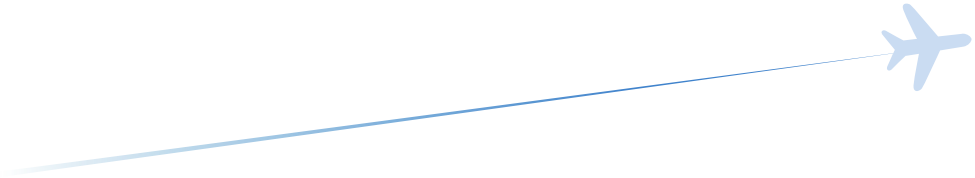

SESAR 2020 VLD AAL2 Demonstration Report – Appendix C and D

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Appendix C Safety Assessment Report (SAR)

C.1 EXE-VLD-V4-100 Safety Assessment Report

C.1.1 Introduction

Considerable local safety assurance was conducted to support the AAL2 VLD. The safety assessment activities were in support of enabling GLS CAT II/CAT I Autoland demonstration and to create necessary evidence required for GLS CAT II demonstration by national regulators. The purpose was to prepare and demonstrate the compliance of this technology solution with the regulatory framework applicable to each ATM/ANS, Ground System, Airworthiness, and Flight Ops domain. This Safety Assessment Report (SAR) summarizes the local safety assessment activities that were carried out in order to generate evidence needed for demonstration of GLS CAT I and GLS CAT II Autoland approach operation enabled by GAST C equipment, to obtain regulatory approvals including System Design Approval of GBAS Ground Station by National Aviation Authority (NAA), EASA aircraft airworthiness approval and airline OPS approval form NAA to fly these operations. This report, therefore, provides the way forward with safety aspects of implementing new operation demonstrations targeting GLS CAT II operation on GAST C equipment. Provided assessment results provide adequate level of safety assurance to obtain the necessary regulatory approval. Both the end-users and appropriate regulatory authorities are involved in the assessment.

Authorities involved in the WP2 safety assessment are:

- European Aviation Safety Agency – EASA,
- German NAA regulator for OPS approval – LBA (Luftfahrt-Bundesamt),
- German NAA regulator for GBAS Ground Station approval – BAF (Bundesaufsichtsamt für Flugsicherung),
- Irish Aviation Authority – IAA.

ANSP/ATC local safety assessment was done by DFS.

Provided safety case supports following documentation to support GLS CAT II/CAT I Autoland demonstrations:

- EASA Airworthiness Approval of Airbus A320fam for GLS CAT II operation,
- BAF System Design Approval of Honeywell SLS-4000 with SBAS option enabled,
- LBA OPS approval of Lufthansa for GLS CAT II operation demo,
- IAA OPS approval of Ryanair for GLS CAT II demonstration,
- Airline Operational Risk Evaluation,
- ANSP local safety assessment (ATC, procedure design, maintenance aspects).

The AAL2 safety case provided in this report is structured as follows:

- GBAS Ground Station Safety Assessment,

- Airborne Safety Assessment,
- Airline Safety Assessment/Operation Risk Evaluation to support GLS CAT II,
- ANSP/ATC local safety assessment.

C.1.2 Airborne Safety Assessment

C.1.2.1 Airbus A320fam Safety Assessment

A simulator session with experimental pilot to support Lufthansa's decision to fly GLS Autoland trials in CAT I or better weather conditions with their technical pilots on A320 family aircraft was organized. This session was considered in the Operational Risk Evaluation for this operation. During demonstrations of GLS Autoland flights, Airbus supported the data analysis of the trials shared by Lufthansa as a part of safety assessment activities.

For the purpose of A320 family aircraft to obtain airworthiness approval for CAT II operation based on GBAS with existing A320 family aircraft, Airbus formally applied to EASA. As part of this application preparation, Airbus produced a Safety Impact Assessment demonstrating the safety impact of GBAS malfunctions (as standardized for GAST C stations) in CAT II operational environment (as already done for CAT I operation) and the ability of the current A320 family avionics to meet CAT II safety objectives based on GBAS. Details are provided in following sections.

a. Standardized GAST C characteristics

i. Accuracy as per ICAO SARPS for GAST C Stations

Following figure describes the standard GAST C accuracy requirements as per ICAO SARPS (Annex 10):

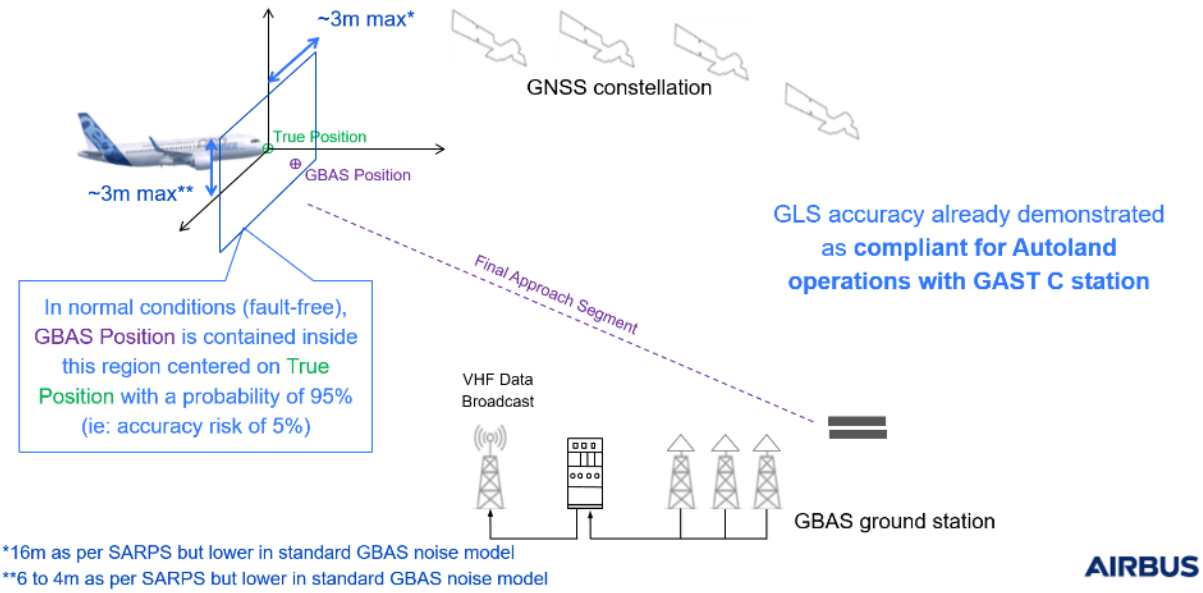


Figure 1 Standard GAST C accuracy requirement

Important note: standard GBAS noise model specifies a distribution of standard deviations to be used for modelling the GAST C noise by a Gaussian distribution. In the very worst case, with a very low

probability, the nominal accuracy at 95% can reach a maximum of around 3m (hence the wording of "~3m max"). However, in most cases, the nominal accuracy at 95% is around 1m.

As Honeywell SLS-4000 Block 2S stations will be demonstrated as compliant to GAST C accuracy requirements, nominal performance of the GLS Autoland function of A320fam is not impacted. This aspect is already certified and available as part of the GLS Autoland CAT I option available on A320fam.

ii. Integrity as per ICAO SARPS for GAST C Stations

Following figures describes the standard GAST C integrity requirements as per ICAO SARPS (Annex 10).

Here below figure describes requirements for Protection Levels:

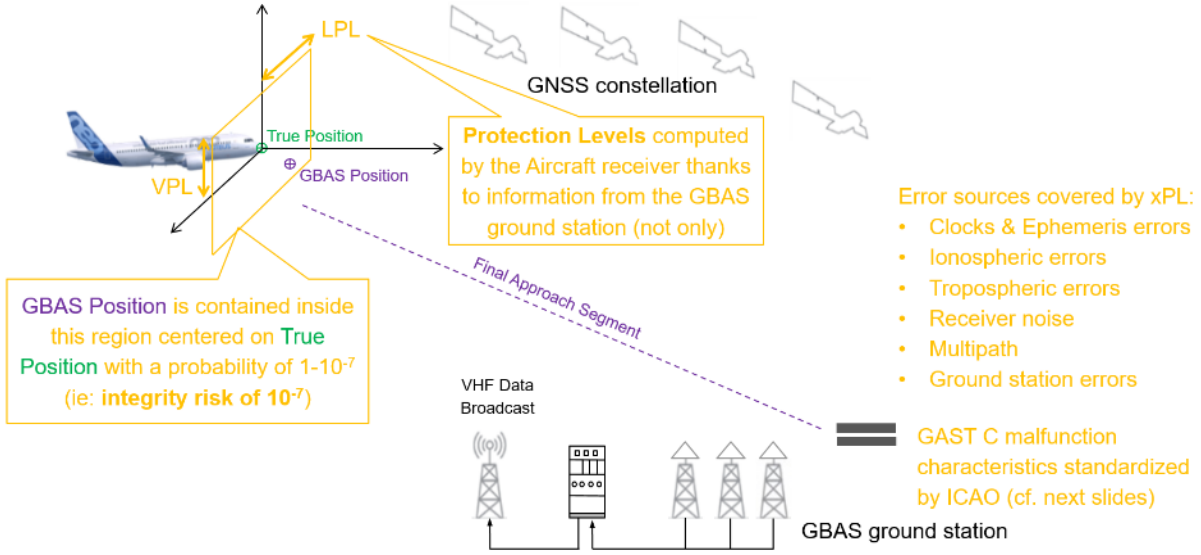


Figure 2 Standard GAST C integrity requirements

Here below figure describes requirements for Alert Limits and Time-To-Alert:

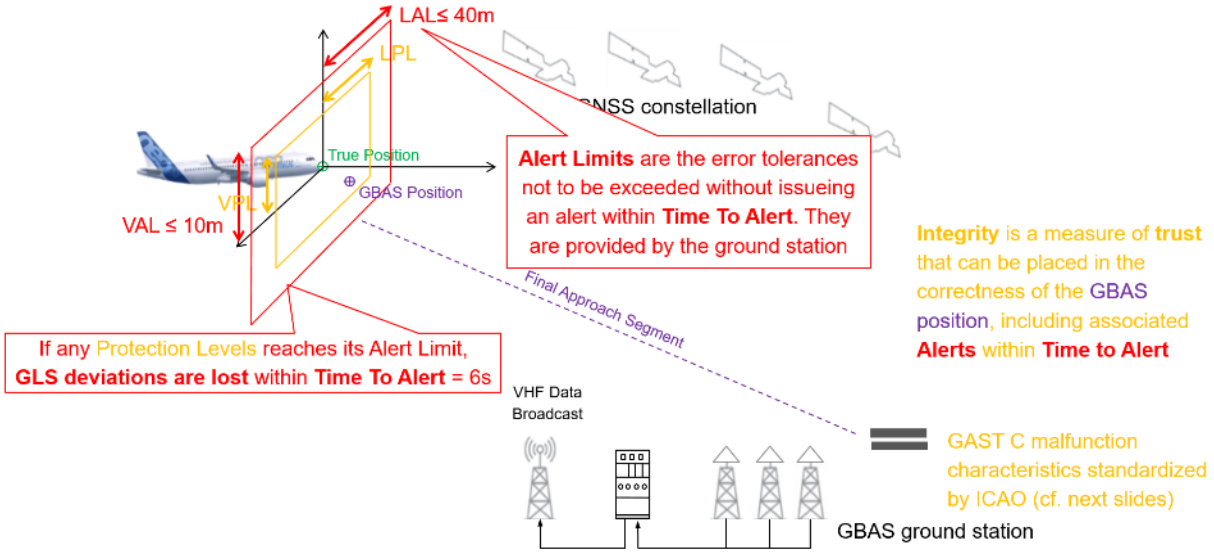


Figure 3 Requirements for Alert Limits and Time to Alert

Here below figure describes how ionospheric uncertainty is embedded in Protection Level computations for GAST C ground stations (as per RTCA DO-253):

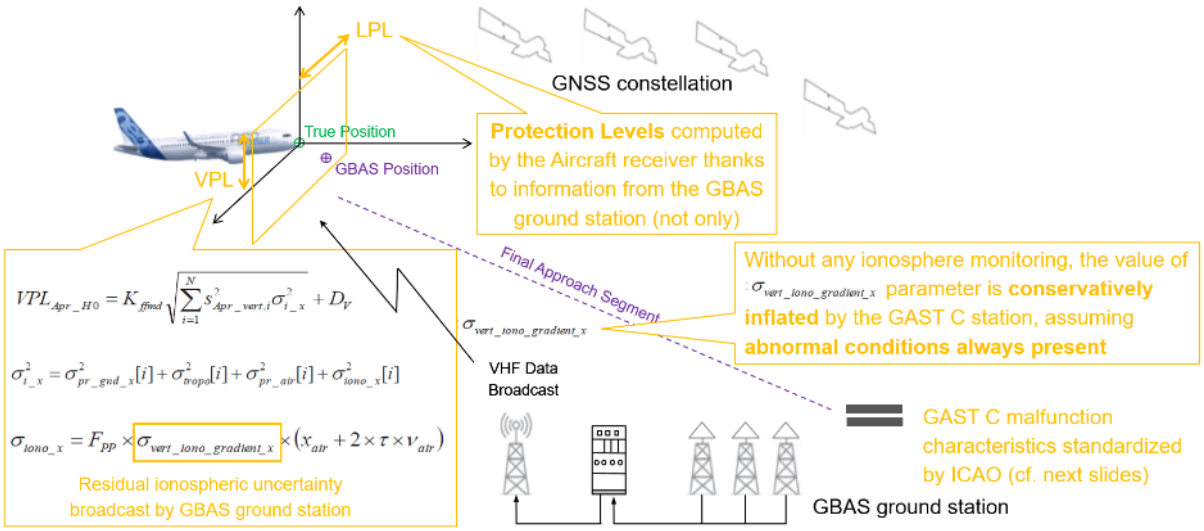


Figure 4 Protection Level computations for GAST C ground station

Note: only H0 hypothesis is described above. For H1 hypothesis, similar mechanisms apply. RTCA DO-253 provides following definitions of H0 and H1 hypothesis:

H_0 Hypothesis – The H_0 hypothesis assumes the situation where no faults are present in the range measurements (includes both the signal and the receiver measurements) used in the ground station to compute the differential corrections.

