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SORT

SAFELY OPTIMISED RUNWAY THROUGHPUT

This VLD3-W2-SORT DEMO report - Part IV Environment Assessment Report (ENVAR) for WP5 is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874520 under European Union's Horizon 2020 research and innovation programme.



Abstract

This document constitutes the DEMO Report-Part IV Environment Assessment Report for WP5, hence is part of the contractual deliverable D1.4 (DEMOR). It is the Environment Assessment Report (ENVAR) for the Solution VLD-03-004. It provides a synthesis of essential information (qualitative and quantitative) related to the assessment of the impact on the environment that Solution VLD-03-004 could have when implemented. This information comes mainly from the environment assessment plans (which are an integral part of the Validation Plan Reports), the results of the environment activities (which are an integral part of the Validation Reports), and the Performance Assessment Report related to this solution.

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1 Executive Summary

This document constitutes the Environment Assessment Report for WP5, hence is part of the contractual deliverable D1.4 (DEMOR). This document consists of part IV of the DEMOR for the VLD-03-004 Exercise (held under WP5) for the solution associated with PJ02-08. The purpose of this document is to present the results with focus on Environmental Performance aspects of the Very Large Demonstration (VLD) of the Integrated Runway Sequence Function (IRSF), based on the PJ02-08-01 solution.

2 Introduction

2.1 Purpose of the document

The purpose of this document is to present the results from assessing the integrated runway sequence functions environmental impact.

2.2 Intended readership

The intended audience for this document is the team members of the DEMO VLD-03-004 under investigation.

Environmental practitioners at the level of the transversal areas are also expected to have an interest in this document.

Other stakeholders that may be interested in this document are to be found among:

- ANS providers
- Airport owners / providers
- Airspace users

2.3 Scope of the document

The VLD-03-004 will focus on potential in minimizing flight time and taxi time in order to lower the overall fuel burn and lowering the number of flights flying over noise sensitive areas. The VLD-03-004 environmental assessment will include data logged during PJ02-08 V3 validation.

2.4 Environment work schedule within the Solution

The environmental focus is to demonstrate the increase of fuel efficiency and improvements of being able to avoid noise sensitive areas that was validated during V3.

2.5 Structure of the document

This document is structured as follows:

- **Section 1** provides an executive summary of the document.
- **Section 2** (this section) introduces the document.
- **Section 3** provides an overview of the Environment assessment process.
- **Section 4** presents the activities performed and the findings obtained from the Environment assessment steps conducted and completed to date.
- **Section 5** lists the documents referenced in this document.

2.6 Terminology

Term	Description
Benefit and Impact Mechanism	A cause-effect description of the impacts of the solution proposed by a project. It describes the positive and the negative impacts that the project solution is expected to provide or demonstrate.
Benefit Diagram	A Benefit and Impact Mechanism is usually shown in a diagram giving an overview of the links between the (new) features that the project is bringing to the world of ATM and indicators (aspects which can be measured or calculated from other metrics), Positive or Negative Impacts for each performance area, and Key Performance Areas (KPAs) or Key Performance Indicators (KPIs). This diagram is supplemented by textual descriptions of the feature, the numbered links and impacts.
Business Case	A Business Case is a tool for decision-makers; it aims to provide them with the information they need to make a fully informed decision on whether funding should be provided and/or whether an investment should proceed. A Business Case is much more than just a financial analysis as it also includes quantitative and qualitative arguments on performance and transversal activities that are key elements to determining the value of the project.
Deployment Scenario	Deployment Scenario consists of a set of SESAR Solutions selected to satisfy the specific performance needs of operating environments in the European ATM System and based upon the timescales in which their performance contribution is needed in the respective operating environments
Environment	Surroundings in which humans interact with the air, water, landscape, natural resources, flora and fauna. In terms of ATM, 'the environment' will be the surroundings in which Air Traffic Management activities are planned or conducted, including research through to development, deployment, and operations.
Environmental Impact	Any modification of the environment that has or could have an effect on the ecosystem. In this document the main environmental impacts of concern are: • Aircraft noise in the vicinity of an airport, • Airport Local Air Quality (mainly CO, NO_x and Particulate Matter), • Global emissions (mainly CO₂) Fuel burnt is also of concern for the environment because of the direct relationship between fuel burnt and CO₂.

