operations. They are more stringent than the requirements for the same approach flown without EFVS.

[12] Key aspects of the different types of EFVS operations are detailed in Section 4.1.

- **EFVS Landing operations allows descents below the DA/H to touchdown.**

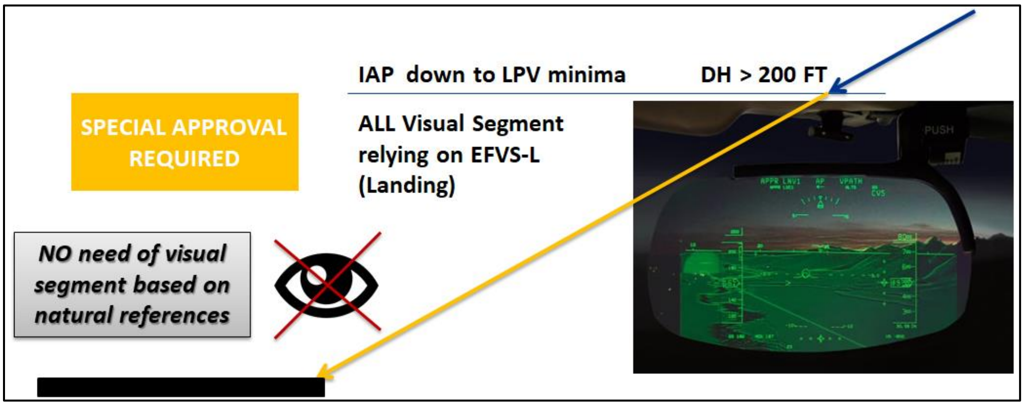


Figure 12: EFVS operation down to touchdown (EFVS Landing)

- At the specified height, pilots must have visual references[13] in sight through natural vision to proceed with landing (not applicable to EFVS Landing operations).

**It is important to highlight that EFVS operations exploit the visual advantage provided by the EFVS to extend the visual segment of an instrument approach. EFVS cannot be used to extend the instrument segment of an approach and thus the DA/H for EFVS operations is always the same as for the same approach conducted without EFVS.**

As can be seen in the previous figures a colour code has been used for each type of EFVS operation: **blue for EFVS 200 operations**, **orange for EFVS Approach operations**, and **yellow for EFVS Landing operations**. This colour code will be used throughout the document when necessary to distinguish between the different types of EFVS operation.

### 3.3.2 Reduction of RVR minima

Runway Visual Range (RVR) refers to 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.

Depending on a combination of factors[14], operators must establish a minimum RVR for each approach operation. Therefore, in conditions of reduced visibility, the RVR for a given runway may be below the minimum RVR established for the intended approach operation, preventing its execution.

[13] As indicated in RD 1 (GM1 CAT.OP.MPA.312, GM1 NCC.OP.235 and GM1 SPO.OP.235 for EFVS 200 operations; and GM4 SPA.LVO.100(c) for EFVS Approach and Landing operations): The visual reference at this point should be the same as that required for the same approach flown without EFVS.

[14] Full lists of elements to be considered by operators to establish aerodrome operating minima are set out in RD 1, points CAT.OP.MPA.110, NCC.OP.110, NCO.OP.110 and SPO.OP.110.

It is in these cases where **the use of a certified EFVS** capable of providing a visual advantage over natural vision **can earn the approach operation an operational credit to reduce the established RVR minima**, increasing the likelihood of the approach being executed and the aircraft landing at the desired runway.

The RVR reduction to be applied will depend on whether the operator has obtained specific approval from the competent authority[15]:

- Without special approval from the competent authority (**EFVS 200 operations**), **RVR reduction of normal values will be carried out as indicated in the following table** (from RD 1 AMC1 CAT.OP.MPA.312(a)(8), AMC1 NCC.OP.235(a)(8) and AMC1 SPO.OP.235(a)(8)). As can be seen, **a minimum RVR of 550 m applies**.

| RVR/CMV (m) required without the use of EFVS | RVR/CMV (m) for EFVS 200 operations |
|---|---|
| 550 | 550 |
| 600 | 550 |
| 650 | 550 |
| 700 | 550 |
| 750 | 550 |
| 800 | 550 |
| 900 | 600 |
| 1 000 | 650 |
| 1 100 | 750 |
| 1 200 | 800 |
| 1 300 | 900 |
| 1 400 | 900 |
| 1 500 | 1 000 |
| 1 600 | 1 100 |
| 1 700 | 1 100 |
| 1 800 | 1 200 |
| 1 900 | 1 300 |
| 2 000 | 1 300 |
| 2 100 | 1 400 |
| 2 200 | 1 500 |
| 2 300 | 1 500 |
| 2 400 | 1 600 |

Table 2: RVR reduction for EFVS 200 operations

- With special approval from the competent authority (**EFVS Approach and Landing operations**), **RVR reduction of normal values will be carried out as**

[15] Key aspects of the different types of EFVS operations are detailed in Section 4.1.

**indicated in the following table** (from RD 1 AMC3 SPA.LVO.100(c)), **unless stated otherwise in the Aircraft Flight Manual**. As can be seen, in the case of EFVS operations with a specific approval, **RVR can be reduced below 550 m**. However, it is important to note that such reductions below 550 m also require that low-visibility procedures (LVPs) be established at the aerodrome.

| RVR/CMV (m) required without the use of EFVS | RVR/CMV (m) with the use of EFVS |
|---|---|
| 550 | 350* |
| 600 | 400* |
| 650 | 450* |
| 700 | 450* |
| 750 | 500* |
| 800 | 550 |
| 900 | 600 |
| 1 000 | 650 |
| 1 100 | 750 |
| 1 200 | 800 |
| 1 300 | 900 |
| 1 400 | 900 |
| 1 500 | 1 000 |
| 1 600 | 1 100 |
| 1 700 | 1 100 |
| 1 800 | 1 200 |
| 1 900 | 1 300 |
| 2 000 | 1 300 |
| 2 100 | 1 400 |
| 2 200 | 1 500 |
| 2 300 | 1 500 |
| 2 400 | 1 600 |
| * Reported RVR should be available (no CMV conversion). | |

Table 3: RVR reduction for EFVS Approach and Landing operations

It is important to mention that the conditions for commencement and continuation of the approach for EFVS operations (EFVS 200, Approach or Landing) are in accordance with RD 1 CAT.OP.MPA.305, NCC.OP.230, NCO.OP.210 and SPO.OP.215 (as applicable).

This means that pilots conducting EFVS operations may commence an approach and continue that approach below 1000 ft above the aerodrome elevation (or into the FAS if the DH or MDH is higher than 1000 ft) if the reported RVR or CMV is equal to or greater than the lowest RVR minima determined in accordance with the previous tables, as long as all the conditions for conducting EFVS operations are met.

Therefore, **the RVR reduction credit of EFVS increases the likelihood of continuing an approach after the approach ban** (when compared to aircraft which are not equipped with EFVS).

Furthermore, it should be highlighted that **this RVR credit is applicable whatever the performance of the EFVS in the actual conditions**. It always gives the aircraft operator a better chance of being able to descend to the DA/H to acquire the required visual references at this point.

# 4 EFVS (EU) Regulatory Framework

As stated previously throughout this document, the European Union Aviation Safety Agency (EASA), within its objective of modernising the regulatory framework applicable to all-weather operations (AWOs), has incorporated provisions allowing for the use of EFVS to obtain operational credits during straight-in[16] 3D approach operations (including operations based on SBAS).

The provisions address all relevant disciplines and update in a coordinated manner the AWO-relevant rules across the domains of air operations (Commission Regulation 965/2012), aerodromes (Commission Regulation 139/2014), aircrew (Commission Regulation 1178/2011), airworthiness (CS-AWO) and ATM/ANS (Commission Regulation 2017/373).

In order to develop the guidelines included in Sections 5, 6 and 7, these provisions (including all associated Guidance Material and Acceptable Means of Compliance) have been analysed, with the key findings summarised in the following subsections.

## 4.1 Commission Regulation 965/2012 – Air Operations

Commission Regulation 965/2012 lays down technical requirements and administrative procedures related to air operations. The provisions included in this regulation regarding the use of EFVS to obtain operational credits during straight-in 3D approach operations describe two distinct types of EFVS operations:

- EFVS 200 operations.
- EFVS Approach and Landing operations.

### 4.1.1 EFVS 200 operations

Detailed definitions and requirements for EFVS 200 operations are detailed in Commission Regulation 965/2012 for CAT, NCC and SPO operations:

- CAT operations: See point CAT.OP.MPA.312 and associated GM and AMC.
- NCC operations: See point NCC.OP.235 and associated GM and AMC.
- SPO operations: See point SPO.OP.235 and associated GM and AMC.

[16] As indicated in RD 1 (GM1 CAT.OP.MPA.312, GM1 NCC.OP.235 and GM1 SPO.OP.235 for EFVS 200 operations; and GM4 SPA.LVO.100(c) for EFVS Approach and Landing operations): EFVSs incorporate a HUD or an equivalent system so that the EFVS image of the scene ahead of the aircraft is visible in the pilot's forward external FOV. Circling operations require the pilot to maintain visual references that may not be directly ahead of the aircraft and may not be aligned with the current flight path. EFVS cannot therefore be used in place of natural visual reference for circling approaches.

Nonetheless, the following paragraphs will provide a summary of the key aspects of the EFVS 200 operational concept:

- EFVS 200 operations allow **descents below the DA/H down to 200 ft above the runway threshold elevation**, based on adequate visual references provided by the EFVS. Beyond this height, natural visual references are required to continue the descent for landing (see Figure 10).

- EFVS 200 operations may benefit from a RVR operational credit reducing the RVR normally required. Operational credit will be applied as a **reduction of normal RVR values** according to AMC1 CAT.OP.MPA.312(a)(8), AMC1 NCC.OP.235(a)(8) or AMC1 SPO.OP.235(a)(8) (see Table 2).

  A **minimum RVR of 550 m** applies.

- Due to the limitations imposed on the operational credits (minimum RVR of 550 m), EFVS 200 operations are not considered to be Low Visibility Operations (LVOs) and, therefore, **no specific approval from the competent authority is required** to execute these operations.

- The equipment required for EFVS 200 operations is a **certified EFVS-A or EFVS-L** (see definitions in Annex C: Definitions). Legacy systems certified as 'EVS with an operational credit' may be considered an EFVS-A if approved by the operator's competent authority.

- EFVS 200 operations should only be conducted as straight-in 3D approach operations, using an IAP in which the final approach track is off-set by a maximum of 3 degrees from the extended centreline of the runway.

- **SBAS is perfectly aligned with the objectives of the EFVS 200 operational concept,** as it allows for IAPs to be established at aerodromes without the ground infrastructure required to carry out approaches based on other types of navigation sensor (e.g. ILS/GLS/VOR/NDB).