H_1 Hypothesis – The H_1 hypothesis assumes the situation when a fault is present in one or more range measurement and is caused by one of the reference receivers used in the ground station.

iii. Improvements due to Honeywell SLS-4000 Block 2S

Following figure describes how the Honeywell SLS-4000 Block 2S ground stations take benefit from SBAS signals to deflate Protection Levels while meeting the GAST C integrity requirements defined above.

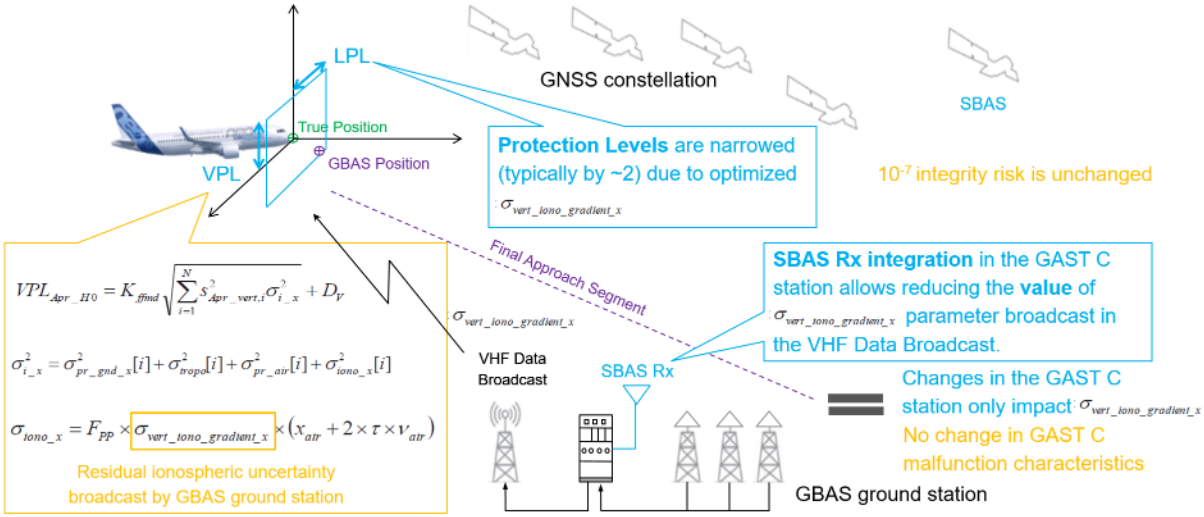


Figure 5 Honeywell SLS-4000 Block 2S ground station description

An additional benefit from this technology is to detect any anomalous ionospheric conditions that could induce an erroneous GBAS position outside Protection Levels (therefore undetected by the system). No probability has been assigned to such events, but with legacy GAST C ground station, margins in the residual ionospheric uncertainty parameter were applied to properly protect the aircraft for CAT 1 operations even in severe anomalous ionospheric conditions.

However, for CAT 2 operations, those margins could be insufficient. The capability of Honeywell SLS-4000 Block 2S ground stations to detect the absence of such severe phenomenon allows to **identify when the GBAS position is properly bounded by Protection Levels as per GAST C integrity requirements**. In such a case, CAT II operations can be envisioned. If not the case (i.e.: in severe anomalous ionospheric conditions), the station warns the ATC that CAT II operations (Service Level B) are now forbidden and "re-inflate" the Protection Levels to properly protect the aircraft for CAT I operations (Service Level A).

Following figure describes the positive impact of the "deflated" Protection Levels on the availability of the GAST C service.

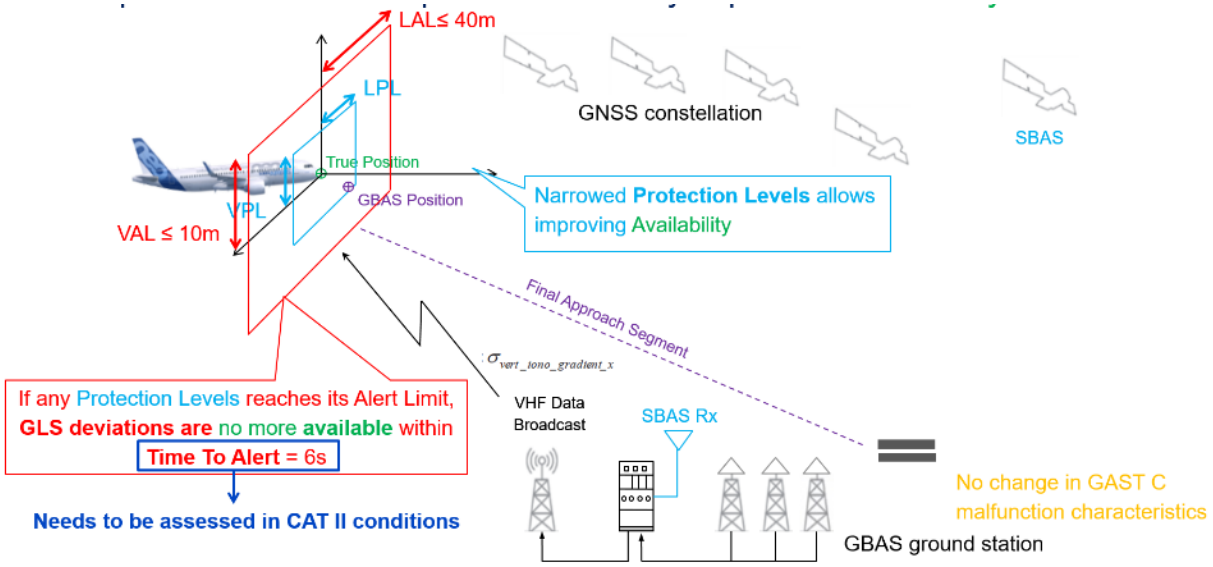


Figure 6 Impact of the "deflated" Protection Levels on the availability of the GAST C service

As shown on the figure above, neither the GAST C "Time to Alert" nor the GAST C malfunctions are modified with the Honeywell SLS-4000 Block IIS ground station. The "Time to Alert" of 6s also differs from standard CAT 1 and CAT 2 ILS (respectively Glide CAT 1: 6s, Glide CAT 2: 2s, Localizer CAT 1: 10s, Localizer CAT 2: 5s).

iv. Standard GAST C malfunctions

Following figures describe standard GAST C malfunctions as per ICAO materials (and draft NPA CS-AWO from EASA) that were considered in the Safety Impact Assessment:

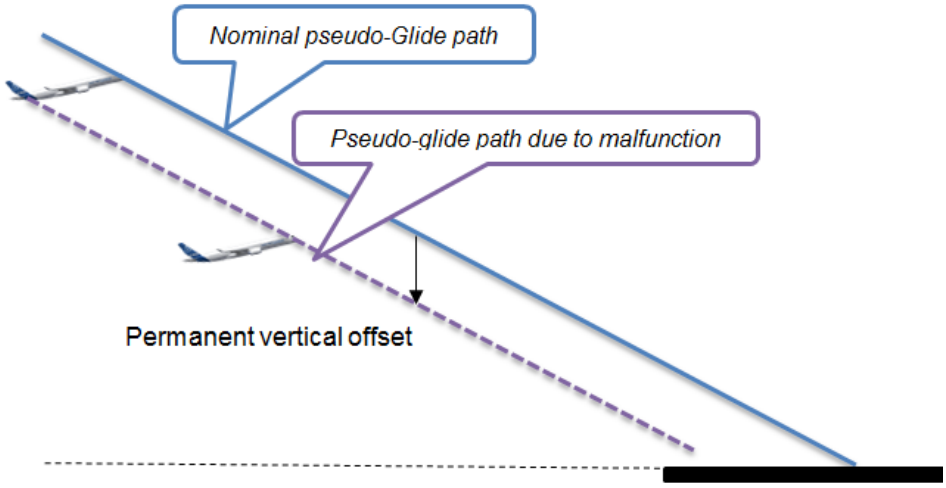


Figure 7 Standard GAST C malfunctions 1

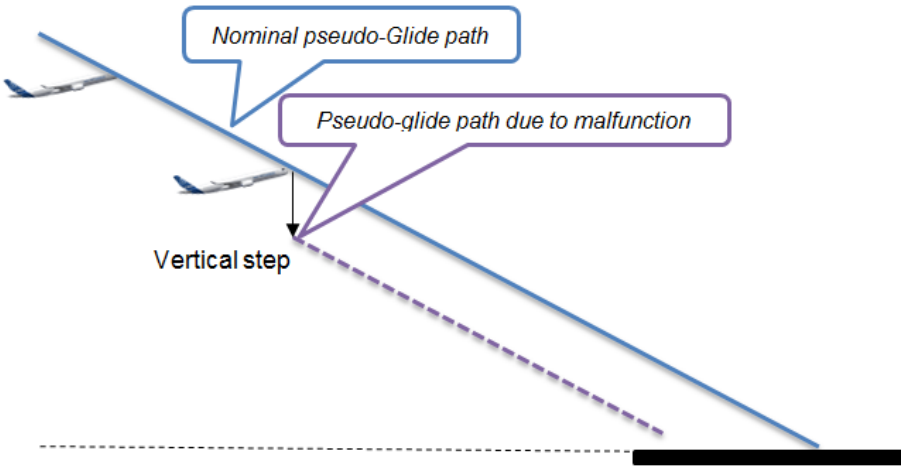


Figure 8 Standard GAST C malfunctions 2

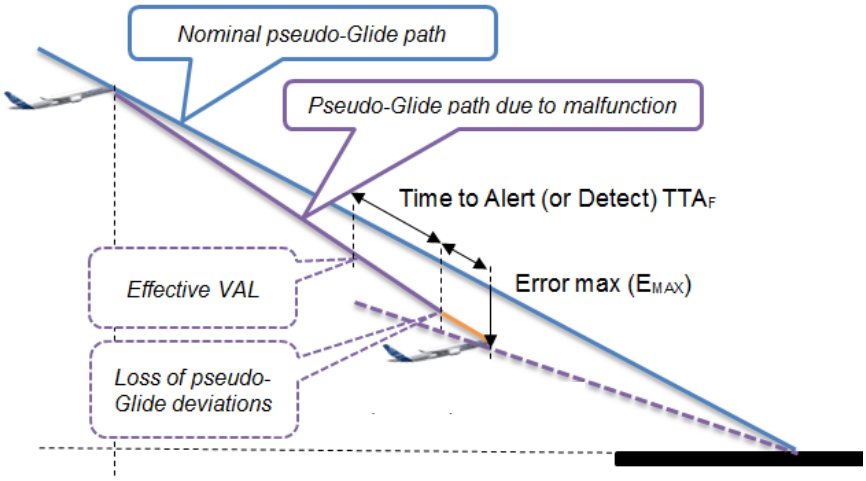


Figure 9 Standard GAST C malfunctions 3

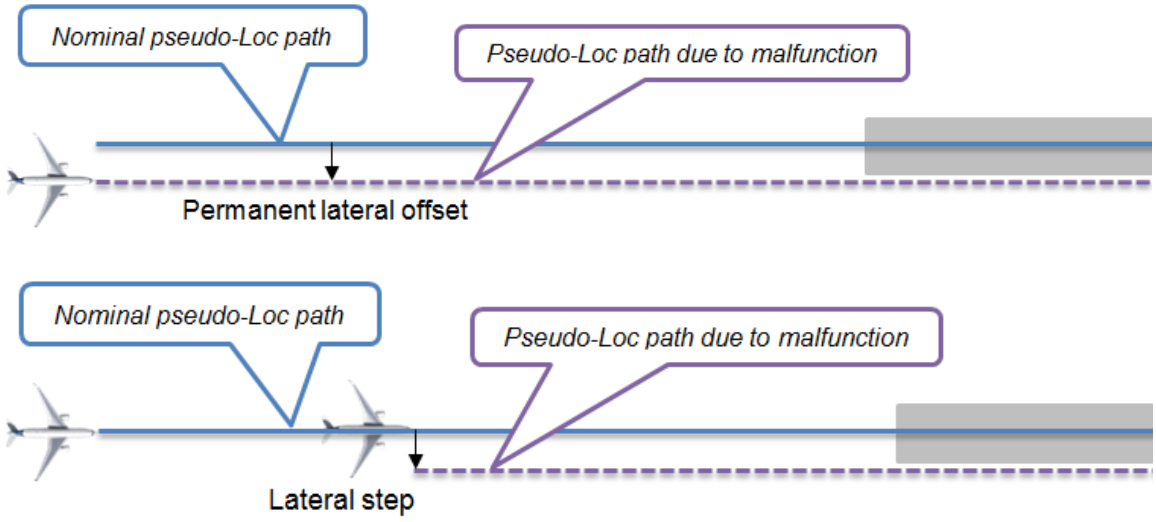


Figure 10 Standard GAST C malfunctions 4

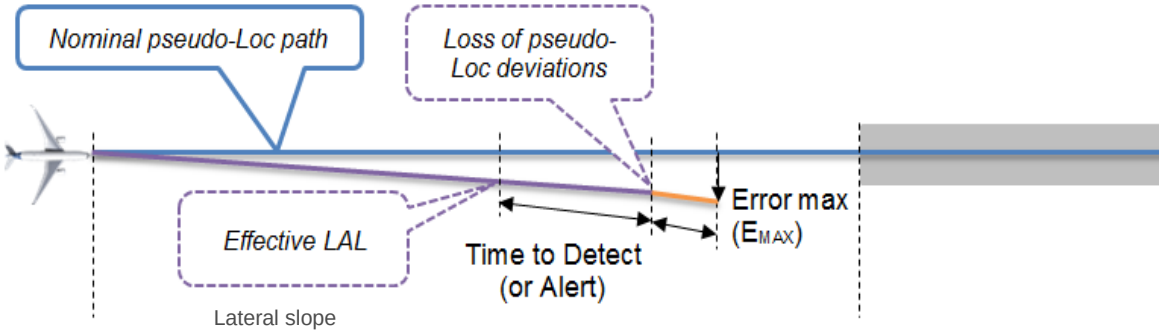


Figure 11 Standard GAST C malfunctions 5

b. Simulator Failure Test Program

i. Preparation

Standard GAST C malfunctions were analysed to identify the worst cases to be evaluated with flight crew on simulators as part of the Simulator Failure Test Program.