Environmental Impact Assessment (EIA)	The process of identifying and evaluating the environmental impacts of projects as well as proposing mitigations to reduce these impacts on the environment. The assessment scope, as it relates to ATM, considers impacts on the environment that can be affected by aircraft operations or that can affect aircraft operations, e.g. through mitigation rules. The main impacts on the environment related to aircraft movements are caused by emissions resulting from fuel burn and noise produced by the engines and airframe.
EIA plan	The Environmental Impact Assessment plan describes the hypothesis to test, metrics to assess, the tools to use, the required input variables for the tools and methodology used for analysing the results.
EUROCONTROL	European Organisation for the Safety of Air Navigation
S3JU Work Programme	The programme which addresses all activities of the SESAR3 Joint Undertaking Agency.
SESAR Programme	The programme that defines the Research and Development activities and Projects for the S3JU.

Table 1: Terminology

2.7 Acronyms

Term	Description
ANSP	Air Navigation Service Provider
ATCO	Air Traffic Controller
ATM	Air Traffic Management
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
DEMOP	DEMOstration Plan
DEMOR	DEMOstration Report
DMAN	Departure MANager
ECAC	European Civil Aviation Conference
EIA	Environmental Impact Assessment
ENV	ENVironment
ENVAR	Environment Assessment Report
FEFF1	Fuel Efficiency average Fuel Flow (1= per flight)
ICAO	International Civil Aviation Organization
IMPACT	EUROCONTROL web portal for the analysis of aircraft noise and emissions
IRSF	Integrated Runway Sequence Function
JU	Joint Undertaking
KPA	Key Performance Area
KPI	Key Performance Indicator
LAQ	Local Air Quality
NO _x	Oxides of Nitrogen, including nitrogen dioxide (NO ₂) and nitrogen oxide (NO).
OSD	Operational Service and Environment Definition
PAR	Performance Assessment Report
PM	Particulate Matter
PU	PUBlic

RNP AR	Required Navigation Performance Authorization Required
RTS	Real Time Simulation
SEL	Sound Exposure Level
SESAR	Single European Sky ATM Research programme
SPR	Safety Performance Requirements
S3JU	SESAR3 Joint Undertaking (Agency of the European Commission)
SORT	SAFELY OPTIMISED RUNWAY THROUGHPUT
SO _x	Oxides of Sulphur
SPR	Safety and Performance Requirements
TS	Technical Specification
VALP	VALidation Plan
VALR	VALidation Report
VLD	Very Large Demonstration
VOC	Volatile organic compounds
WG	Working Group
WP	Work Package

Table 2: Acronyms

3 The Environment Assessment Process: Objective and Approach

The SESAR Environment Assessment Process [3] was derived from the ICAO Guidance document (Doc 10031) [4] “Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes” and adapted to the SESAR validation framework.

As can be seen in on the Figure below, which shows the correspondence between the ICAO assessment process (right-hand side) and the one adopted for SESAR (left-hand side), the resulting process is quite generic and straightforward. Results from the environmental impact assessments can also be used to refine the ATM change, making the process cyclic and compatible with the classic Plan-Do-Check-Act approach to validation.