  Although SBAS in and of itself may allow for IAPs with a DH as low as 200 ft (LPV-200) with minimal ground infrastructure, the combination with the EFVS 200 operational concept will still provide an added benefit, by allowing the operator to compensate for relatively high RVR resulting from factors such as reduced lighting infrastructure.

### 4.1.2 EFVS Approach and Landing operations

Detailed definitions and requirements for EFVS Approach and Landing operations requiring specific approval are detailed in Part-SPA[17] of Commission Regulation 965/2012, and associated GM and AMC.

[17] Applicable to CAT, NCC, NCO and SPO operations.

Nonetheless, the following paragraphs will provide a summary of the key characteristics of the EFVS Approach and Landing operations:

- **EFVS Approach and Landing operations allow descent below the DA/H based on adequate visual references provided by the EFVS**. The minimum height above the threshold elevation that may be reached before acquiring natural visual references depends on the capabilities of the EFVS installed:
    - **EFVS Approach operations allow descents beyond the DA/H down to a height which will be specified in the AFM; if not specified, natural visual references are required 100 ft above the threshold elevation** (see Figure 11).
    - **EFVS Landing operations allow descents beyond the DA/H without natural visual references down to touchdown** (see Figure 12).
- EFVS Approach and Landing operations may benefit from a RVR operational credit applied as a **reduction of normal RVR values**. The lowest RVR minima to be used should be determined in accordance with criteria specified in the AFM for the expected weather conditions or, if no such criteria are specified, as a reduction of normal values according to AMC3 SPA.LVO.100(c) (see Table 3).

  A **minimum RVR of 350m (or less if stated in the AFM)** applies.

  An **RVR of less than 550 m requires that the aerodrome has low-visibility procedures (LVPs) established**.
- Given that the operational credits associated with EFVS Approach and Landing operations allow a minimum RVR of less than 550 m, these EFVS operations are Low Visibility Operations (LVOs) and, therefore, **require specific approval (SPA) from the competent authority**.
- **EFVS Approach operations require certified EFVS-A equipment, while EFVS Landing operations require certified EFVS-L**. Legacy systems certified as 'EVS with an operational credit' may be considered an EFVS-A if approved by the operator's competent authority.
- EFVS Approach and Landing operations should only be conducted as straight-in 3D approach operations, using an IAP in which the final approach track is offset by a maximum of 3 degrees, unless a different approach offset is stated in the AFM.
- **SBAS approach procedures are perfectly aligned with the objectives of the EFVS Approach and Landing operational concept**, with the combination of both technologies allowing advanced capabilities with minimal investment in ground infrastructure.

### 4.1.3 Comparison between EFVS operations

The following table summarises the key aspects of EFVS operations discussed throughout this section, allowing the comparison between EFVS 200 operations and EFVS Approach and Landing operations:

| Type of EFVS operation | Operational credit obtained | On-board equipment required | Special approval required (SPA.LVO) | AIR-OPS operations applicability |
|---|---|---|---|---|
| **EFVS 200** | **Descent below DA/H without natural visual references**<br>**Down to 200 ft** above threshold elevation (THRE).<br>**RVR operational credit**<br>Reduction of normal RVR values according to AIR-OPS:<br>AMC1 CAT.OP.MPA.312(a)(8)<br>AMC1 NCC.OP.235(a)(8)<br>AMC1 SPO.OP.235(a)(8)<br>(See Table 2)<br>**Minimum RVR of 550 m.** | **EFVS-A or EFVS-L**<br>**Implemented on HUD or equivalent system** | **NO** | **CAT NCC SPO** |
| **EFVS Approach** | **Descent below DA/H without natural visual references**<br>**Down to** height specified in AFM or **100 ft** above THRE, if not stated in the AFM.<br>**RVR operational credit** | **EFVS-A**<br>**Implemented on HUD or equivalent system** | **YES** | **CAT NCC NCO SPO** |

<table>
<tr><th>Type of EFVS operation</th><th>Operational credit obtained</th><th>On-board equipment required</th><th>Special approval required (SPA.LVO)</th><th>AIR-OPS operations applicability</th></tr>
<tr><td></td><td>Reduction of normal RVR values according to AFM criteria or, if not stated in AFM, according to AIR-OPS:<br>AMC3 SPA.LVO.100(c)<br>(See Table 3)<br>Minimum RVR of 350m or less if stated in the AFM.<br>RVR of less than 550 m requires the aerodrome has LVPs established.</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">EFVS Landing</td><td>Descent below DA/H without natural visual references</td><td rowspan="4">EFVS-L<br><br>Implemented on HUD or equivalent system</td><td rowspan="4">YES</td><td rowspan="4">CAT<br>NCC<br>NCO<br>SPO</td></tr>
<tr><td>Down to touchdown.</td></tr>
<tr><td>RVR operational credit</td></tr>
<tr><td>Equivalent to EFVS Approach.</td></tr>
</table>

Table 4: Summary: Key aspects of EFVS operations

## 4.2 Commission Regulation 139/2014 – Aerodromes

Commission Regulation 139/2014 lays down requirements and administrative procedures related to aerodromes. Among these, in order to contribute to the safety of operations under all weather conditions, specific provisions applicable to the aerodrome operator have been added.

The objective of these provisions is to support the implementation of AWOs by:

- Ensuring that the aerodrome operator provides and maintains, directly or through arrangements with third parties, visual and non-visual aids, meteorological equipment, and any other equipment, commensurate with the type of operations conducted at the aerodrome.

  See point ADR.OR.C.005 (e) in Annex III of Commission Regulation 139/2014.

- Ensuring that the aerodrome operator provides, directly or through arrangements with third parties, all necessary aeronautical data to enable AWOs, such as information on the aerodrome lighting system, charts relevant to the aerodrome, radio navigation and landing aids and visual segment surface (VSS) penetration.

See points ADR.OPS.A.070, ADR.OPS.A.075, ADR.OPS.A.080 and ADR.OPS.A.085 in Annex IV of Commission Regulation 139/2014, and associated guidance material and acceptable means of compliance for these provisions.

- Establishing rules for low visibility procedures (LVPs)[18], which describe when LVPs are required at an aerodrome as well as the obligations of the aerodrome operator when implementing them (e.g. cooperation and coordination with air traffic services provider; establishment of criteria for preparation, initiation and termination of LVPs; provision of information to the aeronautical information services provider and air traffic services provider, as appropriate, of any change on the status of the aerodrome equipment and facilities that have an impact on low-visibility operations; provision of information regarding LVPs to the aeronautical information services provider for publication in the AIP; need for approval by the competent authority).

  The detailed rules are set out in point ADR.OPS.B.045 in Annex IV of Commission Regulation 139/2014, and associated guidance material and acceptable means of compliance for this provision.

  Of particular importance in the case of EFVS operations are the provisions detailed in AMC1 ADR.OPS.B.045(a)(3) regarding the suitability of runways for EFVS Approach and Landing operations[19] (see Section 6.1).

## 4.3 Commission Regulation 1178/2011 – Aircrew

It is important to note that Commission Regulation 965/2012 (see Section 4.1) lays down detailed rules for air operations, including requirements for operators to provide to their crew regular training and conduct checking regarding the specific type of operation (operator training and checking). The amendments made to Commission Regulation 965/2012 regarding all-weather operations are designed to constitute the comprehensive regulatory framework for low-visibility IFR approaches.

Due to this, AWO-relevant requirements for aircrew in Commission Regulation 1178/2011-Part FCL have been deleted or, where necessary, replaced by references to Commission Regulation 965/2012.

Therefore, Commission Regulation 1178/2011 will not be analysed in this section.

## 4.4 CS-AWO – Airworthiness

EASA's CS-AWO (Certification Specifications for All Weather Operations) Issue 2 addresses the required regulatory changes (certification specifications and associated

[18] Provisions related to surface movement guidance and control systems (SMGCS) are also provided in order to support implementation of AWOs (see RD 2 ADR.OPS.B.030 and associated GM and AMC).

[19] Provisions regarding the suitability of runways for EFVS 200 operations are also mentioned in RD 2 (GM2 ADR.AR.C.035(e)), though in the context of authority requirements for issuance of certificates.

acceptable means of compliance) in the airworthiness domain to complement the relevant AWO requirements in other domains from a design and certification point of view.

Among these specifications are those applicable to the use of technologies such as EFVS equipment, which must be certified in order to be used to carry out EFVS operations with operational credits. The following is a list of the aspects covered by CS-AWO Issue 2 (Subpart A, Section 3) regarding EFVS technology:

- General specifications (CS AWO.A.EFVS.101).
- EFVS designation specifications (CS AWO.A.EFVS.102).
- EFVS depiction specifications (CS AWO.A.EFVS.103).
- EFVS display specifications (CS AWO.A.EFVS.104).
- HUD EFVS symbology specifications (CS AWO.A.EFVS.105).
- EFVS display controls specifications (CS AWO.A.EFVS.106).
- EFVS safety assessment specifications (CS AWO.A.EFVS.107).
- EFVS level of safety specifications (CS AWO.A.EFVS.108).
- EFVS performance specifications (CS AWO.A.EFVS.109).
- EFVS-L landing performance specifications (CS AWO.A.EFVS.110).
- EFVS monitoring, annunciation and alerting specifications (CS AWO.A.EFVS.111).
- EFVS documentation specifications (CS AWO.A.EFVS.112).

It is also important to note, due to the requirement for EFVS to be displayed on a HUD or equivalent display, that CS-AWO Issue2 also provides certification specifications and associated acceptable means of compliance for head-up displays (Subpart A Section 2).

## 4.5 Commission Regulation 2017/373 – ATM/ANS

Commission Regulation 2017/373 lays down common requirements for providers of air traffic management/air navigation services (ATM/ANS). Among these, in order to facilitate the implementation of the ‘all-weather operations (AWOs)’ concept, specific provisions have been included to ensure the publication of required aeronautical data/information in the AIP in a consistent and harmonised manner.

These provisions concerning the content and structure of the AIP, set out in Annex VI (Part-AIS) to Regulation (EU) 2017/373, address the publication of AWO-relevant aeronautical data such as information on LVPs, the aerodrome lighting system, relevant charts, radio navigation and landing aids and visual segment surface (VSS) penetrations (among others).

As indicated previously in the analysis of Commission Regulation 139/2014 (see Section 4.2), the AWO- relevant data to be published in the AIP should be provided, directly or through arrangements with third parties, by the aerodrome operator.

# 5 Guidelines for aircraft operators

**These guidelines describe the various steps that must be accomplished by an aircraft operator to realise operational capability for EFVS operations**. Though guidance is provided for EFVS operations in general, it is important to note that different types of EFVS operations (EFVS 200, EFVS Approach, EFVS Landing) may have different requirements in certain areas; these instances are clearly identified throughout the provided guidelines.

The overall process is comprised of the following main steps. To facilitate traceability between these steps and the corresponding regulation (Commission Regulation 965/2012 – Air Operations), references to the applicable Implementing Rule paragraphs are included for each step (as applicable).