A combination of analysis, simulations, and preparatory simulator sessions participated to this task.

Important effort was done to properly simulate the GAST C malfunctions as described above, including combinations of lateral and vertical malfunctions.

ii. Simulator sessions

Airbus A320fam integration simulators were used to expose Airbus experimental flight crew to a set of critical malfunctions that were identified as worst cases scenarios. The goal was to assess that:

- Either the crew detect the position errors and takes timely appropriate action for safe manoeuvre: safe go around or take over and manual control of the aircraft.
- Either the crew does not detect the position errors and safe autoland is ensured.

The most severe CAT II conditions (DH=100ft and RVR of 300m) were simulated thanks to high fidelity visual system. Standard CAT II lighting system on the runway was used consistently with the operation. Following pictures were taken during the simulator sessions.

Figure 12 Simulator session 1

Figure 13 Simulator session 2

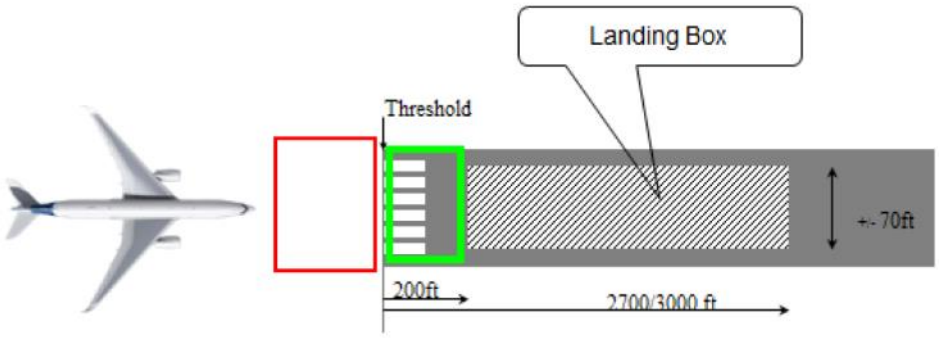
Following information is displayed on Flight Mode Annunciator on PFD:

- "AUTO LAND" showing that the aircraft status complies with GLS Autoland operation
- "RADIO 100" (entered by pilot during approach preparation) showing that CAT 2 operation is in progress. This drives the standard audio call outs "Hundred Above" at 200ft and "Minimum" at 100ft, based on Radio Altimeter height.

- "GLS" indicates that the operation is based on GBAS signals.

Wind conditions where set as per usual policy for failure case assessment for Autoland Simulator Failure Test Programs.

Pass/Fail criteria defined in latest draft of CS-AWO were used and are presented in following figure:



+ sink rate at touchdown does not exceed the limit rate of descent used for certification

+ margin of 1m above Obstacle Clearance Surface.

Figure 14 Pass/Fail criteria

Human Factors, Safety and Operational specialists observed the sessions and wrote a Simulator Failure Test Report.

iii. Simulator results

Similar results compared to the ones performed when certifying GBAS based operation with Autoland in CAT I conditions were observed:

- The thresholds of error detection by pilot are unchanged.
- Similar pilot behaviour is noticed in function of the error type. A slight difference was noted: pilot is more prompt to trigger a go around than to take over manually the aircraft due to the reduced visibility.

As a conclusion, the GLS Autoland in CAT II conditions is a safe operation: any position deviation within the system detection thresholds does not lead to any unsafe situation.

c. System Safety Assessment update for GLS CAT II

New Failure Conditions were created in A320fam System Safety Assessment documents to address GLS CAT 2.

Safety classification was assigned to those Failure Conditions, considering similarities with ILS CAT 2 and outcomes from GLS CAT II simulator sessions.

Then, Airbus verified that the current design of A320fam already approved for GLS CAT 1 Autoland complies with the safety requirements of the new GLS CAT II Failure Conditions.

d. Conclusion of Airbus A320fam Safety Assessment

From an Airbus perspective, A320fam can be certified for GLS CAT II operations with Honeywell SLS-4000 Block IIS ground stations or any equivalent GAST C station capable of detecting severe anomalous ionospheric conditions. However, the certification process with EASA is not completed and must be respected to get GLS CAT 2 airworthiness approval for A320fam.

C.1.2.2 Lufthansa Operational Risk Evaluation

In the frame of OPS approval preparation, Lufthansa continuously cooperated with LBA (Luftfahrt Bundesamt) on preparation of required elements for GLS CAT II OPS approval for full GLS CAT II demonstration targeted by AAL2. Lufthansa prepared dossier for GLS CAT II OPS approval, conduct trial in simulator on both B747-8 and A320 fam aircraft and demonstrated GLS CAT II operation in simulator to the regulator. As GLS CAT I Autoland trials were required a predecessor for OPS approval by regulator to grant GLS CAT II Autoland approval, Lufthansa focused on the Operational Risk Evaluation (ORE) for both GLS Autoland Trial and GLS CAT II Autoland trial. Below is provided Lufthansa evaluation of both GLS Autoland and GLS CAT II Autoland aspects. After period of GLS CAT I Autoland flights, safety assessment of Autoland results was conducted.

a. GLS Autoland Trial ORE Summary

Lufthansa prepared Operational Risk Evaluation that focused on trials of Airbus A320 and Boeing B747-8 aircraft and provides GLS Autoland risk scenarios, risk identification, risk assessment and mitigations identification. The evaluation focused on GLS Autoland and a possible envelope extension toward GLS CAT II including general aircraft behaviour during approach, landing and rollout, the current OM-B (Operating Manual/Part B) procedures, required changes, training requirements for a possible expansion to GLS CAT II and HMI. As a part of evaluation, simulator session on B747-8 was performed focusing on normal conditions, system degradation, corner cases and review of FMA. Simulator session in Airbus Toulouse simulator for A320fam was preceding, where detailed aspects of GLS Autoland operations were addressed. Safety objectives and safety criteria were set to comply with requirements for GLS CAT II demonstration.

As a result, from the ORE, the following mitigation steps are implemented for GLS Autoland Trial on revenue flights, despite the aircraft has already received a GLS Autoland certification:

- Minimum visibility and ceiling CAT I,
- Maximum crosswind component according to OM-B,
- Special Crew complement: Training CPT/Training FO,
- There are no open or deferred TLB complaints on GPS, FMGC or AFS,
- Opposite ILS is not radiating
  (Precautionary measure, technically proven by DFS that although permissible limit slightly exceeded, no effect / disturbance of on-board MMR),
- Airport/ATC confirms prior commencing approach, that GLS station is fully operational without disturbances,

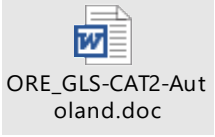
- After implementing adequate mitigations all risks have been rated “low “. After acceptance of the Operational Risk Evaluation (ORE), Head of B747 Fleet, approved the trial flights under the conditions outlined in the ORE.

b. GLS Autoland Trial ORE Study

c. GLS Autoland Trial ORE for CAT II Summary

GLS Autoland Trial ORE for CAT II focused on manipulation of GLS signal, added landing capability downgrade and human error threats and included failure of airborne equipment, GLS signal loss and disturbance of GPS signal.

d. GLS Autoland Trial ORE for CAT II Study



C.1.2.3 Ryanair Safety Assessment

In the frame of OPS approval preparation, Ryanair worked to prepare required elements to grant GLS CAT II OPS approval for AAL2 demonstrations. Activities started with GLS CAT I manual approaches trial per IAA approval, before whole Ryanair GLS equipped B737 fleet approval is granted. Preparation activities included building the required safety case and trial execution that was continuously coordinated with IAA and which consist a predecessor for GLS Autoland and CAT II operation. Experience from GLS CAT I manual approaches were shared with IAA and considered in the safety case preparation.

A Risk Assessment Forum (RAF) was assembled to assess the commencement of an GLS Autoland trial. In 2018 the CAT I Manual landing GLS trail commenced in AGP / BRE and FRA airports. The trial has been successful with a failure rate of <4% only attributable to MMR receiver technical issues. Following on from this Ryanair plans to commence a GLS Autoland trial as approved by and detailed in the B737 AFM (Annex 2).

- GLS CAT 1 Manual landing trial completed 2019 - Available to all pilots.
- GLS Installation/Activation as per Boeing Standard Selections Specification 0226C594A32 and 0226C594A28.

- FCOM/QRH/FCTM/eLearning Module: SOP, Profiles, FMA, PFD, Deviation Indications, Contingency Procedures Identical to ILS with exception of GLS IDENTS displaying versus ILS IDENTS.

- Autoland Operations are approved in the Boeing AFM for ILS CAT II / III operations (Annex 2).

The objectives of the conducted Safety Risk Assessment (SRA) were to:

1. Identify Hazard associated with introduction of GLS Autoland approaches into Ryanair Operations.

2. Identify Risks Associated with the Hazard & present/required Control Measures.

3. Identify if there is an acceptable level of risk associated with the introduction of GLS Autoland approaches into the Ryanair Operations.

After hazard identification, risks associated with hazard such as awareness of aircraft configuration, CRM mistake/error, high energy approach, GLS failure, A/P disconnect at low altitude and others, were determined. In the frame of risk assessment prior risk level, control measures with references and owners together with post risk level were identified. The assembled group concluded that the risk of commencing a GLS Autoland trial was acceptable.

The Autoland trial was initially planned to follow on from the completion over 100 monitored GLS approaches to manual landings flown by Ryanair crews during the first phase of the GLS trial. Out of the 100 approaches flown crew reported an extremely good performance and Ryanair achieved a good capture rate of data. Of the approaches flown there were only 5 approaches that were classified as not successful, but the cause was identified and closed accordingly. Additional risk of No FLARE is classified with minor impact, Ryanair crew are qualified in Boeing 737 Autoland operation, familiar with these conditions and trained in correct response/recover techniques through the Recurrent Simulator Training (RST) programme.

The GLS Autoland trial is planned to commence at selected airports currently supporting GLS (AGP/BRE/FRA). All trial approaches is planned to continue to be subject to crew reports and all unsuccessful approaches require an ASR and will be investigated to establish the route cause. Ryanair will maintain safety assurance through the safety office, including data collection and reporting.

Ryanair GBAS CAT II demonstrations targets EDDW airport. Safety case documentation prepared by Ryanair for IAA to support GBAS CAT II approval for AAL2 flight demonstration with GBAS equipped B737NGs was supported by Boeing.

C.1.3 GBAS Ground Station Safety Assessment

Ground station safety case under AAL2 demonstrations focused on safety assurance activities mainly related to the incorporation of EGNOS into the SLS-4000 Block 2 with SBAS further mentioned as GBAS. The system design approval for WAAS incorporation into GBAS was already provided by FAA prior AAL2 project in February 2017.

Satellite-Based Augmentation System (SBAS) complement existing Ground-Based Augmentation System (GBAS) using geostationary (GEO) satellites. This Ground Station Safety Assessment does not

include the integration of the SBAS hardware option (this hardware option was included in a system design approval activity that was outside AAL2) but enables the SBAS functionality using EGNOS.

The purpose of the incorporation of EGNOS is to allow real-time bounding of the ionospheric error, which reduces excessive overbounding of the Vertical Protection Level (VPL) and enhances availability. This capability may enable CAT II operations by reducing the worst-case errors the ionosphere can produce, but no type of GAST D or CAT II approval is being requested.

With SBAS option enabled the station may operate in either service level A or B. In Service Level B, the GBAS ground station uses EGNOS data to bound the ionospheric errors within the 10 m VPL, this value is site-specific but was arbitrary set by German regulator. In the case EGNOS will indicate that the ionosphere has become too active or unstable to allow full error bounding, the system safety design allows two options:

- The impacted satellite(s) are excluded from the solution and the system remains in Service Level B
- The system downgrades to Service Level A and protects the aircraft using monitoring which limits the ionospheric error to tolerable error limit at the 200 ft decision altitude. The required integrity is always attained.

The primary benefit for the addition of the SBAS Receiver is to significantly reduce the level of ionospheric bounding required to mitigate the ionospheric threat by providing real-time monitoring. Besides the improvement in operational availability this capability enables the support of advanced operation. These advanced operations can include the following:

- Autoland operations,
- CAT II approach operations against a GAST-C Ground Station,
- Extended Service Volume (ESV) Operations / Increased Dmax,
- Operations using Differential Correction Position Service (DCPS).