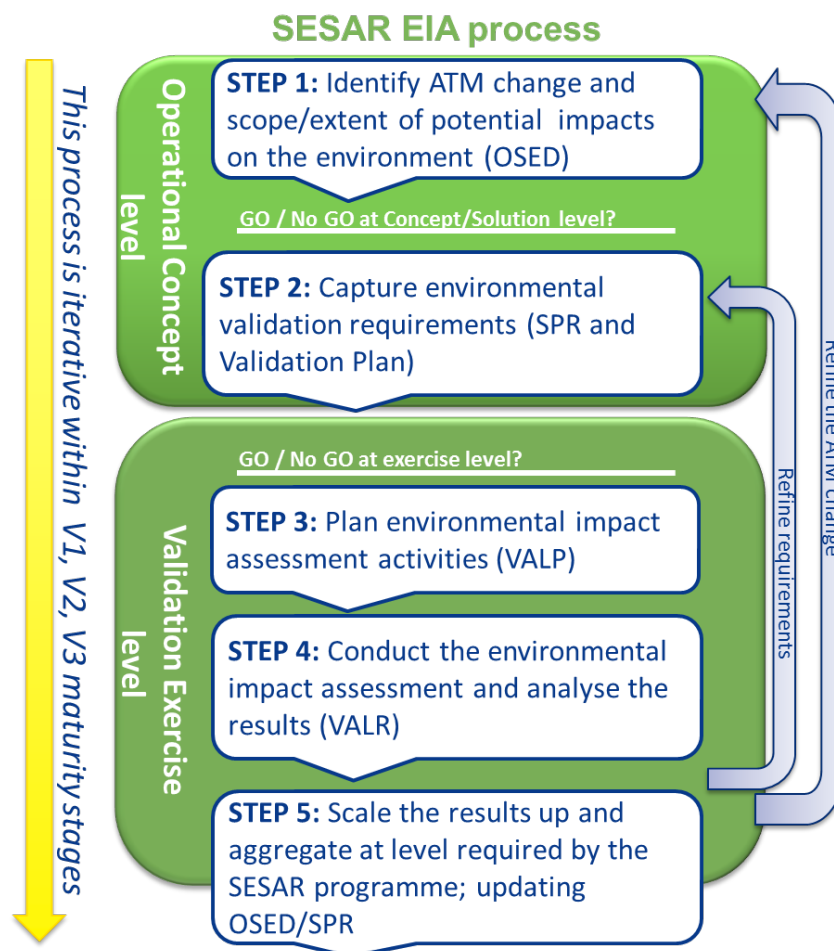


Figure 1: SESAR environmental impact assessment process.

This process should enable environmental impact assessment activities to be easily carried out as part of the overall validation process where necessary.

The SESAR EIA process consists of 5 main steps:

- EIA Step 1: Identify ATM change and the scope of potential impacts on the environment;
- EIA Step 2: Define environmental validation requirements;
- EIA Step 3: Plan environmental impact assessment activities;
- EIA Step 4: Conduct the environmental impact assessment exercise;
- EIA Step 5: Scale the results up and aggregate.

The SESAR EIA process encompasses two "Go-No-Go" decisions about carrying out further environmental impact assessments. The first one occurs after EIA Step 1 in order to identify very early on in the process whether it is worth undertaking an environmental impact assessment or whether or not more assessments are required later on in the process. The second one occurs at the Exercise level and allows the decision on conducting a detailed environmental impact assessment to be taken before the writing of the validation plan for that exercise. This decision will be based on criteria determined by the validation exercise management. In any case, every "Go-No-Go" decision should be included in the validation plan.

Please refer to the SESAR Environment Assessment Process for full guidance [3].

4 Environment Performance Assessment

4.1 Assessment Sources and Summary of Validation Exercise Performance Results

Previous Validation Exercises (pre-SESAR2020 Wave 2, etc.) relevant for this assessment are listed below.

Organisation	Document Title	Publishing Date
PJ02-08 members	PJ02-08 V2 validation exercises (refer to PJ02-08 V2 PAR [7])	12.10.2018
PJ02-08 members	PJ02-08 V3 validation exercises (refer to PJ02-08 V3 PAR [8])	31.01.2020

Table 3: Pre-SESAR2020 Exercises

SESAR Validation Exercises of this Demo (completed ones and planned ones) are listed below.