**Step 1**
- Aircraft certification
- CAT.OP.MPA.312/NCC.OP.235/SPO.OP.235 (a)(1), for EFVS 200
- SPA.LVO.105(a), for EFVS Approach & Landing

**Step 2**
- Amend operational procedures and relevant manuals
- CAT.OP.MPA.312/NCC.OP.235/SPO.OP.235 (a)(4,5,6,8), for EFVS 200
- SPA.LVO.105(c,d,e), for EFVS Approach & Landing

**Step 3**
- Verification of suitability of aerodromes, runways / FATOs and IAPs
- CAT.OP.MPA.312/NCC.OP.235/SPO.OP.235 (a)(2), for EFVS 200
- SPA.LVO.105(f) and SPA.LVO.110, for EFVS Approach & Landing

**Step 4**
- Update and implement training and checking programmes
- CAT.OP.MPA.312/NCC.OP.235/SPO.OP.235 (a)(3), for EFVS 200
- SPA.LVO.105(b) and SPA.LVO.120, for EFVS Approach & Landing

**Step 5**
- Carry out safety assessments and establish performance indicators
- CAT.OP.MPA.312/NCC.OP.235/SPO.OP.235 (a)(7), for EFVS 200
- SPA.LVO.105(g), for EFVS Approach & Landing

**Step 6**
- Obtain operational approval
- SPA.LVO.100(c), for EFVS Approach & Landing

**Step 7**
- Introduction of the capability into the operation

Figure 13: Process for aircraft operators implementing EFVS operations

Wherever necessary, these steps are broken down into associated lower-level items and tasks in order to support the conversion project.

## 5.1 Aircraft certification

Aircraft operators intending to implement EFVS operations will most likely either purchase an aircraft with EFVS already installed and approved or have EFVS retrofitted as a package which will include all the elements necessary to ensure compliance with the EFVS certification requirements. That is, aircraft operators will not usually be involved in carrying out aircraft certification activities, as these will be completed by aircraft manufacturers / design organisations.

It is for this reason that tasks associated with the aircraft modification, upgrade and airworthiness re-certification have not been included in this section and have instead been detailed in Section 7 - Guidelines for aircraft manufacturers / design organisations.

Nevertheless, it should be noted that the aircraft operator must ensure that all EFVS certification requirements have been met prior to effectively implementing EFVS operations. Depending on the type of EFVS operation the aircraft operator intends to carry out, it must ensure that the aircraft is suitably equipped with a certified EFVS-A or EFVS-L.

## 5.2 Amend operational procedures and relevant manuals

Providing that an airworthy installation and functions compliant with the requirements for EFVS is successfully accomplished, the operation of new functions must be integrated with the existing aircraft functions and standard operating procedures. To achieve this:

- The **Operations Manual (OM)** should be amended to reflect the implementation of EFVS operations and establish the required operating procedures (e.g. checking the satisfactory functioning of the aircraft equipment, correct seating and eye position, determination of aerodrome operating minima considering the operational credit obtained, checking the establishment of LVPs at the destination aerodrome, required visual references, actions to be taken in the event of inability to acquire or loss of the required visual references, procedures for balked landing, etc.)[20].

- The **Minimum Equipment List (MEL)** should be amended to identify the minimum equipment necessary to satisfy EFVS operations.

- The EFVS manufacturer's Instructions for Continued Airworthiness (ICA) should be incorporated into the operator's **maintenance programme**.

[20] Operating procedures which should be included in the OM for the different types of EFVS operations are described in detail in RD 1: see AMC corresponding to CAT.OP.MPA.312(a)(4), NCC.OP.235(a)(4) and SPO.OP.235(a)(4) for EFVS 200 operations; and AMC corresponding to SPA.LVO.105(c) for EFVS Approach and Landing operations.

## 5.3 Verification of suitability of aerodromes, runways / FATOs and IAPs

EFVS operations allow operation below the DA/H without 'natural' visual reference by relying on the visual advantage provided by the EFVS in the visual segment of the approach. Due to this, EFVS operations may present a higher probability of initiating a go-around below the DA/H than non-EFVS operations.

With this in mind, **it is required that aircraft operators carry out an assessment to verify the suitability of aerodromes, runways / FATOs and Instrument Approach Procedures (IAPs) prior to authorising EFVS operations**. The purpose of this assessment is to confirm that clearance from terrain and obstacles will be available at every stage of the approach including the visual segment and, in the event of a go-around initiated below the DA/H, the missed approach segment.

Commission Regulation 965/2012 (air operations) includes acceptable means of compliance (AMC) and guidance material (GM) regarding the suitability assessment for each type of EFVS operation:

- **For EFVS 200 operations, AMC to CAT.OP.MPA.312(a)(2), NCC.OP.235(a)(2) and SPO.OP.235(a)(2)** describe the **operational assessment** to be carried out by the aircraft operator to verify suitability. It is important to highlight that this operational assessment is not the same as the operational assessment described below for EFVS Approach and Landing operations, as it does not require that actual flights be performed.
- **For EFVS Approach and Landing operations, AMC and GM to SPA.LVO.110** indicate that the suitability assessment to be carried out by the aircraft operator should be made by means of one or a combination of the following methods:
    - An **assessment of previous operational data** for the particular aerodrome, runway and instrument flight procedures.
    - A **desktop assessment** checking if the aircraft data and capabilities are compatible with the aerodrome and instrument approach procedure characteristics. If this is the case the aerodrome and runway should be considered suitable for the intended EFVS operation.
    - An **operational assessment** where actual flights[21] should be performed to verify suitability. In this assessment method, the aircraft operator should verify each aircraft type and runway combination by successfully completing the determined number of approaches and landings (based on identified risks and agreed with the competent authority).

      Due to its increased complexity and cost, this type of assessment is meant to be used only if the previous methods prove insufficient to ensure suitability of the aerodrome for the intended EFVS operation.

[21] If approved by the competent authority, the aircraft operator may replace these flights partially or completely with simulations on FSTDs.

Regardless of the method used, the following is a non-exhaustive list of the elements the aircraft operator should consider when carrying out the suitability assessment:

- Promulgation of the runway as suitable for EFVS operations (or certification as a precision approach CAT II or III runway) by the State of the aerodrome.
- Relevant aerodrome factors, such as:
    - Runway and runway environment characteristics (e.g. runway physical dimensions and coordinates/elevations, pre-threshold terrain characteristics in the case of EFVS Landing operations).
    - Available infrastructure (e.g. navigation facilities, visual and non-visual aids, meteorological equipment).

      As EFVS operations allow the extension of the visual segment of the approach, attention should be paid to verifying the suitability of the Approach Lighting System (ALS) and runway lighting systems (threshold configuration in particular). Consideration should be given to the presence of LED lights, as these may greatly reduce the efficacy of enhanced vision systems due to their reduced thermal profile.
    - Determination of aerodrome operating minima.
- The availability of suitable aerodrome operating procedures and their compatibility with the intended aircraft operations. For example, if the operator wishes to carry out EFVS operations classified as LVOs (i.e. EFVS Approach and Landing operations with a runway visual range less than 550 m), the aerodrome must have LVPs established.
- The availability of suitable IAPs. In order to accommodate EFVS operations, aerodromes must be served by straight-in 3D IAPs designed in accordance with PANS-OPS Volume II (ICAO Doc 8168) or equivalent criteria. Additionally:
    - The final approach track should not be offset by more than a specified limit from the extended runway centreline (generally 3 degrees).
    - Consideration should be given to the obstacle environment, as IAPs with obstacles that require visual identification and avoidance are not suitable for EFVS operations. Attention should be paid to ensuring:
        - Obstacle clearance during the visual segment (from the DA/H to the runway threshold). This may be ensured by the establishment of an Obstacle Free Zone (OFZ) or, if no OFZ is published, the Visual Segment Surface (VSS) must be free of penetrations.
        - Obstacle clearance during a balked landing (go-around initiated below the DA/H). This may be ensured by the establishment of an Obstacle Free Zone (OFZ) or, if no OFZ is published, aircraft operators should carry out an analysis of the aircraft performance for the missed approach and propose a procedure for balked landing.

- Aircraft data and capabilities, such as that included in the AFM or additional data from the TC/STC holder (e.g. visual advantage provided by the EFVS equipment, EFVS ability to perceive LED lighting, climb gradient performance if required to ensure obstacle clearance in the event of a balked landing).
- Any other non-standard conditions that may affect the operations. Particular attention should be paid to verifying that any specific requirements stipulated in the AFM can be met.

Although it is the aircraft operator's responsibility to carry out the suitability assessment described in this section, the aircraft operator has no direct control over many of the factors which should be assessed (see list above), as they are the responsibility of the aerodrome operator and/or ANSP. For this reason, **these factors are analysed in further detail in Section 6 - Guidelines for Aerodrome Operators and/or ANSPs**. **Aircraft operators should refer to said section for further information regarding the suitability assessment**.

## 5.4 Update and implement training and checking programmes

To ensure that the flight crew members and all relevant personnel are competent to conduct the intended operation and associated tasks, **an adequate training and checking programme will be established for**:

- **Flight crew[22].**

  The training and checking programme established for the flight crew should be structured to provide sufficient theoretical and practical knowledge regarding the EFVS technology and concept of operation to be implemented, as well as the use of the aircraft's approach system in such operations; it shall include normal, abnormal and emergency procedures, as well as take into account human factor risks.

  To achieve this, the operator shall establish and implement a programme addressing all requirements for initial, recurrent and differences training and checking; and establish methods to ensure recent experience requirements are met.

- **Maintenance personnel.**

  Maintenance personnel (e.g. mechanics, maintenance controllers, avionics technicians, inspection/quality assurance personnel) should receive initial and recurrent training to establish and maintain an effective EFVS maintenance programme.

[22] Flight crew training and checking requirements for the different types of EFVS operations are described in detail in RD 1: see AMC and GM corresponding to CAT.OP.MPA.312(a)(3), NCC.OP.235(a)(3) and SPO.OP.235(a)(3) for EFVS 200 operations; and AMC and GM corresponding to SPA.LVO.120 for EFVS Approach and Landing operations.

- **Dispatch personnel (if any).**

  Dispatchers and other persons authorised to exercise operational control must fully understand the capabilities and limitations of the EFVS equipment installed in the operator's aircraft (e.g. negative effect of specific weather conditions on EFVS sensor performance), operational factors which may affect the ability to conduct EFVS operations (e.g. restrictions in place at destination aerodromes), as well as operational procedures related to the use of EFVS (e.g. monitoring of weather conditions, dispatch or diversion procedures).

  These factors should be addressed as required through initial, recurrent and differences training.

All required training and checking shall be conducted by appropriately qualified personnel, such as Approved Training Organisations (ATO) / Pilot Training Organisations (PTO), and the operator shall keep records of the training and qualifications.