Safety Approach to allow exploit the 100 ft Decision Height (DH) without having to upgrade to GAST-D (CAT II/III) systems applied for Honeywell SLS-4000 GBAS Ground Station:

- Objective: Validate the use of EGNOS as an adjunct to GBAS and enable advanced approach and landing operations.
  - The use of the US SBAS (known as WAAS) for this purpose was validated under the Honeywell SmartPath GBAS Block 2 FAA System Design Approval (SDA) process,
  - Validate European SBAS (EGNOS) the same way as WAAS,
  - Identify compliance to German Type Approval.

C.1.3.1 GBAS Minimum Performance Requirements

The GBAS is a safety-critical system consisting of hardware and software that augments the GPS Standard Positioning Service (SPS) providing a precision approach and landing capability to GAST-C. Justification of the technical system design options are provided for current SLS-4000 bellow.

The design was to meet or exceed the minimum performance requirements as specified in the following regulation:

- FAA-E-3017, the Federal Aviation Administration (FAA) Non-Federal Navigation Facility, Category I Local Area Augmentation System Ground Facility specification which has been determined by the FAA to comply with the ICAO Standards and Recommended Practices (SARPS),
- EUROCAE ED-114A MOPS for GBAS Ground Equipment to Support Category I Operations,
- Using the GPS signal-in-space as specified in ICD-GPS-200C, the Navstar GPS Space Segment/Navigation User Interfaces, GBAS will transmit Type 1, Type 2, and Type 4 messages according to the interface requirements specified in RTCA/DO-246C,
- The SLS-4000 implemented safety features to mitigate the hazards identified in the GBAS Functional Hazard Assessment (FHA), and satisfy the requirements specified in the GBAS Preliminary System Safety Assessment (PSSA).

Requirements Compliance Matrix for GBAS SLS-4000 Block 2 were produced in the US for FAA. With respect to ICAO SARPS Annex 10, several alternate requirements were identified for CAT II operations.

Current Status of WAAS Integration in the US is summarized below:

- **FAA** fully approved Honeywell GBAS SLS-4000 Block 2 with SBAS (WAAS),
- Installation of this Block 2 with SBAS functionality is done in Houston and Newark,
- Any future GBAS installation are planned to be Block II with SBAS – in the US.

To obtain German Type Approval, following regulatory baseline was used:

- German Type Approval Requirements
  - **NfL II 51/08** Notification Concerning the Requirements for Type-Certification of GBAS Ground Facilities as Aeronautical Radio Navigation Stations,
- Industry safety and design assurance standards and guidelines for the design:
  - **ARP-4754** Certification Considerations for Highly-Integrated or Complex Aircraft Systems,
  - **RTCA RTCA/DO-254** Design Assurance Guidance for Airborne Electronic Hardware,
  - **RTCA RTCA/DO-278** Guidelines for CNS/ATM Systems Software Integrity Assurance,
  - **RTCA RTCA/DO-178B** Software Considerations in Airborne Systems and Equipment Certification.

German regulation **NfL II-51/08** requires providing compliance to following areas and documents:

- System safety and security
  - ICAO Annex 10, Volume 1,

- ARP 4754, Civil Aircraft and system development process,
- ARP4761, Safety Assessment Process,

- Software requirements
  - Developed according to EUROCAE ED-109,
- Technical functional requirements
  - ICAO Annex 10, Volume 1,
  - Tests per EUROCAE ED-114,
  - Ground and Flight inspections per ICAO Doc 8071 chapter 4,
  - All weather operations, NfL I-1/99,
  - Remote monitoring,
  - Environmental requirements,
- Environmental requirements
  - ED-114, MOPS for GBAS equipment to support CAT I operations,
  - NfL I-328/01, Guidelines Concerning Obstacle Clearance for Instrument Runways.

Summary of Honeywell SLS-4000 GBAS Ground Station compliance is provided bellow:

- German Type Approval GBAS Bodenanlage SLS-4000 Block I (D-0029/2014) was reached before starting AAL2 project,
- German Type Approval GBAS Bodenanlage SLS-4000 Block II (May 2019) was reached in May 2019 and was predecessor for Block II with EGNOS,
- German Type Approval GBAS Bodenanlage SLS-4000 Block IIS GBAS with EGNOS is required to allow GLS CAT II operation on SLS-4000 in Germany.

Honeywell interacted with German regulator to answer raised questions related to safety case analysis for Block II and Block IIS.

C.1.3.2 GBAS/SBAS Safety Integration Concept

To quantitatively evaluate navigation integrity, an aircraft computes vertical and lateral protection levels as position-error bounds using integrity parameters broadcast by a nearby GBAS. These parameters include a standard deviation of ionosphere spatial decorrelation because the range errors introduced by the ionosphere vary between GBAS receivers and aircraft users. Thus, it is necessary to estimate typical ionosphere gradients for nominal days and to determine an appropriate upper bound to sufficiently cover the differential error due to the ionosphere spatial decorrelation. Ground based differential GPS Systems are sensitive to the spatial decorrelation due to variation in ionosphere delay between aircraft and ground station.

By integrating with an SBAS receiver, GBAS can take advantage of SBAS's independent Anomalous Ionosphere monitoring. SBAS ionospheric information can be used to determine if the worst-case, or less severity, Ionospheric gradient could potentially be present, or if it is valid to assume quiet ionospheric conditions. Allowing the GBAS monitoring to protect against a much smaller anomalous threat space or elimination of Geometry Screening inflation.

In previous GBAS versions when GBAS operates without additional SBAS ionospheric data inputs. The station must always assume the worst-case storm being always present affecting aircraft with the worst-case possible subset geometry of GPS satellites. This is a significant driver of GBAS availability performance.

Grid Points (IGPs) provide data that enable the GBAS to determine the magnitude of local ionosphere activity. With this data the GBAS is able to determine a value of sigma VIG which ensures the aircraft protection levels overbound potential errors in the differential correction caused by current ionospheric conditions to the extend needed for target operation.

Within AAL2 project, Honeywell has developed a gradient overbound for each of the GIVE index values used in the SBAS (EGNOS) integration.

C.1.3.3 GBAS/SBAS Validation

The main objective of the GBAS Ground Safety Assessment activities was to validate use of EGNOS as an adjunct to GBAS in the same way as WAAS to enable advanced approach and landing operations. The use of US SBAS (known as WAAS) for this purpose was validated under the Honeywell SmartPath GBAS Block 2 FAA System Design Approval (SDA) process.

The EGNOS satellites are used to obtain the real-time status of ionospheric conditions using Ionospheric Grid Points (IGP) from EGNOS as the GPS signal pierces through the ionosphere. The grid points have an associated ionospheric delay, developed by EGNOS. This allows to GBAS to characterize the current ionospheric conditions and determine a value of sigma VIG, which overbounds current ionospheric conditions. The sigma VIG is a statistical confidence factor related to iono error.

The integration of a SBAS Receiver enables GBAS to access to EGNOS Iono Grid Points (IGP) and associated Grid Iono Vertical Error (GIVE) data. The GIVE data is the time delay experienced in that grid from a tracked satellite. GBAS does not use EGNOS satellites (GEOs) as ranging sources and the GBAS does not provide corrections for them.

Honeywell has performed a safety study which correlates EGNOS GIVE data with observed ionospheric gradients within the EGNOS Operation Area. For this assessment, the historical EGNOS GIVE data and high-rate dual frequency GPS data from Continuously Operation Reference Stations (CORS) were used to determine the magnitude of the local ionospheric activity and its potential impact for all satellites in view.

The GPS CORS data were processed to calculate the ionospheric gradients. The observed ionosphere gradients are assumed to be representative of the ionosphere gradient present between the GBAS station and the airborne user. The residual ionospheric error is defined conservatively as the distribution of ionosphere gradients from the worst-case day and location. These distributions of ionosphere gradients were corelated with EGNOS GIVE values. And based on this correlation, a gradient overbound was developed. This overbound includes pre-defined conservative margin for each

of the used GIVE index values. The broadcast parameter sigma VIG, which ensures the aircraft protection levels by overbounding potential ionospheric errors is equal to 1-sigma value of that gaussian gradient data overbounding.

The Honeywell Safety Case showed that the probability for a GIVE-gradient combination to exceed the corresponding overbound value will be less than 10-7. Broadcast a sigma VIG using the GBAS-EGNOS integration is less conservative (lower) than GBAS that always protects against worst-case iono storm conditions. The results show that the GBAS ground station that uses EGNOS data can bound the ionospheric errors within 10m VPL. Honeywell SLS-4000 Block IIS supports 3 seconds Time-to-Alert for CAT I operations (GAST C TTA is 3 seconds) but for ILS CAT II operations the TTA of 2 seconds is required. The difference is mitigated in the aircraft by showing that they can meet airworthiness requirements (Landing in the box) with the longer TTA.

C.1.4 ANSP, ATC and Approach Procedure

Safety risk assessment activities for ANSP, ATC and approach procedure areas were conducted by DFS. The objective of the safety documentation process is to analyse the project in terms of its impact on the functional system air traffic control and, if it is a change in the functional system air traffic control, to evaluate it. In this safety documentation it shall be demonstrated and comprehensibly documented that only acceptable risks for aviation emanate from the change examined here.

A GBAS system has been in operation at Bremen Airport since 2012. Since then, this system has supported CAT I precision approaches.

Within the SESAR AAL2 project the aim is to use the system down to the CAT II minimum for a period of about 6 months.

GLS CAT II offers, among other things, the advantage that approaches with suitable equipped aircraft can be conducted with a lower Runway Visual Range (RVR) or a lower ceiling. In CAT I, the RVR is 550 metres and the ceiling is 200 feet, in CAT II, the RVR is 300 metres and the ceiling is 100 feet.

For this project, GLS CAT II approaches with previous RNP (Required Navigation Performance) segments will be carried out with the current GBAS system and an installed SBAS (Space Based Augmentation System) receiver. This requires an adaptation of the existing GBAS system. This adaptation includes the use of the latest software version (Block II) as well as the installation of additional hardware (SBAS receiver). The reference antenna system remains unchanged. At regulatory level, these adaptations are currently being supplemented in the type certification. They are not relevant for the safety documentation.

The ATC and maintenance interface functions to DFS systems were changed. In the case GBAS station downgrade to service level supporting CAT I operation, this status condition will be displayed to both ATCOs and maintenance supervisory, see Chapter 3.4.2.1.2. Operating method description – Aerodrome and ATC.

C.1.4.1. Description of the project for safety analysis purposes

A GBAS system "SLS-4000" from Honeywell Inc. has been in operation at Bremen Airport since 2012. Since then, this system has supported CAT I precision approaches.

In the frame of WP2, GLS CAT II approaches with the current GBAS system in combination with an SBAS option are planned to be carried out.

For this purpose, the GBAS system was be upgraded to be able to be used down to the CAT II minimum.

The approach minimums are planned to be changed and newly published in the German AIP. For GLS CAT II operations, ICAO has no guidance for an obstacle analysis. GBAS and ILS are basically treated identically according to ICAO DOC 8168 Vol II as amended. This circumstance is therefore not considered as a deviation from ICAO recommendations, but a further specification.

The RNP segments are an established ICAO standard and are not the subject of the safety assessment. The possibility of using the current GBAS system with an SBAS option also for GLS CAT II approaches was reviewed within the scope of the type approval.

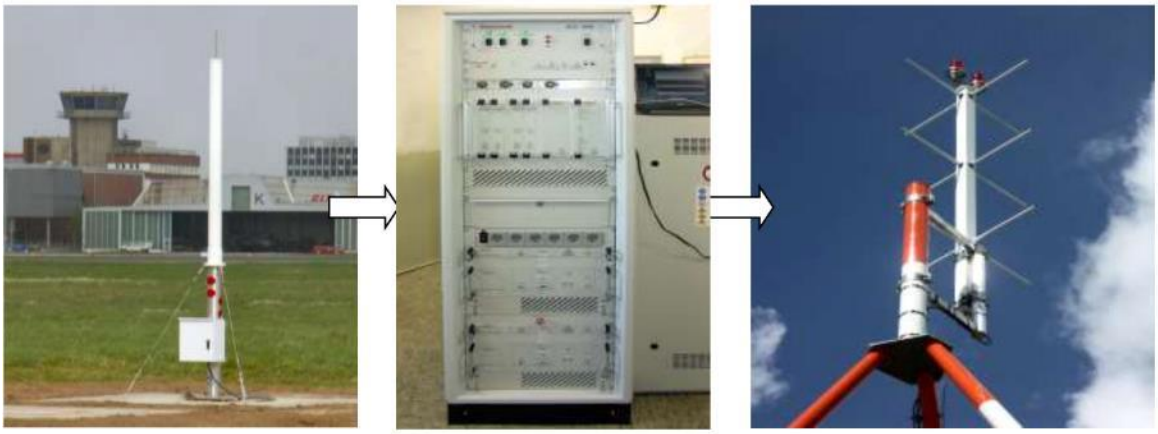


Figure 15: GBAS system SLS-4000 in Bremen

In order to achieve the state of operational use for GLS CAT II, DFS had previously identified and implemented various requirements, which are included in the operational concept [CONOPS].

Since not all aircraft are yet equipped with GBAS, a permanent mixed operation of ILS and GBAS approaches is to be assumed. For the sake of simplicity, the protection zones required for pure ILS operation are also used and active for GBAS/ILS mixed operation. In pure GLS operation, it is not necessary to keep the ILS protection zones free.

The vertical and lateral alert limits (VAL or LAL) used by the multimode receiver of the aircraft are transmitted by the GBAS ground station The LAL is reduced from 40 m (CAT I) to 10 m for GBAS CAT II operations. The VAL remains unchanged.