Exercise ID	Exercise Title	Release	Maturity	Status
EXE.02-08.V2.003	Integrated Runway Sequence function to integrate arrivals and departures on mixed mode parallel runways at Stockholm-Arlanda airport and TMA environment (COOPANS RTS)	R7	V2	Completed
EXE.02-08.V3.002	Integrated Runway Sequence function to integrate arrivals and departures on mixed mode parallel runways at Stockholm-Arlanda airport and TMA environment (COOPANS RTS)	R8	V3	Completed
EXE-VLD-03-004	Demonstration for integrated Runway Sequence function to integrate arrivals and departures on mixed mode parallel runways at Stockholm-Arlanda airport and TMA environment.	R9	V4	Completed

Table 4: SESAR2020 Validation Exercises

V2 validation

Seed traffic sample come from 2012. Sample taken from typical weekday (during the busiest month), during high peak situation. The sample was taken during normal conditions. 5% additional flight inserted in the sample to reflect 2014 traffic level. For 2019 traffic sample the traffic density to be the same as 2014, but increased number of heavy wake vortex category aircraft. Scenarios also contained both consistent good weather as well as degraded conditions.

The results from EXE-06.08.04-VP-357 shows that the average taxi out fuel burn per flights was less in all except one DMAN exercise where the ATCOs strictly followed the DMAN without coordinating with the Tower Supervisor.

The results from EXE-06.08.04-VP-358 shows an indication for slightly lower taxi out times, resulting in lower fuel burn. However, there was only a low number of runs performed.

V3 validation

Traffic scenario was development based on real traffic samples from Stockholm-Arlanda.

The solution has a positive impact on fuel burn and CO₂ emissions, this due to the solution being able to optimize the sequence and thereby lowering the flying time. During the V3 validation the arrival fuel burn was lower compared to the reference scenario while the departure fuel burn was slightly higher compared to the reference scenario, this due to departure taxi gaps being too small making departure of heavy flights hard resulting in longer waiting times and thereby higher fuel burn, see V3 VALR [5] section 4.2.2. The combined figures for arrival and departure fuel burn from the V3 validation shows an overall decrease in fuel burn.

Demonstration

During demonstrations the arrival gaps on final was tuned in IRSF making the departure of heavy flights easier, thereby lowering the overall waiting times and fuel burn.

The solution can avoid noise sensitive areas by landing arriving aircraft on better suitable runways or to make it easier for ATCOs to plan RNP AR to appropriate runway in order to lower the number of flights over noise sensitive areas.

The following table provides a summary of information collected from available performance outcomes.

Exercise	OI Step	Exercise scenario & scope	Performance Results	Notes
V2 exercises	Refer to [8].	Refer to [7].	Refer to [7].	Refer to [7].
V3 exercise	Refer to [8].	Refer to [8].	Refer to [8].	Refer to [8].
VLD-03-004	TS-0301	Real Time Demonstration of Stockholm-Arlanda Airport and TMA environment with focus on Tower and Approach. The	FEFF1 increased CAP3 increased	Demonstration results are based on observations

exercise		objective is to mainly demonstrate the improvements in predictability and punctuality as well as environmental benefits that the solution has.		and debriefs and not on data from the system.
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Table 5: Summary of Validation Results.

4.2 Conditions / Assumptions for Applicability

The solution are expected to be applied in Medium to Very Large Airports with runways operated in mixed mode or having other dependencies between arrivals and departures between the runways. The solution is expected to provide benefits in all conditions but especially when runways are used in mixed mode operations.

The following table 6 summarises the applicable operating environments in accordance with 2019 SESAR 2020 airports classification provided by PJ20 sWP2.2 WG.