## 5.5 Carry out safety assessment and establish performance indicators[23]

**Prior to commencing EFVS operations, an operator should demonstrate that such operations will achieve an acceptable level of safety**. This requires the operator to gather data from EFVS operations and conduct safety assessments taking that data into account.

The intention of these safety assessments is to validate the use and effectiveness of the applicable aircraft EFVS system, operating procedures, flight crew training, and aircraft maintenance programme (AMP); and to identify hazards. The intention is not to repeat the statistical analysis required for certification of equipment (see Section 7.1.6), but to demonstrate that the various elements of the 'total system' work together for a particular operator.

The operator should gather the data required for the safety assessments from approaches conducted in a representative sample of expected operating conditions (such as prevalent weather, planned destinations and operating bases), and over a sufficient period to be representative of the planned operation.

**Additionally, key safety performance indicators should be established and monitored throughout EFVS operations in order to sustain the required safety level and achieve a continuously improving safety performance**.

[23] Detailed descriptions regarding the safety assessment and establishment of performance indicators are provided in RD 1 for LVOs and operations with operational credits (Part-SPA): see AMC and GM corresponding to SPA.LVO.105(g).

There are no specific provisions at AMC/GM level regarding the safety assessment and establishment of performance indicators to be carried out for EFVS 200 operations, though such activities will also be required for this type of operation (as stated in CAT.OP.MPA.312/NCC.OP.235/SPO.OP.235 (a)(7)).

The following are some examples of the performance indicators which should be considered: the rate of unsuccessful approaches, measures of performance of the required airborne equipment, safety performance indicators related to other specific risks associated with LVOs (if applicable).

Data should be collected by means of the operator's flight data monitoring programme (if available), supplemented by other means including reports submitted by flight crew.

## 5.6 Obtain operational approval

Once all the activities described previously (Sections 5.1 through 5.5) are carried out:

- **In the case of EFVS 200 operations, there is no requirement to submit a formal application seeking to obtain a specific approval (SPA)**, nevertheless:
  - CAT operators are required to notify important changes to the scope of the certificate or the operations specifications to their authority in advance[24].
  - NCC and SPO operators are required to submit a declaration providing the competent authority with all relevant information prior to commencing operations, and to notify the authority of any changes to this declaration[25].

  This may (or not) lead to discussions between the operator and the competent authority until all evidence is found satisfactory and the changes are accepted.

- **In the case of EFVS Approach and EFVS Landing operations, a specific operational approval (SPA) shall be sought from the competent authority.**

  The operator must prepare a written (SPA) proposal to the regulator with evidences of the activities carried out in order to implement EFVS operations. These evidences are normally extracts from the AFM and STC or SB documentation for the airworthiness part, extracts from the OM and copies of ATOs/PTOs training for the operational part, and safety assessment documentation.

  Once the authority evaluates the application and agrees that the requirements are met, the specific operational approval is given via an amendment to the OM, an OpSpec associated with the Air Operator Certificate (AOC), or a Letter of Authorisation (LOA) in the case of non-commercial operators.

## 5.7 Introduction of the capability into the operation

**The capabilities achieved must be introduced into the flight dispatch practice so that they can be applied in daily flight planning**. It is highly recommended that the aircraft operator declares the operational credit provided by the EFVS in field 18 of the Flight Plan.

[24] See RD 1: ORO.GEN.130 and associated GM and AMC.

[25] See RD 1: ORO.DEC.100 and associated GM and AMC.

Since it is possible that aircraft in the fleet will be modified over an extended period, a degree of difference in capability between individual tail numbers may exist. Dispatch, flight operations and maintenance must be advised of these differences so that the proper function and performance capability may be applied in flight planning and flight execution. Appropriate communications must be put in place to inform and coordinate the relevant offices.

# 6 Guidelines for aerodrome operators and/or ANSPs

Although the activities required for implementation of EFVS operations are eminently the responsibility of aircraft operators (see Section 5), **the AWO-relevant provisions in Commission Regulation 139/2014 (aerodromes) and Commission Regulation 2017/373 (ATM/ANS) establish that aerodrome operators and/or ANSPs wishing to accommodate EFVS operations will also be required to attend to certain key aspects to ensure a safe implementation can be carried out**.

With this in mind, **this section aims to provide guidance regarding these key aspects for aerodrome operators and/or ANSPs wishing to accommodate EFVS operations**[26]:

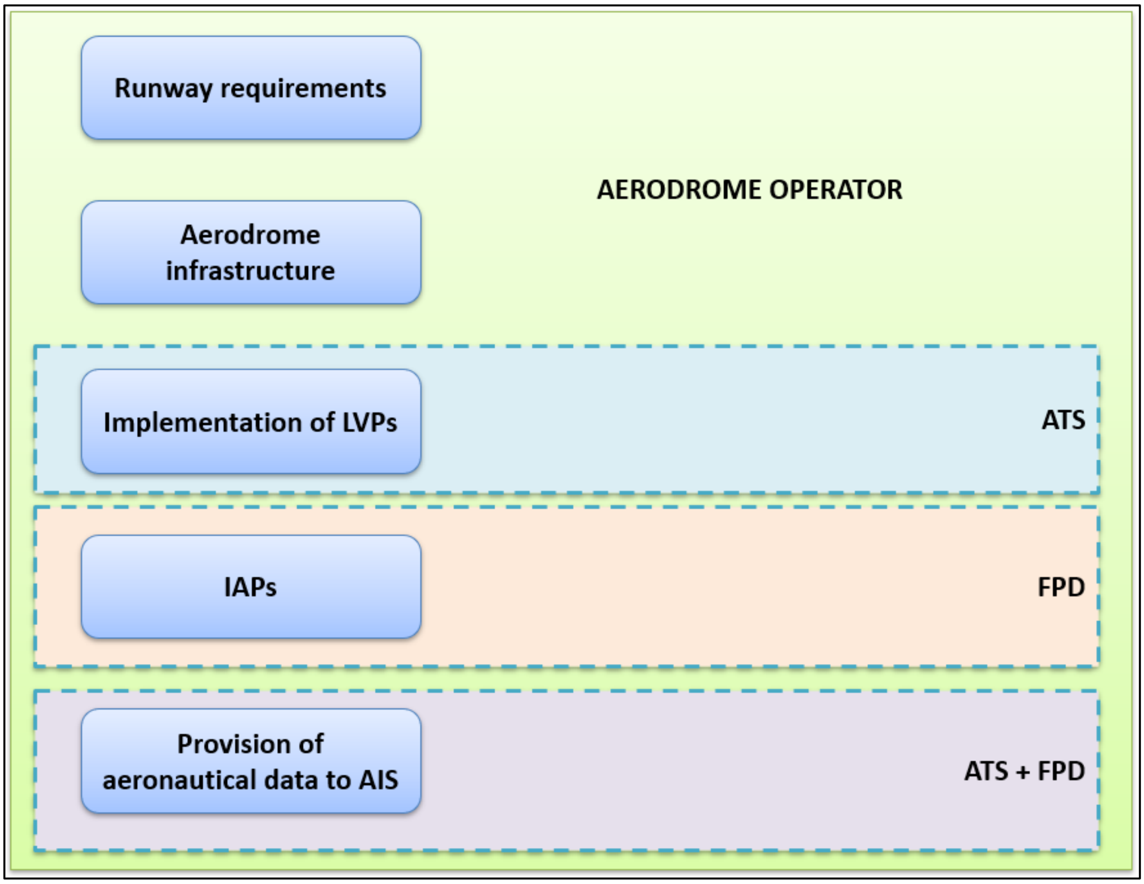


Figure 14: Key aspects for aerodrome operators and/or ANSPs regarding EFVS operations

It is important to highlight that the content of this section should be considered as a baseline and should be duly adjusted in accordance with the local aerodrome / ANSP organisation.

[26] Though guidance is provided for EFVS operations in general, it is important to note that different types of EFVS operation (EFVS 200, EFVS Approach, EFVS Landing) may have different requirements in certain areas; these instances are clearly identified throughout the provided guidelines.

## 6.1 Runway requirements

**Aerodrome operators wishing to accommodate EFVS operations should ensure that runways are suitable for their implementation.**

In addition to the provisions included in Commission Regulation 965/2012 (air operations) regarding the verification of the suitability of aerodromes, runways / FATOs and IAPs (see Section 5.3), Commission Regulation 139/2014 (aerodromes) details the following criteria to determine the suitability of runways for EFVS operations.

**GM2 ADR.AR.C.035(e) Issuance of certificates**
EFVS 200 OPERATION

A runway is suitable for EFVS 200 operation when:

(a) an instrument approach procedure providing at least lateral guidance in which the final approach track is offset by a maximum of 3 degrees from the extended centre line of the runway is established; and
(b) either an obstacle free zone (OFZ) is established or the visual segment surface (VSS) is not penetrated by obstacles, and an instrument departure procedure is established.

**AMC1 ADR.OPS.B.045(a)(3) Low-visibility procedures**
SUITABILITY OF RUNWAYS FOR EFVS APPROACH AND LANDING OPERATIONS

(a) An EFVS-A operation may be conducted on a runway if:
    (1) it is served by a straight-in instrument approach procedure in accordance with Part-FPD of Regulation (EU) 2017/373;
    (2) an OFZ is established or a VSS is not penetrated by obstacles, and an instrument departure procedure is established;
    (3) the touchdown zone (TDZ) RVR is available;
    (4) low-visibility procedures are in effect;
    (5) the switch-over time for runway edge, threshold and end lights meets the specifications in CS ADR-DSN.S.880 for CAT II/III runways.
(b) An EFVS-L operation may be conducted on a runway when, in addition to point (a):
    (1) an aerodrome obstacle chart – ICAO Type A is published in the AIP; and
    (2) a precision approach terrain chart – ICAO is published in the AIP.