The GLS CAT II regulations regarding the decision height of 100 ft and the decision distance of 0.25 NM necessary for the introduction, are ICAO standards for CAT II final approaches and do not require any separate instruction. The requirements for stop bars are included in the operating concept [CONOPS] and are part of the instruction of the operating personnel.

The subject of the safety assessment is therefore the remaining regulatory requirement for GLS CAT II analogous to ILS CAT II, which is assessed within a safety workshop.

No external services or internal services were considered within the scope of the safety documentation.

There are no interactions with ATM services in/through other countries or from/through other ANSPs.

C.1.4.2 How to carry out the analysis

The following method was selected for the analysis and evaluation of the project:

- Change in assessment level 1, *non-safety-relevant change*

A qualitative assessment for argumentatively representable, non-safety-relevant changes to the system air traffic control was selected without identifying threats, as this is a change whose size and complexity, including its interfaces and dependencies, is small and easy to present.

C.1.4.3 Aim of the analysis

The following objective was chosen for the analysis:

Change in valuation level 1:

The objective of this assessment is to document in a comprehensible manner that there is no demonstrable impact on air traffic safety when changing the functional system of air traffic control.

C.1.4.4 Analysis and result of the assessment

Valuation level 1

In order to first fully capture the change under consideration and to identify the resulting potential threats and effects on air traffic, a team of experts conducted a threat analysis.

During the threat analysis, no threats were identified in connection with the project.

The need for GLS CAT II analogous to ILS CAT II described and realised above has, from the expert's point of view, only the changed fact that in pure GLS approach operation the CAT II/III holds (stop bars) applicable for ILS for securing the ILS protection zones can be taken into account, but do not have to be taken into account. Thus, neither attention nor non-attention of the regulations for these CAT II/III holds will have an impact on the safety of air traffic.

In case of mixed operation GLS/ILS these CAT II/III holds have to be used very well, and the procedures described for ILS apply.

C.1.4.5 Summary of the achievement of the objective of the safety analysis

Project Evaluation stage 1 ➔ no change

Valuation level 1

The method used was suitable and detailed enough to demonstrate that the objectives had been achieved with sufficient precision.

The project is acceptable in terms of safety, as no effects on air traffic safety are discernible.

C.1.5 Validation Approach Compliance with SRM Guidance

a) Technical System Implementation		
Objective		**Completion**
1	Show that equipment validation tests and other validation measures are adequate to demonstrate that all technical system functional (including performance) requirements are satisfied	N/A, Completed outside AAL2 as a part of Block IIS System Design Approval with FAA and German Type Approval with BAF.
2	Show that technical system safety requirements (success) are satisfied and identify any which are not fully satisfied	Covered in Honeywell proprietary documents: • GBAS Block II System Safety Assessment Report (SSA) (not part of AAL2) • GBAS Block II Safety Case Addendums
3	Show that any residual non-conformances to Safety requirements (success) are suitably mitigated	Covered in Honeywell proprietary documents: • GBAS Block II System Safety Assessment Report (SSA) (not part of AAL2) • GBAS Block II Safety Case Addendums • NFL-II 51/08 Compliance Report for the SLS-4000 Block II GBAS (not part of AAL2)
4	Show that equipment elements/subsystems will meet their overall failure rate targets	N/A
5	Show that new software elements have been developed to the allocated SIL/SWAL	N/A
6	Show that modifications to existing software elements has not degraded their integrity	N/A
7	Show that pre-existing off-the-shelf software is of sufficient integrity to meet the software integrity requirements	N/A
8	Show that any residual non-conformances to integrity requirements in the Safety requirements are suitably mitigated	Covered in Honeywell proprietary documents: • GBAS Block II System Safety Assessment Report (SSA) (not part of AAL2) • GBAS Block II Safety Case Addendums • NFL-II 51/08 Compliance Report for the SLS-4000 Block II GBAS (not part of AAL2)
b) ATC and Flight Crew Procedure Design		*Promulgation of ATC and Flight Crew Procedures is not covered here*
1	Show that all new or modified ATC and Flight Crew Procedures have been designed to satisfy the	N/A

	ATC and Flight Crew Procedure safety requirements from V3	
2	Show that all new or modified ATC and Flight Crew Procedures have been validated	N/A
c) Engineering Procedure Design		
1	Show that all new or modified Engineering Procedures have been designed to satisfy the Engineering Procedure safety requirements from V3	N/A
2	Show that all new or modified Engineering Procedures have been validated	N/A
d) ATC and Flight Crew Training Design		*Deliveries of ATC and Flight Crew training, and satisfaction of other ATC and Flight Crew competence requirements*
1	Conduct a Training Needs Analysis (TNA)	Covered in the GLS CAT II Concept of Operation for Bremen
2	Show Controller Training Design covers required level of safety	Covered in the GLS CAT II Concept of Operation for Bremen
3	Show Flight Crew Training covers required level of safety	N/A
e) Engineering Training Design		*Delivery of Engineering training, and satisfaction of other Engineering competence requirements, are not covered here*
1	Conduct a Training Needs Analysis (TNA)	Covered in Maintenance training provided by Honeywell
2	Show that Engineering Training Design satisfies the safety requirements established at V3	covered in SLS-4000 COMMERCIAL INSTRUCTION BOOK (Honeywell proprietary)
3	Show that Engineering staff Training Design has been validated	covered in SLS-4000 COMMERCIAL INSTRUCTION BOOK (Honeywell proprietary) reviewed as a part of FAA SDA process.
f) Installation and Commissioning		
- **Preparation**		
1	Show, prior to installation of the VLD equipment, that all hazardous effects of Installation & Commissioning have been identified on local equipment, local operations, and external agencies	N/A, Excising ground equipment is used. Modification have been considering within German type approval process
2	Show that potential adverse effects of installation & Commissioning have been mitigated by suitable means	N/A, Excising ground equipment is used. Modification have been considering within German type approval process
3	Show that building infrastructure services are adequate to support new equipment	N/A, SLS-4000 Block IIS upgrade does not require building additional infrastructure. Installation of SBAS KIT was performed according to HON instructions detailed in Commercial Instruction Book
- **Execution**		

1	Show that commissioning trials and other validation measures are adequate to demonstrate that all technical system requirements are satisfied	Ground Station has been tested according to ICAO Doc. 8071 Vol. II ground and flight-testing requirements
2	Show that the majority of technical system requirements are satisfied and identify any which are not fully satisfied	Ground Station has been tested according to ICAO Doc. 8071 Vol. II ground and flight-testing requirements
3	Show that any residual non-conformances to safety requirements (success) or integrity requirements are suitably mitigated	N/A

Table 1: GBAS validation approach compliance with SRM guidance to support CAT II operation on GAST-C station

C.2 EXE-VLD-V4-200 Safety Assessment Report

C.2.1 Introduction

Safety assurance work that was conducted as part of SESAR AAL2 for EFVS to land operation is a major contribution to the project.

The purpose of safety assessment activity is double. Safety risk assessments were first produced to authorize execution of safe EFVS to land flights at the pioneer European aerodromes of the project in the context of SESAR VLD. And beyond the SESAR VLD context, safety assessments were produced to serve as example for providing guidance for ANS/ATM in the perspective of large deployment of the EFVS operation over Europe.

Although the Safety risk assessment related to EFVS activity covers the entire aspect of the operation by addressing air segment as well as ground segment, the materials produced in the frame of that project are more focused on the ATM/ ANS including aerodrome aspects and are not intended to replace the ops approval the operator has to obtain for conducting the operation.

Safety risk assessment were conducted under the lead of the ANSPs of each state of the project and involved all the relevant stakeholders including end users such as the aerodrome operator and air operators.

Safety assessments were addressed over the different domains:

- The Air operator including aircraft/ aircrew aspects
- The ATM/ANS including the Instrument Approach Procedure aspects,
- The Aerodrome operator including infrastructure and ground procedure aspects

Safety risk assessment were carried out taking into consideration the EFVS to land operation as newly defined in the EASA NPA AWO 2018-06 (based on the inputs of SESAR AAL). AAL2 Safety materials were submitted to Aviation Authorities for detailed assessment in the perspective of deliverance of experimental approval for EFVS VLD.

The purpose of that Safety Assessment Report (SAR) is to presents in detail the safety materials that have been produced and conclusions that have been made for the 4 aerodromes (3 states) of that project:

- Antwerp (EBAW) in Belgium
- Le Bourget (LFPB) in France
- Perigueux (LFBX) in France
- Payerne (LSMP) in Switzerland

EASA was kept informed of the progress of the AAL2 project through the participation of the SESAR AAL2 WP3 leader to the EASA AWO RMT0379 (All Weather Operation Rulemaking Task).

C.2.2 Experimental approval materials

From a general standpoint, the following materials were prepared and submitted to authorities for supporting deliverance of experimental approval:

- Air operator safety risk assessment. One document was issue by each of the two air operator involved in the demo (Dassault and ATR). In addition to safety related aspect, this document contains a description of the concept of operation, the scope of the demo including the OPS credit to be considered, the crew procedure to be followed and the climb gradient to be applied in case of missed approach.
- The ATM/ ANS safety study. This document deals with the impacts of EFVS-L on the ATM/ANS.
- An aerodrome safety study. This document deals with the impacts of EFVS-L on the aerodrome infrastructure and procedures.

C.2.3 Regulatory basis for EFVS to land operation

EFVS to land operation (EFVS-L) has been newly defined in Europe by EASA in NPA 2018-06 produced by the Rule Making Task RMT0379 and covering All Weather Operations including EFVS operations. NPA contains four parts (A-D) addressing the different pillars of the operation (rationale, airworthiness, AIR OPS, aerodromes aspects).

The NPA that was officially published for public comment in July 2018 has been considered as a reference for the EFVS concept of operation for SESAR AAL2 activities.

In order to support the safety risk assessment, a compliance matrix containing all the EFVS relevant requirements was created and filled in for each aerodrome (provided here below).

Compliance matrix template with NPA 20

The Safety risk assessment produced in the project is consistent with NPA AWO 2016-08.

NPA is currently on going (final stage of CRD process) and opinion is planned to be delivered by EASA in 2020.

C.2.4 Air operator aspects

With respect to safety assessment, ATR and Falcon Aircrafts manufacturers are involved as air operators in the demonstrations and they produced all the necessary safety materials related to the air operation.

The aircrafts proposed for the demo i.e. a Falcon 8X for Dassault and an ATR42-600 for ATR are either EASA certified (Falcon) or in final stage of certification (ATR) for EFVS operation down to 100ft HAT at the time the demo were performed (ATR finally obtained the EASA certification for EFVS operations end 2019).

In order to allow EFVS to land demo flights in the frame of that SESAR project, Dassault and ATR applied the EASA process approved under DOA EASA.21J.051 (respectively EASA.21J.044 for ATR) privilege for flight tests. In accordance, they conducted the safety assessment and defined the procedures and flight conditions as part of an FCAS for allowing the issuance of a permit to fly.

The dedicated Safety Risk Assessment Analysis and Test Methodology document that were produced identify the safety cases related to the EFVS to land operation from aircraft standpoint and propose associated mitigation means when necessary. It defines a progressive method for Demos flights and describes the specific test means that are required to be used for these low visibility trials. In addition, the safety assessment requires a safety pilot/ flight engineer using independent system to monitor the trajectory of the aircraft below minima.

In accordance with AMC5 SPA.LVO.110 (ANS- and aerodrome-related requirements, verifying the suitability of runways for EFVS operations) stating that the go-around contingency procedure is under operator responsibility, an analysis was carried out to address the go around below Minima. This study takes for assumption that go around could be initiated at any point prior to touchdown and determine appropriate climb gradient to apply for ensuring safe execution of the maneuver during EFVS-L operation. The air operator related safety materials for missed approach were revised for each aerodrome to take into account specificity of the environment.

This air operator related documentation is part of the materials submitted to the authority for requesting approval for the AAL2 demos.

The safety risk assessment related to ATM/ANS including aerodrome are detailed in following section for each aerodrome separately.

As part of air operator safety assessment and because aerodrome environment may be specific (urban aerodrome, proximity with CDG…), familiarization flight in good weather conditions at some aerodrome have been performed as a prerequisite for Demos.

The following documents provides air operators justifications for allowing regulator to deliver the approval for the SESAR AAL2 demo flights.

- Dassault: DGT170243: AIR OPERATOR elements for SESAR AAL2 Demos
- ATR: EVT-997/19: AIR OPERATOR elements for SESAR AAL2 Demos

These documents contain FCAS, Aircraft Type certificates and EFVS Major change approval (Dassault), DOA certificates, safety risk assessment, go around below minimum procedure, profile of flight crews….

C.2.5 ATM/ANS and aerodrome safety risk assessment

1. Antwerp (EBAW)

Antwerp is a CATI type controlled aerodrome with limited lighting infrastructure. It is very representative of the aerodromes targeted for EFVS deployment. Antwerp is an urban aerodrome.

a. methodology

From a global perspective, a CONOPS documentation summarizing all the aspect of the operation from ATM/ aerodrome environment standpoint has been produced by the ANSP (skeyes) in close collaboration with all involved stakeholders (aerodrome, air operators, ATC, etc.). This document contains also a description of the scope of the operation as a reference for all involved partners.