OE	Applicable sub-OE	Special characteristics
Airport	Very Large	Multiple runways: EDDF Flughafen Frankfurt/Main EDDM Munich Airport EGKK Gatwick Airport EGLL Heathrow Airport EHAM Amsterdam Airport EKCH Copenhagen Airport LEBL Aeropuerto de Barcelona-El Prat LEMD Aeropuerto de Adolfo Suárez Madrid-Barajas LFPG Aéroport de Paris-Charles de Gaulle LIRF Aeroporto di Roma-Fiumicino LSZH Flughafen Zürich ENGM Oslo-Gardermoen Airport LOWW Vienna International Airport LTBA Atatürk International Airport
	Large	Single runways: EGSS Stansted Airport LSGG Genève Aéroport Multiple runways: LFPO Aéroport de Paris-Orly ESSA Stockholm-Arlanda Airport EBBR Brussels Airport EDDL Düsseldorf International Airport EIDW Dublin Airport LEPA Aeropuerto de Palma de Mallorca

		EGCC Manchester Airport LIMC Milano Malpensa LPPT Lisbon Airport EFHK Helsinki-Vantaa Airport EPWA Warsaw Frederic Chopin Airport LKPR Prague Airport
	Medium	<u>Single runways:</u> EVRA Riga International Airport <u>Multiple runways:</u> LFMN Aéroport Nice Côte d'Azur EDDB Schönefeld Airport LROP Henri Coanda International Airport UKBB Boryspil State International Airport

Table 6: Applicable Operating Environments.

4.3 Environment: Fuel Efficiency / CO2 emissions

To reduce the CO2 emissions from flights, it is necessary to reduce their fuel consumption as every tonne of fuel burned generates 3.15 tonnes of CO2 emissions.

4.3.1 Performance Mechanism

Fuel efficiency benefits due to the application of operational concepts addressed by the solution have been indirectly identified taking into account:

- Reduction in arrival time
- Reduction in departure time

Taxi in time and departure time after take-off are seen to be the same for both reference and solution scenario. It is thereby the arrival flight time and taxi out time where the solution are seen to be able to lower fuel burn and CO2 emissions the most.

4.3.2 Assessment Data (Exercises and Expectations)

Fuel efficiency and CO2 emission benefits of the solution are analysed using results from demonstration and compared with earlier results from validations.

Exercise ID or Expert judgement	Benefits contribution to FEFF1	Benefits contribution to ENV1
EXE-06.08.04-VP-357	Lowering fuel consumption for flights during taxi out.	Lowering CO2 emissions for flights during taxi out.
EXE-06.08.04-VP-358	Lowering fuel consumption for flights during taxi out.	Lowering CO2 emissions for flights during taxi out.
EXE.02-08.V3.002	Lowering fuel consumption for flights during both arrivals and departures.	Lowering CO2 emissions for flights during both arrivals and departures.

Table 7: Fuel burn and CO2 emissions saving per Exercise

OI step	Relative benefits contribution to FEFF1	Relative benefits contribution to ENV1
TS-0203	N/A	N/A
TS-0309	N/A	N/A
TS-0301	N/A	N/A
TS-0313	N/A	N/A
TOTAL	N/A	N/A

Table 8: Fuel burn and CO2 emissions saving relative benefit per OI step

4.3.2.1 Assumptions

Assumptions are the same as in PJ02.08 V3 validations, see list below:

- Fuel burn rate Departure/Taxi (see [Ref – Assumptions for Performance Aggregation – CPA 2018]) = 900 kg/h = 15 kg/min

- Fuel burn rate Arrival (see [Ref – Assumptions for Performance Aggregation – CPA 2018]) = 500 kg/h = 8.3 kg/min
- CO₂/Fuel ratio = 3.15
- Average fuel burn per flight = 4800 kg
- Share of ECAC traffic to which the Integrated Runway Sequence function (TS-0301) applies: 45.3%.

4.3.3 Extrapolation to ECAC wide

Values seen in table 9 are only based on savings with focus on arrival time.

KPIs / PIs	Unit	Calculation	Mandatory	Absolute expected performance benefit in SESAR2020	% expected performance benefit in SESAR2020
FEFF1 Actual Average fuel burn per flight	Kg fuel per movement	Total amount of actual fuel burn divided by the number of movements	YES	3.8 kg/flight	0.078%
ENV1 Actual Average CO ₂ Emission per flight	Kg CO ₂ per flight	Amount of fuel burnt x 3.15 (CO ₂ emission index) divided by the number of flights	YES	11.8 kg/flight	0.078%

Table 9: Fuel burn and CO₂ emissions saving for Mandatory KPIs / PIs

Table 10 is showing the average fuel burn per phase of flight based on results from the demonstration.