**The following diagram summarises the runway requirements for each type of EFVS operation**, in accordance with the provisions of Commission Regulation 965/2012 (air operations) and Commission Regulation 139/2014 (aerodromes) referred to above:

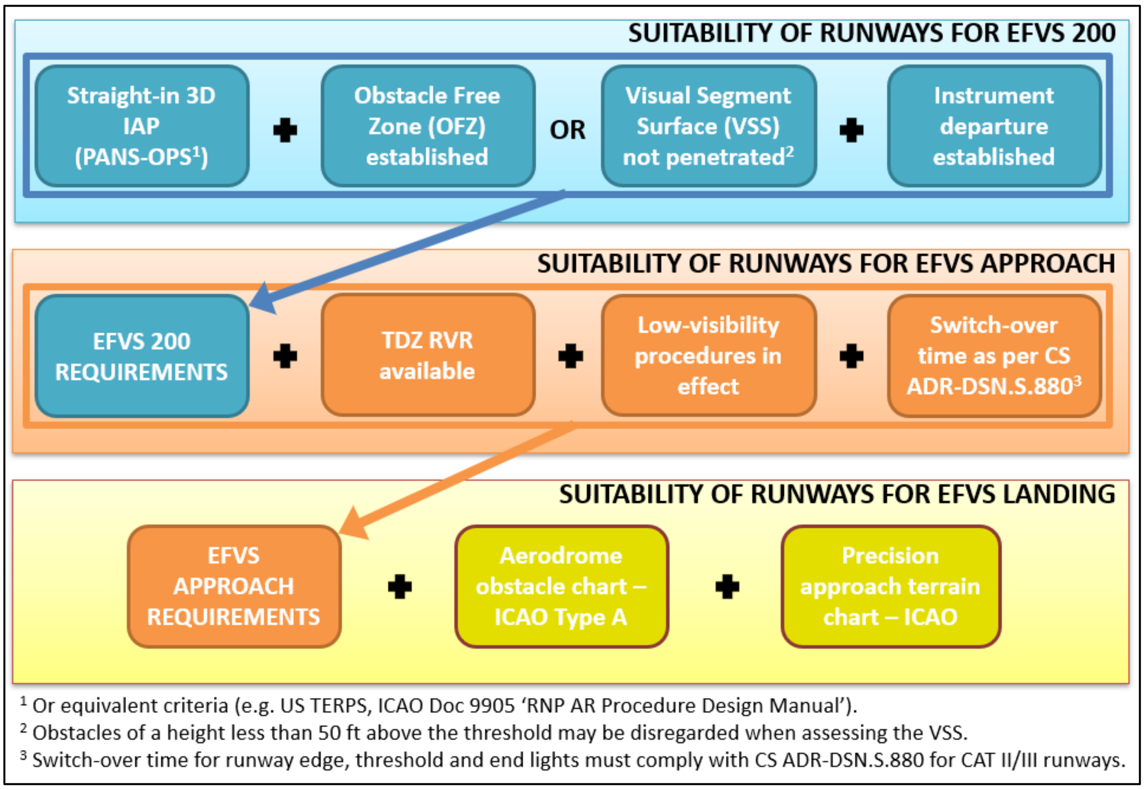


Figure 15: Suitability of runways for EFVS operations

Additionally, in order to determine the suitability of a runway for EFVS operations, consideration should be given to the possible promulgation of the runway as suitable for EFVS operations (or certification of the runway as a precision approach CAT II or III runway) by the State of the aerodrome.

## 6.2 Aerodrome infrastructure

**No additional aerodrome infrastructure is expected to be required as a direct consequence of the implementation of EFVS operations**[27]. This agrees with the advantages resulting from the implementation of EFVS during SBAS approaches as described in Section 3.2: improvement of accessibility to airports without a significant investment in ground infrastructure (e.g. lighting, ground-based navigation aids).

However, as stated in point ADR.OR.C.005 (e) of RD 2:

[27] The only scenario where additional infrastructure may be required is in the case of aerodromes where implementation of LVPs is carried out to accommodate EFVS Approach or Landing operations (this situation is addressed in Section 6.3).

**ADR.OR.C.005 Aerodrome operator responsibilities**

(…)

(e) The aerodrome operator, in order to ensure the safe operation of aircraft at the aerodrome, shall provide and maintain, directly or through arrangements with third parties, visual and non-visual aids, meteorological equipment and any other equipment, commensurate with the type of operations conducted at the aerodrome.

**This provision, when implemented by the aerodrome operator, ensures that aerodrome infrastructure required for the execution of EFVS operations is fit for purpose and available.**

## 6.3 Implementation of Low-Visibility Procedures (LVPs)

Depending on the type of EFVS operation to be carried out, LVPs may need to be established at the aerodrome:

- For EFVS operations with an RVR ≥ 550 m (e.g. EFVS 200 operations), LVPs are not required.
- **For EFVS operations with an RVR < 550 m (e.g. EFVS Approach and Landing operations), LVPs must be established.**

According to ADR.OPS.B.045 of RD 2, the aerodrome operator shall establish and implement the low-visibility procedures in cooperation with the Air Traffic Services (ATS) provider. Additionally, it is also required in RD 3 that ATS providers establish arrangements with the aerodrome operator for the relevant aspects and the definition of the respective responsibilities in conducting low-visibility operations (LVOs).

**Consequently, coordination between aerodrome operator and ATS provider will be required for the implementation of LVPs and LVOs (EFVS Approach and EFVS Landing).**

The development of specific guidelines for the implementation of LVPs at an aerodrome is not within the scope of this document; aerodrome operators should refer to the relevant documentation[28].

Nonetheless, it is important to note that development and implementation of all phases of LVPs at an aerodrome (Preparation, Operation and Termination) is a challenging process which requires the fulfilment of numerous criteria related to the aerodrome infrastructure and equipment as well as specific documented procedures.

[28] For example, Chapter 7 of *ICAO EUR Doc 013 - European Guidance Material on All Weather Operations at Aerodromes* provides consolidated guidance related to the initial establishment and implementation of Low Visibility Procedures.

For example, the following is a non-exhaustive list of aerodrome requirements for the implementation of LVPs: compliant runway environment, power supply redundancy for resilience, enhanced surveillance and maintenance of visual and non-visual aids such as aerodrome lighting and MET equipment, restrictions to taxying routes and ground aircraft movements, protection of ILS Critical and Sensitive Areas, presence of a surveillance display system (SMR or A-SMGCS), specific staff training (ATC, drivers), etc.

Additionally, meeting these requirements will call for the cooperative efforts of many aerodrome stakeholders, including but not limited to: the aerodrome operator, airport security agencies, ground support providers and major operators, technical and engineering section(s) responsible for establishment and/or maintenance of visual and non-visual aids and power supplies, meteorological services, air traffic services, rescue and fire-fighting services, aeronautical information services and competent authorities.

## 6.4 Instrument Approach Procedures (IAPs)

**In order to accommodate EFVS operations, aerodromes must be served by straight-in 3D IAPs designed in accordance with PANS-OPS Volume II (ICAO Doc 8168) or equivalent criteria** (e.g. US TERPS, ICAO Doc 9905 'RNP AR Procedure Design Manual'). This includes operations based on SBAS down to LP (if flown as CDFA) or LPV minima.

However, no modification to IAPs should be necessary. This is because EFVS operations exploit the visual advantage provided by the EFVS to extend the visual segment of an instrument approach. An EFVS cannot be used to extend the instrument segment of an approach and thus the DA/H for EFVS operations is always the same as the DA/H established for the approach conducted without EFVS.

According to RD 3, after the 27th of January 2022 Flight Procedure Design activities, including design of airspace structures, will only be provided by a certified service provider organisation. Therefore, **the design of Instrument Approach Procedures (IAPs) which may accommodate EFVS operations shall be carried out by FPD providers.**

### 6.4.1 Final Approach Segment (FAS) requirements

IAPs may have the final approach course significantly offset from the centreline of the runway and still be considered 'straight-in' approaches. Additionally, many approach procedures with an offset final approach course are constructed so that the final approach course crosses the extended runway centreline significantly before the threshold.

Depending on the construction of a particular procedure, the wind conditions, and the available field of view of a specific EFVS installation, the required visual references may not come into view before the aircraft reaches the DA/H.

Due to this, the final approach track of IAPs for which operational credit is sought through the use of EFVS equipment must meet the following restrictions:

- **For EFVS 200 operations: final approach track is offset by a maximum of 3 degrees from the extended centreline of the runway.**
- **For EFVS Approach and EFVS Landing operations: final approach track is offset by a maximum of 3 degrees, unless a different value is stated in the AFM.**

**FPD service providers should take these requirements into account to ensure that the designed approaches can safely accommodate EFVS operations.**

### 6.4.2 Obstacle environment

As mentioned throughout this document, EFVS operations allow aircraft to descend below the IAP's published DA/H without natural visual reference. This is achieved using electronic means that provide the flight crew with a real-time sensor-derived or enhanced display of the external scene topography, which allows an extension of the visual segment of the approach.

Depending on the specific performance capabilities of the EFVS installation, certain obstacles that could be avoided with natural vision may not be obvious to the crew using the EFVS display and, therefore, **the approach procedure used must ensure that obstacle clearance is provided throughout the whole visual segment**.

As indicated previously (see Section 6.1), **adequate obstacle protection in the visual segment may be ensured by the establishment of an Obstacle Free Zone (OFZ)**. **If an OFZ is not established or if the DH for the approach is above 250 ft, then the Visual Segment Surface (VSS) must be free of penetrations**[29].

It is also important to highlight that, during EFVS operations, pilots will rely on the EFVS display below the procedure's DA/H and will have to acquire natural visual reference at some point prior to touchdown (except in the case of EFVS Landing operations). Due to this, EFVS operations may present a higher probability of initiating a go-around below the DA/H (balked landing) than standard operations.

Therefore, **it is important to confirm that obstacle clearance**[30] **will be available in the event of a go-around initiated below the DA/H (balked landing). This may be ensured by the establishment of an Obstacle Free Zone (OFZ).**

If no OFZ is established, aircraft operators should carry out an analysis of the aircraft performance for the missed approach and propose a procedure for balked landing.

[29] Obstacles of a height less than 50 ft above the threshold may be disregarded when assessing the VSS.

[30] The obstacle clearance required in the missed approach phase for EFVS operations should be no less than for the same approach flown without EFVS.

Depending on the environment characteristics, aircraft operators may need to implement alternative operational procedures to ensure the required obstacle clearance, for example:

- Following a departure procedure for the landing runway. Consideration must be given to the fact that aircraft must be able to comply with the required climb gradients for the instrument departure.
- Establishing a minimum height before which the aircraft must initiate a go-around if adequate visual reference is not available through natural vision. The established height must be determined to ensure obstacle clearance during the missed approach. For example, an aircraft carrying out an EFVS 200 operation may need to establish a minimum height of 230 ft (instead of 200 ft).
- Developing alternative lateral profiles for go-arounds initiated below the DA/H.
- Imposing a mass restriction so that aircraft can achieve a climb performance which allows them to clear missed approach obstacles.

## 6.5 Provision of aeronautical data to AIS

In accordance with point ADR.OPS.A.005 - Aerodrome Data of RD 2 (Subpart A of Annex IV), **aerodrome operators are required to determine, document and maintain data relevant to the aerodrome and available services and to provide this data to the users and the relevant air traffic services and aeronautical information services providers**.

Among the data to be provided by the aerodrome operator to the aeronautical information service (AIS) provider, **the following data is of specific importance to ensure a successful implementation of EFVS operations**:

- **Information on the aerodrome lighting system parts where light units are light emitting diode (LED) lights (ADR.OPS.A.070).**

  EFVS technology may rely on the infrared heat signature provided by incandescent lights and their replacement with LED lights might restrict the use of EFVS. The information is important to aircraft operators to assess the suitability of the runway to conduct EFVS operations.