Based on the CONOPS, and for allowing SESAR EFVS-L demos flights in Antwerp, safety impacts of the operation have been analyzed applying standard safety processes. This activity has been conducted under the lead of the ANSP (skeyes) with the contribution of relevant departments of ANSP and

aerodrome operator (LEM). Following stakeholders are involved in that aerodrome related safety assessment of Antwerp:

- Belgian Civil Aviation Authority (BCAA)
- Belgian Supervisory Authority (BSA)
- Antwerp Aerodrome operator– Luchthaven Exploitatie Maatschappij (LEM)
- skeyes
    - skeyes Antwerp
    - skeyes CANAC (APP)
    - Strategy & Performance/Environment & Flight Procedure Design
    - Process, Monitoring & Reporting (Safety)
    - Special Activities Coordination Center (SPACC)
    - Meteo services

The safety activity was set up to analyses in detail which parts of the ATM/airport system are impacted by EFVS-L related changes, as well as to show and to check that all the necessary requirements are fulfilled.

A standard safety assessment process was applied:

- Scope of the EFVS-L demo has been first defined
- Changes introduced by EFVS-L compared to the existing operations have been identified in a safety perspective.
- Failure events have been defined, resulting impacts have been assessed, and associated severity and frequency levels were determined. When necessary appropriate mitigations were proposed for allowing safe EFVS-L demo in Antwerp.

The following aspects were examined (current method, safety related changes and mitigation means):

- Infrastructure/Operational environment (description)
- Working methods and changes for EFVS demo flights
- Procedures
- Airspace design
- Phraseology
- Equipment
- Degraded modes
- ATCO Training Plan & Documentation

SESAR AAL2 related Safety materials consist in the CONOPS completed by:

- INITIAL SAFETY IMPACT ASSESSMENT (ISIA) report for ATC environment/ operation aspects. This document is produced by skeyes;
- an ENHANCED VISION SYSTEMS II – DEMO FLIGHTS IN EBAW report for aerodrome related aspects. This document is produced by LEM.

As EFVS-L is not part of certified operation yet, the NPA 2018-06 (part A to D, see dedicated section) was used to understand in detail the foreseen impact in term of requirements for performing operation in Antwerp.

The following section presents the main impacts and mitigation means proposed for allowing SESAR EFVS-L demo flights in Antwerp. The topics are those examined as part of the safety assessment in the different documents cited here above. Details of analysis are given in these documents attached.

b. Changes and safety mitigations status

Conclusion of ISIA report related ATM aspect is that Significant change is LOW. The change is found "acceptably safe." As the working methods described for the trials only induces some adaptations to the existing procedures and it is an exceptional situation, it is estimated not to be necessary to set any Safety Monitoring Requirements on this change.

With respect to aerodrome environment, ENHANCED VISION SYSTEMS II – DEMO FLIGHTS IN EBAW report concludes that after application of mitigating measures, the risks identified are deems at acceptable level allowing safe EFVS demos.

c. ATM/ ANS safety analysis

This section addresses the safety study related to ATM/ANS aspects. Safety aspects that are under aerodrome responsibility are addressed in specific section.

i. Changes in Working methods

This section addresses the modification of the working method for safety of EFVS-L operations.

1. flight trajectory

At this stage, in Antwerp, only take-offs (from both runways 11 and 29) are allowed in Low Visibility Conditions. For the demo flights, LVP procedures have been established for arrivals too, for both runways. Therefore, permission from CAA is required from BCAA, by means of approving the safety materials associated to the demo.

Antwerp TWR will follow the currently applicable practices and procedures for vectoring the aircraft, as well as for the communication and coordination with Brussels Departure (APP). No non-standard communication or coordination with regards to the demo flights is needed or expected to take place.

Resulting from EFVS-L operation in Low Visibility Conditions, in case another aircraft needs to depart from EBAW, the demo flight will receive vectors prior to the instrument approach procedure. This is necessary, because in Low Visibility conditions the one-aircraft-movement-at-a-time principle is adhered to at Antwerp Airport:

- The other aircraft needs to remain at its stand until the demo aircraft is airborne; and
- The demo aircraft cannot land until the other aircraft is airborne.

2. ATC

The demo aircraft will be under ATC control of Antwerp GND/TWR, on the same frequencies as other flights. In other words, there is no dedicated frequency for the demo flights only.

During demo, there is no change in procedures, working methods and communication between Antwerp TWR/GND and other ATC units, in particular Brussels APP. As the aircraft is not handed over from Antwerp TWR to Brussels Departure (APP), and vice versa, Brussels APP is just advised regarding the demo flights. They are informed, via the SPACC message.

A document 'EFVS Demo Flights at EBAW – Airport Information' was produced by skeyes (the change leader) and distributed to the aerodrome operator (LEM) for supporting briefing of aerodrome stakeholders involved in the demo (a.o. airside inspection and firefighting). See dedicated section here bow for details about briefing.

Because of the relatively long time between the regional demos (April 2019) and business jet demos (end of 2019), a refresh of the briefing has been achieved before business jet demo.

3. Flight plan

SPACC (see here above section) reference is required to be mentioned in the flight plan as a remark to indicate the flight concerns the SESAR demo flight.

In addition, it is stated that the RVR capabilities of the aircraft resulting from EFVS could be mentioned in field 18 of the flight plan for information purpose.

4. Taxi

The demo flight comes to a full stop on the taxiway and awaits the follow-me car.

The demo flights will use the regular LVP taxi routes and procedures defined for departures when LVP are in operational phase.

The standard routes for the follow-me car are also defined. The follow-me car shall await the demo flight arrival at the prescribed taxiway (i.e. TWY F or TWY A2, depending on the runway in use), but no closer to the runway than the runway holding point.

Detailed taxi routes are described in the CONOPS documentation appendix C.

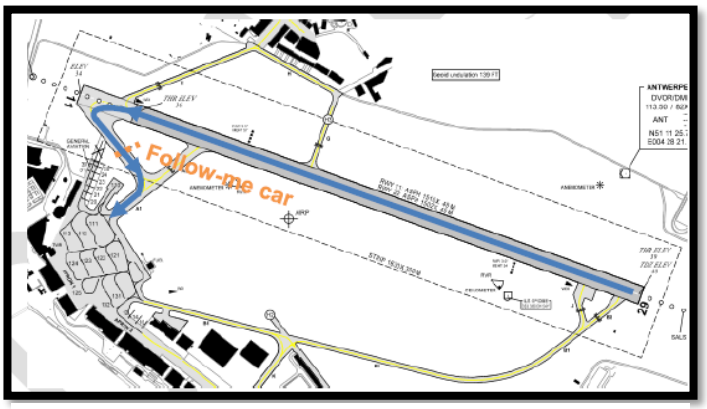


Figure 16 LPV TAXI route

Note: In case LVP is in the operational phase, the one-aircraft-movement-at-a-time principle is adhered to.

5. LVP ground working methods during the demo flights

The objectives of this LVP are to protect the physical area around the RWY to ensure the safety of aircraft during landing as well as to maintain the safety of movements on the movement area during the period of the demo.

Currently LVP procedures for departures on runway 11 and 29 are published in the AIP and there are no LVP procedures for arrivals (both RWY 11 and RWY 29) at Antwerp Airport meaning that currently no arrivals can take place in Low Visibility conditions (anyway, the lowest minima, corresponding to ILS CAT I -RVR > 750 m- is well above the LVO conditions).

For the SESAR demonstration flights, LVP ground working methods were set up, for both arrivals and departures and for the two runways. At a later stage, these procedures could be used for establishing general LVP procedures.

During the demonstrations, the demo flight is allowed to land (on RWY 29) when LVPs are in operational phase. Therefore, there might be an impact on aircraft utilizing the existing LVP for departures. The departure LVPs are adapted to incorporate the possibility that arrivals might take place. The ground Working method defined for landing are not conflicting with current LVP procedures for departure but are complementary.

The LVP ground working methods during the demo flights will enable the demo aircraft to:

- Takeoff from runway 11/29, when 150 m ≤ RVR < 550 m
- Land on runway 11/29, when 500 m ≤ RVR < 550 m

LVP ground working methods are described in detail in Appendix A of the CONOPS documentation.

Figure 17 LVP

ii. Procedure

The following three procedures have been selected for supporting EFVS demos in accordance with the eligibility criteria described for that operation in the NPA 2018-06:

- RWY 11:
  - RNAP APCH APV/BARO (LNAV/VNAV minima)
  - RNP APCH APV/SBAS (LPV minima)
- RWY 29: ILS CAT I (PA)

In accordance with the AMC5 SPA.LVO.110 of the NPA 2018-06, an operational assessment is conducted before authorizing the use of the following approach procedures for EFVS operations.

In order to ensure that safe operations are guaranteed in terms of obstacle clearance, a PANS-OPS analysis taking into account the latest data survey (done by the aerodrome operator) has been carried out. The three selected instrument approach procedures for EFVS demo were subjected to this study.

The procedures flown during the EFVS demonstrations are all existing procedures. It implies that certain obstacle assessments have already been performed before. This PANS-OPS study then focuses on the additional requirements for allowing EFVS operations:

- According to the AIP, runway 29 has an OFZ. This ensures adequate obstacle protection in case of a balked landing for EFVS on the ILS CAT I approach.
- Runway 11 does not have an OFZ, as it is not used for precision approaches. The PANS-OPS study showed that the VSS associated to the two procedures (and hence also the OCS) are not penetrated (after trees at fort III have been pruned) and then adequate obstacle protection is provided for EFVS operation on RNAV/GNSS approaches.

As stated in GM1 CAT.OP.MPA.312 (b), skeyes indicates the fact the VSS is established for both APV procedures for runway 11 should be clearly mentioned in the AIP. The AIP already contains information regarding the OFZ of runway 29.

Note: As part of the PANS OPS study, and because Antwerp is in urban area, the selected minima for demo were accurately assessed (including latest survey data and crane requests in the neighborhood of the airport

And vegetation pruning) and they were confirmed as not impacted by the works, the future buildings in construction and vegetation growth in the period of the demos. See aerodrome part in sections here below

iii. Airspace design

No change

iv. Phraseology

The general phraseology for EFVS operations with operational credits is identical to that of regular approaches.

However, as the demo flights follow specific procedures deployed in the frame of that SESAR project and for air operator of that project only (other aircraft should not be able to do this), it is essential that:

- The demo aircraft flight crew identifies itself clearly as the demo aircraft (by means of its callsign);
- and ATC only provides the specific approvals (procedures, operating below standard conditions) to the demo aircraft.

All involved parties identify the applicable flight as being the demo aircraft, simply by means of the callsign.

When LVPs are activated (only the case for departure at EBAW out of SESAR AAL2 scope), there is specific phraseology from/to the follow-me car. The introduction of LVO at Antwerp for arrival requires the addition of such a phraseology, specifically for the runway inspection which needs to be performed prior to the demo flight arrival.

The phraseology is described in the Appendix A of the CONOPS document.

v. Equipment

For safety reasons, EASA NPA 2018-06 introduces additional requirements for EFVS-L operation.

Therefore, a compliance matrix has been created to check the compliancy to new requirements for Antwerp focusing on the aerodrome, the runway and the instrument procedural aspects including missed approach procedures.

This activity involved the Antwerp aerodrome operator and the ANSP (skeyes). It addresses the AIP, the ATCO OPS Manual, and the aerodrome manual (“Vliegveldhandboek”) managed by respectively Belgocontrol AIM Belgium, Belgocontrol ATS Publications office and LEM.

For EFVS-L Demo, the following requirements were successfully satisfied for Antwerp.

- GM1 CAT.OP.MPA.312
- AMC1 CAT.OP.MPA.312(b)
- AMC2 CAT.OP.MPA.312(b)
- AMC7 SPA.LVO.105(c)

- AMC4 SPA.LVO.110 ANS
- AMC5 SPA.LVO.110 ANS
- AMC1 ADR.OPS.A.005 Aerodrome data
- AMC3 ADR.OPS.B.030(b) Surface movement guidance and control system
- AMC1 ADR.OPS.B.045 Low-visibility operations
- CS ADR-DSN.S.880 Electrical power supply systems
- CS ADR-DSN.S.895 Serviceability levels
- CS ADR-DSN.S.930 Meteorological equipment

Compliance matrix is given in appendix C of the CONOPS. A template of the compliance matrix is provided in previous section of that document.

vi. Degraded mode

The demonstration flights in LVO conditions cannot take place if failure occurs to crucial airport and/or aircraft equipment. With respect to aerodrome, this includes, amongst others:

- failure to ground infrastructure required for executing the ILS or the APV approaches
- failure of RVR sensor

vii. ATCO training plan and documentation

Whereas the flight procedures, as well as the airspace design, remain unchanged it is judged that no dedicated ATCO training is needed for performing the demonstrations.

However, extensive briefings were given on how the demonstrations have to be performed and should be dealt with by ATCOs.

The ATCOs on duty during the demo flights both on the GND and TWR position received a specific briefing (Notes2ATS) during which the following items described in the CONOPS document are discussed:

- Introduction to EFVS concept
- Explanation on operational credits, and principle of using enhanced view (in lieu of natural vision)
- AAL2 Demo flights objectives
- AAL2 Demo scope: arrival procedures – applicable minima (including EFVS OPS credits)
- Demo plan
  - Flight trajectory (including standard manoeuvres)
  - Parking
  - Taxi routes
  - ATC working methods during demo flights
  - LVP ground working methods during demo flights

- Phraseology
- Equipment
- Degraded modes

Prior and during the demo flights, this Notes2ATS can be used as a reference.

In addition to air operators that are involved in the SESAR demo, the here above set of documentation is distributed for review to:

- skeyes Antwerp
- skeyes - Strategy & Performance/Environment & Flight Procedure Design
- skeyes - Process, Monitoring & Reporting (Safety)
- Antwerp Airport operator – Luchthaven Exploitatie Maatschappij (LEM)

Demo took place after these documents were published.

d. Aerodrome safety analysis

Aerodrome operator conducted a safety risk assessment.