	Taxi out	TMA departure	En-route	TMA arrival	Taxi in
FEFF1 Actual Average fuel burn per flight	No data from demonstration	Same as reference scenario	Not to be covered	8.5 kg/flight	Same as reference scenario
ENV1 Actual Average CO ₂ Emission per flight	No data from demonstration	Same as reference scenario	Not to be covered	26.15 kg/flight	Same as reference scenario

Table 10: Average fuel burn and fuel burn savings per phase of flight.

4.3.4 Discussion of Assessment Result

Results for fuel burn and CO₂ emissions are based on the time improvements. It is important to notice that the system has not been logging data during demonstration, the values are based on limited number of observations as the system was never run in Fast Time Simulation. Fuel efficiency and CO₂ emissions for taxi out could not be gathered as no taxi-out times could be gathered, see section 4.9 in this document. However, observations shows that the solution held flights at gate compared to the

real data where flights instead were put on hold during taxi. This shows that the solution would lower the fuel burn and CO₂ emissions for taxi out as engines was not started until needed for taxi with as little stops as possible. The taxi in and departure fuel burn and CO₂ emissions are seen as the same as the reference scenario.

The overall results from the demonstration are in line with the results from the V3 validation. This indicates that the results from the V3 validation can be trusted.

4.3.5 Additional Comments and Notes

No additional comments

4.4 Environment: Noise, Local Air Quality, and non-CO2 Emissions

The noise focus area only covers aircraft noise source; other noise sources around the airport contributing to the background noise are not considered. This KPA focuses on the quantification of the number of people exposed to aircraft noise, using different types of metrics, capturing different aspects of noise impact such as the notion of noise exposure (noise energy perceived on the ground), peaks in noise levels (maximum noise level perceived on the ground), and the frequency of “noisy” events (number of flights/operations exceeding a given noise level threshold during a certain time period).

Airport local air quality is a commonly used term to designate the condition of the ambient air to which humans and nature are typically exposed in the vicinity of an airport. In most cases, determining the quality of the air around an airport is based on an estimation of the concentration of pollutants. These concentrations are compared with regulations and standards that are established to define acceptable levels of local air quality, including the necessary measures to achieve them. Many issues particular to the local air quality in and around airports are subject to these same regulations. Normally, airport environments comprise a complex mix of emission sources including aircraft, ground support equipment, terminal buildings and ground vehicular traffic (see ICAO Doc 9889). In the context of SESAR, in most cases only exhaust emissions resulting from jet-fuel consumption can be estimated and only these are considered therefore.

Aviation emissions are not limited to CO₂, which is the biggest Green House Gas resulting from the combustion of fuel, there are also a large range of non-CO₂ emissions, which might have a significant contribution to climate change.

Although no performance targets have been defined for these environmental aspects, they need to be reported to help figure out the overall environmental impact of the deployment of the Solution.

Extrapolation at the ECAC level is not provided for noise and local air quality, and not required for non-CO₂ emissions.

The solution can avoid noise sensitive areas by landing arriving aircraft on better suitable runways or to make it easier for ATCOs to plan RNP AR to appropriate runway in order to lower the number of flights over noise sensitive areas.

4.4.1 Performance Mechanism

No benefit mechanism for lowering number of flights flying over noise sensitive areas.

4.4.2 Assessment Data (Exercises and Expectations)

Observations during the demonstrations has been performed in order to understand if the number of flights can be lowered over noise sensitive areas. No data from demonstration has been collected and no calculations such as noise contour has been performed. The observations mainly focus on understanding if ATCOs can lower number of flights over noise sensitive areas with the help of the solution. This is mainly done by ATCOs choosing to land arrival flights on the departure runway or using an RNP AR approach. This makes it ideal to use observations in order to collect information regarding lowering number of flights over noise sensitive areas.