  It is worth highlighting that the latest generation of EFVS does not rely on infrared sensors only, consisting instead of a combination of sensors (some of them with a high sensitivity in the visual spectrum) managed with fusion algorithms. This type of EFVS has demonstrated the capability to perceive LED lights.

- **Charts relevant to the aerodrome (ADR.OPS.A.075).**

  Information on charts is included in Commission Regulation (EU) 2017/373.

- **Information on the radio navigation and landing aids associated with the instrument approach and the terminal area procedures at the aerodrome (ADR.OPS.A.080)**.

  The information to be included shall be (as appropriate): type of aids; magnetic variation; type of supported operation; facility classification and designation; station declination; identification; frequency, channel number, service provider and reference path identifier; hours of operation; geographical coordinates; elevation of significant points (e.g. DME antennas, GBAS reference point, SBAS LTP/FTP).

- **Information on visual segment surface (VSS) penetration, including procedure and procedure minima affected (ADR.OPS.A.085).**

  Information to be provided to the AIS provider on VSS penetrations should clearly indicate the name of the affected procedure and the procedure minima affected and be published under AD 2.25. Additionally, information regarding the obstacles that penetrate the VSS should be provided to be published under 'AD 2.10 Aerodrome obstacles'.

**In any case, the provision of all this information to the AIS shall be coordinated by the aerodrome operator with the appropriate stakeholders (such as ATS or FPD service providers) in accordance with the national or local aerodrome / ANSP organisation.**

**The AIS will then be responsible for publication of the information in the AIP in accordance with the provisions concerning the content and structure of the AIP, set out in Annex VI (Part-AIS) to Regulation (EU) 2017/373.**

# 7 Guidelines for aircraft manufacturers / design organisations

**Tasks associated with the aircraft modification, upgrade and airworthiness re-certification can be subdivided as follows**. To facilitate traceability between these steps and the corresponding regulation (Certification Specifications and Acceptable Means of Compliance for All-weather Operations – CS-AWO Issue 2), references to the applicable Certification Specifications are included for each step (as applicable).

- **Step 1.1** — **Establishing the Certifying Authority**
- **Step 1.2** — **Agreeing the certification basis**
- **Step 1.3** — **Agreeing the compliance summary**
- **Step 1.4** — **Timeline of deliverables**
- **Step 1.5** — **System and installation design and engineering descriptions**
  - CS.AWO.A.EFVS.101/102/103/104/105/106/111
- **Step 1.6** — **Safety assessment**
  - CS.AWO.A.EFVS.107/108
- **Step 1.7** — **Performance demonstration**
  - CS.AWO.A.EFVS.109/110
- **Step 1.8** — **Documentation of demonstrated capability / limitations in the AFM**
  - CS.AWO.A.EFVS.112
- **Step 1.9** — **Delivery and approval of certification data package**

Figure 16: Sub-steps for aircraft modification, upgrade, and airworthiness re-certification

### 7.1.1 Establishing the certifying authority

Establishing the certification authority (the authority from here on out) will **determine with whom the certification/compliance basis for the aircraft changes and subsequent re-certification must be discussed and agreed**. “Establishing” the authority typically involves contacting the authority and agreeing the specific project to fall under the authority’s jurisdiction and competence. In response, the authority will open a dossier on the specific project and assign a timeline to its completion, based on available resources and competences. This timeline will become the driver and reference in the remainder of the work.

Typically and by default, the authority is the National Competent Authority (NCA) of the country where the aircraft operator is legally vested or where the aircraft in question is registered. But exceptions occur, for example where the authority requests delegation of the project to another national authority, due to workload restrictions, or for reasons of specific competence.

In such a case, the agreement on a project dossier and timeline may be complicated by the fact the delegated authority will work under priorities assigned by dossiers from its specific national obligation. The bottom line is that establishing the certifying authority must be undertaken early in the process, since timing of all other tasks may become contingent on the timeslots that can be agreed.

### 7.1.2 Agreeing the certification basis

A discussion is undertaken with the authority regarding the certification basis for the modifications in question. **Due to the fact that EFVS technology is used in support of all-weather operations, criteria set forth in EASA's Certification Specifications for All-Weather Operations (CS-AWO Issue 2) will be considered as a basis for airworthiness approval.**

**Implemented EFVS functions will also require airworthiness approval per the criteria set forth in the corresponding European Aviation Safety Agency (EASA) Certification Specification (CS)**[31].

The following is a non-exhaustive list of CSs in CS-25 that could be affected by an EFVS installation. Applicants for normal-category aeroplanes (CS-23) can use the list below to establish whether the equivalent aspects in CS-23 are affected and address them accordingly.

| Certification Specification | Description |
|---|---|
| 25.251 | Vibration and buffeting |
| 25.301 | Loads |
| 25.303 | Factor of safety |
| 25.307 | Proof of structure |
| 25.561/25.562(c)(5) | Emergency landing conditions; head injury criterion (HIC) |
| 25.571 | Damage-tolerance and fatigue evaluation of structure |
| 25.581 | Lightning protection |
| 25.601 | Design and Construction - General |
| 25.603 | Materials |
| 25.605 | Fabrication methods |
| 25.609 | Protection of structure |
| 25.611 | Accessibility provisions |

[31] Large Aeroplanes: CS-25; Normal, Utility, Aerobatic, and Commuter Category Aeroplanes: CS-23 http://www.easa.europa.eu/agency-measures/certification-specifications.php

| Certification Specification | Description |
|---|---|
| 25.613 | Material strength properties and material design values |
| 25.619 | Special factors |
| 25.625 | Fitting factors |
| 25.629(d)(8) | Aeroelastic stability |
| 25.631 | Bird strike damage |
| 25.771 | Pilot compartment |
| 25.773 | Pilot compartment view |
| 25.777 | Cockpit controls |
| 25.1301 | Function and installation |
| 25.1309 | Equip, systems, and installations |
| 25.1316 | Electrical and electronic system lightning protection |
| 23.1308 and 25.1317 | High-intensity radiated fields (HIRF) protection |
| 25.1321 | Arrangement and visibility |
| 25.1322 | Flight crew alerting |
| 25.1323 | Airspeed indicating systems |
| 25.1329 | Flight guidance system |
| 25.1353 | Electrical equipment and installations |
| 25.1357 | Circuit protective devices |
| 25.1381 | Instrument lights |
| 25.1419 | Ice protection |
| 25.1431(a)(c) | Electronic equipment |
| 25.1459(e) | Flight data recorders |
| 25.1501 | Operating limitations and information; General |
| 25.1523 | Minimum flight crew |
| 25.1525 | Kinds of operation |
| 25.1529 | Instructions for Continued Airworthiness |
| 25.1581 | Aeroplane flight manual - General |
| 25.1583 | Operating limitations |
| 25.1585 | Operating procedures |

Table 5: Certification Specifications from CS-25 affected by an EFVS installation

There may be other certification specifications declared applicable, subject to discussion with the authority.

The authority may propose other certification requirements for the specific category of aircraft and/or operation, based on its understanding of the scope of the change. But the discussion will lead to a level of agreement which decides the certification basis, so that compliance with those requirements will be what it takes to achieve an installation that will be approvable from the airworthiness perspective.

This agreement will be documented, so that there is an undisputable compliance basis, applicable to the specific EFVS function, the aircraft type in question and their operation.

### 7.1.3 Agreeing the compliance summary

Once the certification basis has been agreed, the next discussion concerns the **means of demonstrating compliance with the certification basis.**

As a result of this discussion, the applicant (aircraft operator) and the authority will agree on the data package, methods and measurements that should become the acceptable means for demonstrating compliance with the previously agreed upon certification requirements.

The final agreement on materials and data to be submitted is captured and summarised in a document ('checklist') to be used in the demonstration campaign for verifying that all agreed materials and data ('deliverables') are provided.

### 7.1.4 Timeline of deliverables

**A timeline will be agreed** for those deliverables, so that both the applicant and the authority may schedule the necessary resources.

### 7.1.5 System and installation design and engineering descriptions

Typically, the **data to be submitted in demonstrating compliance will comprise a design data package showing the aircraft installation (or any revisions)**. Particularly the electrical installation (wire sizes, electrical circuit breakers, racking and cooling, etc.) in order to provide evidence of proper electrical loading (normal bus and battery), wire sizes and electrical currents to be expected (with the aim of ensuring wire protection), cooling fan performance (with a view to ensuring adequate equipment operation and thermal protections), and mechanical installation (with a view to addressing vibration, rack loading, weight distribution, etc.)

**Data substantiating the flight deck interfaces, annunciations, crew interactions, labels and placards will also have to be included**. Particular attention should be placed on absence of interference, in the sense that any newly installed or modified equipment and/or wiring must be analysed and demonstrated to not cause radio interference (radiated and/or conducted) in excess of what was the case before the modification.

A typical set of engineering files as a result of the design may be:

- Engineering descriptions and associated job cards.
- Drawings.
- Wires list.
- Installation kit parts list(s) (if any).
- Installation part list (if any).

Equipment installed will have to conform to aviation standards in order to meet the requirement of the EASA CS. The authority may call for additional specific information to be comprised in the data package regarding the applied standards.

In practice, the EFVS capability requires function (software) changes primarily downstream to the display systems (annunciations, possibly deviation pointer symbology), as well as any associated input/output changes to the associated systems.

In terms of actual hardware, racking and wiring changes, the main elements to be considered will be the forward-looking imaging sensor, the computer unit and the HUD (or equivalent) display.

A detailed upfront survey of the existing aircraft installations will be part of the effort to validate the original data package and to assure that the assumptions in the assessment of the certification requirements and the design of the change orders are correct.

### 7.1.6 Safety assessment

The normal operation of the installed EFVS must not adversely affect, or be adversely affected by, other aircraft systems. Furthermore, the hazard effects of any malfunction of the EFVS that could adversely affect interfaced equipment or associated systems should be determined and assessed.

Therefore, **to ensure that the required safety level is achieved, a safety assessment of the installed EFVS, considered separately and in conjunction with other relevant installed systems, shall be conducted** to meet the requirements of CS 23.2510 or CS 25.1309, as applicable. Specifically, an aircraft and system level functional hazard assessment (FHA) and system safety assessment (SSA) shall be prepared to determine the hazard level associated with system failure conditions and to determine the minimum required software and hardware design assurance levels (DALs).

The EFVS safety analysis should also consider flight crew factors such as possible alleviating flight crew actions and flight crew workload (in accordance with CS 23.2600 or CS 25.1302).

### 7.1.7 Performance demonstration

In addition to meeting the applicable requirements in regards to system design and engineering (see Section 7.1.5), **the EFVS installation must be able to demonstrate that the proposed system performance criteria, in terms of the visual advantage of the system when low-visibility conditions exist[32], can be achieved**.