The safety impacts of changes resulting from EFVS-L operation were assessed according to standard process using a risk-effect versus risk-probability matrix. When necessary, mitigations were proposed.

As a result of that aerodrome safety study, following hazards were identified and associated main mitigations were proposed

- Visual aids
  - Visual aids are checked according to routine procedures.
- Obstacles
  - Obstacle survey of obstacles
  - Coordination with municipality for confirming required Pruning works have been done
  - Prohibition of use of telescopic cranes the day of the demo and visual inspection the morning day of the demo
- Movement on maneuvering area
  - Definition of taxi route for EFVS demo flights
  - Runway inspection before EFVS demo flights
  - Apron 1 only authorized
  - No training or labor traffic
- Demo flights in extreme weather conditions (thunderstorm, strong wind gust…)
  - Alert system is active

Aerodrome remains compliant with ICAO Annex 14 and EUR Doc 013 (e.g. RESA, RWY & TWY lighting, clear of obstacles, updated manuals, procedures, electrical switch-over time,…) and makes sure that fire brigade, airport inspection (= follow-me) and all airport users are aware of the trial and the ground working methods for the demo flights.

Detailed failure cases and mitigations are provided in ENHANCED VISION SYSTEMS II – DEMO FLIGHTS IN EBAW report

e. Experimental approval certificate

BSA/BCAA approval was requested for SESAR AAL2 EFVS-L demos.
The official documentation submitted to BSA/BCCA for formal approval for EFVS demo includes:

- A formal letter, summarizing the request
- The Demo Concept of Operations and Implementation Plan
- Safety Assessment (INITIAL SAFETY IMPACT ASSESSMENT REPORT, ENHANCED VISION SYSTEMS II – DEMO FLIGHTS IN EBAW)
- Compliance matrix, including supporting documents

Based on the safety assessment and supporting documentation and dedicated meetings, the formal approval was granted by BSA/BCCA for authorizing the SESAR AAL2 EFVS-L demos at Antwerp.

2. Le Bourget (LFPB)

Le Bourget is the first European aerodrome for business aviation in Europe. Le Bourget is very specific in the sense the operations are highly integrated with the CDG HUB traffic regulation. In particular, the three parallel and simultaneous approach concept is implemented and Le Bourget runways are very close to the CDG HUB.

In order to limit complexity of traffic management and keep workload of ATC at an acceptable level during very dense period of traffic, a limitation of traffic in Le Bourget is applied depending on the traffic rate at CDG (CONSIGNE OPERATIONNELLE 08/C/2019).

a. methodology

In order to allow SESAR EFVS-L demos flights in Le Bourget, safety impacts of the operation have been analyzed applying standard EPIS CA safety processes.

This activity has been conducted under the lead of the ANSP (DSNA Le Bourget Circulation Aérienne) with the contribution of relevant ANSP departments as well as the aerodrome operator (ADP LBG). Following stakeholders are involved in that aerodrome safety assessment of Le Bourget:

- French Civil Aviation Authority (DSAC)
- Aeroport de Paris Le Bourget (ADP LBG)
- DSNA central
- DSNA CDG-Le Bourget
    - Subdivision Controle le Bourget (TWR LB)
    - Subdivision Controle CDG (APP CDG)
    - Flight procedure design department

The safety activity is set up to analyze in detail which parts of the ATM/airport system are impacted by EFVS-L related changes, as well as to show that all the necessary requirements are fulfilled.

The standard EPIS CA safety assessment process that was applied consist in following steps:

- definition of the Scope of the EFVS-L demo
- identification and assessment of the changes introduced by EFVS-L compared to the existing operations (CAT I)
- definition of Failure hazard and assessment of the associated risk (severity and frequency). When necessary appropriate mitigations are proposed for allowing safe EFVS-L demo in Le Bourget.

The following aspects were examined (current method, safety related changes and mitigation means):

- Infrastructure/Operational environment (description)
- Working methods and changes for EFVS demo flights
- Procedures

- Airspace design
- Phraseology
- Equipment
- Degraded modes
- ATCO Training Plan & Documentation

With respect to requirements related to EFVS-L operation at Le Bourget, the NPA 2018-06 (part A to D, see section above) was used as a reference as EFVS-L is not part of certified operation yet. Compliance matrix has been created for that purpose (see section here below).

b. Changes and safety mitigations status

With respect to navigation service (Circulation Aerienne service), the risk for Le Bourget has been assessed as acceptable for Demos after the mitigating measures proposed in EPIS CA have been put in place.

ADP has checked that the MANEX of the aerodrome allows safe EFVS-L operation at Le Bourget

c. ATM/ ANS safety analysis

This section addresses the safety study related to ATM/ANS aspects. Safety aspects that are under aerodrome responsibility are addressed in specific section.

i. Changes in Working methods

This section addresses the modification of the working method for flying EFVS-L operations safely.

1. flight trajectory

Le Bourget TWR will follow the currently applicable practices and procedures for vectoring the aircraft, as well as for the communication and coordination with CDG. No non-standard coordination with regards to the demo flights is needed or expected to take place.

2. ATC

The demo aircraft is under ATC control of CDG and Le Bourget on the same frequencies as other flights. In other words, there is no dedicated frequency for the demo flights only.

As per standard procedure, first contact is established with CDG APP and the flight is handed over from CDG APP to Le Bourget TWR.

Considering the complexity of traffic at CDG, and because of the nature of the demonstration (demo and Low visibility conditions), a zero-traffic rate is set in Le Bourget by CDG for the demo. Aircrafts

participating to the demo are retrieved from this traffic regulation limitation using the registration of aircrafts and specific phraseology are used for that purpose.

During Demo, the ATC adhere to the LVO procedure defined for the demos and use adapted phraseology (see dedicated section).

3. Flight plan

The RVR capabilities of the aircraft ("XCOND") resulting from EFVS is requested to be mentioned in field 18 of the flight plan for allowing a preliminary filtering of the demo aircraft in the traffic regulation.

4. Taxi

The demo flights will use the regular taxi routes and associated procedures. Hot spots are identified, in particular crossing runway locations (there are three runways in Le Bourget).

As part of LVO, taxi speed is also limited to 15 kt.

In case LVO is in the operational phase, the one-aircraft-movement-at-a-time principle is adhered to. Taxiway inspections are suspended.

5. LVP ground working methods during the demo flights

At this stage (before AAL2 project), there is no LVP in Le Bourget (because LVP is formal term dedicated to CATII/III infrastructures). Landing are therefore limited to RVR 800m in runway 27 (and Take off limited to 400m in day conditions). French authorities granted LVO approval in 2019 as part of a separate project.
For EFVS and SESAR demo flight purpose, the LVO procedures of runway 27 are amended jointly with ADP to allow landing in Low Visibility Conditions using EFVS in RVR as low as 400m.

The objective of these LVO is to protect the physical area around the RWY to ensure the safety of aircraft during landing as well as to maintain the safety of movements on the movement area during the period of the demo. Below 550m, the one-aircraft-movement-at-a-time principle is adhered to.

LVO ground working methods are described:

- for the ATC in the "EFVS CONSIGNE OPERATIONNELLE TEMPORAIRE CONTROLE" established by DSNA Le Bourget
- for ADP ground operation in the "EXPLOITATION EN CONDITION DE VISIBILITÉ DÉGRADÉE (EVD) AMENDÉE AVEC EXPÉRIMENTATION EFVS" produced by ADP.

ii. Procedure

In accordance with the eligibility criteria described for the EFVS operation in the NPA 2018-06, the following three procedures have been selected for supporting the demos:

- RWY 27:

- ILS CAT I (PA)
- RNAV APCH APV/BARO (LNAV/VNAV minima)
- RNP APCH APV/SBAS (LPV minima)

In accordance with the AMC5 SPA.LVO.110 of the NPA 2018-06, an operational assessment is conducted before authorizing the use of the following approach procedures for EFVS operations.

In order to ensure that safe operations are guaranteed in terms of obstacle clearance, an analysis taking into account the up to date data survey has been carried out for runway 27 intended for demos.

The procedures flown during the EFVS demonstrations are all existing procedures. It implies that certain obstacle assessments have already been performed before. For allowing safe EFVS operation, the following additional requirements were verified by ADP with the contribution of flight procedure design department of DSNA CDG-Le Bourget:

- The runway 27 has an OFZ. This ensures adequate obstacle protection including in case of a balked landing.
- In addition, the VSS of the runway 27 has been checked.

iii. Airspace design

No change

iv. Phraseology

For demo, for traffic regulation purpose (see ATC section) and also to anticipate possible missed approach and avoid possible conflict with other aircrafts controlled by CDG either in approach or during the missed approach, following phraseology modifications were proposed

- At first contact (with CDG), the Pilot: « F-XX – request RNAV or ILS in 27 Le Bourget with EFVS (+asking for lighting aids at MAX)
- ATC: « EVP in force in Le Bourget, check your minima »
- ATC: “F-XX authorized for ILS CAT 1 (or RNAV) with EFVS approach”

v. Equipment

For safety reasons, EASA NPA 2018-06 introduces additional requirements for EFVS-L operation.

Therefore, a compliance matrix has been created to check the compliancy to new requirements for Le Bourget focusing on the aerodrome, the runway and the instrument procedural aspects including missed approach procedures.

This activity involved the leader of the change (DSNA Le Bourget).

For Demo, the EFVS-L related requirements were successfully satisfied for Le Bourget.

vi. Degraded mode

The demonstration flights in LVO conditions cannot take place if failure occurs to crucial airport and/or aircraft equipment. With respect to aerodrome, this includes, amongst others:

- failure to ground infrastructure required for executing the ILS or the APV approaches
- failure of RVR sensor

vii. ATCO training plan and documentation

Whereas the flight procedures, as well as the airspace design, remain unchanged it is judged that no dedicated ATCO training is needed for performing the demonstrations.

However, extensive briefings were given on how the demonstrations have to be performed and should be dealt with by ATCOs.

As part of strategic coordination activity, all the relevant participants (DSNA, ADP, air operators) involved in the demo participated to a specific briefing during which the following items (described in the documentation) are discussed:

- EFVS concept of operation: explanation on operational credits, and principle of using enhanced view (in lieu of natural vision)
- AAL2 Demo flights objectives
- AAL2 Demo scope: arrival procedures – applicable minima (including EFVS OPS credits)
- Traffic regulation conditions
- Demo plan
  - Flight trajectory in coordination between Le Bourget and CDG, including missed approach
  - Parking
  - Taxi routes, follow me car and hot spots
  - ATC working methods during demo flights
  - LVP ground working methods during demo flights
- Phraseology
- Equipment
- Degraded modes

As part of tactical activities, coordination meetings were planned involving ATC from both Le Bourget and CDG and the commander of the demo flights.

A note (« EFVS CONSIGNE OPÉRATIONNELLE TEMPORAIRE ») summarizing the demo particularities is established by the Demo change Lead for ATC Le Bourget to be used as a reference prior and during the demos.

Demo took place after procedures are released and all personnel involved properly briefed.

d. Aerodrome safety analysis

Aerodrome operator contributed to safety assessment lead by DSNA.

The safety impacts of changes resulting from EFVS-L operation were assessed according to standard process using a risk-effect versus risk-probability matrix. When necessary, mitigations were proposed.

Following hazards were identified and associated main mitigations were proposed

- Visual aids
  - Visual aids are checked according to routine procedures. For example, 1 second switch power time is active for lightings in LVO.
- Obstacles
  - Up to date obstacle survey is made available for PANS OPS surface analysis
- Movement on maneuvering area
  - Speed limitation and possible use of follow me car if necessary
  - No taxiway inspection
- RFFS (rescue and Firefighting services)
  - Placed in Stand by during LVO

Aerodrome remains compliant with ICAO Annex 14 and EUR Doc 013 (e.g. RESA, RWY & TWY lighting, clear of obstacles, updated manuals, procedures, electrical switch-over time,…) and makes sure that fire brigade, airport inspection and all airport users are aware of the trial and the ground working methods for the demo flights.

e. Experimental approval certificate

French authorities' approval was requested for SESAR AAL2 EFVS-L demos.

The request for change described in [EFVS-L @LFPB] EPIS-CA _ CHGT-006499 document has been submitted with all necessary materials to DSAC for deliverance of approval for SESAR EFVS demo in Le Bourget.

Based on these materials, the formal approval was granted by DSAC for authorizing the SESAR AAL2 EFVS-L demos at Le Bourget.

3. Perigueux (LFBX)

Périgueux is a rural and very small aerodrome located in countryside. It is CAT I type uncontrolled aerodrome, which an AFIS agent employed by the municipality provides the information and rescue services. AFIS agent is assisted by two personnel for RFFS.

a. methodology

In order to allow SESAR EFVS-L demos flights in Périgueux, safety impacts of the operation have been analyzed applying standard EPIS CA (CHGT_181105) safety processes.

This activity has been conducted by the AFIS personnel with the contribution of the aerodrome operator services (RFFS). Following stakeholders are involved in that aerodrome safety assessment of Le Bourget:

- French Civil Aviation Authority (DSAC SO)
- Aerodrome operator (Municipality of Périgueux)
- DSNA (SNA SO)
- Air operator: RFFS

The safety activity is set up to analyze in detail which parts of the ATM/airport system are impacted by EFVS-L related changes, as well as to show that all the necessary requirements are fulfilled.

The standard EPIS CA safety assessment process that was applied consist in following steps:

- Definition of the Scope of the EFVS-L demo
- Identification and assessment of the changes introduced by EFVS-L compared to the existing operations (RNP LPV)
- Definition of Failure hazard and assessment of the associated risk (severity and frequency). When necessary appropriate mitigations are proposed for allowing safe EFVS-L demo in Périgueux.