Exercise ID or Expert judgement	Benefits contribution to NOI1	Benefits contribution to NOI2	Benefits contribution to NOI4	Benefits contribution to LAQ1
EXE.02-08.V3.002	Not covered	Not covered	Lowering number of people affected by arriving or departing flights.	Not covered

Table 11: Noise and Local Air Quality benefits per Exercise

OI step	Relative benefits contribution to NOI1	Relative benefits contribution to NOI2	Relative benefits contribution to NOI4	Relative benefits contribution to LAQ1
TS-0301	Not covered	Not covered	N/A	Not covered
TS-0313	Not covered	Not covered	N/A	Not covered
TOTAL	Not covered	Not covered	N/A	Not covered

Table 12: Noise and Local Air Quality relative benefit per OI step

PIs	Unit	Calculation	Mandatory	Absolute expected performance benefit in SESAR2020	% expected performance benefit in SESAR2020
NOI1 Relative noise scale	-2 to +2	It is a qualitative scale based on expert judgment. -2 very negative effect or benefit, 0 neutral and +2 very positive effects or benefit. The objective of this metric is to provide a global assessment of the noise impact. This metric is built upon the other quantitative noise PIs (NOI2, NOI3, NOI4, NOI5)	YES for Airport OE Solutions	No data from demonstrations	No data from demonstrations
NOI2 Size and location of noise contours	Contours of noise level thresholds (e.g. LDEN 55 see ERM document for the list of recommended PIs). Surface of these contours(Km ²)	Noise contours to be calculated according to the ECAC Doc.29 methodology. Surface of the noise contours calculated using a GIS tool or modules. Suggest the use of IMPACT tool.	YES for Airport OE Solutions	No data from demonstrations	No data from demonstrations
(NOI4) Number of people exposed to noise levels exceeding a given threshold	Number of people inside noise contours.	Population count inside the contours calculated above. Need the availability of population census data. Calculated using a GIS tool or modules. IMPACT tool includes this functionality, using the EEA population database.	YES for Airport OE Solutions	No data from demonstrations	No data from demonstrations

PIs	Unit	Calculation	Mandatory	Absolute expected performance benefit in SESAR2020	% expected performance benefit in SESAR2020
LAQ1 Geographic distribution of pollutant concentrations	Airport Local Air Quality (ALAQS) Studies inventory method generally uses mg/m ³ for each pollutant	Measurement to be performed within LTO cycle. • NOx: Nitrogen oxides, including nitrogen dioxide (NO₂) and nitrogen oxide (NO); • VOC: Volatile organic compounds (including non-methane hydrocarbons (NMHC)); • CO: Carbon monoxide; • PM: Particulate matter (fraction size PM_{2.5} and PM₁₀); • SOx: Sulphur oxides. • Recommended tools: Open-ALAQS	YES for Airport OE Solutions relative to LTO (=>below 3000ft)	No data from demonstrations	No data from demonstrations

Table 13: Noise and Local Air Quality benefit for Mandatory PIs

4.4.3 Extrapolation to ECAC wide

There is no ECAC wide extrapolation required for this KPI.

4.4.4 Discussion of Assessment Result

The main result from demonstrations is that the solution allows ATCOs to, in an easier way, reduce flights over noise sensitive areas. No data from the simulator has been gathered, instead observations has been performed in order to see the potential of reducing noise with the help of the solution. The observations shows that the solution is able to lower number of flights over noise sensitive areas and reduce the size of the noise contour as the number of flights managed by radar vectoring can be reduced.

4.4.5 Additional Comments and Notes

No additional comments

4.5 Overall conclusion on the environmental impact of the Solution

The solution is able to lower fuel consumption and CO₂ emissions while also lowering number of flights over noise sensitive areas. This is all done by improving planning and sequences for arriving and departing flights, giving the ATCOs more information that improves punctuality and predictability.

5 References

- [1] SESAR Performance Framework (2019), Edition 01.00.01, Dec 2019.
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