The applicable performance criteria to be considered will depend on the intended functions of the EFVS. For example, in the case of EFVS used during approaches the performance evaluations should include demonstrations of approaches, missed approaches, failure conditions and cross wind conditions. Performance should also be demonstrated at the lateral and vertical limits for the type of approach (e.g. PA, APV, NPA flown as CDFA with vertical path guidance calculated by on-board equipment) for which operational credit is being sought.

It is also important to highlight that performance criteria will vary depending on the type of EFVS system to be certified: EFVS-A or EFVS-L; with more stringent requirements established for EFVS-L. For example, EFVS-L must be capable of providing flare prompt or flare guidance and displaying height above the runway using a radio altimeter (or other device capable of providing equivalent performance).

The applicant should demonstrate required performance compliance through flight test using an aircraft that is fully representative for the purpose of the test in terms of flight deck geometry, instrumentation, alerts, indications, and controls (in the air or on the ground). In addition, the applicant should use any of these three general verification methods to supplement flight testing:

- Analysis: demonstrate compliance using an engineering analysis.
- Laboratory test: demonstrate compliance using an engineering bench representative of the final EFVS being certified.
- Simulation: demonstrate compliance using a flight simulator.

Nevertheless, the individual verification methods that are to be used should be specified in the certification plan to be agreed by the relevant certifying authority.

### 7.1.8 Documentation of demonstrated capability / limitations in the AFM

[32] EUROCAE ED-291 Test Procedures for Quantified Visual Advantage Issue 1 contains an acceptable methodology for determining and quantifying the visual advantage for an EFVS-A or EFVS-L, and should be used as the basis for the flight test.

**The demonstrated capability and any specific EFVS limitations shall be included within the relevant Aircraft Flight Manual (AFM) section**. As stated in AMC AWO.A.EFVS.112 of EASA CS-AWO (Certification Specifications and Acceptable Means of Compliance for All-weather Operations) Issue 2:

**AMC AWO.A.EFVS.112 EFVS documentation**

The following minimum information should be provided in the AFM:

(a) the approved limits established as a result of consideration of any other factor that the certification has shown to be appropriate;
(b) the normal and abnormal procedures, including airspeeds;
(c) the minimum required equipment;
(d) any additional aeroplane performance limitations;
(e) if appropriate, the type of approaches and the xLS navigation means (facilities external to the aircraft) and associated limitations (if any) which have been used as the basis for certification;
(f) any related limitations and/or assumptions on the runway or aerodrome conditions that are affected by the use of the EFVS; for EFVS-L, this should also consider:
    (1) runway elevation,
    (2) approach path slope,
    (3) touchdown zone slope,
    (4) ground profile under the approach path;
(g) the type and mode of operation/configuration of the approach lights (i.e. LED or incandescent) that have been used or assumed during the certification demonstration of the EFVS;
(h) the demonstrated performance in accordance with CS AWO.A.EFVS.109;
(i) wind speed limitations that are affected by the use of the EFVS;
(j) any applicable assumptions that have been made during the certification demonstration of the EFVS.

### 7.1.9 Delivery and approval of certification data package

Upon completion of the previous tasks, **the results should be summarised in a concluding report consistent with the compliance summary and timeline agreed upon and delivered to the authority**. **Based on the provided information, the authority will make the decision to approve the changes and certify the EFVS equipment and installation**, or to request additional information until it is fully satisfied that the applicable requirements are met.

It should be noted that changes made to implement the EFVS capability in the aircraft installation and its certification are supplementary to its type certificate. The changes are classified as a major change and can be implemented in the form of a Supplemental Type Certificate (STC) or a Service Bulletin (SB):

- Supplemental Type Certificate (STC): Any additions, omissions or alterations to the aircraft's certified layout, built-in equipment, airframe, and engines, initiated by any party other than the type certificate holder, need an approved supplementary ("supplemental" in FAA terminology) type certificate, or STC. STCs are applied due to either the type certificate holder's refusal (frequently due to economics) or its inability to meet some owners' requirements. STCs are frequently raised for out-of-production aircraft types conversions to fit new roles. Before STCs are issued, procedures similar to type certificate changes for new variants are followed, likely including thorough flight tests. STCs belong to the STC holder and are generally more restrictive than type certificate changes.
- Service Bulletin (SB): With increasing in-service experience, the type certificate holder may find ways to improve the original design resulting in either lower maintenance costs or increased performance. These improvements (normally involving some alterations) are suggested through service bulletins to their customers as optional (and may be extra cost) items. The customers may exercise their discretion as to whether to incorporate the bulletins. Sometimes SBs can become mandated by relevant Airworthiness Directives (ADs).

## Annex A: Reference documents

| RD | Title |
|---|---|
| RD 1. | EASA Easy Access Rules (EAR)[33] for Air Operations (Regulation (EU) 965/2012), as amended by Commission Implementing Regulation (EU) 2021/2237, Decision 2022/012/R and Decision 2022/014/R. |
| RD 2. | EASA Easy Access Rules (EAR)[33] for Aerodromes (Regulation (EU) 139/2014), as amended by Commission Delegated Regulation (EU) 2022/208 and Decision 2022/013/R. |
| RD 3. | EASA Easy Access Rules (EAR)[33] for Air Traffic Management/Air Navigation Services (Regulation (EU) 2017/373), as amended by Commission Implementing Regulation (EU) 2022/938 and Decision 2022/015/R. |
| RD 4. | EASA Easy Access Rules (EAR)[33] for Aircrew (Regulation (EU) 1178/2011), as amended by Commission Implementing Regulation (EU) 2021/2227 and Decision 2022/014/R. |
| RD 5. | EASA Easy Access Rules (EAR)[33] for the Certification Specifications for All-Weather Operations, as updated by Decision 2022/007/R (EAR for CS-AWO Issue 2). |
| RD 6. | EASA Easy Access Rules (EAR)[33] for Airborne Communications, Navigation and Surveillance (CS-ACNS). |
| RD 7. | EASA Easy Access Rules (EAR)[33] for European Technical Standard Orders (CS-ETSO). |
| RD 8. | EASA Opinion No 03/2022 - Amendments to the aeronautical data catalogue and the aeronautical information publication structure and content. |
| RD 9. | EGNOS Safety of Life Service Definition Document (EGNOS SoL SDD). |
| RD 10. | ICAO EUR Doc 013 - European Guidance Material on All Weather Operations at Aerodromes. |
| RD 11. | ICAO Doc 8168 - Procedures for Air Navigation Services - Aircraft Operations (PANS-OPS) |
| RD 12. | EUROCAE ED-179B. Minimum Aviation System Performance Standards (MASPS) for Enhanced Vision Systems, Synthetic Vision Systems, Combined Vision Systems and Enhanced Flight Vision Systems. |
| RD 13. | EUROCAE ED-291. Test Procedures for Quantified Visual Advantage. |

Table 6: Reference documents

[33] Although Easy Access Rules are not an official publication by EASA, they have been considered as reference documentation as they contain the officially published regulations, certification specifications and the related AMC & GM adopted so far.

## Annex B: Acronyms and abbreviations

| Acronym | Definition |
|---|---|
| 2D | Two-dimensional |
| 3D | Three-dimensional |
| AD | Airworthiness Directive |
| AD / ADR | Aerodrome |
| AFM | Aircraft Flight Manual |
| AIP | Aeronautical Information Publication |
| AIS | Aeronautical Information Service |
| ALS | Approach Lighting System |
| AMC | Acceptable Means of Compliance |
| AMP | Aircraft Maintenance Program |
| ANS | Air Navigation Service |
| ANSP | Air Navigation Service Provider |
| AOC | Air Operator Certificate |
| APV | Approach with Vertical guidance |
| ATM | Air Traffic Management |
| ATO | Approved Training Organisation |
| AWO | All Weather Operations |
| CAT | Commercial Air Transport operations |
| CAT I/II/III | Category I/II/III |
| CDFA | Continuous Descent Final Approach |
| CMV | Converted Meteorological Visibility |
| CORSIA | Carbon Offsetting and Reduction Scheme for International Aviation |
| CS | Certification Specifications |
| CVS | Combined Vision System |
| DME | Distance Measurement Equipment |
| DA | Decision Altitude |
| DAL | Design Assurance Level |
| DH | Decision Height |
| EASA | European Aviation Safety Agency |
| EFVS | Enhanced Flight Vision System |

| Acronym | Definition |
|---|---|
| EFVS-A | Enhanced Flight Vision System used for Approach |
| EFVS-L | Enhanced Flight Vision System used for Landing |
| EGNOS | European Geostationary Navigation Overlay Service |
| ETSO | European Technical Standard Orders |
| EU | European Union |
| EU ETS | EU Emissions Trading System |
| EUROCAE | European Organization for Civil Aviation Equipment |
| EVS | Enhanced Vision System |
| FAA | Federal Aviation Administration |
| FAS | Final Approach Segment |
| FATO | Final Approach and Take-Off area |
| FCL | Flight Crew Licensing |
| FHA | Functional Hazard Assessment |
| FMS | Flight Management System |
| FOV | Field Of View |
| FPV | Flight Path Vector |
| FSTD | Flight Simulation Training Devices |
| FTP | Fictitious Threshold Point |
| GBAS | Ground Based Augmentation System |
| GM | Guidance Material |
| GNSS | Global Navigation Satellite System |
| GLS | GBAS Landing System |
| HUD | Head Up Display |
| IAP | Instrument Approach Procedure |
| ICA | Instructions for Continued Airworthiness |
| ICAO | International Civil Aviation Organization |
| IFR | Instrument Flight Rules |
| ILS | Instrument Landing System |
| IR | Implementing Rule |
| LED | Light-Emitting Diode |
| LOA | Letter of Authorisation |
| LP | Localiser Performance |

| Acronym | Definition |
|---|---|
| LPV | Localiser Performance with Vertical guidance |
| LSAA | Landing System Assessment Area. |
| LTP | Landing Threshold Point |
| LVO | Low Visibility Operations |
| LVP | Low Visibility Procedures |
| MASPS | Minimum Aviation System Performance Standard |
| MDA | Minimum Descent Altitude |
| MDH | Minimum Descent Height |
| MEL | Minimum Equipment List |
| MFD | Multi-Function Display |
| MLS | Microwave Landing System |
| NCA | National Competent Authority |
| NCC | Non-Commercial operations with Complex motor-powered aircraft |
| NCO | Non-Commercial ops. with Other than complex motor-powered aircraft |
| NPA | Non Precision Approach |
| NPA | Notice of Proposed Amendment |
| NVG | Night Vision Goggles |
| NVIS | Night Vision Imaging System |
| PA | Precision Approach |
| PANS-OPS | Procedures for Air Navigation Services – Aircraft Operations |
| PBN | Performance Based Navigation |
| PBN-IR | PBN – Implementing Rule |
| PFD | Primary Flight Display |
| POH | Pilots Operating Handbook |
| PTO | Pilot Training Organisation |
| RD | Reference Document |
| RMT | Rule Making Task |
| RNP AR | Required Navigation Performance Authorisation Required |
| RWY | Runway |
| SB | Service Bulletin |
| SBAS | Satellite Based Augmentation System |
| SDD | Service Definition Document |

| Acronym | Definition |
|---|---|
| SMGCS | Surface Movement Guidance and Control System |
| SMR | Surface Movement Radar |
| SoL | Safety of Life |
| SPA | Specific Approval |
| SPO | Specialised Operations |
| SSA | System Safety Assessment |
| STC | Supplemental Type Certificate |
| SVGS | Synthetic Vision Guidance System |
| SVS | Synthetic Vision System |
| TC | Type Certificate |
| TDZ | Touchdown Zone |
| TDZE | Touchdown Zone Elevation |
| THR | Threshold |
| THRE | Threshold Elevation |
| US TERPS | United States Standard for Terminal Instrument Procedures |
| VSS | Visual Segment Surface |

Table 7: Acronyms and abbreviations

## Annex C: Definitions

The following definitions are applicable throughout this document.