The following aspects were examined (current method, safety related changes and mitigation means):

- Infrastructure/Operational environment
- Working methods and changes for EFVS demo flights
- Procedures
- Airspace design
- Phraseology
- Equipment
- Degraded modes
- AFIS agent Training Plan & Documentation

With respect to requirements related to EFVS-L operation at Périgueux, the NPA 2018-06 (part A to D, see section above) was used as a reference as EFVS-L is not part of certified operation yet. Compliance matrix has been created for that purpose.

b. Changes and safety mitigations status

With respect to navigation service as well as the aerodrome, the risks for Perigueux have been assessed as low for Demos after the mitigating measures proposed in EPIS CA have been put in place.

This statement was also supported by the three following points:

- Very low level of traffic at Périgueux
- Operation in line with already deployed method for Low vis take off and for which Services are familiar with

c. ATM/ ANS safety analysis

This section addresses the safety study related to ATM/ANS aspects. Safety aspects that are under aerodrome responsibility are addressed in specific section.

i. Changes in Working methods

This section addresses the modification of the working method for flying EFVS-L operations safely.

1. flight trajectory

Périgueux TWR will follow the currently applicable practices and procedures for vectoring the aircraft, as well as for the communication and coordination with AQUI APP (Sub Control SNA/ SO). No non-standard coordination with regards to the demo flights is needed or expected to take place.

2. ATC

As per standard procedure, first contact is established with AQUI APP and the flight is handed over from AQUI APP to Périgueux TWR.

During Demo, the ATC adhere to the EVP procedure defined for the demos and use adapted phraseology (see dedicated section).

3. Flight plan

The RVR capabilities of the aircraft resulting from EFVS is recommended to be mentioned in field 18 of the flight plan for allowing the aerodrome to be informed of the capacity of the aircraft.

4. Taxi

The demo flights will use EVP defined taxi routes and associated procedures.

As part of LVO, taxi speed is also limited to 10 kt.

In case EVP is in the operational phase, the one-aircraft-movement-at-a-time principle is adhered to.

5. LVP ground working methods during the demo flights

Currently LVP procedures on runway 11 and 29 are published for departures in the AIP and there are no LVP procedures for arrivals at Périgueux aerodrome meaning that currently no arrivals can take place in Low Visibility conditions.

For the SESAR demonstration flights, LVP ground working methods were set up (called as EVP), for arrival and departures and for the two runways. At a later stage, these procedures could be used for establishing general LVP procedures.

During the demonstrations, the demo flight is allowed to land (on RWY 29) when EVPs are in operational phase (AFIS presence required).

The objective of these LVO is to protect the physical area around the RWY to ensure the safety of aircraft during landing as well as to maintain the safety of movements on the movement area during the period of the demo. Below 550m, the one-aircraft-movement-at-a-time principle is adhered to.

LVO procedures are described in the manex of the aerodrome.

ii. Procedure

In accordance with the eligibility criteria described for the EFVS operation in the NPA 2018-06, the following procedures has been selected for supporting the demos:

- RWY 29:
  - RNP LPV 29 (RVR 1500m)

In accordance with the AMC5 SPA.LVO.110 of the NPA 2018-06, an operational assessment is conducted before authorizing the use of the following approach procedures for EFVS operations.

In order to ensure that safe operations are guaranteed in terms of obstacle clearance, an analysis taking into account the up to date data survey has been carried out for runway 29 intended for demos.

The procedures flown during the EFVS demonstrations is existing procedures. It implies that certain obstacle assessments have already been performed before. For allowing safe EFVS operation, Perigueux personnel verified with the contribution of flight procedure design department of DSNA SO that the VSS of the RNP LVP 29 procedure is not penetrated by obstacles.

iii. Airspace design

No change

iv. Phraseology

For demo purpose (as per exceptional nature of the flight), for better coordination between Périgueux TWR and AQUI APP, and also to anticipate possible missed approach and avoid possible conflict with other aircrafts controlled by AQUI APP following phraseology modifications were proposed

- Pilot : "F-XX –REQUEST RNP WITH EFVS" and ask for lighting setting at max
- ATS : « EVP in force, CHECK YOUR MINIMA » before final approach and "F XX authorized for RNP LPV 29 with EVS approach"

v. Equipment

For safety reasons, EASA NPA 2018-06 introduces additional requirements for EFVS-L operation.

Therefore, a compliance matrix has been created to check the compliancy to new requirements for Périgueux focusing on the aerodrome, the runway and the instrument procedural aspects including missed approach procedures.

This activity was achieved by the AFIS personnel.

For Demo, the EFVS-L related requirements were successfully satisfied for Périgueux.

vi. Degraded mode

The demonstration flights in LVO conditions cannot take place if failure occurs to crucial airport and/or aircraft equipment. With respect to aerodrome, this includes, amongst others:

- failure to ground infrastructure required for executing the RNP LPV approach
- failure of RVR sensor

vii. AFIS training plan and documentation

Extensive briefings were given on how the demonstrations have to be performed and should be dealt with by AFIS and RFFS agents.

All the relevant participants (RFFS, AFIS personnel, AQUI APP) involved in the demo participated to a specific briefing during which the following items (described in the documentation) are discussed:

- EFVS concept of operation
- AAL2 Demo flights objectives

- AAL2 Demo scope: arrival procedures – applicable minima (including EFVS OPS credits)
- Demo plan
  - Flight trajectory in coordination between AQUI APP and Périgueux TWR, including missed approach
  - Parking
  - Taxi routes
  - AFIS working methods during demo flights
  - EVP ground working methods during demo flights
- Phraseology
- Equipment
- Degraded modes

Coordination meetings was planned involving Perigueux AFIS agent and the crew of the demo flight.

d. Aerodrome safety analysis

Aerodrome safety study was achieved by the AFIS personnel with the support of the RFFS agents.

The safety impacts of changes resulting from EFVS-L operation were assessed according to standard process using a risk-effect versus risk-probability matrix. When necessary, mitigations were proposed.

Following hazards were identified and associated main mitigations were proposed

- Visual aids
  - Visual aids are checked according to routine procedures. For example, 1 second switch power time is active for lightings in LVP.
- Movement on maneuvering area
  - Speed limitation and possible use of follow me car if necessary
- RFFS (Rescue and FireFighting Services)
  - Placed in Stand by during EVP

Aerodrome makes sure that fire brigade, airport inspection and all airport users are aware of the trial and the ground working methods for the demo flights.

e. Experimental approval certificate

As per standard process for such AFIS aerodrome under the entire responsibility of the municipality, the safety study described in EPIS-CA _ CHGT-181105 document by AFIS agent was endorsed by DSNA SO who submit it to the local authority (DSAC SO). Authority considered changes proposed are minor for Périgueux and decided not to follow it.

Based on that status and considering the safety study (EPIS CA), the AFIS aerodrome issued a positive opinion allowing SESAR EFVS demo in Perigueux.

4. Payerne

Payerne is a military aerodrome that has been opened to civil traffic (in particular for business aviation) for 5 years. Payerne has a non-Instrument runway fitted with both ILS and GNSS LPV procedures. As a military aerodrome it presents deviations compared to international standards. Moreover, it has been placed out of the scope of EASA certification by Swiss authorities and has to deal with ICAO regulation.

For Payerne, no approval was delivered. Skyguide was informed mid 2019 that Military authorities will not deliver authorization for SESAR EFVS-L demos in the intended period (winter 2019-2020). Following to that decision, Civil authorities decided to stop the ongoing civil approval process and informed skyguide that the discussion about EFVS operations at the very specific military aerodrome of Payerne will resume after the regulation has been published by EASA.

a. methodology

Safety process has been initiated for Payerne aerodrome under the lead of the aerodrome operator (Swiss aeropole) assisted by the ANSP (skyguide) and Dassault Aviation.

On One hand, skyguide and Dassault produced materials with impacts on ATC/ ANS aspects and with respect to air operation for supporting approval of EFVS-L in Payerne. On the other hand, the aerodrome operator was asked to work on a Unit Safety Risk Assessment (same process was applied for the other aerodromes of the project) to analyze in detail which parts of the ATM/airport system are impacted by EFVS-L related changes.

In addition, and as a prerequisite to EFVS-L safety assessment, Swiss authority (FOCA) requested a full compliance matrix to ICAO requirements is provided by the aerodrome operator for the military aerodrome of Payerne. Moreover, beyond the checking of the VSS penetration, FOCA requested an analysis about the obstacles penetrating the OLS be provided for assessment.

Following stakeholders were involved in the aerodrome safety assessment of Payerne:

- Federal Office of Civil Aviation (Authority)
- Military Aviation Authority
- Aerodrome operator (Swiss Aeropole)
- Swiss ANSP (skyguide)
- Dassault-Aviation

With respect to requirements related to EFVS-L operation at Payerne, the NPA AWO 2018-06 (part A to D, see section above) was used as a reference as EFVS-L is not part of certified All Weather Operations (AWO) yet. A Compliance matrix has been created for that purpose.

b. Changes and safety mitigations status

With respect to navigation service and skyguide operations, a positive opinion has been issued by the Swiss ANSP that concludes *"there is no operational limitation to conduct the SESAR EFVS-L flight trials, as long as the operations are coordinated through the usual processes in place in Payerne"*.

With respect to aerodrome, Unit Safety Risk Assessment was in progress when the decision to stop the project was taken (see section approval below).

The following materials were submitted as preliminary justifications to FOCA:

- "DGT 172235 - AIR OPERATOR elements for SESAR AAL2 Demos in Payerne" containing all necessary information related to air operator: scope of demos, permit to fly, climb gradient, AFM procedure, EASA approved risk assessment and test flight methodology for EFVS flights, aircraft and intended flight crew…
- "AAL0001e - Impact of AAL/2 on skyguide operations Augmented Approaches to Land / 2 analysis" concluding that from an Instrument Flight Procedure standpoint
- Compliance matrix of Payerne to EASA NPA 2018-06

c. ATM/ ANS safety analysis

i. Changes in Working methods

This section addresses the modification of the working method for flying EFVS-L operations safely.

1. flight trajectory

Payerne TWR will follow the currently applicable practices and procedures for vectoring the aircraft. No non-standard coordination with regards to the demo flights is needed or expected to take place.

In Payerne, per standard procedure, all civil activities require PPR to ensure appropriate coordination with military authorities.

2. ATC

The clearance to approach and the duties of the ATC will remain strictly identical to the normal operations. No specific procedures will be issued or conducted by the local ATC.

3. Flight plan

No specific information except those related to standard PPR requested by Payerne for civil operations is required.

4. Taxi

No change. Demo were intended to occur in RVR greater than 1000m.

5. LVP ground working methods during the demo flights

There is no need of LVP ground working method in Payerne as the min RVR intended for EFVS demonstration is 1000m (corresponding to an OPS credit of 30%).

ii. Procedure

The published approach procedure will be used during the demonstration flights. In the case of an intended or needed missed-approach, the aircraft will follow the published missed-approach procedure (adhering to the min climb gradient defined by the air operator).

In accordance with the eligibility criteria described for the EFVS operation in the NPA 2018-06, the following procedures has been selected for supporting the demos:

- RWY 23:
  - ILS 23
  - LPV 23

In accordance with the AMC5 SPA.LVO.110 of the NPA 2018-06, an operational assessment is conducted before authorizing the use of the following approach procedures for EFVS operations.

The current Approach Procedures in Payerne have limitations due to the fact that the Runway is classified as a non-instrument runway. This is imposed by the Swiss Regulator (FOCA) with Directive SI/SB-001 from 16 December 2009. The limitation is to establish and publish a DA/MDA above the effective OCA/H as calculated by the PANS-OPS Criteria, as specified in ICAO Doc. 816, vol II. In Payerne Runway 23, DA/H is 500ft and the RVR is 1500m.

For Payerne, skyguide determined that the visual reference to the approach lighting system will be obtained at an altitude above the calculated OCA/H of the procedure and therefore the required PANS-OPS protection level will never be exceeded (document AAL0001e - Impact of AAL/2 on skyguide operations Augmented Approaches to Land / 2).

In addition, an assessment of the Visual Segment Surfaces (VSS) conducted within the latest periodic review of the intended procedures also indicates that these are free of critical obstacles.

iii. Airspace design

No change

iv. Phraseology

No special phraseology will be used by the local ATC

v. Equipment

For safety reasons, EASA NPA 2018-06 introduces additional requirements for EFVS-L operation.

Therefore, a compliance matrix has been created to check the compliancy to new requirements for Payerne focusing on the aerodrome, the runway and the instrument procedural aspects including missed approach procedures.

This activity was achieved by the aerodrome operator with the support of Dassault.

For Demo, the EFVS-L related requirements were successfully satisfied for Payerne.

vi. Degraded mode

Not analyzed (see rationale in approval certificate section).

vii. AFIS training plan and documentation

Extensive briefings was intended to be given on how the demonstrations have to be performed, and should be dealt with by ATCO and ground personnel.

No demo occurred in Payerne.

d. Aerodrome safety analysis

Aerodrome safety study was on going on aerodrome side when the process has been decided to be stopped. No detailed aerodrome safety analysis was delivered in the frame of the AAL2 project.

Note: ICAO annex 14 compliance matrix and detailed obstacle analysis including OLS were requested by FOCA for allowing approval for demos.

e. Experimental approval certificate

No approval was delivered by Swiss civil authorities for Payerne as the ongoing process was stopped following to the decision of the military authorities not to authorize EFVS-L demos in Payerne.

As a military aerodrome, Payerne needs an authorization from military authorities for allowing SESAR demo.

Appendix D Security Assessment Report (SecAR)

Not Applicable.