**Adequate aerodrome**, as per Regulation (EU) 965/2012 – Annex I:
'Adequate aerodrome' means an aerodrome on which the aircraft can be operated, taking account of the applicable performance requirements and runway characteristics.

**Aerodrome operating minima**, as per Regulation (EU) 965/2012 – Annex I:
'Aerodrome operating minima' means the limits of usability of an aerodrome for:

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

b) landing in 2D instrument approach operations, expressed in terms of visibility and/or RVR, minimum descent altitude/height (MDA/H) and, if necessary, ceiling; and

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

**Continuous Descent Final Approach (CDFA)**, as per Regulation (EU) 965/2012 – Annex I:
'Continuous descent final approach (CDFA)' means a technique, consistent with stabilised approach procedures, for flying the final approach segment (FAS) of an instrument non-precision approach (NPA) procedure as a continuous descent, without level-off, from an altitude/height at or above the final approach fix altitude/height:

a) for straight-in approach operations, to a point approximately 15 m (50 ft) above the landing runway threshold or the point where the flare manoeuvre begins; or

b) for circling approach operations, until MDA/H or visual flight manoeuvre altitude/height is reached.

Additionally, as per Regulation (EU) 965/2012 – GM 33 Annex I:
A non-precision approach procedure flown as CDFA with vertical path guidance calculated by on-board equipment is considered to be a 3D instrument approach operation. Depending on the limitations of the equipment and information sources used to generate vertical guidance, it may be necessary for the pilot to cross-check this guidance against other navigational sources during the approach and to ensure that the minimum altitude/height over published step-down fixes is observed. CDFAs with manual calculation of the required rate of descent are considered 2D operations.
**Decision Altitude (DA) or Decision Height (DH)**, as per Regulation (EU) 965/2012 – Annex I:

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

**Enhanced Flight Vision System (EFVS)**, as per Regulation (EU) 965/2012 – Annex I:
'Enhanced flight vision system (EFVS)' is an electronic means to provide the flight crew with a real-time sensor-derived or enhanced display of the external scene topography (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 system; if an EFVS is certified according to the applicable airworthiness requirements and an operator holds the necessary specific approval (when required), then it may be used for EFVS operations and may allow operations with operational credits.

**EFVS operation**, as per Regulation (EU) 965/2012 – Annex I:
'EFVS operation' means an operation in which visibility conditions require an EFVS to be used instead of natural vision in order to perform an approach or landing, identify the required visual references or conduct a roll-out.

**EFVS 200 operation**, as per Regulation (EU) 965/2012 – Annex I:
'EFVS 200 operation' means an operation with an operational credit in which visibility conditions require an EFVS to be used down to 200 ft above the FATO or runway threshold. From that point to land, natural vision is used. The RVR shall not be less than 550 m.

**Enhanced Flight Vision System (EFVS)-Approach (EFVS-A)**, as per Regulation (EU) 965/2012 – GM31 Annex I:
'Enhanced flight vision system (EFVS)-Approach (EFVS-A)' means a system that has been demonstrated to meet the criteria to be used for approach operations from a decision altitude/height (DA/H) or a minimum descent altitude/height (MDA/H) to 100 ft (30 m) threshold elevation while all system components are functioning as intended, but may have failure modes that could result in the loss of EFVS capability. It should be assumed for an EFVS-A that:

a) the pilot will conduct a go-around at or above 100 ft threshold elevation, in the event of an EFVS failure; and

b) descent below 100 ft above the threshold elevation through to touchdown and roll-out should be conducted using natural vision so that any failure of the EFVS does not prevent the pilot from completing the approach and landing.

**Enhanced Flight Vision System (EFVS)-Landing (EFVS-L)**, as per Regulation (EU) 965/2012 – GM31 Annex I:

'Enhanced flight vision system (EFVS)-Landing (EFVS-L)' means a system that has been demonstrated to meet the criteria to be used for approach and landing operations that rely on sufficient visibility conditions to enable unaided roll-out and to mitigate for loss of EFVS function.

**Enhanced Vision System (EVS)**, as per Regulation (EU) 965/2012 – Annex I:
'Enhanced vision system (EVS)' is an electronic means to provide the flight crew with a real-time image of the actual external scene topography (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.

**Final Approach and Take-Off Area (FATO)**, as per Regulation (EU) 965/2012 – Annex I:
'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)**, as per Regulation (EU) 965/2012 – Annex I:
'Final approach segment (FAS)' means that segment of an instrument approach procedure (IAP) in which alignment and descent for landing are accomplished.

**Go-around**, as per Regulation (EU) 965/2012 – Annex I:
'Go-around' means a transition from an approach operation to a stabilised climb. This includes manoeuvres conducted at or above the MDA/H or DA/H, or below the DA/H (balked landings).

**Head-up Display (HUD) or equivalent display system**, as per Regulation (EU) 965/2012 – GM31 Annex I:
'Head-up display (HUD) or equivalent display system' means a display system which presents flight information to the pilot's forward external field of view (FOV), and which does not significantly restrict the external view.

**Instrument Approach Operation**, as per Regulation (EU) 965/2012 – Annex I:
'Instrument approach operation' means an approach and landing using instruments for navigation guidance based on an instrument approach procedure (IAP). There are two methods for executing instrument approach operations:

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

b) a three-dimensional (3D) instrument approach operation, using both lateral and vertical navigation guidance.

**Instrument Approach Procedure (IAP)**, as per Regulation (EU) 965/2012 – Annex I:

'Instrument approach procedure (IAP)' 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. IAPs are classified as follows:

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

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

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

**Instrument Runway**, as per Regulation (EU) 139/2014 – Annex I:
'Instrument runway' means one of the following types of runways intended for the operation of aircraft using instrument approach procedures:

1. 'non-precision approach runway': a runway served by visual aids and at least one non-visual aid, intended for landing operations following a type A instrument approach operation;
2. 'precision approach runway, category I': a runway served by visual aids and at least one non-visual aid, intended for landing operations following a type B CAT I instrument approach operation;
3. 'precision approach runway, category II': a runway served by visual aids and at least one non-visual aid, intended for landing operations following a type B CAT II instrument approach operation;
4. 'precision approach runway, category III': a runway served by visual aids and at least one non-visual aid, intended for landing operations following a type B CAT III instrument approach operation.

**Landing System Assessment Area (LSAA)**, as per Regulation (EU) 965/2012 – GM31 Annex I:
'Landing system assessment area (LSAA)' means the part of the runway that extends from the threshold to a distance of 600 m from the threshold.

*Note — Although the landing systems certification criteria use a value greater than 600 m after the threshold to evaluate limit conditions, for the purpose of flight operations assessment a distance of 600 m is the relevant part as landing beyond this point is not expected to occur in day-to-day operations. The LSAA may not necessarily be coincident with the touchdown zone. The touchdown zone is specified in CS-ADR DSN.*

**Low Visibility Procedures (LVPs)**, as per Regulation (EU) 965/2012 – GM31 Annex I:

‘Low-visibility procedures (LVPs)’ means procedures applied by an aerodrome for the purpose of ensuring safety during low-visibility operations (LVOs).

**Low Visibility Operations (LVOs)**, as per Regulation (EU) 965/2012 – Annex I:
‘Low-visibility operations (LVOs)’ means approach or take-off operations on a runway with a runway visual range less than 550 m or with a decision height less than 200 ft.

**Operational Credit**, as per Regulation (EU) 965/2012 – Annex I:
‘Operational credit’ means a credit for operations with an advanced aircraft enabling lower aerodrome operating minima than would normally be established by the operator for a basic aircraft, based upon the performance of advanced aircraft systems utilising the available external infrastructure. Lower operating minima may include a lower decision height/altitude or minimum descent height/altitude, reduced visibility requirements or reduced ground facilities or a combination of these.

**Required visual reference**, as per Regulation (EU) 965/2012 – GM31 Annex I:
‘Required visual reference’ refers to that section of the visual aids or of the approach area which should have been in view for sufficient time for the pilot to have made an assessment of the aircraft position and rate of change of position, in relation to the desired flight path. In the case of a circling approach, the required visual reference is the runway environment.

**Runway Visual Range (RVR)**, as per Regulation (EU) 965/2012 – Annex I:
‘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.

**Satellite-Based Augmentation System (SBAS)**, as per Regulation (EU) 965/2012 – GM31 Annex I:
‘Satellite-based augmentation system (SBAS)’ means a wide coverage augmentation system in which the user receives augmentation information from a satellite-based transmitter. The most common form of SBAS in Europe is the European Geostationary Navigation Overlay Service (EGNOS).

**Switch-over time (light)**, as per Regulation (EU) 139/2014 – CS ADR-DSN.A.002:
‘Switch-over time (light)’ means the time required for the actual intensity of a light measured in a given direction to fall from 50 % and recover to 50 % during a power supply changeover, when the light is being operated at intensities of 25 % or above.

**Synthetic Vision System (SVS)**, as per Regulation (EU) 965/2012 – GM31 Annex I:
‘Synthetic vision system (SVS)' means a system that displays data derived synthetic images of the external scene from the perspective of the flight deck .
**Touchdown Zone (TDZ)**, as per Regulation (EU) 965/2012 – GM31 Annex I:
‘Touchdown zone (TDZ)’ means the portion of a runway, beyond the threshold, where landing aeroplanes are intended to first contact the runway.

**Type A Instrument Approach Operation**, as per Regulation (EU) 965/2012 – Annex I: 'Type A instrument approach operation' means an instrument approach operation with an MDH or a DH at or above 250 ft.

**Type B Instrument Approach Operation**, as per Regulation (EU) 965/2012 – Annex I: 'Type B instrument approach operation' means an operation with a DH below 250 ft. Type B instrument approach operations are categorised as:

a) Category I (CAT I): a DH 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 Operation**, as per Regulation (EU) 965/2012 – Annex I:
'Visual approach operation' means an approach operation by an IFR flight when either a part or all parts of an IAP is (are) not completed and the approach operation is executed with visual reference to terrain.